

PROJECT MANUAL

Sonora High School Science Lab Modernization

401 S Palm St. La Habra, CA 90631
DSA Back Check

1/27/2026

LPA Project No.: C33023



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FOR BID ONLY NOT FOR CONSTRUCTION

**SECTION 000105
CERTIFICATIONS PAGE**

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SECTION 024100 DEMOLITION

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Selective demolition of built site elements.
- B. Selective demolition of building elements for alteration purposes.

1.02 RELATED REQUIREMENTS

- A. Section 011000 - Summary: Limitations on Contractor's use of site and premises.
- B. Section 015000 - Temporary Facilities and Controls: Site fences, security, protective barriers, and waste removal.
- C. Section 01 6000 - Product Requirements: Handling and storage of items removed for salvage and relocation.
- D. Section 01 7000 - Execution and Closeout Requirements: Project conditions; protection of bench marks, survey control points, and existing construction to remain; reinstallation of removed products; temporary bracing and shoring.
- E. Section 01 7419 - Construction Waste Management and Disposal: Limitations on disposal of removed materials; requirements for recycling.

1.03 DEFINITIONS

- A. Demolish: Dismantle, raze, destroy, or wreck any building or structure or any part thereof.
- B. Remove: Detach or dismantle items from existing construction and dispose of them off site, unless items are indicated to be salvaged or reinstalled.
- C. Remove and Salvage: Detach or dismantle items from existing construction in a manner to prevent damage. Clean, package, label and deliver salvaged items to Owner in ready-for-reuse condition.
- D. Remove and Reinstall: Detach or dismantle items from existing construction in a manner to prevent damage. Clean and prepare for reuse and reinstall where indicated.
- E. Existing to Remain: Designation for existing items that are not to be removed and that are not otherwise indicated to be salvaged or reinstalled.

1.04 REFERENCE STANDARDS

- A. 29 CFR 1926 - Safety and Health Regulations for Construction; Current Edition.
- B. NFPA 241 - Standard for Safeguarding Construction, Alteration, and Demolition Operations; 2022, with Errata (2021).

1.05 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Site Plan: Indicate:
 - 1. Vegetation to be protected.
 - 2. Areas for temporary construction and field offices.

3. Areas for temporary and permanent placement of removed materials.
- C. Demolition Plan: Submit demolition plan as required by OSHA and local AHJs.
 1. Indicate extent of demolition, removal sequencing, bracing and shoring, and location and construction of barricades and fences.
 2. Summary of safety procedures.
 3. Demolition firm qualifications.
- D. Project Record Documents: Accurately record actual locations of capped and active utilities and subsurface construction.

PART 2 PRODUCTS -- NOT USED

PART 3 EXECUTION

3.01 DEMOLITION

- A. Remove paving and curbs required to accomplish new work.
- B. Remove portions of concrete slabs on grade as indicated on drawings.
- C. Remove other items indicated, for salvage, relocation, and recycling.
- D. Fill excavations, open pits, and holes in ground areas generated as result of removals, using specified fill.

3.02 GENERAL PROCEDURES AND PROJECT CONDITIONS

- A. Comply with requirements in Section 01 7000 - Execution and Closeout Requirements.
- B. Comply with applicable codes and regulations for demolition operations and safety of adjacent structures and the public.
 1. Obtain required permits.
 2. Take precautions to prevent catastrophic or uncontrolled collapse of structures to be removed; do not allow worker or public access within range of potential collapse of unstable structures.
 3. Provide, erect, and maintain temporary barriers and security devices.
 4. Conduct operations to minimize effects on and interference with adjacent structures and occupants.
 5. Do not close or obstruct roadways or sidewalks without permits from authority having jurisdiction.
 6. Conduct operations to minimize obstruction of public and private entrances and exits. Do not obstruct required exits at any time. Protect persons using entrances and exits from removal operations.
 7. Obtain written permission from owners of adjacent properties when demolition equipment will traverse, infringe upon, or limit access to their property.
- C. Do not begin removal until receipt of notification to proceed from Owner.
- D. Do not begin removal until built elements to be salvaged or relocated have been removed.
- E. Protect existing structures and other elements to remain in place and not removed.
 1. Provide bracing and shoring.
 2. Prevent movement or settlement of adjacent structures.
 3. Stop work immediately if adjacent structures appear to be in danger.
- F. Partial Removal of Paving and Curbs: Neatly saw cut at right angle to surface.

3.03 EXISTING UTILITIES

- A. Coordinate work with utility companies. Notify utilities before starting work, comply with their requirements, and obtain required permits.
- B. Protect existing utilities to remain from damage.
- C. Do not disrupt public utilities without permit from authority having jurisdiction.
- D. Do not close, shut off, or disrupt existing life safety systems that are in use without at least 7 days prior written notification to Owner.
- E. Do not close, shut off, or disrupt existing utility branches or take-offs that are in use without at least 3 days prior written notification to Owner.
- F. Locate and mark utilities to remain; mark using highly visible tags or flags, with identification of utility type; protect from damage due to subsequent construction, using substantial barricades if necessary.
- G. Remove exposed piping, valves, meters, equipment, supports, and foundations of disconnected and abandoned utilities.

3.04 SELECTIVE DEMOLITION FOR ALTERATIONS

- A. Existing construction and utilities indicated on drawings are based on casual field observation and existing record documents only.
 - 1. Verify construction and utility arrangements are as indicated.
 - 2. Report discrepancies to Architect before disturbing existing installation.
 - 3. Beginning of demolition work constitutes acceptance of existing conditions that would be apparent upon examination prior to starting demolition.
- B. Maintain weatherproof exterior building enclosure, except for interruptions required for replacement or modifications; prevent water and humidity damage.
- C. Remove existing work as indicated and required to accomplish new work.
 - 1. Remove rotted wood, corroded metals, and deteriorated masonry and concrete; replace with new construction indicated.
 - 2. Remove items indicated on drawings.
- D. Services including, but not limited to, HVAC, Plumbing, Fire Protection, Electrical, and Telecommunications: Remove existing systems and equipment as indicated.
 - 1. Maintain existing active systems to remain in operation, and maintain access to equipment and operational components.
 - 2. Where existing active systems serve occupied facilities but are to be replaced with new services, maintain existing systems in service until new systems are complete and ready for service.
 - 3. Verify that abandoned services serve only abandoned facilities before removal.
 - 4. Remove abandoned pipe, ducts, conduits, and equipment, including those above accessible ceilings. Remove back to source of supply where possible, otherwise cap stub and tag with identification.
- E. Protect existing work to remain.
 - 1. Prevent movement of structure. Provide shoring and bracing as required.
 - 2. Perform cutting to accomplish removal work neatly and as specified for cutting new work.
 - 3. Repair adjacent construction and finishes damaged during removal work.
 - 4. Patch to match new work.

3.05 DEBRIS AND WASTE REMOVAL

- A. Comply with Section 01 7419 - Construction Waste Management and Disposal.

- B. Remove debris, junk, and trash from site.
- C. Remove materials not to be reused on site.
- D. Leave site in clean condition, ready for subsequent work.
- E. Clean up spillage and wind-blown debris from public and private lands.

END OF SECTION

**SECTION 031000
CONCRETE FORMING AND ACCESSORIES**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Formwork for cast-in place concrete, with shoring, bracing and anchorage.
- B. Openings for other work.
- C. Form accessories.
- D. Form stripping.

1.02 RELATED REQUIREMENTS

- A. Section 032000 - Concrete Reinforcing.
- B. Section 033000 - Cast-in-Place Concrete.
- C. Section 051200 - Structural Steel Framing: Placement of embedded steel anchors and plates in cast-in-place concrete.

1.03 REFERENCE STANDARDS

- A. The applicable version of the standards listed below shall be per Chapter 35 of Part 2 of the 2022 edition of the California Building Code (CBC), including addendums and errata. Where the standard is not listed, then the most current version of the standard shall be used or as referenced by other standards.
 - 1. ACI 117 - Standard Specifications for Tolerances for Concrete Construction and Materials.
 - 2. ACI 301 - Specifications for Structural Concrete.
 - 3. ACI 303R – Guide to Cast-in-Place Architectural Concrete for Buildings.
 - 4. ACI 318 - Building Code Requirements for Structural Concrete.
 - 5. ACI 347R - Guide to Formwork for Concrete.
 - 6. ASME A17.1 - Safety Code for Elevators and Escalators.
 - 7. ASTM D1621 – Test Method for Compressive Properties of Rigid Cellular Plastics.
 - 8. ASTM D1622 – Standard Test Method for Apparent Density of Rigid Cellular Plastics
 - 9. ASTM D6817/D6817M – Standard Specification for Rigid Cellular Polystyrene Geofoam
 - 10. U.S. Department of Commerce Product Standard:
 - a. PS 1 - Structural Plywood.
 - 11. West Coast Lumber Inspection Bureau (WCLIB):
 - a. Grading and Dressing Rules No. 17
 - 12. United States Green Building Council (USGBC):
 - a. Leadership in Energy and Environmental Design (LEED):
 - b. Green Building Rating System.

1.04 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data on void form materials and installation requirements.
- C. Shop Drawings: Indicate pertinent dimensions, materials, bracing, and arrangement of joints and ties.

1. Indicate location of form ties on exposed concrete walls.
 2. Include locations and placement of steel embeds.
 3. Indicate proposed locations of constructions joint.
- D. Shoring and Reshoring:
1. Submit for records proposed design of shoring, schedule and sequencing of shoring installation and removal, and installing and removing reshoring.
- E. Designer's Qualification Statement.
- F. Design Data: As required by authorities having jurisdiction.

1.05 QUALITY ASSURANCE

- A. Designer Qualifications: Design formwork under direct supervision of a Professional Civil or Structural Engineer experienced in design of concrete formwork and licensed in the State in which the Project is located.
- B. Neither the Architect nor the Architect's consultants have been retained to design formwork, nor to determine the means and methods by which such operations are accomplished.
- C. Prior to erecting formwork, coordinate locations of plumbing, mechanical, and electrical blockouts in concrete slabs.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Deliver prefabricated forms and installation instructions in manufacturer's packaging.
- B. Store prefabricated forms off ground in ventilated and protected manner to prevent deterioration from moisture.
- C. Protect plastic foam products from damage and exposure to sunlight.

PART 2 PRODUCTS

2.01 FORMWORK - GENERAL

- A. Provide concrete forms, accessories, shoring, and bracing as required to accomplish cast-in-place concrete work.
- B. Design and construct concrete forms that complies with design with respect to shape, lines, and dimensions.
- C. Limit deflections to 1/8" between supports after placement of concrete.
- D. Comply with applicable state and local codes with respect to design, fabrication, erection, and removal of formwork.
- E. Formwork design shall comply with ACI 347R, ACI 301, and ACI 318.
 1. Design shall be based on calculations prepared by a licensed engineer in the State in which the Project is located.
- F. Erect formwork in a manner that will ensure the safety of construction personnel and the public.

2.02 WOOD FORM MATERIALS

- A. Plywood: PS 1, Grade B-B, Class I.
 1. Douglas Fir species; solid one side grade; sound undamaged sheets with clean, true edges.
- B. Lumber: Douglas species; structural grade; with grade stamp clearly visible.

2.03 METAL FORM MATERIALS

- A. Metal: Min 16 ga sheet steel, tight fitting, and stiffened to support weight of concrete such that tolerances are maintained.
- B. Metal Deck Forms: Metal deck as specified in Contract Drawings.

2.04 FORMWORK ACCESSORIES

- A. Form Ties: Removable or snap-off type, galvanized metal or glass-fiber-reinforced plastic, fixed length, with waterproofing washer, free of defects that could leave holes larger than 1 inch in concrete surface.
 - 1. Ties should leave no corrodible metal closer than 1 inch to exposed concrete surface.
 - 2. Ties shall be designed to resist lateral pressure of concrete on forms and prevent spalling of concrete on removal.
- B. Form Release Agent: Capable of releasing forms from hardened concrete without staining or discoloring concrete or forming bugholes and other surface defects, compatible with concrete and form materials, and not requiring removal for satisfactory bonding of coatings to be applied.
 - 1. Composition: Colorless reactive, mineral oil-based, soy-based, or vegetable-oil based compound.
 - 2. VOC Content: In compliance with applicable local, State, and federal regulations.
 - 3. Products:
 - a. SpecChem, LLC; Bio Strip WB (water-based): www.specchemllc.com/#sle.
 - b. W. R. Meadows, Inc; Duogard: www.wrmeadows.com/#sle.
 - c. Substitutions: See Section 016000 - Product Requirements.
- C. Dowel Sleeves: Plastic sleeve and nailable plastic base for smooth, round, steel load-transfer dowels.
- D. Filler Strips for Chamfered Corners: Rigid plastic or wood type; size per contract drawings; maximum possible lengths.
- E. Flashing Reglets: Galvanized steel, at least 22 gage, 0.0299 inch thick, longest possible lengths, with alignment splines for joints, foam filled, release tape sealed slots, anchors for securing to concrete formwork.
- F. Nails, Spikes, Lag Bolts, Through Bolts, Anchorages: Sized as required, of sufficient strength and character to maintain formwork in place while placing concrete.
- G. Embedded Anchor Shapes, Plates, Angles and Bars: As specified in Section 051200.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify lines, levels and centers before proceeding with formwork. Ensure that dimensions agree with drawings.

3.02 EARTH FORMS

- A. Earth Forms may be used if compacted fill or natural soil can be accurately cut and maintained.
- B. Hand trim sides and bottom of earth forms. Remove loose soil prior to placing concrete.

3.03 ERECTION - FORMWORK

- A. Erect formwork, shoring and bracing to achieve design requirements, in accordance with requirements of ACI 301.

- B. Provide bracing to ensure stability of formwork. Shore or strengthen formwork subject to overstressing by construction loads.
- C. Arrange and assemble formwork to permit dismantling and stripping. Do not damage concrete during stripping. Permit removal of remaining principal shores.
- D. Align joints and make watertight. Keep form joints to a minimum.
- E. Obtain approval before framing openings in structural members that are not indicated on drawings.
- F. Coordinate this section with other sections of work that require attachment of components to formwork.
- G. If formwork is placed after reinforcement, resulting in insufficient concrete cover over reinforcement, request instructions from Architect before proceeding.

3.04 APPLICATION - FORM RELEASE AGENT

- A. Apply form release agent on formwork in accordance with manufacturer's recommendations.
- B. Apply non-staining, rust-preventative form oil or other means of protection against rusting to steel forms.
 - 1. Rust-stained steel formwork is not acceptable for use.
- C. Apply prior to placement of reinforcing steel, anchoring devices, and embedded items.
- D. Do not apply form release agent where concrete surfaces will receive special finishes or applied coverings that are affected by agent. Soak inside surfaces of untreated forms with clean water. Keep surfaces coated prior to placement of concrete.

3.05 INSERTS, EMBEDDED PARTS, AND OPENINGS

- A. Provide formed openings where required for items to be embedded in passing through concrete work.
- B. Locate and set in place items that will be cast directly into concrete.
- C. Coordinate with work of other sections in forming and placing openings, slots, reglets, recesses, sleeves, bolts, anchors, other inserts, and components of other work.
- D. Install accessories in accordance with manufacturer's instructions, so they are straight, level, and plumb. Ensure items are not disturbed during concrete placement.
- E. Install waterstops in accordance with manufacturer's instructions, so they are continuous without displacing reinforcement. Heat seal joints so they are watertight.
- F. Provide temporary ports or openings in formwork where required to facilitate cleaning and inspection. Locate openings at bottom of forms to allow flushing water to drain.
- G. Close temporary openings with tight fitting panels, flush with inside face of forms, and neatly fitted so joints will not be apparent in exposed concrete surfaces.

3.06 FORM CLEANING

- A. Clean forms as erection proceeds, to remove foreign matter within forms.
- B. Clean formed cavities of debris prior to placing concrete.

3.07 FORMWORK TOLERANCES

- A. Construct formwork to maintain tolerances required by ACI 117, unless otherwise indicated.
- B. Construct and align formwork for elevator hoistway in accordance with ASME A17.1.

3.08 FIELD QUALITY CONTROL

- A. An independent testing agency will perform field quality control tests, as specified in Section 014000 - Quality Requirements.
- B. Inspect erected formwork, shoring, and bracing to ensure that work is in accordance with formwork design, and to verify that supports, fastenings, wedges, ties, and items are secure.
- C. Do not reuse formwork without Architect's approval. When approved, do not reuse wood formwork more than 2 times for concrete surfaces to be exposed to view. Do not patch formwork.
 - 1. Reused formwork shall meet appearance requirements of new formwork.
 - 2. Reused formwork shall be free of splaying, fraying, delamination or other damage.
 - 3. Follow all requirements as for new formwork.

3.09 FORM REMOVAL

- A. Do not remove forms or bracing until concrete has gained sufficient strength to carry its own weight and imposed loads.
- B. Formwork not supporting weight of concrete, such as sides of beams, walls, columns, and similar parts of the work, may be removed after curing at not less than 50 degrees F for 72 hours after placing concrete, provided concrete is sufficiently hard to not be damaged by form removal operations, and provided curing and protection operations are maintained.
- C. Formwork supporting weight of concrete, such as beam soffits, joists, slabs, and other structural elements may not be removed until concrete has attained 28-day minimum design compressive strength, but in no case less than 21 days for standard reinforced concrete and 7 days for post-tensioned concrete. Determine potential compressive strength of in- place concrete by testing representative field-cured concrete specimens of concrete in question.
- D. Form facing material may be removed 7 days after placement only if shores and other vertical supports have been arranged to permit removal of form facing material without loosening or disturbing shores and supports.
- E. Loosen forms carefully. Do not wedge pry bars, hammers, or tools against finish concrete surfaces scheduled for exposure to view.
- F. Store removed forms to prevent damage to form materials or to fresh concrete. Discard damaged forms.
- G. If accelerated form removal is desired, submit methods to Architect for review. Review by Architect does not alleviate contractor of responsibility for means and methods of construction and protection of structure during construction.
- H. Reshore members as required in section below.

3.10 RESHORING

- A. Shoring and reshoring shall conform to the requirements of ACI 347.
- B. Extend shoring and reshoring over a sufficient number of stories to distribute loads in such a manner that no floor or member will be excessively loaded or will induce tensile stress in concrete.
- C. Plan and sequence removal of shores and reshore to avoid damage to concrete. Provide adequate reshoring to support construction without excessive stress or deflection.
- D. Shores shall not be removed prior to concrete achieving 28 day strengths.

- E. While reshoring operations are under way, no construction loads shall be permitted on the new construction.

END OF SECTION

**SECTION 032000
CONCRETE REINFORCING**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Reinforcing steel for cast-in-place concrete.
- B. Supports and accessories for steel reinforcement.
- C. Reinforcing steel for masonry work.

1.02 RELATED REQUIREMENTS

- A. Section 014113.11 - Regulatory Requirements - Global Warming Potential (GWP)
- B. Section 031000 - Concrete Forming and Accessories.
- C. Section 033000 - Cast-in-Place Concrete.

1.03 REFERENCE STANDARDS

- A. The applicable version of the standards listed below shall be per Chapter 35 of Part 2 of the 2022 edition of the California Building Code (CBC), including addendums and errata. Where the standard is not listed, then the most current version of the standard shall be used or as referenced by other standards.
 - 1. ACI 301 - Specifications for Concrete Construction.
 - 2. ACI 315 – Details and Detailing of Concrete Reinforcement.
 - 3. ACI 318 - Building Code Requirements for Structural Concrete and Commentary.
 - 4. ACI MNL-66 - ACI Detailing Manual.
 - 5. ASTM A184/A184M - Standard Specification for Welded Deformed Steel Bar Mats for Concrete Reinforcement.
 - 6. ASTM A615/A615M - Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
 - 7. ASTM A706/A706M - Standard Specification for Deformed and Plain Low-Alloy Steel Bars for Concrete Reinforcement.
 - 8. ASTM A884/A884M - Standard Specification for Epoxy-Coated Steel Wire and Welded Wire Reinforcement.
 - 9. ASTM A1064/A1064M - Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.
 - 10. AWS A2.4 - Standard Symbols for Welding, Brazing, and Nondestructive Examination
 - 11. AWS A5.1 – Specification for Carbon Steel Electrodes for Shielded Metal Arc Welding
 - 12. AWS A5.5 – Specification for Low-Alloy Steel Electrodes for Shielded Metal Arc Welding
 - 13. AWS D1.1/D1.1M – Structural Welding Code – Steel.
 - 14. AWS D1.4/D1.4M - Structural Welding Code - Steel Reinforcing Bars.
 - 15. AWS D1.8/D1.8M - Structural Welding Code - Seismic Supplement.
 - 16. CRSI (DA4) - Manual of Standard Practice.
 - 17. CRSI (P1) - Placing Reinforcing Bars.
- B. California Code of Regulations (CCR):
 - 1. CBSC, Title 24, Part 2- California Building Code (CBC), 2022 edition.
 - a. Chapter 17A - Structural Tests and Inspections

- b. Chapter 19A - Concrete
- 2. CBSC, Title 24, Part 11 - California Green Building Standards Code (CALGreen)
 - a. Supplement 1, July 2024
- C. US Army Corps of Engineers (USACE)
 - 1. CW03210: Civil Works Construction Guide Specifications for Steel Bars, Welded Wire Fabric and Accessories for Concrete Reinforcement
- D. United States Green Building Council (USGBC):
 - 1. Leadership in Energy and Environmental Design (LEED):
 - 2. Green Building Rating System.

1.04 GENERAL

- A. Coordination: Refer to Section 017419 - Construction Waste Management and Disposal regarding procedures for implementing construction waste management requirements.
- B. Coordination: Coordinate Work specified in this Section with other Sections which require placement of embedded products and provision of openings and recesses. If formwork is placed after reinforcing, resulting in insufficient concrete cover over reinforcing, request instructions from Architect (Structural Engineer) before proceeding.
- C. Refer to Section 013000 - Administrative Requirements for RFI requirements.

1.05 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Reinforcing Shop Drawings:
 - 1. Prepare Shop Drawings in accordance with the applicable requirements of ACI 318 and the CRSI Manual.
 - 2. Provide scaled, dimensioned reinforcing plans for each floor level indicating size and spacing of reinforcing. Coordinate additional bars with locations of slab openings, penetrations, depressions and steps. Shop drawing shall be coordinated with concrete shop drawings. Ensure penetrations from affected trades for utilities are coordinated.
 - 3. Provide scaled, dimensioned reinforcing elevations for each wall line indicating size and spacing of reinforcing. Coordinate additional bars with locations of openings, penetrations, and recesses. Shop drawing shall be coordinated with concrete shop drawings. Ensure penetrations from affected trades for utilities are coordinated.
 - 4. Indicate welds in accordance with AWS D1.4/D1.4M and AWS A2.4.
 - 5. Indicate type of corrosion resistant reinforcing proposed and locations, if applicable.
 - 6. Include bar schedules, shapes of bent bars, spacing of bars, and location of splices.
- C. Test Reports: Submit certified laboratory test reports confirming physical characteristics of materials used in the performance of the work of this Section.
 - 1. Where reinforcing is subject to welding, submit carbon equivalent determination reports in accordance with requirements of Source Quality Control.
- D. Certificates: Submit copies of steel producer's certificates of mill analysis, tensile, and bend tests for reinforcing steel. Transmit copy to installer for welded splices.
- E. Manufacturer's Certificate: Certify that reinforcing steel and accessories supplied for this project meet or exceed specified requirements.
- F. Sustainable Design Submittals:
 - 1. Type III factory-specific or product-specific environmental product declarations (EPD) for each grade of reinforcement proposed for the project.

1.06 QUALITY ASSURANCE

- A. Perform work of this section in accordance with ACI 318, ACI 301, CRSI and CBC Chapter 19.
- B. Fabricator's Qualifications:
 - 1. When required, show evidence of approval by governmental agencies having jurisdiction.
- C. Welding of reinforcing shall be in conformance with AWS D1.1/D1.1M, AWS D1.4/D1.4M, AWS D1.8/D1.8M, CBC Chapter 19, and CBC Chapter 19A.
- D. Qualification of Welds, Welding operators, and welders:
 - 1. Comply with applicable building code standard. Perform welding procedure qualification, except for prequalified procedures, as required by AWS D1.4/D1.4M, prior to executing any welding of reinforcing steel.
 - 2. Only AWS Certified Welding Inspectors shall be used for tests and qualifications associated with welding of reinforcing steel.
 - 3. Only AWS qualified welders or welding operators shall perform welding of reinforcing steel.
 - 4. Welders' Certificates: Submit certifications for welders employed on the project, verifying AWS qualification within the previous 12 months and in accordance with AWS D1.4/D1.4M.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, and handle steel reinforcement to prevent bending and damage. Deliver reinforcing materials bundled and with identifying labels or tags affixed and legible.
 - 1. Bundle reinforcing, tag with identification, and transport and store so as not to damage any material. Use metal tags indicating size, length and other marking shown on placement drawings. Maintain tags after bundles are broken.
- B. The Inspector and/or Architect reserves the right to observe deliveries, to review bills of lading, and to reject the following:
 - 1. Reinforcing not accompanied by required mill certificates.
 - 2. Reinforcing exhibiting rusting or other contamination which might prohibit or inhibit bonding of concrete.
- C. Store materials off ground and under cover.
 - 1. Store reinforcement to avoid excessive rusting or fouling with grease, oil, dirt or other bond-weakening contaminants.
 - 2. Store welding electrodes in accordance with AWS standards.

PART 2 PRODUCTS

2.01 REINFORCEMENT

- A. Provide deformed-type reinforcing conforming to ASTM Standards and material Grades as noted on Structural Contract Drawings.
 - 1. When welding is indicated, provide reinforcing conforming to the requirements of ASTM A 706, Grade 60.
- B. Steel Welded Wire Reinforcement (WWR): Plain type; ASTM A1064/A1064M.
 - 1. Form: Flat Sheets.
 - 2. WWR Style: As indicated on drawings.
- C. Global Warming Potential (GWP) Limit: as indicated on the drawings.
- D. Reinforcement Accessories:
 - 1. Tie Wire: Annealed, minimum 16 gage, 0.0508 inch, conforming to ASTM A1064/A1064M , Grade 60.

2. Chairs, Bolsters, Bar Supports, Spacers: Sized and shaped for adequate support of reinforcement during concrete placement.
3. Provide stainless steel components for placement within 1-1/2 inches of weathering surfaces.

2.02 MECHANICAL REBAR SPLICING:

- A. Coupler Systems: For use where indicated on drawings, mechanical devices for splicing reinforcing bars; designed to develop minimum $1.25F_y$ or F_u of the reinforcing bars in both tension and compression, conforming to ACI 318 Type II coupler. Splicing system shall be listed by the International Code Council (ICC) or by the International Association of Plumbing and Mechanical Officials Evaluation Service (IAPMO-ES)
 1. Mechanically Locked Sleeves: Steel sleeves with internal gripping rails and external shear bolts, designed to positively engage the unaltered ends of butted reinforcing bars.
 - a. Products: Dayton Superior "Bar-Lock" System.
 - b. Substitutions: See Section 016000 - Product Requirements.
 2. Dowel Bar Splicers: Integral forged bar end, female-threaded, with nailing flange on one bar and integral matching male threads on the other bar. Provide specially forged bar ends, such that the cut male threads do not diminish the original bar cross section dimension.
 - a. Products: Dayton Superior; "DBDI" System.
 - b. Substitutions: See Section 016000 - Product Requirements.

2.03 FABRICATION

- A. Do not fabricate reinforcing until shop drawings have been reviewed by LPA.
- B. Fabricate concrete reinforcing in accordance with CRSI (DA4) - Manual of Standard Practice, ACI MNL-66: Detailing Manual, and ACI 318.
- C. In case of fabrication errors, do not rebend or straighten reinforcing in a manner that will injure or weaken the material.
- D. Do not heat reinforcing to facilitate bending.
- E. Welding of reinforcement is permitted only where shown on drawings using ASTM A706 reinforcing. Perform welding in accordance with AWS D1.4/D1.4M.
 1. Protect joints from drafts during cooling process. Accelerated cooling is prohibited.
 2. Do not tack weld reinforcing.
 3. Fusion welding is not permitted unless approved by Engineer of Record.
- F. Locate reinforcing splices not indicated on drawings at point of minimum stress.
- G. Comply with tolerances per ACI 117 and CRSI Manual.
- H. Reinforcing with any of the following defects will not be permitted:
 1. Lengths, depths, and bends not conforming to the specified fabrication tolerances.
 2. Bends or kinks not indicated in the drawings.
 3. Reinforcing with reduced cross-section due to excessive rusting or other causes.

2.04 SOURCE QUALITY CONTROL

- A. Tests: Materials for which physical characteristics have been stipulated shall have had such characteristics independently confirmed by laboratory tests employing industry recognized procedures.
- B. Reinforcing to be welded:
 1. Submit a copy of the mill test report to the Architect prior to placement of reinforcing steel in concrete members.

2. If mill test reports are not available, perform a chemical analysis of reinforcing representative of the reinforcing to be welded. The carbon equivalent (CE) shall not exceed 0.55.
 3. Special inspection is required for welding of steel reinforcing.
- C. Source Quality Control: Testing Laboratory shall test samples of reinforcing, ties, and stirrups from the material at the site or from place of distribution. Each sampling shall include at least two 18-inch long pieces. Perform the following tests according to ASTM A615:
1. Identified Reinforcing: Samples shall be obtained from bundles delivered from the mill, identified by heat number and accompanied by mill analyses and mill test reports. Reinforcing shall be properly tagged with Identification Certificate so as to be readily identified. Then perform one tensile and one bend test for each 10 tons or fraction thereof of each size of reinforcing per CBC Section 1910A.2. Submit mill reports when samples are selected.
 2. Unidentified reinforcing is not permitted.
 3. Refer to Section 014000 - Quality Requirements.

PART 3 EXECUTION

3.01 PREPARATION

- A. Surface Preparation: Clean reinforcing to remove loose rust and mill scale, earth, and other materials which might reduce or destroy bond with concrete.

3.02 PLACEMENT

- A. General: Comply with the CRSI Manual of Standard Practice and CRSI Placing Reinforcing Bars, 10th edition, for details and methods of placing reinforcing and supports.
1. Do not displace or damage vapor barrier while placing concrete reinforcing. If damage occurs, repair vapor barrier before placing concrete.
 - a. Provide for movement which equals joint width plus 1/2-inch.
 2. Expansion Joints in Slab-on-grade: Interrupt reinforcing at expansion joints. Provide No. 5 by 24-inch long dowelled joints at 18 inches on centers with one end of dowel set in capped dowel sleeve.
 3. Construction Joints: Allow reinforcing to run through without interruption, unless otherwise noted on Contract Structural Drawings.
- B. Support: Position, support, and secure reinforcing against displacement by formwork, construction or concrete placement operations. Locate and support reinforcing by metal chairs, runners, bolsters, spacers, and hangers as required and as indicated on Contract Drawings.
1. Provide sufficient numbers and sizes of supports to carry reinforcing.
 - a. Do not place reinforcing more than 2 inches beyond the last leg of any continuous reinforcing support.
 - b. Do not use supports as bases for runways for concrete conveying equipment and similar construction loads.
 - c. Provide additional reinforcing for support where required to support reinforcing shown on Contract Drawings.
 2. Repair and resupport reinforcing which may have moved during concrete placement operations.
- C. Securing in Place:
1. Accurately place reinforcing and wire tie in precise position where reinforcing cross. Bend ends of wire ties away from the forms. Wire tie reinforcing to corners of ties and stirrups.

2. Support reinforcing according to the current edition of CSRI Recommended Practice for Placing Reinforcing Supports using approved accessories and chairs.
3. Place precast concrete cubes with embedded wire ties to support reinforcing steel in concrete placed on grade and in footings. Precast concrete cubes are not acceptable in elevated concrete slabs, beams, or concrete filled metal deck.
4. Use care not to damage vapor barriers where they occur.
5. Dowel Bar Couplers:
 - a. Attach flanged, internally threaded end of dowel bar coupler to inside of formwork, using nails or screws.
- D. Coverage: Place reinforcing to obtain minimum coverages for concrete protection in accordance with ACI 318 Chapter 20.5.1.3, or as indicated on Contract Structural Drawings. Securely tie reinforcing and related supports together with tie wire to hold reinforcing accurately in position during concrete placement operations. Place wire ties so that twisted ends are directly away from exposed concrete surfaces.
- E. Clearance Between Reinforcing: Per ACI 318 and as indicated on Contract Drawings.
- F. Splicing:
 1. Provide standard reinforcing splices by lapping ends and tying securely with tie wire. Comply with details indicated on Contract Structural Drawings.
 - a. Unless noted otherwise on Contract Drawings, comply with requirements of ACI 318 for minimum lap of Class B spliced reinforcing, including ACI 318 as amended by CBC.
 2. Provide 1-1/2-inch minimum clearance between sets of splices. Stagger horizontal reinforcing so that adjacent splices are greater than 4 feet apart, unless noted otherwise on Structural Contract Drawings.
 3. Field Welding: Comply with the requirements of AWS D1.4 where field welding is required. Prior to field welding, determine the weldability of reinforcing in accordance with section "Source Quality Control" in Part 2. Only steel conforming to the chemical requirements of AWS D1.4 may be welded.
 4. Splices: Do not splice reinforcing at the points of maximum stress except where indicated. Lap splices as shown or required to develop the full strength of reinforcing. Stagger splices in horizontal wall reinforcing at least 24" longitudinally in alternate reinforcing and opposite faces.
 5. Mechanical Couplers:
 - a. Mechanically Locked Sleeves:
 - 1) During installation, ensure no damage or misalignment occurs to gripping rails; discard sleeve if damage occurs.
 - 2) Insert first reinforcing bar completely, until it contacts internal divider.
 - 3) Holding bar in position, hand-tighten all bolts.
 - 4) Repeat above procedure for second bar.
 - 5) In random, alternating order, tighten all bolts to 50% of the specified torque.
 - 6) In random, alternating order, tighten all bolts to 75% of the specified torque
 - 7) In random, alternating order, drive each bolt until head shears off.
 - b. Dowel Bar Couplers:
 - 1) Splice open end of dowel bar to internal reinforcing steel.
 - 2) After concrete has set up, thread externally threaded dowel bar into internally threaded dowel bar; hand tighten.
 - 3) Then, attempt to rotate coupler further 1/4 turn by hand-tightening.
 - 4) Splice open end of dowel bar to internal reinforcing steel.
- G. Wire Fabric: Install welded wire fabric in longest lengths practicable. Lap adjoining pieces at least 12 inches minimum, and lace splices with tie wire. Offset end laps in adjacent widths to prevent continuous laps.

1. Extend fabric to within 1 inch of edge at slabs.
- H. Slab on Grade Reinforcing: Do not displace or damage vapor retarder at slab on grade.
- I. Dowels: Secure tie dowels in place before depositing concrete. Provide No. 3 reinforcing for securing dowels where no other reinforcing is provided
- J. Maintaining Reinforcing in Position: Provide adequate means to ensure that reinforcing position and spacing is maintained during placement of concrete.
- K. Adjustment and Inspection: Do not bend or straighten reinforcing in a manner injurious to material. Do not use reinforcing with kinks or bends not shown on Drawings and reviewed shop drawings or reinforcing with reduced cross-section due to corrosion or other cause.
- L. Tolerances: Placement tolerances shall conform to CRSI Manual of Standard Practice and ACI 117.

3.03 FIELD QUALITY CONTROL

- A. An independent testing agency, as specified in Section 014000 - Quality Requirements, will inspect installed reinforcement for conformance to contract documents before concrete placement.
- B. Inspection and Tests of Welds: Provide special inspection of shop and field welding in accordance with CBC Section 1704A, 1705A, 1903A, and Structural Contract Drawings.
 1. Tests will be made by testing laboratory for reinforcing welds, as follows:
 - a. Qualification of welders engaged in electric-arc welding of reinforcing.
 - b. Verification of location of reinforcing for accuracy.
 - c. Inspection of reinforcing welds by certified welding inspectors.
 - d. X-ray test of one of the first three arc-welds made by each welder.
 2. Tensile tests of sample welds of the largest size reinforcing for each type of welding.
 3. When welds are judged to be deficient, provide and pay for such additional X-rays and tests as directed by the Architect. Defective welds shall be repaired, replaced, and retested.
- C. Placing: Provide special inspection as required by CBC 1705A.
 1. Placement of Grade 60 or higher reinforcing steel for concrete above grade requires special inspection.
 2. Schedule inspecting of reinforcing steel for conduit, sleeves, and embedded items to allow for correction, if necessary, before placement of overlying grids on reinforcing steel.

3.04 ADJUSTING

- A. Defective Reinforcing Work: The following shall be considered defective and may be ordered removed and reconstructed at no change in Contract Time or Contract Sum:
 1. Reinforcing with kinks or bends not shown on Contract Drawings.
 2. Reinforcing injured due to bending or straightening.
 3. Reinforcing heated or bent.
 4. Reinforcing not placed in accordance with Contract Documents.
 5. Reinforcing that is rusty or oily.
 6. Reinforcing exposed in surface of concrete

END OF SECTION

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**SECTION 033000
CAST-IN-PLACE CONCRETE**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Concrete building frame members.
- B. Concrete for composite floor construction.
- C. Elevated concrete slabs.
- D. Floors and slabs on grade.
- E. Concrete shear walls, elevator shaft walls, and foundation walls.
- F. Concrete foundations.
- G. Joint devices associated with concrete work.
- H. Site Concrete Elements, including, but not limited to freestanding walls and their foundations, retaining walls and their foundations, light pole bases and their foundations, and flagpole bases and their foundations.
- I. Miscellaneous concrete elements, including equipment pads and equipment pits.
- J. Concrete curing.

1.02 RELATED REQUIREMENTS

- A. Section 014113.11 - Regulatory Requirements - Global Warming Potential (GWP)
- B. Section 031000 - Concrete Forming and Accessories: Forms and accessories for formwork.
- C. Section 032000 - Concrete Reinforcing.
- D. Section 079200 - Joint Sealants: Products and installation for sealants and joint fillers for saw cut joints and isolation joints in slabs.
- E. Section 323353 - Architectural Site Concrete for additional requirements for retaining walls and other site concrete.

1.03 REFERENCE STANDARDS

- A. The applicable version of the standards listed below shall be per Chapter 35 of Part 2 of the 2022 edition of the California Building Code (CBC), including addendums and errata. Where the standard is not listed, then the most current version of the standard shall be used or as referenced by other standards.
 - 1. ACI 117 - Specification for Tolerances for Concrete Construction and Materials.
 - 2. ACI 211.1 - Selecting Proportions for Normal-Density and High Density-Concrete - Guide.
 - 3. ACI 211.2 - Standard Practice for Selecting Proportions for Structural Lightweight Concrete.
 - 4. ACI 232.2R – Report on the Use of Fly Ash in Concrete
 - 5. ACI 233R – Guide to the Use of Slag Cement in Concrete
 - 6. ACI 234R – Guide for the Use of Silica Fume in Concrete
 - 7. ACI 301 - Specifications for Concrete Construction.
 - 8. ACI 302.1R - Guide to Concrete Floor and Slab Construction.
 - 9. ACI 303R – Guide to Cast-in-Place Architectural Concrete Practice

10. ACI 304R - Guide for Measuring, Mixing, Transporting, and Placing Concrete.
11. ACI 305R - Guide to Hot Weather Concreting.
12. ACI 306R - Guide to Cold Weather Concreting.
13. ACI 308R - Guide to External Curing of Concrete.
14. ACI 318 - Building Code Requirements for Structural Concrete and Commentary.
15. ACI 347R - Guide to Formwork for Concrete.
16. ACI 360R – Guide to Design of Slabs-on-Ground
17. ACI 503.4 – Standard Specification for Repairing Concrete with Epoxy Mortars
18. ACI MNL-15 – Field Reference Manual
19. ASTM C31/C31M - Standard Practice for Making and Curing Concrete Test Specimens in the Field.
20. ASTM C1602/C1602M - Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete.
21. ASTM C33/C33M - Standard Specification for Concrete Aggregates.
22. ASTM C39/C39M - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
23. ASTM C94/C94M - Standard Specification for Ready-Mixed Concrete.
24. ASTM C109/C109M - Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50 mm] Cube Specimens).
25. ASTM C143/C143M - Standard Test Method for Slump of Hydraulic-Cement Concrete.
26. ASTM C150/C150M - Standard Specification for Portland Cement.
27. ASTM C157/C157M - Standard Test Method for Length Change of Hardened Hydraulic-Cement Mortar and Concrete.
28. ASTM C171 - Standard Specification for Sheet Materials for Curing Concrete.
29. ASTM C172/C172M - Standard Practice for Sampling Freshly Mixed Concrete.
30. ASTM C173/C173M - Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method.
31. ASTM C231/C231M - Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
32. ASTM C260/C260M - Standard Specification for Air-Entraining Admixtures for Concrete.
33. ASTM C289 - Standard Test Method for Potential Alkali-Silica Reactivity of Aggregates (Chemical Method).
34. ASTM C295/C295M - Standard Guide for Petrographic Examination of Aggregates for Concrete.
35. ASTM C309 - Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
36. ASTM C330/C330M - Standard Specification for Lightweight Aggregates for Structural Concrete.
37. ASTM C494/C494M - Standard Specification for Chemical Admixtures for Concrete.
38. ASTM C579 - Standard Test Methods for Compressive Strength of Chemical-Resistant Mortars, Grouts, Monolithic Surfacing, and Polymer Concretes.
39. ASTM C595/C595M - Standard Specification for Blended Hydraulic Cements.
40. ASTM C618 - Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.
41. ASTM C685/C685M - Standard Specification for Concrete Made by Volumetric Batching and Continuous Mixing.
42. ASTM C755 - Standard Practice for Selection of Water Vapor Retarders for Thermal Insulation.
43. ASTM C979/C979M - Standard Specification for Pigments for Integrally Colored Concrete.
44. ASTM C989/C989M - Standard Specification for Slag Cement for Use in Concrete and Mortars.

45. ASTM C1059/C1059M - Standard Specification for Latex Agents for Bonding Fresh to Hardened Concrete.
 46. ASTM C1107/C1107M - Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink).
 47. ASTM C1240 - Standard Specification for Silica Fume Used in Cementitious Mixtures.
 48. ASTM C1315 - Standard Specification for Liquid Membrane-Forming Compounds Having Special Properties for Curing and Sealing Concrete.
 49. ASTM D882 - Standard Test Method for Tensile Properties of Thin Plastic Sheetings.
 50. ASTM D1709 - Standard Test Methods for Impact Resistance of Plastic Film by the Free-Falling Dart Method.
 51. ASTM D2047 - Standard Test Method for Static Coefficient of Friction of Polish-Coated Flooring Surfaces as Measured by the James Machine.
 52. ASTM D4258 - Standard Practice for Surface Cleaning Concrete for Coating.
 53. ASTM E154/E154M - Standard Test Methods for Water Vapor Retarders Used in Contact with Earth Under Concrete Slabs, on Walls, or as Ground Cover.
 54. ASTM E1155 - Standard Test Method for Determining FF Floor Flatness and FL Floor Levelness Numbers.
 55. ASTM E1643 - Standard Practice for Selection, Design, Installation, and Inspection of Water Vapor Retarders Used in Contact with Earth or Granular Fill Under Concrete Slabs.
 56. ASTM E1745 - Standard Specification for Plastic Water Vapor Retarders Used in Contact with Soil or Granular Fill Under Concrete Slabs.
 57. ASTM F710 - Standard Practice for Preparing Concrete Floors to Receive Resilient Flooring.
 58. ASTM F1869 - Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride.
 59. ASTM F2170 - Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs Using in situ Probes.
 60. ASTM E96/E96M - Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials.
- B. California Code of Regulations (CCR):
1. CBSC, Title 24, Part 2- California Building Code (CBC), 2022 edition.
 - a. Chapter 11b - Accessibility to Public Buildings, Public Accommodations, Commercial Buildings, and Public Housing:
 - 1) Division 3 - Building Blocks.
 - (a) Section 11B-302 - Floor or Ground Surfaces.
 - 2) Division 4 - Accessible Routes.
 - (a) Section 11B-403 - Walking Surfaces.
 - b. Chapter 17A - Structural Tests and Inspections.
 - c. Chapter 19A - Concrete.
 2. CBSC, Title 24, Part 11 - California Green Building Standards Code (CALGreen), 2022 edition.
 - a. Supplement 1, July 2024
- C. US Army Corps of Engineers (USACE)
1. COE CRD-C 513 - Handbook for Concrete and Cement Corps of Engineers Specifications for Rubber Waterstops 1974.
- D. ICC Evaluation Service, Inc. (ICC ES), a subsidiary corporation of the International Code Council:
1. ICC ES Evaluation Reports (ESR) for Materials, Products, Methods, and Types of Construction with current report conforming to the applicable building code.
- E. International Association of Plumbing and Mechanical Officials (IAPMO):

1. IAPMO Uniform Evaluation Service (UES) Report for Materials, Products, Methods, and Types of Construction with current report conforming to the applicable building code.
- F. Public Works Standards, Inc. (PWS):
 1. Standard Specifications for Public Works Construction, (Greenbook), latest edition with amendments, published by BNi Building News.
- G. United States Green Building Council (USGBC):
 1. Leadership in Energy and Environmental Design (LEED):
 2. Green Building Rating System.

1.04 GENERAL

- A. Identify finish flooring manufacturers' concrete slab vapor emission and alkalinity requirements and coordinate concrete slab mixing and installation procedures to achieve desired results. Concrete slab requirements for finish flooring may be more restrictive than general requirements of the Contract Documents, and may require additional materials, means, or methods. Additional materials, means, or methods shall be included as part of the work.
- B. Coordinate method of securing reinforcing and other embedded items in concrete slabs on grade without penetrating vapor barriers.
- C. Verify depth of slab depressions for waterproofing and toppings at walking decks.
- D. Verify depth of slab depression for frame and pan of entrance floor grilles. Coordinate leveling of floor with floor leveling compound and embedment of frame.

1.05 DEFINITIONS

- A. Embodied Carbon Footprint: Embodied carbon is the carbon dioxide equivalent (CO₂e) footprint of the Project before it becomes operational. Embodied carbon is expressed as Global Warming Potential (GWP).
- B. Global Warming Potential: Global Warming Potential (GWP) is the heat absorbed by any greenhouse gas in the atmosphere as a multiple of the heat that would be absorbed by the same mass of carbon dioxide. GWP is 1 for CO₂. GWP for reinforcing is expressed as kg of CO₂e per metric ton of fabricated steel reinforcing.
- C. Environmental Product Declaration: An Environmental Product Declaration (EPD) quantifies environmental information on the life cycle of a product to enable comparisons between products fulfilling the same function. EPDs are conducted in accordance with a Product Category Rule for the specific product being evaluated.
- D. Product Category Rule: Product Category Rules (PCR) are a set of rules, requirements, and guidelines for developing Environmental Product Declarations (EPD) for one or more categories.
- E. Life Cycle Assessment: Life Cycle Assessment (LCA) is a methodology for assessing environmental impacts associated with all the stages of the life cycle of a commercial product, process, or service.

1.06 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Submit manufacturers' data on manufactured products showing compliance with specified requirements and installation instructions, along with agency approvals (ICC, IAPMO, etc.) where applicable.
- C. Mix Design: Submit proposed concrete mix design for approval.

1. Submit design mix data for each type of concrete and each compressive strength required on the Contract Drawings. Submittal of mix designs shall not relieve Contractor of its responsibility to furnish concrete of proper consistency and specified strengths. Where used for concrete subject to special inspections, submit mix designs to testing laboratory for review and written acceptance.
 - a. Indicate proposed mix design complies with requirements of ACI 301, Section 4 and ACI 318 26.4.3.
 - b. Design mix submittal shall be stamped and signed by a professional engineer licensed in the State of California.
 - c. For each material, including admixtures and water, state water-cement ratio and maximum allowable water content.
 - d. For each material, state manufacturer's name, designation, and source.
 - e. Submit shrinkage and creep factors for each type of aggregate, and each source proposed for use, for acceptance-review.
 - f. For each mix design:
 - 1) Pay costs associated with mix design preparation.
 - 2) Consider concrete cover and clear distances between reinforcing bars as indicated on the Contract Drawings in determining the aggregate size for mix designs. This may result in an aggregate size smaller than specified elsewhere in this Specification.
 - 3) Submit a schedule which identifies the locations within the structure where each mix design is proposed for use.
 - 4) Submit project specific 28-day shrinkage test results in accordance with shrinkage test requirements in Part 2 "CONCRETE MIX DESIGN."
 - 5) Indicate proposed mix design complies with fiber reinforcing manufacturer's written recommendations.
- D. Shop Drawings. Concrete shop drawings shall be coordinated with shop drawings requirements for reinforcement and formwork. Submit the following items for review:
 1. Layout drawings showing locations of slab-on-grade joints.
 2. Scaled, dimensioned plans for each floor level indicating size and location of slab openings, penetrations, depressions, and steps. Shop drawing shall be coordinated with reinforcing shop drawings. Ensure penetrations from affected trades for utilities are coordinated.
 - a. Provided review stamp, with signature and date, of each trade proposed to work within the opening or penetration.
 3. Proposed Construction Joints.
 4. Scaled, dimensioned concrete elevations for each wall line indicating size and location of openings, penetrations, and recesses. Shop drawing shall be coordinated with reinforcing shop drawings. Ensure penetrations from affected trades for utilities are coordinated.
 - a. Provided review stamp, with signature and date, of each trade proposed to work within the opening or penetration.
- E. Concrete Placement Schedule: Submit the proposed concrete placement schedule to the Architect for review prior to start of concrete placement.
- F. Samples:
 1. Pigment Color Selection: Submit manufacturer's complete sample chip set, including pigment number and required dosage rate for each color.
 2. Submit samples of underslab vapor retarder to be used.
 3. Submit two, 12 inch long samples of waterstops and construction joint devices.
 4. Aggregate proposed for exposed finish, indicating color, texture, and size, for acceptance-review. Submit not less than 1 pound of aggregate.
- G. Test Reports: Submit report for each test or series of tests specified.

1. Submit certified laboratory test reports to Architect and, when applicable, the authority having jurisdiction, confirming physical characteristics of materials used.
 2. Shrinkage and petrographic tests on concrete with the proposed aggregate.
- H. Material Certificates: For each of the following, signed by manufacturers:
1. Cementitious materials.
 2. Aggregates and sand.
 3. Admixtures.
 4. Fiber reinforcement.
 5. Curing compounds.
 6. Floor and slab treatments.
 7. Bonding agents.
 8. Adhesives.
 9. Vapor retarders.
 10. Semi-rigid joint filler.
 11. Joint-filler strips.
 12. Repair materials.
- I. Sustainable Design Submittals:
1. Embodied Carbon Footprint Submittals
 - a. Plant-specific Environmental Product Declaration (EPD) for each concrete mixture proposed for the project accompanying each concrete mixture submittal.
 - b. A calculation showing that the Global Warming Potential (GWP) of all the concrete supplied for the project shall be lower than the GWP target set in Section 2.
- J. Project Record Documents:
1. Accurately record actual locations of embedded utilities and components that will be concealed from view upon completion of concrete work.
 2. Floor surface flatness and levelness measurements indicating compliance with specified tolerances.
 3. Concrete Placement: Date and time of each placement as provided in the placement schedule. Include start and end times, temperatures, humidities, and wind velocities.
 4. Test Cylinders: Cross-reference to placement record entries

1.07 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with CBC Chapter 19A.
1. Chemical products field-applied to concrete shall comply with the air quality requirements of authorities having jurisdiction.
- B. Perform work of this section in accordance with ACI 301 and ACI 318.
1. Maintain one copy of each document on site.
- C. Follow recommendations of ACI 305R when concreting during hot weather.
- D. Follow recommendations of ACI 306R when concreting during cold weather.
- E. Installer Qualifications: A qualified installer who employs on the Project personnel qualified as an ACI-certified Flatwork Technician and Finisher and a supervisor who is an ACI-certified Concrete Flatwork Technician.
- F. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C94/C94M requirements for production facilities and equipment.
1. Manufacturer shall be certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities." The certificate shall indicate that the plant has automatic batching and recording capabilities such that requirements of CBC 1705A.3.3.1 are met.

- G. Testing Agency Qualifications: An independent agency, acceptable to authorities having jurisdiction, qualified according to ASTM C1077 and ASTM E329 for testing indicated.
 - 1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-1 or an equivalent certification program.
 - 2. Personnel performing laboratory tests shall be ACI-certified Concrete Strength Testing Technician and Concrete Laboratory Testing Technician - Grade I. Testing Agency laboratory supervisor shall be an ACI-certified Concrete Laboratory Testing Technician - Grade II.
- H. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, obtain aggregate from single source, and obtain admixtures from single source from single manufacturer.
- I. Pre-installation Conference: Conduct conference at Project site.
 - 1. Before submitting design mixtures, review concrete design mixture and examine procedures for ensuring quality of concrete materials. Require representatives of each entity directly concerned with cast-in-place concrete to attend, including the following:
 - a. Contractor's superintendent.
 - b. Independent testing agency responsible for concrete design mixtures.
 - c. Ready-mix concrete manufacturer.
 - d. Concrete subcontractor.
 - e. Special concrete finish subcontractor.
 - 2. As applicable to the Work, review special inspection and testing and inspecting agency procedures for field quality control, concrete finishes and finishing, cold- and hot-weather concreting procedures, curing procedures, construction contraction and isolation joints, and joint-filler strips, semirigid joint fillers, forms and form removal limitations, shoring and reshoring procedures, vapor-retarder installation, anchor rod and anchorage device installation tolerances, steel reinforcement installation, floor and slab flatness and levelness measurement, concrete repair procedures and concrete protection.
- J. Mock-up
 - 1. Construct and erect mock-up panel for architectural concrete surfaces indicated to receive special treatment or finish as result of formwork.
 - a. Panel Size: Sufficient to illustrate full range of treatment.
 - 2. Accepted mock-up panel is considered basis of quality for the finished work. Keep mock-up exposed to view for duration of concrete work.
 - 3. Mock-up may not remain as part of the Work.

1.08 WARRANTY

- A. See Section 017800 - Closeout Submittals, for additional warranty requirements.
- B. Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.
- C. Warrant concrete floor sealer to be free from manufacturing defects for a period of 15 years. Applications completed by an approved installer in accordance with published technical data will be warranted for the suppression and control of water vapor emission, alkalinity, and relative humidity from concrete during the warranty period.

1.09 DELIVERY, STORAGE, AND HANDLING

- A. Comply with requirements of ASTM C595/C595M for packaging and marking for cement delivery.

PART 2 PRODUCTS

2.01 GENERAL

- A. Comply with ACI 301 and ACI 318 for interpreting design requirements of reinforced concrete.
 - 1. Contractor shall keep a copy of ACI Field Reference Manual MNL-15(16) in the field office.
- B. Comply with, regulations of the air quality management district in force at the time of the performance of the work of this Section regarding sealers and curing compounds.
- C. Finish concrete surfaces shall be stable, firm, and in compliance with CBC Section 11B-403 requirements for slip resistance.
 - 1. Concrete paving shall have a minimum slip resistance coefficient of friction of 0.6 as tested in accordance with ASTM D2047.
 - 2. Refer to Part 3 for non-slip finish procedures at exterior concrete platforms, steps, and ramps.
- D. Sloping Floors:
 - 1. The running slope of walking surfaces shall not be steeper than 1:20.
 - 2. The cross slope of walking surfaces shall not be steeper than 1:48.
 - 3. At plazas where there is no dominant direction of travel, and at turns, slope shall not exceed 1:48 in any direction.

2.02 FORMWORK

- A. Comply with requirements of Section 031000.

2.03 REINFORCEMENT MATERIALS

- A. Comply with requirements of Section 032000.

2.04 CONCRETE MATERIALS

- A. Hydraulic Cement: Type as indicated on drawings
 - 1. Acquire cement for the entire project from the same source
 - 2. Color: Standard Gray UNO.
- B. Normal Weight Aggregates: ASTM C33/C33M and CBC 1903A.5.
 - 1. Aggregate shall be nonreactive as determined by one of the methods in ASTM C33/C33M Appendix XI: Methods for Evaluating Potential for Deleterious Expansion Due to Alkali Reactivity of an Aggregate.
 - 2. Fine Aggregate: Washed natural sand consisting of hard particles, containing not more than the maximum limits of deleterious material allowed by Table 1 of ASTM C33/C33M.
 - a. Fineness modulus shall be in the range of 2.90 to 3.10.
 - 3. Coarse Aggregate, Structural Concrete:
 - a. Clean washed gravel or sound crushed rock, containing not more than 5 percent flat, thin, elongated, or laminated material, and containing not more than the maximum limits of deleterious material allowed by Table 3 of ASTM C33/C33M for moderate weathering regions.
 - 1) Grade 1-inch aggregate from No. 100 sieve to 1 inch.
 - 2) Grade 1-1/2-inch aggregate from No. 100 sieve to 1-1/2 inches.
 - b. Maximum Size: As indicated on drawings and as noted below.
 - 1) Aggregate shall be no larger than:
 - (a) 3/4 of the clear space between reinforcing bars or between reinforcing bars and forms

- (b) 1/5 of the narrowest dimension between sides of forms
 - (c) 1/3 of the depth of slab.
 - 2) 3/8" aggregate may be utilized at areas of congestion only when submitted for review, indicating specifically where intended use will be, and approved by the architect.
 - 3) Pea Gravel shall not be used.
- 4. Acquire aggregates for entire project from same source.
- C. Lightweight Aggregate: ASTM C330/C330M.
 - 1. Provide lightweight aggregates having a loss of not more than 8 percent when tested by sodium sulfate solution and a loss of not more than 10 percent when tested by magnesium sulfate solution in accordance with ASTM C 88
 - 2. Maximum Size: 3/4 in or as noted below.
 - a. Aggregate shall be no larger than:
 - 1) 3/4 of the clear space between reinforcing bars or between reinforcing bars and forms
 - 2) 1/5 of the narrowest dimension between sides of forms
 - 3) 1/3 of the depth of slab.
- D. Fly Ash: ASTM C618, Class C or F.
- E. Slag Cement: ASTM C989/C989M
- F. Silica Fume: ASTM C1240, proportioned in accordance with ACI 211.1.
- G. Color Additives: Pure, concentrated mineral pigments specifically intended for mixing into concrete and complying with ASTM C979/C979M.
- H. Water: ASTM C1602/C1602M; clean and not detrimental to concrete.

2.05 ADMIXTURES

- A. General:
 - 1. Admixtures and additives shall be reviewed by architect prior to use.
 - 2. Admixtures and additives shall be incorporated and tested in accepted combinations and mixes
 - 3. Admixtures containing chlorides will not be permitted.
- B. Air Entrainment Admixture: ASTM C260/C260M.
- C. High Range Water Reducing Admixture: ASTM C494/C494M Type F.
 - 1. Manufacturers:
 - a. Euclid Chemical Company; PLASTOL 6420: www.euclidchemical.com/#sle.
 - b. Master Builders Solutions; MasterRheobuild 1000: www.master-builders-solutions.com/en-us
 - c. Substitutions: See Section 016000 - Product Requirements.
- D. Water Reducing Admixture: ASTM C494/C494M Type A.
 - 1. Water reduction: Not less than 5%.
 - 2. Increase in compressive strength: Not less than 10% at 28 days.
 - 3. Dry Shrinkage: Less than concrete without admixture at 21 days.
 - 4. Manufacturers:
 - a. Euclid Chemical Company; EUCON NW: www.euclidchemical.com/#sle.
 - b. Substitutions: See Section 016000 - Product Requirements.
- E. Shrinkage Reducing Admixture:
 - 1. ASTM C494/C494M, Type S.
 - 2. Manufacturers:
 - a. Euclid Chemical Company; Eucon SRA Floor: www.euclidchemical.com/#sle.

- b. Euclid Chemical Company; Eucon SRA-XT: www.euclidchemical.com/#sle.
 - c. Substitutions: See Section 016000 - Product Requirements.
- F. Plasticizer: ASTM C494/C494M , Type F

2.06 ACCESSORY MATERIALS

- A. Underslab Vapor Retarder: Min 15 mils thick, reinforced high density polyethylene sheet material complying with ASTM E1745, Class A; stated by manufacturer as suitable for installation in contact with soil or granular fill under concrete slabs. The use of single ply polyethylene is prohibited.
- 1. Water Vapor Permeance: 0.02 Perms maximum, in accordance with ASTM E154/E154M Section 7.
 - 2. Puncture Resistance: 2200 grams minimum, in accordance with ASTM D1709 Method B.
 - 3. Tensile Strength: 45 lbf/in minimum, in accordance with ASTM E154/E154M Section 9, Method ASTM D882.
 - 4. Installation: Comply with ASTM E1643.
 - 5. Accessory Products: Vapor retarder manufacturer's recommended tape, adhesive, mastic, prefabricated boots, etc., for sealing seams and penetrations.
 - 6. Manufacturers: Comply with ASTM C755
 - a. ISI Building Products; Viper VaporCheck II 15-mil (Class A): www.isibp.com/#sle.
 - b. Stego Industries, LLC: www.stegoindustries.com/#sle.
 - c. W. R. Meadows, Inc; PERMINATOR Class A - 15 mils (0.38 mm): www.wrmeadows.com/#sle.
 - d. Substitutions: See Section 016000 - Product Requirements.
- B. Subslab Waterproofing (At Floor Slabs Subject to Minor Hydraulic Moisture Pressures): Vapor barrier under slab on grade with hydraulic moisture pressures or wet soils.
- 1. Reinforced high density polyethylene (HDPE), mylar geomembrane, or 1/8-inch thick pre-molded membrane having the following minimum properties:
 - a. Water Vapor Permeance: 0.005 Perms maximum, in accordance with ASTM E96/E96M.
 - b. Water Vapor Barrier Classification: Class A, in accordance with ASTM E1745.
 - c. Puncture Resistance: 2400 grams minimum, in accordance with ASTM D1709 Method B.
 - d. Tensile Strength: 70 lbf/in minimum, in accordance with ASTM E154/E154M Section 9, Method ASTM D882.
 - 2. Accessory Products: Provide vapor proofing mastic, pipe boots, and related accessory products recommended by manufacturer of vapor retarder.
 - 3. Manufacturers: Comply with ASTM C755.
 - a. Alumiseal Corporation; Alumiseal Zero Perm Vapor Barrier.
 - b. Reef Industries; Griffolyn VAPORguard.
 - c. Stego Industries, LLC; Stego Wrap 15-Mil Class A Vapor Barrier.
 - d. Substitutions: See Section 016000 - Product Requirements
 - 4. Seam Tape:
 - a. High density reinforced polyethylene vapor retarding seam tape with pressure sensitive adhesive as recommended by manufacturer of vapor retarder/barrier. Minimum 6 inches in width and of a contrasting color.
 - 5. Non-Shrink Cementitious Grout:
 - a. Non-Shrink Grout: Prepackaged, non-metallic, non-gaseous, aggregate grout complying with ASTM C1107/C1107M. Contractor shall select type for each special application as recommended by manufacturer.
 - b. Minimum Compressive Strength at 28 Days, ASTM C109/C109M: As indicated on the Contract Drawings.

- c. Flowable Products:
 - 1) Euclid Chemical Company; NS GROUT: www.euclidchemical.com/#sle.
 - 2) Five Star Products, Inc; Five Star Fluid Grout 100: www.fivestarproducts.com/#sle.
 - 3) The QUIKRETE Companies; QUIKRETE® Exterior Use Anchoring Cement: www.quikrete.com/#sle.
 - 4) Substitutions: See Section 016000 - Product Requirements.
- d. Low-Slump, Dry Pack Products:
 - 1) Euclid Chemical Company; DRY PACK GROUT: www.euclidchemical.com/#sle.
 - 2) Five Star Products, Inc; Five Star Grout: www.fivestarproducts.com/#sle.
 - 3) The QUIKRETE Companies; QUIKRETE® FastSet™ Non-Shrink Grout: www.quikrete.com/#sle.
 - 4) Substitutions: See Section 016000 - Product Requirements.
- 6. Non-Shrink Epoxy Grout: Moisture-insensitive, two-part; consisting of epoxy resin, non-metallic aggregate, and activator.
 - a. Minimum Compressive Strength at 7 days, ASTM C579: 12,000 pounds per square inch.
 - b. Manufacturers:
 - 1) Euclid Chemical Company; E3-DEEP POUR: www.euclidchemical.com/#sle.
 - 2) Five Star Products, Inc; Five Star DP Epoxy Grout: www.fivestarproducts.com/#sle.
 - 3) Five Star Products, Inc; Five Star HP Epoxy Grout: www.fivestarproducts.com/#sle.
 - 4) Substitutions: See Section 016000 - Product Requirements.
- 7. Patching Mortar:
 - a. Provide Polymer modified portland cement mortar. Compressive strength shall equal or exceed compressive strength of substrate concrete.
 - b. Mortars shall conform to ASTM C928.
 - c. Manufacturers:
 - 1) Horizontal Application:
 - (a) Durapatch Industrial, manufactured by L&M Construction Chemicals.
 - (b) Embeco R310, manufactured by BASF Admixture Systems.
 - (c) ProSpec Vinyl Concrete Patch, as manufactured by Bonsal American.
 - 2) Vertical and Overhead application: equal to:
 - (a) Durapatch VOH, manufactured by L&M Construction Chemicals.
 - (b) Emaco R350, manufactured by BASF Admixture Systems.
 - (c) ProSpec Vertical Leveling Mortar, as manufactured by Bonsal American.
- 8. Floor Leveling Compound: Two-part acrylic polymer latex concrete with compressive strength as tested by ASTM C109/C109M equal or greater than substrate concrete compressive strength.
 - a. Manufacturers:
 - 1) Ardex; K-15.
 - 2) L&M Construction Chemicals; Levelex.
 - 3) Maxxon Corporation; Level-Right Plus.
 - 4) Substitutions: See Section 016000 - Product Requirements
- 9. Floor Patching Materials:
 - a. Patching Materials shall match or exceed compressive strength of the substrate concrete.
 - 1) Interstate Epoxy Patching Compound.
 - 2) Sakrete Fast Setting Cement Patcher.

- 3) ProSpec Floor Patch Pro, manufactured by Bonsal American.
10. Skim Coat: Blended compound of portland cement, graded silica aggregates, and special chemical additives formulated for bonding, smoothing, rubbing, and thin coating concrete surfaces.
 - a. Pavcrete manufactured by Lyons Manufacturing or Rapid Set WunderFixx manufactured by CTC Cement.
 - b. Bonding Agent: Manufacturer's Type II acrylic bonding agent, when applicable. Do not use PVA Type I bonding agents.
 - c. Pigment: SGS ColorFlo Liquid iron oxide color pigments, as manufactured by Solomon Colors, or equal, in accordance with ASTM C 979.
 - d. Admixture: Chromix-L manufactured by L.M. Scofield Products, or equal product manufactured by Davis Colors.
11. Isolation Joint Sealant: Provide polyurethane type compatible with fiber joint filler.

2.07 BONDING AND JOINTING PRODUCTS

- A. Chemical Bonding Agent: Non-redispersable acrylic latex, complying with ASTM C1059/C1059M, Type II. Agent shall be freeze-thaw resistant and suitable for brush or spray application.
 1. Manufacturers:
 - a. Euclid Chemical Company; AKKRO-7T: www.euclidchemical.com/#sle.
 - b. Larsen Products Corp.; Weldcrete.
 - c. SpecChem, LLC; Strong Bond Acrylic Bonder: www.specchemllc.com/#sle.
 - d. W. R. Meadows, Inc; ACRY-LOK-: www.wrmeadows.com/#sle.
 - e. Substitutions: See Section 016000 - Product Requirements.
- B. Waterstops: Rubber, complying with COE CRD-C 513.
 1. Configuration: As indicated on drawings.
 2. Size: As indicated on drawings.
- C. Slab Isolation Joint Filler: 1/2 inch thick, height equal to slab thickness, with removable top section that will form 1/2 inch deep sealant pocket after removal.
- D. Slab Construction Joint Devices: Combination keyed joint form and screed, galvanized steel, with rectangular or round knockout holes for conduit or rebar to pass through joint form at 6 inches on center; ribbed steel stakes for setting.

2.08 CURING AND SEALING MATERIALS

- A. Floor Liquid Curing Compound Type FCC: For use on concrete slabs that will be exposed with separately applied floor sealer finish, or on slabs that will be covered by breathable floor coverings or mortar beds.
 1. Compound shall be a water-based non-staining dissipating, translucent resin, conforming to ASTM C309, Type 1, Class B.
 - a. Sodium silicate compounds will not be permitted.
 2. Product shall be compatible with subsequently applied toppings (sealers, hardeners, finishes, or coverings).
 3. Manufacturers:
 - a. Euclid Chemical Co.; Kurex Vox.
 - b. L&M Construction Chemicals; L&M Cure R.
 - c. Sonneborn Building Products; Sonosil.
 - d. W.R. Meadows; Sealtight 1100 Clear.
 - e. Substitutions: See Section 016000 - Product Requirements
- B. Curing Barriers:

1. Waterproof Curing Paper: Conform to ASTM C171, non-staining reinforced type.
 - a. Manufacturer:
 - 1) Fortifiber Corporation; Orange Label Sisalkraft.
2. Reinforced Curing Barriers: Transguard 4000 manufactured by Reef Industries or equal.
- C. Floor Remedial Vapor Emission and Alkalinity Control Sealer Type FCS: For remedial use on concrete slabs on grade that do not meet manufacturer's specific moisture emission and alkalinity limits for non-breathable floor finishes.
 1. Manufacturers:
 - a. Sinak Corporation; Sinak VC5: www.sinak.com.
 - b. Bonsal American; ProSpec Moisture Guard Max.
 - c. Synthetics International; Synthetic30 two-component liquid-applied, waterborne polymer-based ultra-low viscosity clear sealer. www.syntheticsintl.com.
 - d. Substitutions: See Section 016000 - Product Requirements
- D. Floor Sealer Finish Type FSF: For general use at exposed concrete slab areas for appearance.
 1. Design is based on the use of high solids, minimum 25% non-yellowing water-based acrylic cure/sealer conforming to ASTM C309, Type 1, Class B and ASTM C1315, Type 1, Grade B, low VOC compliant meeting all local air quality regulations.
 2. Product shall be in compliance with volatile organic compounds (VOC) content limits required by air quality management district at the time of performance of the work.
 3. At Exposed Concrete Surfaces at Garage Areas:
 - a. Compound shall be a water-based non-staining dissipating, translucent resin, conforming to ASTM C309, Type 1, Class B.
 4. Sodium silicate compounds will not be permitted.
 5. Manufacturers:
 - a. Euclid Chemical Co.; Euclid Aqua Cure VOX Super.
 - b. L&M Construction Chemicals; Dress & Seal WB30.
 - c. W.R. Meadows; VOCComp 25.
 - d. Sinak Corporation; HLQ-125.
 - e. Substitutions: See Section 016000 - Product Requirements
- E. Wall Sealer and Water Repellent Finish Type WSR: For general use at exposed concrete wall surfaces in Restrooms for code compliance.
 1. Design is based on the use of a modified neat silane repellent system offering invisible protection and low volatility combined with water and oil repellency on concrete substrates to prevent staining by waterborne and oily substance.
 2. Product shall be in compliance with volatile organic compounds (VOC) content limits required by air quality management district at the time of performance of the work.
 3. Manufacturers:
 - a. Miracle Sealants Co.; 511 Impregnator.
 - b. Prosoco, Inc.; Stand Off SLX100 Water & Oil Repellent.
 - c. Substitutions: See Section 016000 - Product Requirements.

2.09 CONCRETE MIX DESIGN

- A. Global Warming Potential (GWP) Limit: As Indicated, per mix
 1. Exception: Concrete may be considered one product category. A weighted average of the maximum GWP for all concrete mixes installed in the project shall be less than the weighted average maximum GWP specified on the structural drawings. Calculation shall be submitted to the Architect (Engineer) for approval
- B. Mix design shall be stamped and signed by a professional engineer licensed in the State of California.
- C. Proportioning Normal Weight Concrete: Comply with ACI 211.1 recommendations.

- D. Proportioning Structural Lightweight Concrete: Comply with ACI PRC-213 recommendations.
- E. The proportioning of ingredients shall be such that the concrete can be readily worked into forms and around reinforcement under the conditions of placement to be used, without segregation or excessive bleeding.
- F. Concrete Compressive Strengths: Provide compressive strengths as noted on drawings, when tested in accordance with ASTM C39/C39M at 28 days.
 - 1. Establish required average strength for each type of concrete on the basis of field experience or trial mixtures, as specified in ACI 301.
 - a. For trial mixtures method, employ independent testing agency acceptable to Architect for preparing and reporting proposed mix designs.
- G. Fly Ash or other pozzolans Content: Maximum 25 percent of cementitious materials by weight.
- H. Total of fly ash or natural pozzolans and silica fume: Maximum 35 percent by weight.
- I. Total of fly ash or natural pozzolans slag cement and silica fume: Maximum 50 percent by weight.
- J. Water-Cementitious Material Ratio: As indicated on the Contract Drawings
 - 1. Slabs-on-Grade: Water to cement content shall not exceed a ratio of 0.42 upon delivery at site.
 - 2. Other Concrete Not in Contact with Soils: Water to cement content shall not exceed a ratio of 0.45 upon delivery to site.
- K. Maximum Slump: As indicated on the Contract Drawings
- L. Accurately control the proportions, water content, and air content. Use weighing equipment accurate to within 1 percent for cement and 2 percent for aggregates, and adjustable for varying aggregate moisture content. A beam auxiliary shall register any part of the last 100 pounds of each aggregate. The aggregate hopper shall have a volume adjustment.
 - 1. Proportion concrete by weight of loose, dry material.
 - 2. Fine aggregate volume shall be at least 35 percent of the sum of the separate fine and coarse aggregate volumes.
- M. Admixtures: Admixtures may only be used if they are incorporated into the accepted concrete mix designs and testing. Where admixture is proposed for use by concrete supplier, conform to types accepted by Architect in writing.
 - 1. Proposed admixtures shall be as recommended in ACI 211.1 and at rates recommended or required by manufacturer.
- N. Fiber Reinforcement: Add to mix at rate indicated on drawings and in accordance to manufacturer's instructions. Provide uniform and complete distribution based on manufacturer's recommendations.
- O. Tests for Concrete Materials at Batch Plant: Utilizing batch plant test records, perform the following tests in accordance with provisions of the building code:
 - 1. Cement: Sample and test cement, or provide mill test reports, as accepted, certifying that the cement conforms to the requirements of this Specification.
 - 2. Aggregate:
 - a. Sample and test concrete aggregate for grading and soundness before concrete mix designs are established.
 - b. Test aggregate for shrinkage characteristics in accordance with ASTM C157/C157M.
 - c. Conduct petrographic examinations of aggregate proposed for use in accordance with ASTM C295/C295M.
 - 3. Air Content: ASTM C173/C173M, volumetric method or ASTM C231/C231M, pressure method. One test for each set of compressive strength test specimens.
 - 4. Refer to "Field Quality Control" in Part 3 for testing of actual concrete mix and placement.

- P. Inspection: Accompany each load of materials or concrete with a signed copy of batch plant's certificate stating quantity of each material, design strength, amount of water added at plant, admixtures, departure time and date, and maximum amount of water allowed to be added at site.
- Q. Shrinkage Test:
 - 1. Before placing any concrete, prepare a trial batch of the mix design, using the same aggregates, cement, and admixtures (if any) proposed for use on the project. Prepare at least three specimens for determining the drying shrinkage of the mix design.
 - 2. The drying shrinkage specimens shall be 4"x4"x11" prisms, made, cured, dried, and measured as specified in ASTM C157/C157M7. Measure and report separately for 7, 14, 21, and 28 days of drying. After 7 days of moist curing. The effective gauge length of the specimens shall be 10 inches.
 - 3. The average drying shrinkage of the test specimens after 28 days of drying shall not exceed 0.045 percent for footing and grade beams, and 0.035 percent for all other locations. Use adequate amount of shrinkage reducing admixture as required.

2.10 MIXING

- A. On Project Site: Mix in drum type batch mixer, complying with ASTM C685/C685M and ASTM C94/C94M.
 - 1. For mixer capacity of 1 cu. yd. (0.76 cu. m) or smaller, continue mixing at least 1-1/2 minutes, but not more than 5 minutes after ingredients are in mixer, before any part of batch is released.
 - 2. For mixer capacity larger than 1 cu. yd. (0.76 cu. m), increase mixing time by 60 seconds for each additional 1 cu. yd. (0.76 cu. m).
 - 3. Provide batch ticket for each batch discharged and used in the Work, indicating Project identification name and number, date, mixture type, mixture time, quantity, and amount of water added. Record approximate location of final deposit in structure.
 - 4. Colored Concrete: Add pigments in strict accordance with manufacturer's instructions to achieve consistent color from batch to batch.
 - 5. Fiber Reinforcement: Batch and mix as recommended by manufacturer for specific project conditions.
- B. Transit Mixers: Comply with ASTM C94/C94M.
 - 1. With each load, provide ticket certifying the materials and quantities as well as compliance with the accepted mix design.
- C. On the transit mix ticket, state the time water was first added to the mix.
 - 1. At the batch plant, withhold 2-1/2 gallons of water per cubic yard of concrete.
 - 2. Upon arrival at the job site, as directed by the Testing Laboratory Inspector, add all or part of the withheld water before the concrete is discharged from the mixer.
 - 3. Mix concrete for not less than 5 minutes after the withheld water has been added, and not less than 1 minute of that time immediately prior to discharge of the batch.
 - a. Drum shall rotate approximately 70 to 100 revolutions at a mixing speed of approximately 6 to 18 rpm.
 - b. After mixing, drum shall rotate at an agitating speed of approximately 2 to 6 rpm.
 - c. Unless otherwise directed, provide 15 minutes total mixing per batch after first addition of water.
 - 4. Discharge of the concrete shall be completed within 90 minutes after water is introduced into the mix, or before the drum has completed 300 revolutions.
- D. Adding Water: If concrete arrives on-site with slump less than suitable for placement, do not add water that exceeds the maximum water-cement ratio or exceeds the maximum permissible slump.
- E. Weather Requirements:

1. Hot Weather Usage: Adjust mix as required to counteract effects of anticipated or probable hot weather on strength of concrete. Conform to recommendations of ACI 305R regarding admixtures, temperature of mixing water, and delivery times.
 - a. During hot weather, proper attention shall be given to ingredients, production methods, handling, placing, protection and curing to prevent excessive concrete temperatures or water evaporation that may impair required strength or serviceability of the member or structure.
 - b. When air temperature is between 85 degrees F. and 90 degrees F, limit mixing and delivery time from 1-1/2 hours to 75 minutes, and when air temperature is above 90 degrees F, limit mixing and delivery time to 60 minutes.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Prior to performing work and placing concrete, verify:
 1. Lines, levels, and dimensions before proceeding with work of this section.
 2. Elevations and depressions of floor finishes
 3. Final excavation required for foundations and footings prior to placing concrete.
 4. Locations of proposed and future breathable and nonbreathable floor finishes in advance of placing concrete to determine type of floor sealers to be applied in finishing operations.
 5. Formwork is properly located such that the unshored concrete will maintain specified tolerances after forms are removed.

3.02 PREPARATION

- A. Formwork: Comply with Section 031000 - Concrete Forming and Accessories.
- B. Reinforcing: Comply with Section 032000 - Concrete Reinforcing.
- C. Verify that forms are clean and free of rust before applying release agent.
- D. Coordinate placement of embedded items with erection of concrete formwork and placement of form accessories.
- E. Where new concrete is to be bonded to previously placed concrete, prepare existing surface by cleaning, roughening to exposed aggregate, and applying bonding agent in according to bonding agent manufacturer's instructions.
 1. Use latex bonding agent only for non-load-bearing applications.
- F. Interior Slabs on Grade: Install vapor retarder under interior slabs on grade over properly prepared subbase per Geotechnical recommendations. Lap joints minimum 6 inches. Tape and seal joints, seams and penetrations watertight with manufacturer's recommended products and follow manufacturer's written instructions. Repair damaged vapor retarder before covering.
 1. Place Slab on Grade directly on vapor retarder.
 2. Avoid grade staking through vapor retarder.

3.03 PLACING CONCRETE

- A. Place concrete in accordance with ACI 304R.
 1. Pour concrete in accordance with accepted pour schedule and construction joint layout.
- B. Place concrete for floor slabs in accordance with ACI 302.1R.
- C. Notify Architect not less than 48 hours prior to commencement of placement operations.
- D. Maintain records of concrete placement. Record date, location, quantity, air temperature, and test samples taken.

- E. Ensure reinforcement, inserts, waterstops, embedded parts, and formed construction joint devices will not be disturbed during concrete placement.
- F. Place concrete continuously between predetermined construction joints per ACI and CBC requirements. Where construction joints are located, before next placement prepare joint surface by removing laitance and exposing the sand and sound surface mortar, by sandblasting or high-pressure water jetting.
- G. Finish floors level and flat, unless otherwise indicated, within the tolerances specified below.
- H. Compacting:
 - 1. General: Spade, rod, vibrate, and consolidate concrete in forms. Vibrators shall not be left in any one spot longer than 30 seconds and shall be kept constantly in motion. One vibrator shall be assigned to each location where concrete is being placed and a standby vibrator shall be kept ready at all times. Avoid creating rock pockets, air bubbles, honeycomb, or separation of ingredients.
 - 2. Work concrete thoroughly around reinforcement and embedded items and into corners and angles of forms by spading, rodding, and tamping.
 - 3. Consolidation: Vibrate to consolidate each layer with previously placed layers, completely embedding reinforcing and fixtures, and bringing fine material to surface of slab to produce proper finish.
- I. Hot Weather Placing: Comply with recommendations of ACI 305R.
- J. Cold Weather Placing: Comply with recommendations of ACI 306R.

3.04 GROUTING

- A. Non-Shrink Grout: Install non-shrink grout per drawing properly beneath bearings of plates, columns, and other structural members using product recommended by manufacturer for specific application and in accordance with printed instructions.
 - 1. Compressive strength of grout shall be tested in accordance with ASTM C109/C109M .

3.05 CONTROL AND CONSTRUCTION JOINTS

- A. Control Joints:
 - 1. Location: As indicated on the Contract Drawings, but not more than 20 feet on centers in both directions at exterior slabs. Limit interior slabs on grade to 400 square foot bays with length to width ratios of 1 to 1.5 maximum.
 - a. Locate on column center lines and at re-entry corners wherever practical.
 - b. Avoid areas receiving tile or paver floor finish.
 - c. Coordinate locations with proposed floor finish joint layout.
 - d. Limit length to width ratios to 1 to 1.25.
- B. Anchor joint fillers and devices to prevent movement during concrete placement.
- C. Isolation Joints: Use preformed joint filler with removable top section for joint sealant, total height equal to thickness of slab, set flush with top of slab.
- D. Saw Cut Contraction Joints: Saw cut joints before concrete begins to cool, within 4 to 12 hours after placing; with width and depth as indicated on drawings.
 - 1. Fill saw cuts in interior walkways with control joint filler specified.
- E. Construction Joints:
 - 1. Details and proposed location of construction joints shall be as indicated on the Drawings, located to least impair strength of structure, in accordance with the following:
 - 2. Thoroughly clean contact surface by sand blasting entire surface not earlier than 5 days after initial placement.

3. A mix containing the same proportion of sand and cement provided in concrete plus a maximum of 50 percent of coarse aggregate shall be placed to a depth of at least one inch on horizontal joints. Vertical joints shall be wetted and coated with a neat cement grout immediately before placing of new concrete.
4. Should contact surface become coated with earth, sawdust, or deleterious material of any kind after being cleaned, entire surface shall be re-cleaned before applying mix.

3.06 SEPARATE NON-STRUCTURAL FLOOR TOPPINGS

- A. Prior to placing floor topping, roughen substrate concrete surface and remove deleterious material. Broom and vacuum clean.
- B. Place required dividers, edge strips, reinforcing, and other items to be cast in.
- C. Non-structural toppings slabs shall be normal-weight concrete, reinforced as noted on the Contract Drawings.
- D. Place concrete floor toppings to required lines and levels.
 1. Place topping in checkerboard panels not to exceed 20 feet in either direction.

3.07 TOLERANCES FOR CONCRETE CONSTRUCTION AND MATERIALS

- A. An independent testing agency, as specified in Section 014000, will inspect finished slabs for compliance with specified tolerances.
- B. Conform to requirements of ACI 117, except as modified by the requirements of these Specifications and CBC.
- C. Formed Surfaces:
 1. Maintain bowing, warping, and dimensional tolerances within the maximum tolerances stated in ACI 117 for Class A surfaces.
 2. Overall Dimension for Height and Width: Plus zero to minus 3/32-inch for surfaces that are 10 feet and over.
 3. Thickness: Plus-or-minus 1/8-inch maximum.
 4. Openings: Accurate to within a tolerance of plus 1/8-inch to minus zero.
 5. Exposed Slab Edges: Free of jogs exceeding 1/8-inch.
- D. Concrete Slabs: Floor finish tolerances shall be measured in accordance with ASTM E1155/E1155M and ACI 302.1R the F-Number System (Inch-Pound Units) for the following conditions:

Element	Specified Overall Value		Minimum Local Value	
	FF	FL	FF	FL
Slab-on-Grade:				
Mech and Electrical Rooms, parking structures	20	15	15	10
Carpeted	25	20	17	15
Thinset Tile, Resilient Flooring	35	25	24	17
Wood Flooring	50	35	35	35
Other not indicated	35	25	24	17
Suspended Slabs:				
Mechanical and Electrical Rooms, parking structures	20	15 (SHORED)	N/A	N/A
Carpeted	25	20 (SHORED)		

Thinset Tile, Resilient Flooring	35	25 (SHORED)		
Wood Flooring	50	35 (SHORED)		
Other not indicated	35	25 (SHORED)		

- E. Verify flatness requirements in accordance with Owner's specification requirements prior to installation.
- F. Suspended Slab Levelness: Where FL is not specified (unshored conditions) floors must be level, and the elevation of the top surface shall fall within a 3/4-inch envelope in accordance with ASCC Tolerances for Suspended Concrete Slabs, unless part of a sloping floor or as otherwise noted.
- G. Concrete Door Sills:
 - 1. Slabs Under Operable Partitions or Sound-Rated Accordion Doors: 1/8-inch from level along line under partition or door.
 - 2. Slabs Under Roll-up Doors: 1/8-inch from level along line under partition or door.
- H. Levelness tolerances shall be measured within 72 hours after slab concrete placement.
 - 1. Tolerances for sloped floors shall not exceed the slopes specified in "REGULATORY REQUIREMENTS" in Part 2.
- I. Owner reserves the right to test floors and concrete members for conformance to ACI 117 by Use of the Dipstick Floor Profiler. Should tolerances not be within the limits specified, the Contractor shall be required to pay the cost of the tests, as well as the repairs required to bring work into compliance.
- J. Corrective Procedures: See "FILLING, LEVELING AND PATCHING."
 - 1. Areas requiring corrective work should be identified and submitted to Architect. Re-measure corrected areas by the same process.

3.08 CONCRETE FINISHING

- A. Formed Concrete
 - 1. Surface Repairs: Repair surface defects, including defective areas and tie holes as recommended in ACI 301 Section 2 or 6.
 - 2. Rough-Formed Finish: Cast concrete texture imparted by form-facing material, not arranged in any specific visual manner. Repair and patch tie holes and defective areas. Rub down or chip off fins and other projections exceeding 1/4-inch in height.
 - a. Apply to concrete surfaces not exposed to public view.
 - 3. Smooth-Formed Finish: Cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch tie holes and defective areas. Completely remove fins and other projections.
 - a. Apply to concrete surfaces exposed to public view or to be covered with a coating or covering material applied directly to concrete, such as waterproofing, damp-proofing, veneer plaster, or painting.
 - b. Apply the following rubbed finish, defined in ACI 301 Section 6, to smooth-formed finished concrete.
 - 1) Grout-cleaned finish.
 - 2) Smooth-rubbed finish.
 - 4. Painted Finish: Entire surface area exposed to view shall be free of voids, cracks, spalls, protrusions, or non-uniform textures.
 - a. Prior to sacking, prepare surfaces in accordance with Section 099113 - Exterior Painting and Section 099123 - Interior Painting as applicable.

- b. Entire surface area of concrete exposed to view shall be repaired, resurfaced, and made ready to receive paint finish specified under Section 099113 - Exterior Painting and Section 099123 - Interior Painting as applicable.
 - 1) Resurfacing of concrete panel surfaces shall be accomplished with specified resurfacing materials in accordance with manufacturer's instructions and the preparation and application procedures of ACI 503.4.
 - c. Interior surfaces at window openings shall be ground smooth, resurfaced, and prepared to receive sealants.
 - 1) Resurface concrete sills, jambs, and heads with specified resurfacing, patching, and finishing materials in accordance with manufacturer's instructions.
 - (a) Interior surfaces at openings shall be ground smooth, resurfaced, and prepared to receive sealants.
 - d. Finish repaired surfaces with primer and two coats of paint finish as specified under Section 099113 - Exterior Painting and Section 099123 - Interior Painting as applicable.
5. Related Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces, unless otherwise indicated.
6. Electrostatic Coatings: Install in accordance with manufacturer's printed instructions.
7. Patching and Skim Coating: Refer to "FILLING, LEVELING AND PATCHING."
- B. Flatwork
- 1. Screeding: Work out irregularities and bring surfaces to true finish grade or elevation. Remove excess water and debris worked to the surface during compaction and screeding.
 - 2. Initial Troweling:
 - a. Do not commence troweling until surface water sheen has disappeared.
 - b. Use wood bullfloats to open top of slab to allow bleed water out.
 - c. Do not use metal floats.
 - d. Do not apply dry cement, sand, or water to surface.
 - e. Slabs to Receive Mortar-bed with Topping or Bonded Finish: Upon completion of pour, and before concrete has hardened, texture surface of slab with stiff broom, or roughen surface.
 - f. Slabs to Receive Crack Isolation Membrane or Mortar-bed with Cleavage Membrane: Finish slabs with typical smooth troweled surface.
 - 3. Final Troweling:
 - a. Interior Slabs: Steel trowel and burnish.
 - 1) Do not finish slab until bleed water has evaporated.
 - 2) Do not apply water to the concrete during finishing.
 - 3) Do not allow rainwater to stand on slab.
 - b. Sills and Other Weather Surfaces: Smooth trowel and burnish. Finish external angles uniform and tooled.
 - c. Sealer: Where specified, apply in accordance with the requirements of Section 033511.
 - 4. Finish for Interior Stairs:
 - a. Sprinkle abrasive aggregate uniformly on unhardened surface immediately prior to finishing, at the rate of 2 pounds per square yard. Work into surface during finishing. Rub lightly to expose abrasive aggregate while concrete is green.
 - b. Concrete walking surfaces shall have a minimum slip resistance coefficient of friction of 0.6 as tested in accordance with ASTM D 2047.
 - c. Stairs: Apply grooves and tooled edges to tread nosing in accordance with the Contract Drawings.
 - 1) Provide medium broom finish.

- d. Warning Stripes: Apply 2-inch wide warning stripe of 70 percent contrasting color at top and bottom nosing of each run at interior stairs, 1 inch maximum from edge of nosing.
- e. Pedestrian, General:
 - 1) Provide medium broom finish.
 - 2) Medium acid etch finish.
- 5. Float Finish:
 - a. After screeding, consolidating, and straightening concrete slabs, do not work surface until ready for floating.
 - b. Begin floating when surface water has disappeared or when concrete has stiffened sufficiently to permit operation of power-driven floats. The application of Portland cement to slab during floating or troweling is prohibited.
 - c. Consolidate surface with power-driven floats or by hand floating if area is small or inaccessible to power driven floats. Restraighten, cut down high spots, and frill low spots. Repeat float passes and straightening until surface is left with a uniform, smooth, granular texture.
 - d. Finish to straightedge tolerance.
 - e. Cut down high areas and fill in low areas.
 - f. After straightening, refloat surface to uniform, smooth, granular texture.
 - g. Locations:
 - 1) Surfaces scheduled for trowel and broom finishes.
 - 2) Surfaces scheduled to receive adhered roofing or waterproofing membrane.
 - 3) Surfaced scheduled to receive thick-set mortar beds on cleavage membrane.
- 6. Trowel Finish:
 - a. After applying float finish, apply first trowel finish and consolidate concrete by hand or power-driven trowel. Continue troweling passes and restraighten until surface is free of trowel marks and uniform in texture and appearance. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.
 - b. Finish to straightedged tolerance.
 - c. Locations:
 - 1) Surfaces scheduled to receive thin-set mortar beds, resilient flooring, carpet, and wood flooring.
 - 2) Exposed surfaces.
 - 3) Surfaces scheduled to receive paint or other thin film finish coating.
- 7. Medium Broom Finish:
 - a. Provide float finish and let set.
 - b. While surface is still plastic draw medium stiff fiber bristle broom uniformly over surface to provide texture perpendicular to main traffic direction.
 - c. Locations:
 - 1) Stair treads.
- 8. Heavy Broom Finish:
 - a. Provide float finish and let set.
 - b. Texture: While surface is still plastic, swirl stiff fiber bristle broom uniformly over level surfaces and perpendicular to main traffic direction at ramp surfaces.
 - c. Locations:
 - 1) Parking garage areas.
- 9. Acid Wash: Top-Cast No. 3 Light Etch.
 - a. Provide acid containment area and comply with CAL OSHA for application and cleanup.
 - b. First Wash: Three days after pour.
 - c. Second Wash: Three weeks after first application.

- d. Third Wash: At time of final completion of Project.
- e. Appearance: Slab surfaces shall exhibit an aggregate exposure of fine aggregate particles constituting not less than 60 percent and not more than 80 percent of the surface, as directed by Architect. Exposure shall be of sufficient depth to provide a surface profile of between 1/16-inch and 3/16-inch.
- 10. Electrostatic Control Coating: Install in accordance with manufacturer's recommendations.
- C. Concrete Slabs: Finish to requirements of ACI 302.1R, and as follows:
 - 1. Other Surfaces to Be Left Exposed: Trowel as described in ACI 302.1R, minimizing burnish marks and other appearance defects.

3.09 SEALING

- A. Formed Concrete Surface:
 - 1. Interior Vertical Surfaces: Where indicated on Contract Drawings, treat vertical surfaces of interior exposed formed concrete with specified sealer finish Type WSR.
 - a. Apply protective treatment in saturating applications without atomizing the product. Use enough to thoroughly wet the surface and create a slight rundown below the spray pattern. Apply uniformly. Don't over apply.
 - 1) Provide two applications of protective treatment at exposed concrete toilet room wall locations. Apply the second coat within a few minutes after the first coat has penetrated and appears dry; do not atomize the product during application.
 - b. Brush heavy runs and drips thoroughly into the surface.
 - c. Protect treated surfaces from contact or by water or for 4 hours.
 - 2. Exterior Vertical Surfaces: Where indicated on Contract Drawings, treat vertical surfaces of exterior exposed formed concrete with sealer in accordance with specified sealer finish Type FSF.
- B. Flatwork
 - 1. Grind and clean floors prior to sealing.
 - 2. Sealer/Dustproofers:
 - a. Prepare substrates and spray apply curing sealer in accordance with manufacturer's directions.
 - b. Locations:
 - c. Mechanical rooms, main trash room, electrical rooms, and telephone rooms.
 - d. Other locations where indicated or scheduled in Contract Drawings.
 - 3. Penetrating Sealer:

3.10 CURING

- A. Comply with requirements of ACI 308R and ACI 318. Immediately after placement, protect concrete from premature drying, excessively hot or cold temperatures, and mechanical injury.
- B. Maintain concrete with minimal moisture loss at relatively constant temperature for period necessary for hydration of cement and hardening of concrete.
 - 1. Normal concrete: Not less than seven days.
- C. Forms containing concrete, top of concrete between forms, and exposed concrete surfaces after removal of forms shall be maintained in a thoroughly wet condition for at least 7 consecutive days after placing.
- D. Surfaces Not in Contact with Forms:
 - 1. Curing Compound: Cure by completely and uniformly applying liquid curing compound in accordance with manufacturer's printed instructions. Apply at least two coats at right angles to each other.
 - a. Reapply curing membrane at saw cut joints and at exposed edges of slab after removal of forms.

- b. Omit curing compound and use moisture curing where required to provide floor sealer.
 - c. Omit curing compound where curing/sealing compound specified provides a concurrent curing function and is applied at the time of concrete placement appropriate to such function.
 - d. Slabs and floors to receive adhesive-applied flooring: Curing compounds and other surface coatings are usually considered unacceptable by flooring and adhesive manufacturers. If such materials must be used, either obtain the approval of the flooring and adhesive manufacturers prior to use or remove the surface coating after curing to flooring manufacturer's satisfaction.
- 2. Continuous Moisture: Cure by keeping concrete continuously wet for a period of at least 7 days after pouring in accordance with ACI 308R and ACI 318 for curing interior slabs to receive flooring finishes. During periods of high temperature, low humidity, or wind, wet concrete as often as required to keep concrete continuously moist for a period of at least 10 days. Cover with waterproof curing paper or reinforced vapor retarder, maintaining a film of water.
- 3. Final Curing: Begin after initial curing but before surface is dry.
- E. Ambient Conditions:
 - 1. Hot Weather Curing:
 - 2. Conform to recommendations of ACI 305R regarding curing of concrete flatwork in hot weather.

3.11 FIELD QUALITY CONTROL

- A. An independent testing agency will perform field quality control tests, as specified in Section 014000 - Quality Requirements.
- B. Provide free access to concrete operations at project site and cooperate with appointed testing agency.
- C. Submit proposed mix design of each class of concrete to inspection and testing firm for review prior to commencement of concrete operations.
- D. Testing:
 - 1. Sample fresh concrete in accordance with ASTM C172/C172M, except modified for slump to comply with ASTM C94/C94M.
 - 2. Slump: Test will be performed in accordance with ASTM C143/C143M. One test will be made for each concrete load at point of discharge and one test for each set of compressive strength test specimens.
 - 3. Concrete Temperature: Test will be taken hourly when air temperature is 40 degrees F or below, and when 80 degrees F or above, and each time a set of compression test specimens is made.
 - 4. Curing: Cure specimens in accordance with ASTM C31/C31M.
 - 5. Frequency of Compressive Strength Testing: Test will be made in accordance with ASTM C39/C39M, ACI 318, CBC Chapter 19A, and Table 1705A.3.
 - a. Test one set of four cylinders for each concrete class placed in any one day for each 50 cubic yards or fraction thereof, or for each 2000 square feet of surface area placed. One specimen will be tested at 7 days, two at 28 days, and:
 - 1) When frequency of testing will provide less than five strength tests for a given class of concrete, testing from at least five randomly selected batches, or from each batch if fewer will be conducted.
 - b. If the average of strength tests of all strength tests of a given class of concrete equals or exceeds the specified strength at 28 days, with no individual strength test less than 500 psi below that specified, the strength level of concrete will be considered satisfactory.

- c. Retain one cylinder for testing at 56 days if 28-day test fails.
- E. Moisture Vapor Emission Testing: After concrete slabs have cured and prior to installation of finish flooring materials, verify that moisture content and alkali content of concrete slabs do not exceed limits acceptable to manufacturer of flooring materials.
 - 1. Testing Equipment: Test methods based on ASTM F2170 using RH meters and testing kits equal to AMT Moisture/Relative Humidity Meter manufactured by American Moisture Test, Inc., or equivalent by Vaprecision Testing Systems may be used at testing agency's option except at concrete floors with exposed or polished finish.
 - 2. Alkalinity: Concrete pH test using calibrated digital 1-14 wide range pH meter equal to PH100 to determine alkalinity level in accordance with ASTM F710. Paper and pencil type tests are not acceptable.
 - 3. Calcium Chloride Testing: After building air conditioning has been in operation for at least 15 days, calcium chloride and pH testing kits may be used: Prepackaged test kit of commercial consistency, equipped with a sealed dish of anhydrous calcium chloride, a metering dome with butyl rubber gasket and instructions for implementation. Weigh dishes on site prior to installation. Conform with requirements of ASTM F1869.
- F. Vapor Emission and Alkalinity Testing:
 - 1. Perform vapor emission and alkalinity testing and take appropriate action based on results in relation to finish floor manufacturer's moisture and alkalinity requirements.
- G. Take one additional test cylinder during cold weather concreting, cured on job site under same conditions as concrete it represents.

3.12 FILLING, LEVELING AND PATCHING

- A. Concrete slabs exhibiting high or low spots and indicated to receive resilient floor covering or soft floor covering, shall have surfaces repaired, or as directed by LPA.
 - 1. High spots shall be honed, or ground with power-driven machines to required tolerances with approval from LPA.
 - 2. Low spots shall be filled with floor leveling compound, installed in accordance with manufacturer's written recommendations.
- B. Holes resulting from form ties or sleeve nuts shall be solidly packed, through exterior walls, by pressure grouting with cement grout, as specified. Grouted holes on exposed surfaces shall be screeded flush and finished to match adjoining surfaces.
- C. Patching Exposed Concrete: After flushing with water, pack tie wire, nail, bolt, and core sample holes which will be exposed as soon as possible after form removal. Grout and repair rough pockets, cracks, or honeycomb. If patches are required, chip defective areas to a uniform depth of at least 1 inch with sides at right angles to surface.
 - 1. Match surrounding concrete surfaces in color and texture. Make trial patch to determine color match. Before applying, moisten surrounding concrete and apply specified bonding compound.
 - 2. Smooth Formed Concrete: Grind off ridges, offsets, and other prominent marks of smooth formed concrete while concrete is green and grind smooth. Sack exposed concrete surfaces.
 - a. Painted concrete shall be considered as being exposed.
 - 3. Patch defects deeper than 1/2-inch in panels with specified patching material and methods deemed by the LPA as the appropriate method to correct such defects.
- D. Skim Coating: Where sack and patch is noted on Contract Drawings, apply to architectural formed cast-in-place concrete walls in accordance with manufacturer's instructions.
 - 1. New concrete must be cured 28 days.
 - 2. pH must be verified prior to skim coating application to determine if primer needs to be applied, as required by manufacturer.
 - 3. Clean concrete in accordance with ASTM D4258.

4. Mixing Skim Coat:
 - a. Add to water, adding only enough to make a stiff trowelable consistency like soft putty.
 - b. Add color additive.
 - c. Working Time: Approximately 15 minutes.
 5. Apply to walls with trowel in smooth uniform coat in continuous operations to maintain a uniform shade.
 6. Patching: Broad deep areas in concrete surface shall be filled with skim coat material in accordance with manufacturer's directions prior to application of skim coat. Where surfaces are shiny smooth, apply manufacturer's Type II bonding agent.
- E. Patching Unexposed Concrete: Ridges, offsets, and other prominent marks need not be ground off, cleaned, or sacked. This requirement applies to concrete areas that will be concealed by other construction.
1. Finish below-grade concrete indicated to receive waterproofing in the same manner as exposed, smooth-formed concrete, except that surfaces need not be sacked.
 2. Patch and repair concrete slabs ready to receive future finish materials installed by Owner.

3.13 DEFECTIVE CONCRETE

- A. Strength
1. Test Results: The testing agency shall report test results in writing to Architect and Contractor within 24 hours of test.
 2. If the strength of any grade of concrete for any portion of Work, as indicated by molded test cylinders, falls below minimum 28 days compressive strength specified or indicated, adjust mix design for remaining portion of construction so that resulting concrete meets minimum strength requirements.
 3. Should strength of any grade of concrete, for any portion of Work indicated by tests of molded cylinders and core tests, fall below minimum 28 days strength specified or indicated, concrete will be deemed defective and shall be evaluated by LPA and replaced or adequately strengthened in a manner acceptable to the LPA and DSA.
 4. Test Cores: Should required test cylinders fail to show minimum design compressive strength, take test cores at locations coordinated with the LPA.
 - a. If results show compressive strength to be less than design stress, concrete shall be deemed defective and shall be replaced in a manner acceptable to the Architect and DSA.
 - b. If results show compressive strength to conform to design stress, grout solid coring holes with grout exceeding design compressive strength and finish to match adjacent surface.
- B. Concrete Work that is not formed as indicated, is not true within tolerances of span, not true to intended alignment, not plumb or level where so intended, not true to intended grades and levels, cracked, contains sawdust shavings, wood or embedded debris, or does not fully conform to Contract provisions, shall be deemed to be defective Work and shall be removed and replaced.
- C. Concrete substrates for non-breathable floor finishes that indicate by testing excess quantities of moisture and alkalinity shall require remedial measures, as specified in this Section.
- D. Repair or replacement of defective concrete will be determined by the Architect. The cost of additional testing, including patching for cores, shall be borne by Contractor when defective concrete is identified.
- E. Do not patch, fill, touch-up, repair, or replace exposed concrete except upon express direction of Architect for each individual area.

3.14 CLEAN UP

- A. Remove rubbish, debris and waste materials and legally dispose of off the Project site.
- B. Wash and clean flatwork surfaces. Leave free from oil, paint, plaster, form coating, and other foreign substances, ready to receive scheduled finishes.

3.15 PROTECTION

- A. Protect the Work of this section until Substantial Completion.
- B. Do not permit traffic over unprotected concrete floor surface until fully cured.

END OF SECTION

SECTION 033511
CONCRETE FLOOR FINISHES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Liquid densifiers and hardeners.
- B. Film-forming sealers.

1.02 REFERENCE STANDARDS

- A. ANSI A326.3 - American National Standard Test Method for Measuring Dynamic Coefficient of Friction of Hard Surface Flooring Materials; 2021.
- B. ASTM D2370 - Standard Test Method for Tensile Properties of Organic Coatings; 2016 (Reapproved 2021).
- C. CAL (CDPH SM) - Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers Version 1.2; 2017.

1.03 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. Sustainable Product Data: See Section 01 6000 - Product Requirements and Section 01 6116 - Volatile Organic Compound (VOC) Content Restrictions.
 - 1. VOC content restrictions data.
 - 2. CAL (CDPH SM) compliance data.
- D. Manufacturer's installation instructions.
- E. Qualification Statements: For manufacturer and installer.
- F. Preconstruction Testing Reports: As specified in Part 1 of this Section.
- G. Preinstallation Testing Reports: As specified in Part 3 of this Section.
- H. Field Quality Control Reports: As specified in Part 3 of this Section.
- I. Maintenance Data: Provide data on maintenance and renewal of applied finishes.

1.04 COORDINATION

- A. Confirm with manufacturer that products are appropriate to Project scope and conditions.
- B. Verify required concrete surface profile with manufacturer.
- C. Confirm with manufacturer minimum required concrete cure duration prior to installation.
- D. Confirm acceptable concrete moisture content with manufacturer.

1.05 QUALITY ASSURANCE

- A. Qualifications: See Section 01 4000 - Quality Requirements.
 - 1. Manufacturer: Company specializing in manufacturing product specified in this Section for minimum 10 years documented experience.

2. Installer: Minimum 5 years documented experience installing products specified in this Section and approved by the manufacturer.
- B. Preinstallation Meetings: See Section 01 3000 - Administrative Requirements.
 1. Convene minimum 2 weeks before starting work of this Section.
- C. Preconstruction Testing: See Section 01 4000 - Quality Requirements.
 1. Owner to engage a qualified testing agency to perform tests and inspections.
 - a. Concrete floor finishes will be considered defective if they do not pass tests and inspections.
 - b. Additional tests and inspections, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
 - 1) Do not install product on the Project until passing test is achieved.
 - c. Testing and inspecting agency to prepare reports and deliver to Owner or Contractor.
 - d. Submit preconstruction testing reports to Architect.
 2. Tests:
 - a. Slip-Resistance.
 - 1) Confirm the dynamic coefficient of friction meets or exceeds the value in Performance Requirements article below. Test to ANSI A326.3.

1.06 MOCK-UPS

- A. See Section 01 4000 - Quality Requirements, for additional information.
- B. Build mockups to verify selections made under sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.
- C. For coatings, construct mock-up area under conditions similar to those that will exist during application, with coatings applied.
- D. Locate where directed by Architect.
- E. Mock-up may remain as part of the work.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. See Section 01 6000 - Product Requirements.
- B. Deliver materials to Project site in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, approval or listing agency markings, and directions for storing.
- C. Protect materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources. Store in a dry location.
- D. Comply with manufacturer's written instructions for handling, storing, and protecting during installation.
- E. See Section 01 7419 - Construction Waste Management and Disposal, for packaging waste requirements.

1.08 FIELD CONDITIONS

- A. Maintain light level equivalent to a minimum 200 W light source at 8 feet above the floor surface over each 20 foot square area of floor being finished.
- B. Do not finish floors until interior heating system is operational.
- C. Maintain ambient temperature of 50 degrees F minimum.

1.09 WARRANTY

- A. See Section 017800 - Closeout Submittals for additional warranty requirements.
- B. Manufacturer Warranty: Provide 10-year manufacturer warranty for concrete floor finish products that fail in material or workmanship within specified warranty period, commencing on the Date of Substantial Completion.

PART 2 PRODUCTS

2.01 SUSTAINABLE PRODUCT REQUIREMENTS

- A. See Section 01 6000 - Product Requirements.
- B. VOC Content Restrictions: Products in this section to not exceed VOC content limits specified in Section 01 6116 - Volatile Organic Compound (VOC) Content Restrictions.
- C. CDPH: Products to comply with CAL (CDPH SM) .

2.02 PERFORMANCE REQUIREMENTS

- A. Dynamic Coefficient of Friction (DCOF): Finished concrete floors to be minimum 0.42, in accordance with ANSI A326.3.

2.03 MANUFACTURERS

- A. Concrete Topical Treatment Manufacturers:
 - 1. ChemMasters.
 - 2. CureCrete.
 - 3. Dayton Superior.
 - 4. Dur-A-Flex.
 - 5. Laticrete.
 - 6. Prosoco.
 - 7. Rust-Oleum.
 - 8. Sika.
 - 9. W.R. Meadows.
 - 10. Substitutions: See Section 01 2500 - Substitution Procedures.

2.04 DENSIFIERS AND HARDENERS

- A. General: Used to protect concrete from moisture penetration, high-abuse, and deicing chemicals.
 - 1. Locations:
 - a. Loading docks and similar locations subject to wear.
 - b. Exterior applications subject to freeze / thaw damage.
 - c. Where shown on the Architectural drawings.
- B. Liquid Densifier and Hardener: Penetrating chemical compound that reacts with concrete, filling the pores, hardening, and dustproofing.
 - 1. Composition: Lithium silicate.
 - a. Products:
 - 1) W. R. Meadows, Inc; Liqui-Hard Ultra: www.wrmeadows.com/#sle.
 - 2) Substitutions: See Section 01 2500 - Substitution Procedures.
 - 2. Composition: Sodium silicate.
 - a. Products:

- 1) Curecrete Distribution, Inc; Ashford Formula: www.curecrete.com/#sle.
- 2) Euclid Chemical Company; EUCO DIAMOND HARD:
www.euclidchemical.com/#sle.
- 3) L&M Construction Chemicals, Inc; SEAL HARD: www.lmcc.com/#sle.
- 4) Substitutions: See Section 01 2500 - Substitution Procedures.

2.05 COATINGS

- A. Film-Forming Concrete Sealing System: 2-component high-solids sealer system applied to surface of ground concrete.
 1. Locations:
 - a. Interior applications, to protect against staining of concrete and infection control.
 - b. Where shown on the Architectural drawings.
 2. Products:
 - a. Dur-A-Flex; Dur-A-Glaze Grind and Seal.
 - b. Westcoat; Gind and Seal System.
 - c. Substitutions: See Section 01 2500 - Substitution Procedures.
 3. Physical Properties:
 - a. Sheen: Semi
 - b. Thickness: 15 to 20 mils.
 - c. Tensile Strength (ASTM D2370): 3,550 psi.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that floor surfaces are acceptable to receive the work of this section.
- B. Verify that flaws in concrete have been patched and joints filled with methods and materials suitable for further finishes.
- C. Preinstallation Testing:
 1. Owner to engage a qualified testing agency to perform tests and inspections.
 - a. Concrete substrates will be considered defective if they do not pass tests and inspections.
 - b. Additional tests and inspections, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
 - c. Testing and inspecting agency to prepare reports and deliver to Owner or Contractor.
 - d. Submit preinstallation testing reports to Architect.
 2. Tests:
 - a. Concrete Substrate Moisture and Alkalinity: Substrate moisture content and alkalinity to be confirmed by testing. See Section 090561 - Common Work Results for Flooring Preparation, for additional information.

3.02 PREPARATION

- A. See Section 01 7000 - Execution and Closeout Requirements.
- B. Prepare substrates according to manufacturer's written instructions to ensure adhesion of concrete floor finishes. Provide remediation as necessary.
 1. See Section 090561 - Common Work Results for Flooring Preparation, for additional information

3.03 INSTALLATION, GENERAL

- A. Apply materials in accordance with manufacturer's instructions.
- B. Do not exceed pot life of material as documented in writing by manufacturer.

3.04 COATING APPLICATION

- A. Verify that surface is 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. Protect adjacent non-coated areas from drips, overflow, and overspray; immediately remove excess material.
- C. Apply coatings in accordance with manufacturer's instructions, matching approved mock-ups for color, special effects, sealing and workmanship.

3.05 FIELD QUALITY CONTROL

- A. See Section 01 4000 - Quality Requirements, for additional requirements.
- B. Owner to engage a qualified testing agency to perform tests and inspections.
 - 1. Concrete floor finishes will be considered defective if they do not pass tests and inspections.
 - 2. Additional tests and inspections, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
 - 3. Testing and inspecting agency to prepare reports and deliver to Owner or Contractor.
 - 4. Submit field quality control reports to Architect.
- C. Tests:
 - 1. Slip-Resistance.
 - a. Confirm the dynamic coefficient of friction (DCOF) meets or exceeds the value in Performance Requirements article above. Test to ANSI A326.3.
- D. Manufacturer's Representative to provide inspection services as specified in Section 01 4000.
 - 1. Manufacturer's representative to prepare site inspection reports and deliver to Contractor.
 - 2. Submit field quality control reports to Architect.

3.06 PROTECTION

- A. See Section 01 7000 - Execution and Closeout Requirements, for additional information.
- B. Provide barrier or other delineation to prevent damage to installed Work from subsequent construction activities.

END OF SECTION

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SECTION 050511
SURFACE PREPARATION AND FINISHING OF METALS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Surface preparation, treatment, and finishing of metals and metal components specified in other Sections, including:
 - 1. Steel and iron surface preparation.
 - 2. Steel galvanizing.
 - 3. Steel Galvaneeling.
 - 4. Galvalume steel.
 - 5. Stainless steel.
 - 6. Weathering steel.
 - 7. Aluminum anodizing.
- B. Shop priming of metals and metal components specified in other Sections for field finish.

1.02 RELATED REQUIREMENTS

- A. Section 050513 - Shop-Applied Coatings for Metal; for coil and extrusion coatings for metal.
- B. Section 051200 - Structural Steel Framing; for surface preparation of structural steel and primer to be applied to structural steel.
- C. Section 099113 - Exterior Painting.
- D. Section 099123 - Interior Painting.
- E. Section 099600 - High-Performance Coatings.

1.03 DEFINITIONS

- A. Mechanical Finish: Provides a surface texture by only mechanical means; does not use chemical, electrochemical treatment, or additive. Finished textures vary widely, based on grinding, polishing, and buffering operations, or combinations, used..
 - 1. Directional Textured Finish: Satiny sheen produced by tiny, nearly parallel scratches in the metal surface produced by wheel or belt polishing with fine abrasives, by hand rubbing with stainless steel wool, or by brushing with abrasive wheels.
 - 2. Non-Directional Textured Finish: Matte finish of varying degrees of roughness, produced by blasting sand, glass beads, or metal shot against the metal under controlled conditions. The smoothest finish is obtained by dust blasting with a very fine abrasive and by vapor honing with a slurry of extremely fine abrasive and water. Non-directional textured finishing is not recommended on material less than 1/4 inch thick, and a surface protective treatment is required.
 - 3. Patterned Finish: Produced by passing sheet between 2 machined matched design rolls, impressing patterns on both sides of the sheet (embossing), or between a design roll and a smooth roll which "coins" one side of the sheet only.
- B. Chemical Treatment: Used as either processing for a final finish, or as a final finish.
 - 1. Surface cleaning only, such as degreasing.
 - 2. To produce a clean matte textured surface.
 - 3. To produce a smooth, bright finish.

4. To chemically convert the surface of the metal, providing a film which is a good substrate for coatings (conversion coating). Can be used to prepare the surface for painting or as a final finish.
- C. Anodic Coating (Anodizing): Process in which metal is immersed in an acid solution (referred to as an electrolyte), and a direct current is passed between the aluminum and the electrolyte, with the metal acting as the anode. This results in the controlled formation of a durable aluminum oxide film or coating, which does not affect the surface of the metal, but greatly increases the metal's resistance to corrosion and abrasion.
- D. Galvanizing: Process of applying a coating of zinc to steel or iron, to prevent rusting. The zinc protects the underlying metal by sealing the surface from airborne corrosives, and through galvanic action.
- E. Galvannealing: Steel which is galvanized, then passed through air knives to remove excess zinc, and finally annealed in a furnace while the zinc is still in a fluid state. This produces a surface layer of zinc-iron alloy. Galvannealed steel has excellent welding and paint adhesion properties.
- F. Metallic-Coated: Steel with a coating of metal by the hot dip process. Common coatings are galvanized, galvalume (55 percent aluminum-zinc alloy coated), and galvannealing.
- G. Passivate: To protect a metal from corrosion by creation of an outer layer, through chemical reaction.
- H. Weathering Steel: A type of steel which patinas under normal atmospheric conditions, protecting it from corrosion.

1.04 REFERENCE STANDARDS

- A. AA DAF-45 - Designation System for Aluminum Finishes; 2003 (Reaffirmed 2009).
- B. AAMA 611 - Specification for Anodized Architectural Aluminum; 2024.
- C. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2023.
- D. ASTM A480/A480M - Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip; 2023b.
- E. ASTM A588/A588M - Standard Specification for High-Strength Low-Alloy Structural Steel, up to 50 ksi [345 MPa] Minimum Yield Point, with Atmospheric Corrosion Resistance; 2019.
- F. ASTM A606/A606M - Standard Specification for Steel, Sheet and Strip, High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled, with Improved Atmospheric Corrosion Resistance; 2018.
- G. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2023.
- H. ASTM A792/A792M - Standard Specification for Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process; 2023.
- I. ASTM D6386 - Standard Practice for Preparation of Zinc (Hot-Dip Galvanized) Coated Iron and Steel Product and Hardware Surfaces for Painting; 2022.
- J. ASTM D7803 - Standard Practice for Preparation of Zinc (Hot-Dip Galvanized) Coated Iron and Steel Product and Hardware Surfaces for Powder Coating; 2019.
- K. SSPC-PA 1 - Shop, Field, and Maintenance Coating of Metals; 2024.
- L. SSPC-Paint 20 - Zinc-Rich Coating (Type I - Inorganic, and Type II - Organic); 2019.
- M. SSPC-SP 3 - Power Tool Cleaning; 2024.
- N. SSPC-SP 6/NACE No.3 - Commercial Blast Cleaning; 2006.
- O. SSPC-SP 16 - Brush-Off Blast Cleaning of Coated and Uncoated Galvanized Steel, Stainless Steels, and Non-Ferrous Metals; 2020.

1.05 SUBMITTALS

- A. Refer to submittals in other Sections which specify finishes in this Section.
- B. Maintenance Materials: Where field repair of shop-applied coating is acceptable, provide container of material to perform minor corrective work.

1.06 COORDINATION

- A. Confirm treatment of metal is compatible with and allows specified warranty for paint and coating systems specified in other sections.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Apply standard protective coverings to finished surfaces.

1.08 FIELD CONDITIONS

- A. Field Measurements: Verify actual dimensions by field measurement before fabrication. Show recorded measurements on shop drawings.
- B. Ambient Conditions:

1.09 WARRANTY

- A. Applicator's Warranty: Applicator agrees to repair finish or replace coated metal products that demonstrate deterioration of factory-applied systems within warranty period.
 - 1. Class I anodized finish: 10 years from date of Substantial Completion.

PART 2 PRODUCTS

2.01 SUSTAINABLE PRODUCT REQUIREMENTS

- A. See Section 01 6000 - Product Requirements.
- B. VOC Content Restrictions: Products in this section to not exceed VOC content limits specified in Section 01 6116 - Volatile Organic Compound (VOC) Content Restrictions.

2.02 PERFORMANCE REQUIREMENTS

- A. Shop-applied finishes to meet or exceed minimum performance requirements in this Section.

2.03 STEEL AND IRON SURFACE PREPARATION

- A. Prepare metal surfaces according to SSPC standards prior to application of coatings listed in this and other Sections.
 - 1. Structural Steel: See 051200 - Structural Steel Framing, for surface preparation of structural steel.
 - 2. SSPC-SP 3: Power Tool Cleaning.
 - a. Description: Requirements for power tool cleaning of steel surfaces. Power tool cleaning removes all loose mill scale, loose rust, loose paint, and other loose detrimental foreign matter. It is not intended that adherent mill scale, rust, and paint be removed by this process. Mill scale, rust, and paint are considered adherent if they cannot be removed by lifting with a dull putty knife.
 - b. Use for the following:
 - 1) Steel items not otherwise listed below.

3. SSPC-SP 6/NACE No.3: Commercial Blast Cleaning.
 - a. Description: Requirements for commercial blast cleaning of uncoated or coated steel surfaces by the use of abrasives. A commercial blast cleaned surface, when viewed without magnification, shall be free of all visible oil, grease, dust, dirt, mill scale, rust, coating, oxides, corrosion products, and other foreign matter. Random staining shall be limited to no more than 33 percent of each unit area of surface, and may consist of light shadows, slight streaks, or minor discolorations caused by stains of rust, stains of mill scale, or stains of previously applied coating.
 - b. Use for the following:
 - 1) Exterior items.
 - 2) Items indicated to receive zinc-rich primer.
4. SSPC-SP 16: Brush-off Blast Cleaning of Coated and Uncoated Galvanized Steel, Stainless Steels, and Non-Ferrous Metals.
 - a. Description: Requirements for roughening and cleaning hot-dip galvanized surfaces to create a profile suitable for painting or coating. Completion of this process produces a profiled surface free of all visible oil, grease, dirt, dust, metal oxides, and other foreign matter when viewed without magnification. The standard also contains unique procedures, including inspection for a passivation treatment and wet storage stain.
 - b. Use for the following:
 - 1) Galvanized-steel items to be painted or coated, including powder coating.
 - c. Acceptable alternative preparation method for galvanized items to be painted: ASTM D6386.
 - d. Acceptable alternative preparation method for galvanized items to be powder-coated: ASTM D7803.

2.04 STEEL GALVANIZING

- A. Galvanizing: Hot-dip galvanize steel and iron items to comply with the following:
 1. Sheet Steel: ASTM A653/A653M. Total both sides weight of coating as follows:
 - a. G30 (Z90 metric): 0.30 oz/ft².
 - b. G40 (Z120 metric): 0.40 oz/ft².
 - c. G60 (Z180 metric): 0.60 oz/ft².
 - d. G90 (Z275 metric): 0.90 oz/ft².
 - e. G115 (Z350 metric): 1.15 oz/ft².
 2. Steel and Iron Hardware: ASTM A153/A153M. Weight of coating as follows:
 - a. Class A: Castings, malleable iron, and steel: 2.0 oz/ft² minimum.
 - b. Class B1: Rolled, pressed, and forged articles 5/8 inch in thickness and over 15 inches in length: 2.0 oz/ft² minimum.
 - c. Class B2: Rolled, pressed, and forged articles under 5/8 inch in thickness and over 15 inches in length: 1.5 oz/ft² minimum.
 - d. Class B3: Rolled, pressed, and forged articles, any thickness and less than 15 inches in length: 1.3 oz/ft² minimum.
 - e. Class C: Fasteners over 3/8 inch in diameter and similar, and washers 3/16 inches and greater in thickness: 1.25 oz/ft² minimum.
 - f. Class D: Fasteners 3/8 inch and under in diameter, including rivets, nails, and similar; and washers under 3/16 inch in thickness: 1.0 oz/ft² minimum.
 3. Steel and iron products made from rolled, pressed, and forged shapes, castings, plates, bars, and strips: ASTM A153/A153M.
 4. Galvanized Steel to be Painted / Coated: Do not quench or apply post-galvanizing treatments that might interfere with paint adhesion.

2.05 STEEL GALVANNEALING

- A. Galvannealed Steel: Zinc-iron alloy-coated (Galvannealed) steel to comply with the following:
 - 1. Steel Sheet: ASTM A653/A653M. Total both sides weight of coating as follows:
 - a. A25 (ZF75 metric): 0.25 oz/ft².
 - b. A40 (ZF120 metric): 0.40 oz/ft².
 - c. A60 (ZF180 metric): 0.60 oz/ft².

2.06 GALVALUME STEEL

- A. Galvalume Steel: 55 percent aluminum-zinc alloy-coated (Galvalume) steel to comply with the following:
 - 1. Steel Sheet: ASTM A792/A792M. Total both sides weight of coating as follows:
 - a. AZ30 (AZM100 metric): 0.30 oz/ft².
 - b. AZ35 (AZM110 metric): 0.35 oz/ft².
 - c. AZ40 (AZM120 metric): 0.40 oz/ft².
 - d. AZ50 (AZM150 metric): 0.50 oz/ft².
 - e. AZ55 (AZM165 metric): 0.55 oz/ft².
 - f. AZ60 (AZM180 metric): 0.60 oz/ft².
 - g. AZ70 (AZM210 metric): 0.70 oz/ft².

2.07 STAINLESS STEEL

- A. Stainless Steel: Alloys of steel containing greater than 10 percent chromium.
 - 1. Standard Environments: Exterior, exposed stainless steel to be Type 304, typical unless noted otherwise.
 - 2. Corrosive Environments: Exterior, exposed stainless steel to be Type 316L, typical unless noted otherwise.
 - 3. See Section 011000 - Summary, for additional information.
- B. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.
- C. Provide finish as specified in other Sections. Finish to align with requirements of ASTM A480/A480M:
 - 1. Unpolished Finishes:
 - a. No. 1: Hot-rolled, annealed, and descaled.
 - 1) Description: Commonly referred to as hot-rolled annealed, or pickled, or descaled. This is a dull, nonreflective finish.
 - b. No. 2B: Cold-rolled, bright finish.
 - 1) Description: A smooth, moderately reflective cold-rolled annealed and pickled or descaled finish typically produced by imparting a final light cold-rolled pass using polished rolls. This general-purpose finish is more readily polished than a No. 1 or 2D finishes.
 - c. No. 2D: Cold-rolled, dull finish.
 - 1) A smooth, non-reflective cold-rolled, annealed, and pickled or descaled finish. This nondirectional finish is favorable for retention of lubricants in deep drawing applications.
 - d. Bright annealed.
 - 1) Description: A smooth, bright, reflective finish typically produced by cold rolling followed by annealing in a protective atmosphere so as to prevent oxidation and scaling during annealing.
 - 2. Polished Finishes:
 - a. No. 3: Intermediate polished finish.

- 1) Description: A linearly textured finish that may be produced by either mechanical polishing or rolling. Average surface roughness (Ra) can generally be up to 40 micro-inches.
 - b. No. 4: General purpose polished finish.
 - 1) Description: A linearly textured finish that may be produced by either mechanical polishing or rolling. Average surface roughness (Ra) can generally be up to 25 micro-inches.
 - c. No. 6: Dull, satin finish, Tampico brushed.
 - 1) Description: Soft, satin appearance typically produced by Tampico brushing a No. 4 finish.
 - d. No. 7: High luster finish.
 - 1) Description: Has a high degree of reflectivity. It is produced by buffing a finely ground surface, but the grit lines are not removed.
 - e. No. 8: Mirror finish.
 - 1) Description: A highly-reflective, smooth finish typically produced by polishing with successively finer grit abrasives, then buffing.
- D. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

2.08 WEATHERING STEEL

- A. Weathering Steel: ASTM A588/A588M and ASTM A606/A606M.

2.09 ALUMINUM, GENERAL

- A. Treat and finish aluminum according to the Aluminum Association Designation System AA DAF-45. Treatment and finish of aluminum components may include combinations of mechanical finishes (M##), chemical treatments and finishes (C##), and anodic coatings (A##), as defined by AA DAF-45.
- B. Subject to compliance with requirements, acceptable aluminum treatment and finishing processors include:
1. ABC Aluminum Solutions.
 2. Linetec.
 3. Lorin.
 4. Pioneer Metal Finishing.
 5. Quality Coatings.
 6. Sierra Aluminum Company.
 7. Southern Aluminum Finishing (SAF).
 8. Substitutions: See Section 01 2500 - Substitution Procedures.

2.10 ALUMINUM ANODIZING

- A. Class I Anodizing: When specified in other Sections, provide anodizing treatment of aluminum as designated by AA DAF-45 and compliant with AAMA 611, Class I:
1. Clear Anodic Finish: AAMA 611, Class I, AA-M12C22A41.
 2. Color Anodic Finish: AAMA 611, Class I, AA-M12C22A42/43/44.
 - a. Color: As specified in applicable Section or as selected by Architect.
 3. AAMA 611, Class I Minimum Performance Requirements:
 - a. Film Thickness: 0.7 mils.
 - b. Salt Spray Resistance: 3,000 hours.
 - c. Color Retention: Maximum of 5 Hunter units of color change in 10 years.
 - d. Gloss Uniformity: 15 unit Variation.

4. Location:
 - a. All exterior applications.
 - b. Interior applications subject to excessive wear or abrasion.
- B. Class II Anodizing: When specified in other Sections, provide anodizing treatment of aluminum as designated by AA DAF-45 and compliant with AAMA 611, Class II:
 1. Clear Anodic Finish: AAAMA 611, Class II, AA-M12C22A31.
 2. Color Anodic Finish: AAMA 611, Class II, AA-M12C22A32/33/34.
 - a. Color: As specified in applicable Section or as selected by Architect.
 3. AAMA 611, Class II Minimum Performance Requirements:
 - a. Film Thickness: 0.4 mils.
 - b. Salt Spray Resistance: 1,000 hours.
 - c. Color Retention: Maximum of 5 Hunter units of color change in 10 years.
 - d. Gloss Uniformity: 15 unit Variation.
 4. Location:
 - a. Interior applications not subject to excessive wear or abrasion.

2.11 STRUCTURAL STEEL SHOP PRIMING

- A. See Section 051200 - Structural Steel Framing for additional information.

2.12 SHOP PRIMING FOR FIELD FINISH

- A. Shop Primers: Provide primers that comply with field finish, as specified in the following Sections:
 1. Section 099113 - Exterior Painting.
 2. Section 099123 - Interior Painting.
 3. Section 099600 - High-Performance Coatings.
- B. Shop Priming: Apply shop primer to comply with SSPC-PA 1.
 1. Stripe paint corners, crevices, bolts, welds, and sharp edges.
 2. Shop prime iron and steel items not indicated to be galvanized unless they are to be embedded in concrete, sprayed-on fireproofing, or masonry, or unless otherwise indicated.

2.13 MISCELLANEOUS MATERIALS

- A. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paint specified to be used over it.

PART 3 EXECUTION

3.01 REPAIR

- A. Field Repair: When acceptable to manufacturer, field repair shop-applied coatings per manufacturer's instructions and materials.
 1. When not acceptable, return to shop for corrections.
- B. Replace items that cannot be repaired.

END OF SECTION

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SECTION 050513
SHOP-APPLIED COATINGS FOR METAL

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Factory-applied, heat-cured coating systems for metal substrates.

1.02 RELATED REQUIREMENTS

- A. Section 099113 - Exterior Painting: For shop and field applied air-cured paint for steel substrates.
- B. Section 099600 - High-Performance Coatings: For shop and field applied air-cured high-performance coatings for steel substrates.

1.03 DEFINITIONS

- A. Coil Coating: Coating system applied in liquid form to continuous flat metal stock. The finished metal is wound into a circular coil for later fabrication by others. This is a type of pre-painting.
- B. Extrusion Coating: Coating system spray-applied to extruded components, flat metal that is too thick to be coil coated (greater than 0.080 inches), and decorative metal with voids and other openings. This is a type of post-painting. Extrusion coatings can be both liquid and powder form.
- C. Mica Finish: Utilizes mica, a naturally occurring mineral, which provides a pearlescent appearance. Mica powder provides better color consistency than metal flakes.
- D. Metallic Finish: Utilizes metal flakes for a sparkle appearance.
- E. Barrier Coat: Used in a four-coat system only, to protect the prime coat below from UV damage.

1.04 REFERENCE STANDARDS

- A. AAMA 2603 - Voluntary Specification, Performance Requirements and Test Procedures for Pigmented Organic Coatings on Aluminum Extrusions and Panels (with Coil Coating Appendix); 2022.
- B. AAMA 2604 - Voluntary Specification, Performance Requirements and Test Procedures for High Performance Organic Coatings on Aluminum Extrusions and Panels (with Coil Coating Appendix); 2022.
- C. AAMA 2605 - Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels (with Coil Coating Appendix); 2022.
- D. ASTM D523 - Standard Test Method for Specular Gloss; 2025.
- E. ASTM D968 - Standard Test Methods for Abrasion Resistance of Organic Coatings by Falling Abrasive; 2022.
- F. ASTM D2244 - Standard Practice for Calculation of Color Tolerances and Color Differences from Instrumentally Measured Color Coordinates; 2023.
- G. ASTM D4214 - Standard Test Methods for Evaluating the Degree of Chalking of Exterior Paint Films; 2023.

- H. ASTM D7091 - Standard Practice for Nondestructive Measurement of Dry Film Thickness of Nonmagnetic Coatings Applied to Ferrous Metals and Nonmagnetic, Nonconductive Coatings Applied to Non-Ferrous Metals; 2022.

1.05 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements.
- B. Refer to submittals in other Sections which specify finishes in this Section.
- C. Maintenance Materials: Where field repair of shop-applied coating is acceptable, provide container of material to perform minor corrective work.
- D. Qualification Statement: For installer.

1.06 COORDINATION

- A. Coordinate substrates and shop-applied coating systems. Where items are indicated to match coatings selected for other items, adjust formulations as required to achieve match.

1.07 QUALITY ASSURANCE

- A. Qualifications: See Section 01 4000 - Quality Requirements.
 - 1. Applicator Qualifications: Coating manufacturer's certified applicator equipped and trained for application of coatings, and approved to provide warranty specified.

1.08 DELIVERY, STORAGE & HANDLING

- A. See Section 01 6000 - Product Requirements.
- B. Deliver, unload, and store coated items so that they remain free of damage and deformation. Package and protect items during shipping and handling. Protect stored items from water. Keep coated items out of contact with materials that may adversely affect the coating.
- C. See Section 01 7419 - Construction Waste Management and Disposal, for packaging waste requirements.

1.09 WARRANTY

- A. See Section 01 6000 - Product Requirements.
- B. Contractor to provide Single Source Specimen Warranty (color, chalk, and fade), as provided by Coating Manufacturer, as part of Total System Executed Warranty (corrosion, adhesion) as provided by end manufacturer for both coil and extrusion products.
- C. Special Coating Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components on which coatings do not comply with requirements or that fail in materials or workmanship within specified warranty period. Warranty does not include normal weathering.
 - 1. Deterioration includes, but is not limited to, the following:
 - a. Color fading more than 5 Hunter units when tested according to ASTM D2244.
 - b. Chalking in excess of a No. 8 rating when tested according to ASTM D4214.
 - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
 - 2. Superior Coatings (AAMA 2605) Warranty Period: 20 years from date of Substantial Completion.
 - 3. High-Performance Coatings (AAMA 2604) Warranty Period: 10 years from date of Substantial Completion.
 - 4. Pigmented Coatings (AAMA 2603) Warranty Period: 1 year from date of Substantial Completion.

PART 2 PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Coatings in this Section are divided into three performance levels, from highest to lowest, as defined by organization standards and supported by manufacturer's warranty:
 - 1. Superior.
 - 2. High-Performance.
 - 3. Pigmented.
- B. Refer to referenced standards for additional performance requirements not listed here.
- C. Superior Coatings:
 - 1. Warrantied Substrates:
 - a. Aluminum extrusions (AAMA 2605).
 - b. Aluminum coil (AAMA 2605 Appendix).
 - c. Galvanized steel coil (AAMA 2605).
 - 2. Minimum Performance Requirements:
 - a. Test Duration: 4,000 hours.
 - b. Dry Film Thickness (ASTM D7091): 1.2 mils minimum.
 - c. Abrasion Resistance (ASTM D968): Coefficient of 40 minimum.
 - d. Color Retention (ASTM D2244): Maximum of 5 Hunter units of color change.
 - e. Chalk Resistance (ASTM D4214): No more than No. 8 rating for color, No. 6 rating for whites, after 10 years.
 - f. Gloss Retention (ASTM D523): More than 50 percent retention after 10 years.
- D. High-Performance Coatings:
 - 1. Warrantied Substrates:
 - a. Aluminum extrusions (AAMA 2604).
 - b. Aluminum coil (AAMA 2604 Appendix).
 - 2. Minimum Performance Requirements:
 - a. Test Duration: 3,000 hours.
 - b. Dry Film Thickness (ASTM D7091): 1.2 mils minimum.
 - c. Abrasion Resistance (ASTM D968): Coefficient of 20 minimum.
 - d. Color Retention (ASTM D2244): Maximum of 5 Hunter units of color change.
 - e. Chalk Resistance (ASTM D4214): No more than No. 8 rating for color after 5 years.
 - f. Gloss Retention (ASTM D523): Minimum 30 percent retention after 5 years.
- E. Pigmented Coatings:
 - 1. Warrantied Substrates:
 - a. Aluminum extrusions (AAMA 2603).
 - b. Aluminum coil (AAMA 2603 Appendix).
 - 2. Minimum Performance Requirements:
 - a. Test Duration: 1,500 hours.
 - b. Dry Film Thickness (ASTM D7091): 0.8 mils minimum.
 - c. Color Retention (ASTM D2244): Slight change allowed.
 - d. Chalk Resistance (ASTM D4214): Slight change allowed.
 - e. Gloss Retention (ASTM D523): Slight change allowed.

2.02 MANUFACTURERS

- A. Manufacturers:
 - 1. AkzoNobel.
 - 2. Sherwin Williams (formerly Valspar).

3. PPG.
 4. Substitutions: See Section 01 2500 - Substitution Procedures.
- B. Single Source: For each coating system, provide all components of system from same manufacturer.

2.03 SHOP-APPLIED COATINGS, GENERAL

- A. Comply with coating manufacturer's written instructions for cleaning, conversion coating, applying, and baking finish.
- B. UV-Stable Primers: For finish coats that are transparent, translucent, iridescent, and metallic, provide UV-stable primer to protect coating system integrity.
- C. Gloss: As selected by Architect from manufacturer's range for specific system, typical.
- D. Clear coat: Optional protection to color coat, except for metallic flake or as another barrier coat that can easily be rinsed with fresh water to eliminate salt residue or used to improve chalk and fade resistance.

2.04 SUPERIOR COATINGS (AAMA 2605)

- A. 70 percent PVDF Fluoropolymer, Two-Coat: Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat.
 1. System Components: Primer and PVDF color coat.
 2. Extrusion Products:
 - a. AkzoNobel; Trinar Ultra.
 - b. PPG; Duranar.
 - c. Sherwin Williams; Fluropon.
 3. Coil Products:
 - a. AkzoNobel; Trinar Ultra.
 - b. PPG; Duranar.
 - c. Sherwin Williams; Fluropon.
 4. Basis of Design Colors:
 - a.
 5. Gloss: As selected from manufacturer's full range.
- B. 70 percent PVDF Mica Fluoropolymer, Two-Coat: Fluoropolymer finish with suspended mica, and containing not less than 70 percent PVDF resin by weight in color coat.
 1. System Components: Primer, PVDF color coat with mica.
 2. Extrusion Products:
 - a. AkzoNobel; Tri-Escent II.
 - b. PPG; Duranar Sunstorm.
 - c. Sherwin Williams; Fluropon Classic II.
 3. Coil Products:
 - a. AkzoNobel; Tri-Escent II.
 - b. PPG; Duranar Sunstorm.
 - c. Sherwin Williams; Fluropon Classic II.
 4. Basis of Design Colors:
 - a.
 5. Gloss: As selected from manufacturer's full range.
- C. 70 percent PVDF Metallic Fluoropolymer, Three-Coat: Fluoropolymer finish with suspended metallic flakes, and containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat.
 1. System Components: Primer, PVDF color coat with metallic flakes, and PVDF clear coat.
 2. Extrusion Products:

- a. AkzoNobel; Trinar TMC.
 - b. PPG; Duranar XL Metallic.
 - c. Sherwin Williams; Fluoropon Classic.
 3. Coil Products:
 - a. AkzoNobel; Trinar TMC.
 - b. PPG; Duranar XL Metallic.
 - c. Sherwin Williams; Fluoropon Classic.
 4. Basis of Design Colors:
 - a.
 5. Gloss: As selected from manufacturer's full range.
- D. Powder Coating, One-Coat: Fluoropolymer finish containing resin and solar-reflective, metal-oxide pigments.
 1. System Components: Color coat.
 2. Extrusion Products:
 - a. AkzoNobel; Interpon D3000.
 - b. PPG; Coraflon Powder.
 - c. Sherwin Williams; Powdura OneCure.
 3. Basis of Design Colors:
 - a.
 4. Gloss: As selected from manufacturer's full range.
- E. Powder Coating, Mica, One-Coat: Fluoropolymer finish containing resin with suspended mica, and solar-reflective metal-oxide pigments.
 1. System Components: Color coat with mica.
 2. Extrusion Products:
 - a. AkzoNobel; Interpon D3000.
 - b. PPG, Coraflon Sunstorm Powder.
 3. Basis of Design Colors:
 - a.
 4. Gloss: As selected from manufacturer's full range.

2.05 HIGH-PERFORMANCE COATINGS (AAMA 2604)

- A. 50 percent PVDF Fluoropolymer, Two-Coat: Fluoropolymer finish containing not less than 50 percent PVDF resin by weight in color coat.
 1. System Components: Primer and PVDF color coat.
 2. Extrusion Products:
 - a. AkzoNobel; Alum-A-Star 50.
 - b. PPG; Acrynar.
 - c. Sherwin Williams; Acroflur.
 3. Basis of Design Colors:
 - a.
 4. Gloss: As selected from manufacturer's full range.
 5. Locations:
 - a. Interior exposed aluminum for aluminum framing systems.

2.06 FIELD TOUCH-UP MATERIAL

- A. Field Touch-Up Material: Field-applied, air-dry system recommended by coating manufacturer for substrate and location.

2.07 FACTORY AND SHOP FINISHING

- A. Pretreatment: Mechanically clean and chemically pre-treat fabricated items in accordance with coating manufacturer's requirements and AAMA requirements for finish indicated.
- B. Apply primer and finish coats in accordance with coating manufacturer's requirements for finish indicated.
- C. Thermally cure coating immediately following application.
- D. Process coil coatings in one production run for metallic coatings.
- E. Surface Appearance: Cured coating must be visibly free from flowlines, streaks, blisters and other surface imperfections on exposed surfaces.
 - 1. Surfaces shall have no signs of mill finish aluminum or galvanized material showing.
 - 2. No rack or gripper marks caused by the finishing process on exposed aluminum surfaces will be permitted.

PART 3 EXECUTION

3.01 EXAMINATION

- A. See Section 01 7000 - Execution and Closeout Requirements.
- B. Examine finished metal products to confirm no damage has occurred.
 - 1. Damaged products that cannot be fixed by field touch-up, to the satisfaction of the Architect, will be rejected.

3.02 REPAIR AND TOUCH-UP

- A. Repair with coating manufacturer's recommended products or system.
- B. Apply to all minor areas of exposed metal due to scratches, abrasions, in-field end cuts or of the like typically occurring during transit or installation of product, to ensure protection of the metal substrate.

3.03 PROTECTION

- A. See Section 01 7000 - Execution and Closeout Requirements.
- B. Provide barrier or other delineation to prevent damage to installed Work from subsequent construction activities.

END OF SECTION

SECTION 051200
STRUCTURAL STEEL FRAMING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Structural steel framing members.
- B. Structural steel .
- C. Base plates, shear stud connectors and expansion joint plates.
- D. Grouting under base plates.

1.02 RELATED REQUIREMENTS

- A. Section 014113.11 - Regulatory Requirements - Global Warming Potential (GWP)
- B. Section 031000 - Concrete Forming and Accessories.
- C. Section 033000 - Cast-in-Place Concrete.
- D. Section : Additional requirements for structural steel members designated as architecturally-exposed structural steel (AESS).
- E. Section 052100 - Steel Joist Framing.
- F. Section 053100 - Steel Decking: Support framing for small openings in deck.
- G. Section 055000 - Metal Fabrications: Steel fabrications affecting structural steel work.

1.03 REFERENCE STANDARDS

- A. The applicable version of the standards listed below shall be per Chapter 35 of Part 2 of the 2022 edition of the California Building Code (CBC), including addendums and errata. Where the standard is not listed, then the most current version of the standard shall be used or as referenced by other standards.
 - 1. AISC (MAN) - Steel Construction Manual.
 - 2. AISC 303 - Code of Standard Practice for Steel Buildings and Bridges.
 - 3. AISC 341 - Seismic Provisions for Structural Steel Buildings.
 - 4. AISC 360 - Specification for Structural Steel Buildings.
 - 5. ASTM A36/A36M - Standard Specification for Carbon Structural Steel.
 - 6. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
 - 7. ASTM A108 - Standard Specification for Steel Bar, Carbon, and Alloy, Cold Finished.
 - 8. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
 - 9. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
 - 10. ASTM A242/A242M - Standard Specification for High-Strength Low-Alloy Structural Steel.
 - 11. ASTM A307 - Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60,000 PSI Tensile Strength.
 - 12. ASTM A449 - Standard Specification for Hex Cap Screws, Bolts and Studs, Steel, Heat Treated, 120/105/90 ksi Minimum Tensile Strength, General Use.
 - 13. ASTM A500/A500M - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.

14. ASTM A501/A501M - Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing.
 15. ASTM A563 - Standard Specification for Carbon and Alloy Steel Nuts.
 16. ASTM A563M - Standard Specification for Carbon and Alloy Steel Nuts [Metric].
 17. ASTM A572/A572M - Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel.
 18. ASTM A992/A992M - Standard Specification for Structural Steel Shapes.
 19. ASTM A1008/A1008M - Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable.
 20. 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.
 21. ASTM C1107/C1107M - Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink).
 22. ASTM E94/E94M - Standard Guide for Radiographic Examination Using Industrial Radiographic Film.
 23. ASTM E164 - Standard Practice for Contact Ultrasonic Testing of Weldments.
 24. ASTM E165/E165M - Standard Test Method for Liquid Penetrant Examination for General Industry.
 25. ASTM E709 - Standard Guide for Magnetic Particle Testing.
 26. ASTM F3125/F3125M - Standard Specification for High Strength Structural Bolts, Steel and Alloy Steel, Heat Treated, 120 ksi (830 MPa) and 150 ksi (1040 MPa) Minimum Tensile Strength, Inch and Metric Dimensions.
 27. ASTM F436/F436M - Standard Specification for Hardened Steel Washers Inch and Metric Dimensions.
 28. ASTM E94 - Standard Guide for Radiographic Examination.
 29. ASTM F959/F959M - Standard Specification for Compressible-Washer-Type Direct Tension Indicators for Use with Structural Fasteners, Inch and Metric Series.
 30. ASTM F1554 - Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength.
 31. AWS A2.4 - Standard Symbols for Welding, Brazing, and Nondestructive Examination.
 32. AWS D1.1/D1.1M - Structural Welding Code - Steel.
 33. AWS D1.4/D1.4M - Structural Welding Code - Reinforcing Steel.
 34. AWS D1.8/D1.8M - Structural Welding Code - Seismic Supplement.
 35. IAS AC172 - Accreditation Criteria for Fabricator Inspection Programs for Structural Steel; International Accreditation Service, Inc.
 36. SSPC SP-1 - Solvent Cleaning.
 37. SSPC SP-2 - Hand Tool Cleaning.
 38. SSPC SP 3 - Power Tool Cleaning.
- B. California Code of Regulations (CCR):
1. CBSC, Title 24, Part 2- California Building Code (CBC) 2022 edition.
 - a. Chapter 17 - Structural Tests and Inspections.
 - b. Chapter 22 - Steel.
 2. CBSC, Title 24, Part 11 - California Green Building Standards Code (CALGreen)
 - a. Supplement 1, July 2024
- C. ICC Evaluation Service, Inc. (ICC ES), a subsidiary corporation of the International Code Council:
1. ICC ES Evaluation Reports, Materials, Products, Methods and Types of Construction, with current report (ESR).
- D. International Association of Plumbing and Mechanical Officials (IAPMO):

1. UES Evaluation Service Reports (IAMPO R&T).
- E. Research Council on Structural Connections
 1. Specification for Structural Joints Using High-Strength Bolts.

1.04 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Shop Drawings:
 1. Indicate profiles, sizes, spacing, locations of structural members, openings, attachments, and fasteners.
 - a. Individual items of structural steel shall be cross-referenced by grid location.
 2. Indicate cambers.
 3. Indicate welded connections with AWS A2.4 welding symbols. Indicate net weld lengths. Indicate shop or field welds.
- C. Manufacturer's Mill Certificate: Certify that products meet or exceed specified requirements.
 1. Submit Charpy-V-Notch (CVN) Impact Test results from the manufacturer for applicable steel members and components.
- D. Mill Test Reports: Indicate structural strength, destructive test analysis and non-destructive test analysis.
- E. Fabricator Test Reports: Comply with ASTM A1011/A1011M.
- F. Welders Certificates: Certify welders employed on the Work, verifying AWS qualification within the previous 12 months.
- G. Fabricator's Qualification Statement.
- H. Fabricator's Qualification Statement: Provide documentation showing steel fabricator is accredited under IAS AC172 or AISC Certified Fabricator.
- I. Welding Procedures:
 1. Submit welding procedures, indicating joint details and tolerances, preheat and interpass temperature, post heat treatment, single or multiple pass, electrode type and size, welding current, polarity, and amperes and roof treatment.
 - a. Project CWI shall review WPS and PQRs prior to submittal to the Architect.
 2. Welding procedures shall comply with the requirements of AWS D1.1 and D1.8, and it shall include the welding parameters recommended by the welding electrode manufacturer.
 3. Refer to Structural Contract Drawings for weld testing and inspection.
 4. Submit Charpy-V-Notch (CVN) Impact Test results from the manufacturer for applicable welds.
- J. Sustainable Design Submittals
 1. Type III factory-specific or product-specific environmental product declarations (EPD) for each of the following products:
 - a. Hot Rolled Structural Steel
 - b. Hollow Structural Steel
 - c. Steel Plate

1.05 QUALITY ASSURANCE

- A. Fabricate structural steel members in accordance with AISC (MAN) "Steel Construction Manual and AISC 303 - Code of Standard Practice.
- B. Structural steel members designated as architecturally-exposed structural steel (AESS) to also comply with Section .

- C. Fabricator: Company specializing in performing the work of this section with minimum 5 years of documented experience.
- D. Fabricator Qualifications: A qualified steel fabricator that is accredited by the International Accreditation Service (IAS) Fabricator Inspection Program for Structural Steel in accordance with IAS AC172 or Certified by AISC or City of Los Angeles.
- E. Erector: Company specializing in performing the work of this section with minimum 5 years of documented experience.
 - 1. Licensed, certified by AISC or City of Los Angeles, and approved in writing by the accepted fabricator.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. A. Storage: Protect steel members that will be stored on site for a prolonged period to protect from adverse effects of exposure to weather.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Steel Angles and Channels: As specified in contract drawings.
- B. Steel W Shapes and Tees: As specified in contract drawings.
- C. Rolled Steel Structural Shapes: As specified in contract drawings.
- D. Steel Plates: As specified in contract drawings.
- E. Cold-Formed Structural Tubing: As specified in contract drawings
- F. Steel Sheet: ASTM A1011/A1011M, Designation SS, Grade 30 hot-rolled, or ASTM A1008/A1008M, Designation SS, Grade 30 cold-rolled.
- G. Pipe: As specified in contract drawings.
- H. Shear Stud Connectors: As specified in contract drawings.
- I. Structural Bolts and Nuts: Carbon steel, ASTM A307, Grade A and galvanized in compliance with ASTM A153/A153M Class C.
- J. High-Strength Structural Bolts, Nuts, and Washers: As specified in contract drawings.
- K. Tension Control Bolts: Twist-off type; ASTM F3125/F3125M.
- L. Load Indicator Washers: Provide washers complying with ASTM F959/F959M at connections requiring high-strength bolts.
- M. Welding Materials: AWS D1.1/D1.1M; type required for materials being welded.
- N. Grout: ASTM C1107/C1107M; Non-shrink; premixed compound consisting of non-metallic aggregate, cement, water reducing and plasticizing agents.
 - 1. Minimum Compressive Strength as indicated in structural drawings.
 - 2. Minimum Compressive Strength at 28 Days: 8,000 pounds per square inch.
- O. Adhesive Anchoring Systems: As indicated in contract drawings.
- P. Mechanical Anchors: As indicated in contract drawings.
- Q. Shop and Touch-Up Primer: Fabricator's standard, complying with VOC limitations of authorities having jurisdiction.
- R. Touch-Up Primer for Galvanized Surfaces: Fabricator's standard, complying with VOC limitations of authorities having jurisdiction.
- S. Global Warming Potential (GWP) Limits:

1. Hot Rolled Structural Steel: as indicated on the drawings
2. Hollow Structural Steel: as indicated on the drawings
3. Steel Plate: as indicated on the drawings.

2.02 FABRICATION

- A. Fabricate structural steel in accordance with the AISC Specification and CBC Chapter 22. Do not start fabrication until mill test reports have been accepted by Architect.
- B. Shop fabricate to greatest extent possible.
- C. Properly mark and match-mark materials for field assembly. Fabricate for delivery sequence which will expedite erection and minimize field handling of materials.
- D. Holes shall be standard hole diameter, unless noted otherwise.
 1. Holes for anchor bolts cast in concrete may be oversized in accordance with AISC Manual. Provide washer as indicated.
- E. Welded Connections: Refer to Structural Contract Drawings for welding requirements.
 1. Make welded connections in accordance with AWS D1.1/D1.1M and AWS D1.8/D1.8M.
- F. Headed Welded Studs: Prepare steel surfaces as recommended by the manufacturer of the shear connectors. Shop or field-weld headed welded studs, spaced as indicated, to beams and columns. Use automatic end welding of headed stud shear connectors in accordance with the manufacturer's printed instructions. Provide complete fusion between end of the stud and the member without porosity or evidence of lack of fusion.
- G. Galvanizing: Hot dip galvanize ferrous metal in accordance with ASTM A 123. Hot dip galvanize exterior ferrous steel. Perform galvanizing after fabrication (shearing, punching, bending, forming, assembling, and welding) in the largest units practicable. Remove projections, barbs, and icicles after galvanizing.

2.03 FINISH

- A. Prepare structural component surfaces in accordance with SSPC-SP 3.
- B. Shop prime structural steel members. Do not prime surfaces that will be fireproofed, field welded, in contact with concrete, or high strength bolted.

2.04 SOURCE QUALITY CONTROL

- A. No structural steel materials may be used, fabricated, or furnished until written acceptance of quality control submittals is issued by the code enforcement agency.
 1. Conduct a thorough material ID and mill certification review for steel products.
 2. Provide identifiable steel per CBC 2202A.
 - a. Unidentifiable steel shall not be permitted for use.
- B. Conform to the inspection requirements of CBC Chapter 17A and the testing requirements of CBC 2204A:
 1. Special inspection of Structural Welding and bolting shall be per CBC 1705A.2.
 - a. Inspection of shop and field welding operations shall be made by a qualified welding inspector approved by the enforcement agency. The minimum requirements for a qualified welding inspector shall be as those for an AWS certified welding inspector (CWI), as defined in the provisions of the AWS QC1. All welding inspectors shall be as approved by the enforcement agency.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that conditions are appropriate for erection of structural steel and that the work may properly proceed.

3.02 ERECTION

- A. Erect structural steel in compliance with AISC 303 and AISC 360.
- B. Allow for erection loads, and provide sufficient temporary bracing to maintain structure in safe condition, plumb, and in true alignment until completion of erection and installation of permanent bracing.
 - 1. Level and plumb individual members of structure within specified AISC tolerances.
- C. Splice members only where indicated and accepted on final shop drawings.
- D. Do not enlarge holes in members by burning or by use of drift pins except in secondary bracing members. Ream holes that must be enlarged to accept bolts.
- E. Back-up bars, dams, and runoff tabs shall be removed: the weld, base metal shall be ground flush and smooth per AWS.
- F. High-Strength Steel Bolting: Perform in accordance with the AISC 303, AISC 36, and in accordance CBC Chapter 22A.
 - 1. Materials, method of installation and tension control, type of wrenches to be used, and inspection methods shall conform to ASTM F3125.
- G. Do not field cut or alter structural members without approval of Architect.
- H. After erection, prime welds, abrasions, and surfaces not shop primed, except surfaces to be in contact with concrete.
- I. Grout solidly between column plates and bearing surfaces, complying with manufacturer's instructions for nonshrink grout. Trowel grouted surfaces smooth, splaying neatly to 45 degrees.

3.03 TOLERANCES

- A. Steel members and erection shall conform with requirements of AISC 303 and AISC 360.

3.04 FIELD QUALITY CONTROL

- A. An independent testing agency will perform field quality control tests, as specified in Section 014000 - Quality Requirements.

END OF SECTION

**SECTION 053100
STEEL DECKING**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Acoustical roof deck.
- B. Roof deck.
- C. Composite floor deck.
- D. Supplementary framing for openings up to and including 18 inches.
- E. Bearing plates and angles.
- F. Stud shear connectors.
- G. Acoustical insulation in roof deck flutes.

1.02 RELATED REQUIREMENTS

- A. Section 031000 - Concrete Forming and Accessories.
- B. Section 032000 - Concrete Reinforcing.
- C. Section 033000 - Cast-in-Place Concrete.
- D. Section 051200 - Structural Steel Framing
- E. Section 052100 - Steel Joist Framing
- F. Section 055000 - Metal Fabrications

1.03 REFERENCE STANDARDS

- A. The applicable version of the standards listed below shall be per Chapter 35 of Part 2 of the 2022 edition of the California Building Code (CBC), including addendums and errata. Where the standard is not listed, then the most current version of the standard shall be used or as referenced by other standards.
 - 1. ASTM A36/A36M - Standard Specification for Carbon Structural Steel.
 - 2. ASTM A108 - Standard Specification for Steel Bar, Carbon, and Alloy, Cold Finished.
 - 3. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
 - 4. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 - 5. A 924-17 - Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process.
 - 6. ASTM A1008/A1008M - Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable.
 - 7. AWS D1.1/D1.1M - Structural Welding Code - Steel.
 - 8. AWS D1.3/D1.3M - Structural Welding Code - Sheet Steel.
 - 9. ICC-ES AC43 - Acceptance Criteria for Steel Deck Roof and Floor Systems.
 - 10. SDI COSP - SDI Code of Standard Practice for Steel Deck.
 - 11. SDI SD - Standard for Steel Deck.

12. SDI QA/QC - Standard for Quality Control and Quality Assurance for Installation of Steel Deck.
- B. California Code of Regulations (CCR):
 1. CBSC, Title 24, Part 2- California Building Code (CBC), 2022 edition.
- C. ICC Evaluation Service, Inc. (ICC ES), a subsidiary corporation of the International Code Council:
 1. ICC ES Evaluation Reports (ESR) for Materials, Products, Methods, and Types of Construction with current report conforming to the applicable building code.
- D. International Association of Plumbing and Mechanical Officials (IAPMO):
 1. IAPMO Uniform Evaluation Service (UES) Report for Materials, Products, Methods, and Types of Construction with current report conforming to the applicable building code.

1.04 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittals procedures.
- B. Product Data: Provide deck profile characteristics, dimensions, structural properties, and finishes.
- C. Shop Drawings: Indicate deck plan, span direction, number of spans, support locations, projections, openings, reinforcement, pertinent details, and accessories.
 1. Clearly identify any locations where single span of deck is proposed.
- D. Submit manufacturer's installation instructions.
- E. Welders Certificates: Certify welders employed on the Work, verifying AWS qualification within the previous 12 months.
- F. Welding Procedures:
 1. Submit welding procedures, indicating joint details and tolerances, preheat and interpass temperature, post heat treatment, single or multiple pass, electrode type and size, welding current, polarity, and amperes and roof treatment.
 - a. Project CWI shall review WPS and PQRs prior to submittal to the Architect.
 2. Welding procedures shall comply with the requirements of AWS D1.1 and D1.3, and it shall include the welding parameters recommended by the welding electrode manufacturer.
 3. Refer to Structural Contract Drawings for weld testing and inspection.
- G. SUSTAINABLE DESIGN SUBMITTALS
 1. Type III factory-specific or product-specific environmental product declarations (EPD) for each of the following products:
 2. Materials & Resources Submittals: Refer to Section 018113 for additional information on LEED submittals.
 - a. Letter Template for MR Credit 2.1 and Credit 2.2: Letter template, signed by Contractor, tabulating total waste material, quantities diverted and means by which it is diverted, and statement that requirements for the credit have been met.
 - 1) Comply with Section 017419 Construction Waste Management and Disposal.
 - b. Product Data and Certification Letter for MR Credit 4.1 and MR Credit 4.2: Indicate percentages by weight of post-consumer and pre-consumer recycled content for products having recycled content. Include statement indicating costs for each product having recycled content.
 - c. Product Data for MR Credit 5.1 and MR Credit 5.2: For regional materials indicating location and distance from Project of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include statement indicating cost for each regional material and the fraction by weight that is considered regional.

1.05 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Currently a member in good standing of the Steel Deck Institute (SDI) or having a demonstrated capability of manufacturing steel structural decking in accordance with SDI standards.
- B. Installer's Qualifications: Regularly engaged and specializing, for the preceding 5 years, in the installation of steel structural decking systems.
 - 1. Specifically trained, licensed, certified, or otherwise approved in writing by the deck unit manufacturer.
- C. Welders' Qualifications: Currently certified in accordance with the requirements of AWS D1.3.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Cut plastic wrap to encourage ventilation.
- B. Separate sheets and store deck on dry wood sleepers; slope for positive drainage.
- C. Do not over-load structure with material stored in concentrated areas.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Steel Deck:
 - 1. Verco Decking Inc.: www.vercodeck.com
 - 2. Nucor-Vulcraft Group: www.vulcraft.com/#sle.
 - 3. ASC Steel Deck, a division of ASC Profiles, Inc., www.ascsd.com.

2.02 STEEL DECK

- A. Steel decks shall be in conformance with SDI Standards and have a current evaluation report (ICC or IAPMO).
- B. Vented Decks: Deck units with concrete fill at areas to receive waterproofing membranes, roofing, elastomeric coatings, and other impermeable membranes shall be vented type.
 - 1. Do not use vent tabs openings to support mechanical equipment.
- C. Fabricate deck units lengths to span two or more bays where possible. Where deck cannot span two or more bays, submit location for review and acceptance by Architect.
- D. Acoustical Deck: Non-composite type:
 - 1. Galvanized Steel Sheet: As specified in drawings.
 - 2. Provide fluted or cellular deck type as indicated in drawings.
 - 3. Structural Properties: As specified in drawings.
 - 4. NRC Rating: As specified in drawings.
- E. Metal Deck: Non-composite type, fluted steel sheet:
 - 1. Galvanized Steel Sheet: As specified in drawings.
 - 2. Structural Properties: As specified in drawings.
- F. Composite Deck: Fluted steel sheet embossed to interlock with concrete:
 - 1. Galvanized Steel Sheet: As specified in drawings.
 - 2. Structural Properties: As specified in drawings.
- G. Acoustical Composite Deck: Composite type, fluted steel sheet embossed to interlock with concrete:
 - 1. Galvanized Steel Sheet: As specified in drawings.
 - 2. Provide cellular deck type as indicated in drawings.

- 3. Structural Properties: As specified in drawings.
- 4. NRC Rating: As specified in drawings.
- H. Global Warming Potential (GWP) Limits: as indicated on the drawings

2.03 ACCESSORY MATERIALS

- A. Bearing Angles: ASTM A36/A36M steel.
- B. Stud Shear Connectors: Per section 051200 - Structural Steel Framing.
- C. Welding Materials: Comply with AWS D1.1/D1.1M and AWS D1.3/D1.3M.
- D. Acoustical Insulation: Glass fiber type, minimum 1.1 lb/cu ft density; profiled to suit deck.

2.04 FABRICATED DECK ACCESSORIES

- A. Sheet Metal Deck Accessories: Metal wet concrete stops and cover plates shall be of same thickness as deck as indicated; finished same as deck.
- B. Fabricate metal closure strips, for openings between decking and other construction, of not less than 12 gage sheet steel, unless otherwise indicated in drawings. Form to provide tight fitting closures at open ends of cells or flutes and sides of decking. Galvanization shall match the deck.
- C. Roof Drain Pans: As indicated in drawings.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Erect metal deck in accordance with SDI Standards and Manufacturer requirements.
- B. Place deck units in straight alignment for entire length of run of cells and with close alignment between cells at ends of abutting units.
- C. Place deck units flat and square, secured to adjacent framing with-out warp or excessive deflection.
- D. On concrete and masonry surfaces provide minimum 4 inch bearing.
- E. On steel supports provide minimum 2" bearing or as required by manufacturer, whichever is larger.
- F. Locate deck units on supporting steel framework and adjust to final position with ends accurately aligned and bearing on supporting members before being permanently fastened. Do not stretch or contract side lap interlocks.
- G. Connect deck to steel support members at ends and intermediate supports, parallel with the deck flute and at each transverse flute as specified in drawings.
- H. Shore deck during concrete placement as required by manufacturer or drawings.
- I. Weld deck in accordance with AWS D1.3/D1.3M.
- J. Provide framing at deck openings as required on drawings.
 - 1. Provide metal closure pieces and additional reinforcement as required for strength, continuity of decking, and support of adjacent work.
- K. At floor edges, install concrete stops upturned to top surface of slab, to contain wet concrete. Provide stops of sufficient strength to remain stationary without distortion.
- L. Weld stud shear connectors through steel deck to structural members below.
 - 1. Welded stud connectors may be used to replace required deck fastening welds on a one-for-one basis.

- M. Immediately after welding deck and other metal components in position, coat welds, burned areas, and damaged surface coating, with touch-up primer.

3.02 FIELD QUALITY CONTROL

- A. Provide inspections of metal deck welds and mechanical fasteners per CBC Chapter 17

END OF SECTION

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**SECTION 054000
COLD-FORMED METAL FRAMING**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Formed steel stud exterior wall and interior wall framing.

1.02 RELATED REQUIREMENTS

- A. Section 053100 - Steel Decking.
- B. Section 072100 - Thermal Insulation: Insulation within framing members.
- C. Section 076200 - Sheet Metal Flashing and Trim: Head and sill flashings.
- D. Section 079200 - Joint Sealants.
- E. Section 092116 - Gypsum Board Assemblies: Lightweight, non-load bearing metal stud framing.
- F. Section 092116 - Gypsum Board Assemblies: Gypsum-based sheathing.
- G. Section 092216 - Non-Structural Metal Framing.
- H. Section 092236 - Lath.
- I. Section 092400 - Cement Plastering.
- J. Section 095100 - Acoustical Ceilings: Ceiling suspension system.

1.03 REFERENCE STANDARDS

- A. The applicable version of the standards listed below shall be per Chapter 35 of Part 2 of the 2022 edition of the California Building Code (CBC), including addendums and errata. Where the standard is not listed in the CBC, then the most current version of the standard shall be used or as referenced by other standards.
 - 1. AISI S100 - North American Specification for the Design of Cold-Formed Steel Structural Members.
 - 2. AISI S202 - Code of Standard Practice for Cold-Formed Steel Structural Framing.
 - 3. AISI S220 - North American Standard for Cold-Formed Steel Nonstructural Framing.
 - 4. AISI S240 - North American Standard for Cold-Formed Steel Structuring Framing.
 - 5. AISI S400 - North American Standard for Seismic Design of Cold-Formed Steel Structural Systems.
 - 6. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
 - 7. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 - 8. ASTM A780 - Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
 - 9. ASTM A 924 - Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process.
 - 10. ASTM A1008/A1008M - Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable.

11. ASTM C955 - Standard Specification for Load-Bearing (Transverse and Axial) Steel Studs, Runners (Tracks), and Bracing or Bridging for Screw Application of Gypsum Panel Products and Metal Plaster Bases.
 12. ASTM C1007 - Standard Specification for Installation of Load Bearing (Transverse and Axial) Steel Studs and Related Accessories.
 13. ASTM E488 - Test Method for Strength of Anchors in Concrete and Masonry Elements.
 14. ASTM E1190 - Test Methods for Strength of Power-Actuated Fasteners Installed in Structural Members.
 15. ASTM E1966 - Standard Test Method for Fire-Resistive Joint Systems.
 16. AWS D1.1/D1.1M - Structural Welding Code - Steel.
 17. AWS D1.3/D1.3M - Structural Welding Code - Sheet Steel.
 18. ICC-ES AC308 - Acceptance Criteria for Water-Resistive Barriers; ICC Evaluation Service, Inc.
 19. Steel Stud Manufacturers Association Technical Guide (ICC ESR-3064P)
 20. UL 2079 - Test for Fire Resistance of Building Joint Systems
- B. California Code of Regulations (CCR):
1. CBSC, Title 24, Part 2- California Building Code (CBC), 2022 edition. Including but not limited to:
 - a. Chapter 17A - Structural Tests and Inspections.
 - b. Chapter 2210A – Cold-Formed Steel
 - c. Chapter 2211A – Cold-Formed Steel Light-Frame Construction.
- C. Gypsum Association
1. GA 216 - Specifications for the Application and Finishing of Gypsum Board
 2. GA 302 - Installation of Screw-type Steel Framing members to Receive Gypsum Board.
- D. ICC Evaluation Service, Inc. (ICC ES), a subsidiary corporation of the International Code Council:
1. ICC ES Evaluation Reports (ESR) for Materials, Products, Methods and Types of Construction with current report conforming to the applicable building code.
- E. International Association of Plumbing and Mechanical Officials (IAPMO):
1. IAPMO Uniform Evaluation Service (UES) Report for Materials, Products, Methods and Types of Construction with current report conforming to the applicable building code.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordinate with work of other sections that is to be installed in or adjacent to the metal framing system, including but not limited to structural anchors, cladding anchors, utilities, insulation, and firestopping.

1.05 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide data on standard framing members; describe materials and finish, product criteria and limitations.
1. Submit framing system manufacturer's standard published load to span charts with accompanying ICC report with members to be used indicated and showing compliance with drawings.
- C. Shop Drawings: Indicate component details, framed openings, bearing, anchorage, loading, welds, and type and location of fasteners, and accessories or items required of related work.
1. Indicate stud and ceiling joist layout.
 - a. Coordinate stud and ceiling joist (including joist hangers and kickers) with MEP trades and indicate on shop drawings.

- D. Manufacturer's Installation Instructions: Indicate special procedures, conditions requiring special attention .
- E. Welders' Qualification Statement: Welders' certificates in accordance with AWS B2.1/B2.1M and dated no more than 12 months before the start of scheduled welding work.
- F. Welding Procedures:
 - 1. Submit welding procedures, indicating joint details and tolerances, preheat and interpass temperature, post heat treatment, single or multiple pass, electrode type and size, welding current, polarity, and amperes and roof treatment.
 - a. Project CWI shall review WPS and PQRs prior to submittal to the Architect.
 - 2. Welding procedures shall comply with the requirements of AWS D1.1 and D1.3, and it shall include the welding parameters recommended by the welding electrode manufacturer.
 - 3. Refer to Structural Contract Drawings for weld testing and inspection.

1.06 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the types of products specified in this section, and with minimum three years of documented experience.
- B. Welder Qualifications: Welding processes and welding operators qualified in accordance with AWS D1.1/D1.1M and AWS D1.3/D1.3M and dated no more than 12 months before start of scheduled welding work.
- C. Installer Qualifications: Company specializing in performing the work of this section with minimum three years documented experience.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Metal Framing:
 - 1. CEMCO: www.cemcosteel.com/#sle.
 - 2. ClarkDietrich: www.clarkdietrich.com/#sle.
 - 3. The Steel Network, Inc: www.SteelNetwork.com/#sle.
 - 4. Substitutions: See Section 016000 - Product Requirements.
- B. Framing Connectors and Accessories:
 - 1. ClarkDietrich: www.clarkdietrich.com/#sle.
 - 2. Simpson Strong Tie: www.strongtie.com/#sle.
 - 3. Substitutions: See Section 016000 - Product Requirements.

2.02 FRAMING SYSTEM

- A. Provide primary and secondary framing members, bridging, bracing, plates, gussets, clips, fittings, reinforcement, and fastenings as required to provide a complete framing system.

2.03 FRAMING MATERIALS

- A. Studs, Joists, and Tracks: ASTM C955; studs formed to channel, C- or Sigma-shaped with punched web; U-shaped track in matching nominal width and compatible height.
 - 1. Gauge and Depth: As indicated on drawings.
 - 2. Material:
 - a. 16 gage and heavier: ASTM A653, SS Grade 50, Minimum yield of 50,000 psi.
 - b. 18 gage and lighter: ASTM A653, SS Grade 33, Minimum yield of 33,000 psi.

3. Galvanized in accordance with ASTM A653/A653M, G60/Z180 coating.
4. Provide components fabricated from ASTM A653 SS with G90 coating.

2.04 FASTENERS

- A. Self-Drilling, Self-Tapping Screws, Bolts, Nuts and Washers: Hot dip galvanized per ASTM A153/A153M.
- B. Anchorage Devices: Powder actuated and Drilled expansion bolts per drawings.
- C. Welding: Comply with AWS D1.1/D1.1M and AWS D1.3/D1.3M.

2.05 WALL SHEATHING

- A. Gypsum Board Wall Sheathing: See Section 092116.

2.06 ACCESSORIES

- A. Bracing, Furring, Bridging: Formed sheet steel, thickness determined for conditions encountered; finish to match framing components.
- B. Plates, Gussets, Clips: Formed Sheet Steel, thickness determined for conditions encountered; finish to match framing components.
- C. Deflection and Slip Clips: As indicated in drawings.
- D. Touch-Up Primer for Galvanized Surfaces: SSPC-Paint 20 Type I - Inorganic, complying with VOC limitations of authorities having jurisdiction.
- E. Water-Resistive Barrier: As specified in Section 072500.

2.07 FABRICATION

- A. Fabricate straight, level and true, without warp or rack.
- B. Fabrication tolerance to be in accordance with ASTM C955
- C. When painted components are provided, provide manufacturer's standard factory applied primer.

PART 3 EXECUTION

3.01 GENERAL

- A. Comply with AISI Code of Standard Practice for Cold-formed Steel Framing.
- B. Verify that substrate surfaces are ready to receive work.
- C. Verify field measurements and adjust installation as required.
- D. Hold members firmly in position until permanently fastened.

3.02 INSTALLATION OF STUDS

- A. Install components in accordance with manufacturers' instructions and ASTM C1007 requirements.
- B. Align floor and ceiling tracks; locate to wall layout. Secure in place with fasteners as indicated in the drawings. Coordinate installation of sealant with floor and ceiling tracks.
- C. Place studs at spacing indicated in drawings.
- D. Cut right angle connections of framing components to fit squarely against abutting members.

- E. Connect studs to tracks using as indicated in drawings.
- F. Construct corners using minimum of four studs. Locate to provide surfaces for attachment of interior and exterior finishes.
- G. Install headers and jambs at wall openings, door and windows as indicated in drawings.
- H. Install load-bearing studs full length in one piece.
- I. Splicing of studs is not permitted unless approved by the Architect.
- J. Coordinate placement of insulation in multiple stud spaces made inaccessible after erection.
- K. Install intermediate studs above and below openings to align with wall stud spacing.
- L. Provide deflection allowance in stud track, directly below horizontal building framing at non-load bearing framing.
- M. Attach cross studs to studs for attachment of fixtures anchored to walls.
- N. Install framing between studs for attachment of mechanical and electrical items, and to prevent stud rotation.
- O. Touch-up field welds and damaged galvanized surfaces with primer.

3.03 INSTALLATION OF JOISTS

- A. Install framing components in accordance with manufacturer's instructions.
- B. Make provisions for erection stresses. Provide temporary alignment and bracing.
- C. Splicing of Joists is not permitted.
- D. Place joists at spacing indicated in drawings and connect joists to supports as indicated in drawings.
- E. Provide end blocking where joist ends are not otherwise restrained from rotation.
- F. Locate joist end bearing directly over load-bearing studs or provide load distributing member to top of stud track.
- G. Provide web stiffeners at reaction points where indicated in drawings.
- H. Touch-up field welds and damaged galvanized surfaces with primer.

3.04 INSTALLATION OF WALL SHEATHING

- A. See Section 092116.

3.05 TOLERANCES

- A. Install work in this section with tolerances in accordance to ASTM C1007.

3.06 FIELD QUALITY CONTROL

- A. Do not use gas cutting for field correction of fabrication without approval from Architect.
- B. Perform inspections at all phases of steel stud construction.
- C. Complete inspection, including steel stud members for bearing, reinforcing, and completeness of attachments, prior to applying loads.

3.07 ADJUSTING

- A. Clean and touch up galvanized coatings at welded and abraded surfaces in accordance With ASTM A780.

END OF SECTION

**SECTION 055000
METAL FABRICATIONS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Shop fabricated steel and aluminum items.
- B. Slotted channel framing.
- C. Abrasive metal nosings.

1.02 REFERENCE STANDARDS

- A. ASTM A1 - Standard Specification for Carbon Steel Tee Rails; 2000 (Reapproved 2018).
- B. ASTM A276/A276M - Standard Specification for Stainless Steel Bars and Shapes; 2024.
- C. ASTM A36/A36M - Standard Specification for Carbon Structural Steel; 2019.
- D. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2022.
- E. ASTM A283/A283M - Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates; 2024.
- F. ASTM A501/A501M - Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing; 2021.
- G. ASTM A554 - Standard Specification for Welded Stainless Steel Mechanical Tubing; 2021.
- H. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2023.
- I. ASTM A666/A666M - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar; 2024.
- J. ASTM A1011/A1011M - Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength; 2023.
- K. ASTM A1018/A1018M - Standard Specification for Steel, Sheet and Strip, Heavy-Thickness Coils, Hot-Rolled, Carbon, Commercial, Drawing, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength; 2018.
- L. ASTM B210/B210M - Standard Specification for Aluminum and Aluminum-Alloy Drawn Seamless Tubes; 2019a.
- M. ASTM B211/B211M - Standard Specification for Aluminum and Aluminum-Alloy Rolled or Cold Finished Bar, Rod, and Wire; 2019.
- N. ASTM B26/B26M - Standard Specification for Aluminum-Alloy Sand Castings; 2018, with Editorial Revision.
- O. ASTM B85/B85M - Standard Specification for Aluminum-Alloy Die Castings; 2018, with Editorial Revision.
- P. ASTM B209/B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2021a.
- Q. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes; 2021.

- R. ASTM B633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel; 2023.
- S. AWS D1.1/D1.1M - Structural Welding Code - Steel; 2025.
- T. AWS D1.2/D1.2M - Structural Welding Code - Aluminum; 2014, with Errata (2020).
- U. IAS AC172 - Accreditation Criteria for Fabricator Inspection Programs for Structural Steel AC172; 2019, with Editorial Revision (2025).
- V. MFMA-4 - Metal Framing Standards Publication; 2004.
- W. SSPC-Paint 15 - Steel Joist Shop Primer/Metal Building Primer; 2004.
- X. SSPC-Paint 20 - Zinc-Rich Coating (Type I - Inorganic, and Type II - Organic); 2019.

1.03 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Sustainable Product Data: See Section 01 6000 - Product Requirements and Section 01 6116 - Volatile Organic Compound (VOC) Content Restrictions.
 - 1. Recycled content data.
- C. Delegated Design Documents: See Section 01 3000 - Administrative Requirements.
 - 1. Provide design documentation prepared by Contractor's Licensed Professionals.
- D. 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. Design data: Submit drawings and supporting calculations, signed and sealed by a qualified professional structural engineer.
 - a. Include the following, as applicable:
 - 1) Design criteria.
 - 2) Engineering analysis depicting stresses.
 - 3) Member sizes and gauges.
 - 4) Details of connections.
 - 5) Support reactions.
 - 6) Bracing requirements.
- E. Designer's Qualification Statement.
- F. Fabricator's Qualification Statement: Provide documentation showing steel fabricator is accredited under IAS AC172.

1.04 QUALITY ASSURANCE

- A. Design metal fabrications under direct supervision of a Professional Structural Engineer experienced in design of this work and licensed in the State in which the Project is located.
- B. 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.
- C. Fabricator Qualifications: A qualified steel fabricator that is accredited by IAS AC172.

PART 2 PRODUCTS

2.01 DELEGATED DESIGN

- A. Delegated Design: See Section 01 3000 - Administrative Requirements.

- B. Engage a qualified professional engineer, as defined in Section 01 4000 - Quality Requirements, to design fabricated metal items.

2.02 SUSTAINABLE PRODUCT REQUIREMENTS

- A. See Section 01 6000 - Product Requirements.
- B. VOC Content Restrictions: Products in this section to not exceed VOC content limits specified in Section 01 6116 - Volatile Organic Compound (VOC) Content Restrictions.
- C. Recycled Content: Products in this Section to meet minimum recycled content thresholds specified in Section 016000.

2.03 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, black finish.
- E. Stainless Steel, General: ASTM A666/A666M, Type 304.
- F. Stainless Steel Tubing: ASTM A554, Type 304, 16 gauge, 0.0625 inch minimum metal thickness, 1-1/2 inch diameter.
- G. Stainless Steel Bars, Shapes and Moldings: ASTM A276/A276M, Type 304.
- H. Mechanical Fasteners: Same material as or compatible with materials being fastened; type consistent with design and specified quality level.
- 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.

2.04 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.

2.05 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. 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.

- D. Furnish components required for anchorage of fabrications. Fabricate anchors and related components of same material and finish as fabrication, except where specifically noted otherwise.

2.06 FABRICATED ITEMS

- A. General: Provide steel framing and supports not specified in other Sections as needed to complete the Work.
 - 1. Fabricate units from steel shapes, plates, and bars of welded construction unless otherwise indicated. Fabricate to sizes, shapes, and profiles indicated and as necessary to receive adjacent construction.
- B. Loose Bearing and Leveling Plates: For steel items bearing on masonry or concrete construction. Drill plates to receive anchor bolts and for grouting.
- C. Bollards: Steel pipe, concrete filled, crowned cap, as detailed; high-performance coating finish.
- D. Ledge Angles, Shelf Angles, Channels, and Plates Not Attached to Structural Framing: For support of metal decking; prime paint finish.
- E. Lintels: As detailed; galvanized finish.
- F. Door Frames for Overhead Door Openings and Wall Openings: Channel sections; prime paint finish.
- G. Elevator Hoistway Divider Beams: Beam sections; prime paint finish.
- H. Toilet Partition Suspension Members: Steel channel sections; prime paint finish.

2.07 SLOTTED CHANNEL FRAMING

- A. Slotted Channel Framing: Cold-formed metal box channels (struts) complying with MFMA-4.
 - 1. Manufacturers:
 - a. ABB Installation Products.
 - b. Eaton.
 - c. Flex-Strut.
 - d. Unistrut (Atkore International).
 - e. Wesanco (ZSI-Foster).
 - f. Substitutions: See Section 01 2500 - Substitution Procedures.
 - 2. Physical Properties:
 - a. Size, Thickness, and Configuration: As indicated, or as otherwise required to support loads.
 - b. Material:
 - 1) Stainless Steel: ASTM A1011/A1011M SS, Grade 33 cold formed steel struts.
 - (a) Fittings: ASTM A1018/A1018M SS, Grade 33 steel.
 - (b) Hardware AISI Type 304 stainless steel.
 - 2) Galvanized Steel: ASTM A653/A653M, commercial steel Type B or structural steel Grade 33 (Grade 230), with G90 coating.
 - c. Closure Strips: Manufacturer's standard snap-in product to close exposed channel openings.
 - d. Framing channels and fittings shall have the manufacturers name, part number, and material heat code identification number stamped in the part itself for identification.

2.08 ABRASIVE METAL NOSINGS

- A. Manufacturers:
 - 1. American Safety Tread.
 - 2. Amstep Products.

3. Balco.
 4. Granger.
 5. Grating Pacific.
 6. Nystrom.
 7. Wooster Products.
 8. Substitutions: See Section 01 2500 - Substitution Procedures.
- B. Extruded Units: Aluminum, with abrasive filler consisting of aluminum oxide, silicon carbide, or a combination of both, in an epoxy-resin binder.
1. Apply clear lacquer to concealed surfaces.
- C. Cast Units: Cast iron, aluminum, bronze, or nickel silver, with an integral abrasive as-cast finish consisting of aluminum oxide, silicon carbide, or a combination of both.
1. Apply bituminous paint to concealed surfaces.
- D. Provide anchors for embedding units in concrete, either integral or applied to units, as standard with manufacturer.
- E. Drill for mechanical anchors and countersink. Locate holes not more than 4 inches from ends and not more than 12 inches on center.

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 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.
- C. Maximum Out-of-Position: 1/4 inch.

END OF SECTION

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**SECTION 055133
METAL LADDERS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Manufactured ladders.
- B. Manufactured ship ladders.
- C. Shop-fabricated metal ladders.

1.02 REFERENCE STANDARDS

- A. AAMA 611 - Specification for Anodized Architectural Aluminum; 2024.
- B. ANSI A14.3 - American National Standard for Ladders -- Fixed -- Safety Requirements; 2008 (Reaffirmed 2018).
- C. ASCE 7 - Minimum Design Loads and Associated Criteria for Buildings and Other Structures; Most Recent Edition Cited by Referring Code or Reference Standard.
- D. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2023.
- E. ASTM A240/A240M - Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications; 2024b.
- F. ASTM A283/A283M - Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates; 2024.
- G. ASTM A307 - Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength; 2021.
- H. ASTM A500/A500M - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes; 2023.
- I. ASTM A1011/A1011M - Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength; 2023.
- J. ASTM B26/B26M - Standard Specification for Aluminum-Alloy Sand Castings; 2018, with Editorial Revision.
- K. ASTM B85/B85M - Standard Specification for Aluminum-Alloy Die Castings; 2018, with Editorial Revision.
- L. ASTM B209/B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2021a.
- M. ASTM B210/B210M - Standard Specification for Aluminum and Aluminum-Alloy Drawn Seamless Tubes; 2019a.
- N. ASTM B211/B211M - Standard Specification for Aluminum and Aluminum-Alloy Rolled or Cold Finished Bar, Rod, and Wire; 2019.
- O. AWS A2.4 - Standard Symbols for Welding, Brazing, and Nondestructive Examination; 2020.
- P. AWS D1.1/D1.1M - Structural Welding Code - Steel; 2025.
- Q. AWS D1.2/D1.2M - Structural Welding Code - Aluminum; 2014, with Errata (2020).

- R. CAL (CDPH SM) - Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers; 2017.
- S. IAS AC172 - Accreditation Criteria for Fabricator Inspection Programs for Structural Steel AC172; 2019, with Editorial Revision (2025).

1.03 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Delegated Design Documents: See Section 011000 - Summary and Section 01 3000 - Administrative Requirements.
 - 1. Provide design documentation prepared by Contractor's Licensed Professionals.
- C. Shop Drawings:
 - 1. Indicate profiles, sizes, connection attachments, reinforcing, anchorage, size and type of fasteners, and accessories. Include erection drawings, elevations, and details where applicable.
 - 2. Indicate welded connections using standard AWS A2.4 welding symbols. Indicate net weld lengths.
- D. Designer's qualification statement.
- E. Fabricator's qualification statement.
- F. Welder's qualification statement.
- G. Warranty.

1.04 QUALITY ASSURANCE

- A. Qualifications: See Section 01 4000 - Quality Requirements.
 - 1. Design fabricated ladders under direct supervision of a Professional Structural Engineer experienced in design of this work and licensed in the State in which the Project is located.
 - 2. 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.
 - 3. Fabricator Qualifications: A qualified steel fabricator that is accredited by IAS AC172.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. See Section 01 6000 - Product Requirements.
- B. Deliver materials to Project site in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, approval or listing agency markings, and directions for storing.
- C. Protect materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources. Store in a dry location.
- D. Comply with manufacturer's written instructions for handling, storing, and protecting during installation.
- E. See Section 01 7419 - Construction Waste Management and Disposal, for packaging waste requirements.

1.06 FIELD CONDITIONS

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

1.07 WARRANTY

- A. See Section 017800 - Closeout Submittals for additional warranty requirements.
- B. Manufacturer Warranty: Provide 5-year manufacturer warranty for material and workmanship. Complete forms in Owner's name and register with manufacturer.

PART 2 PRODUCTS

2.01 DELEGATED DESIGN

- A. Delegated Design: See Section 01 3000 - Administrative Requirements.
- B. Engage a qualified professional engineer, as defined in Section 01 4000 - Quality Requirements, to design fabricated ladders.
 - 1. Include comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

2.02 SUSTAINABLE PRODUCT REQUIREMENTS

- A. See Section 01 6000 - Product Requirements.
- B. VOC Content Restrictions: Products in this section to not exceed VOC content limits specified in Section 01 6116 - Volatile Organic Compound (VOC) Content Restrictions.
- C. CDPH: Products to comply with CAL (CDPH SM) .
- D. Life Cycle: Products in this section to have LCA as specified in Section 016000.
- E. Recycled Content: Products in this Section to meet minimum recycled content thresholds specified in Section 016000.

2.03 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Design fabricated ladders to withstand the effects of gravity loads within limits and under conditions indicated.
- B. Seismic Performance: Provide metal fabrications capable of withstanding the effects of earthquake motions determined according to ASCE 7.
- C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes acting on exterior metal fabrications by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects.
 - 1. Temperature Change: 120 deg F ambient; 180 deg F material surfaces.

2.04 MANUFACTURERS

- A. Steel Ladder Manufacturers:
 - 1. Alaco Ladder.
 - 2. Cotterman.
 - 3. Industrial Ladder & Scaffolding.
 - 4. Substitutions: See Section 01 2500 - Substitution Procedures.
- B. Aluminum Ladder Manufacturers:
 - 1. Alaco Ladder.
 - 2. Industrial Ladder & Scaffolding.
 - 3. O'Keefe's.
 - 4. Precision Ladders.
 - 5. Substitutions: See Section 01 2500 - Substitution Procedures.

2.05 MANUFACTURED LADDERS

- A. Steel Ladder: Welded metal unit complying with ANSI A14.3; factory fabricated to greatest degree practical and in the largest components possible.
 - 1. Components: Manufacturer's standard rails, rungs, treads, handrails, returns, platforms and safety devices complying with the requirements of the MATERIALS article of this section.
 - 2. Materials: Carbon steel; Grade 36, minimum.
 - 3. Finish: Manufacturer's standard hot-dipped galvanizing; comply with ASTM A153/A153M.
- B. Aluminum Ladder: Welded metal unit complying with ANSI A14.3; factory fabricated to greatest degree practical and in the largest components possible.
 - 1. Components: Manufacturer's standard rails, rungs, treads, handrails, returns, platforms and safety devices complying with the requirements of the MATERIALS article of this section.
 - 2. Materials: Aluminum; 6061 alloy, T6 temper.
 - 3. Finish: Manufacturer's standard clear anodized coating, comply with AAMA 611, Class 1.

2.06 MANUFACTURED SHIP LADDERS

- A. Steel Ship Ladder: Welded metal unit complying with ANSI A14.3; factory fabricated to greatest degree practical and in the largest components possible.
 - 1. Components: Manufacturer's standard rails, rungs, treads, handrails, returns, platforms and safety devices complying with the requirements of the MATERIALS article of this section.
 - 2. Materials: Carbon steel; Grade 36, minimum.
 - 3. Incline: 60 degrees.
 - 4. Finish: Manufacturer's standard hot-dipped galvanizing; comply with ASTM A153/A153M.
- B. Aluminum Ship Ladder: Welded metal unit complying with ANSI A14.3; factory fabricated to greatest degree practical and in the largest components possible.
 - 1. Components: Manufacturer's standard rails, rungs, treads, handrails, returns, platforms and safety devices complying with the requirements of the MATERIALS article of this section.
 - 2. Materials: Aluminum; 6061 alloy, T6 temper.
 - 3. Incline: 60 degrees.
 - 4. Finish: Manufacturer's standard clear anodized coating, comply with AAMA 611, Class 1.

2.07 FABRICATED LADDERS

- A. Fabricated Steel Ladder: In compliance with ANSI A14.3; with mounting brackets and attachments.
 - 1. Configuration: See Architectural drawings.
 - 2. Side Rails: 3/8 by 2 inches members spaced at 20 inches.
 - 3. Rungs: One inch diameter solid round bar spaced 12 inches on center.
 - 4. Space rungs 7 inches from wall surface.
 - 5. Finish: High-performance coating.
 - a. See Section 099600 - High-Performance Coatings, for additional information.
 - b. Color: As selected by Architect.

2.08 MATERIALS - STEEL

- A. Steel Sections: ASTM A36/A36M.
- B. Steel Tubing: ASTM A501/A501M hot-formed structural tubing.

- C. Plates: ASTM A283/A283M.
- D. Mechanical Fasteners: Same material or compatible with materials being fastened; type consistent with design and specified quality level.
- E. Bolts, Nuts, and Washers: ASTM A307, plain.
- F. Welding Materials: AWS D1.1/D1.1M; type required for materials being welded.

2.09 MATERIALS - ALUMINUM

- A. Extruded Aluminum: ASTM B211/B211M, 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, 6061 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.

2.10 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. Supply components required for anchorage of fabrications. Fabricate anchors and related components of same material and finish as fabrication, except where specifically noted otherwise.

PART 3 EXECUTION

3.01 EXAMINATION

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

3.02 PREPARATION

- A. Supply setting templates to the appropriate entities for steel items required to be cast into concrete or embedded in masonry.

3.03 INSTALLATION

- A. Install in accordance with manufacturer's written instructions and approved shop drawings.
- B. Install items plumb and level, accurately fitted, free from distortion or defects.
- C. Provide for erection loads, and for sufficient temporary bracing to maintain true alignment until completion of erection and installation of permanent attachments.
- D. Perform field welding in accordance with AWS D1.1/D1.1M.

- E. Obtain approval prior to site cutting or making adjustments not scheduled.

END OF SECTION

SECTION 055213
PIPE AND TUBE RAILINGS

PART 1 GENERAL

1.01 SECTION INCLUDES

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

1.02 RELATED REQUIREMENTS

- A. Section 321313 - Concrete Paving.

1.03 REFERENCE STANDARDS

- A. AAMA 2605 - Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels (with Coil Coating Appendix); 2022.
- B. AISC 207 - Standard for Certification Programs; 2025.
- C. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2022.
- D. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2024.
- E. ASTM A500/A500M - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes; 2023.
- F. ASTM A780/A780M - Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings; 2020.
- G. AWS A2.4 - Standard Symbols for Welding, Brazing, and Nondestructive Examination; 2020.
- H. AWS D1.1/D1.1M - Structural Welding Code - Steel; 2025.
- I. CAL (CDPH SM) - Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers Version 1.2; 2017.
- J. SSPC-Paint 15 - Steel Joist Shop Primer/Metal Building Primer; 2004.

1.04 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: For each item to be installed
- C. Sustainable Product Data: See Section 01 6000 - Product Requirements and Section 01 6116 - Volatile Organic Compound (VOC) Content Restrictions.
 - 1. VOC content restrictions data.
 - 2. CAL (CDPH SM) compliance data.
 - 3. Recycled content data.

- D. 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.
 - 2. Include the design engineer's seal and signature on each sheet of shop drawings.
- E. Designer's Qualification Statement.
- F. Fabricator's Qualification Statement.

1.05 QUALITY ASSURANCE

- A. Qualifications: See Section 01 4000 - Quality Requirements.
- B. Structural Designer Qualifications: Professional Structural Engineer experienced in design of this work and licensed in the State in which the Project is located, or personnel under direct supervision of such an engineer.
- C. Fabricator Qualifications:
 - 1. A qualified steel fabricator that is certified by the American Institute for Steel Construction (AISC) under AISC 207.
 - 2. A company specializing in manufacturing products specified in this section, with not less than years of experience.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. See Section 01 6000 - Product Requirements.
- B. Deliver materials in factory-provided protective coverings and packaging.
- C. Protect materials against damage during transit, delivery, storage, and installation at site.
- D. Inspect materials upon delivery for damage. Replace damaged items.
- E. Prior to installation, store materials and components under cover in dry location.
- F. See Section 01 7419 - Construction Waste Management and Disposal, for packaging waste requirements.

1.07 FIELD CONDITIONS

- A. Ambient Conditions:
 - 1. Do not install railings until project is enclosed and ambient temperature of space is minimum 65 degrees F and maximum 95 degrees F.
 - 2. Maintain ambient temperature of space at minimum 65 degrees F and maximum 95 degrees F for 24 hours before, during, and after railing installation.
- B. Field Measurements: Verify actual dimensions by field measurement before fabrication. Show recorded measurements on shop drawings.

1.08 WARRANTY

- A. See Section 01 6000 - Product Requirements and Section 01 7800 - Closeout Submittals for additional warranty requirements.
- B. Provide manufacturer's standard warranty for each product.

PART 2 PRODUCTS

2.01 DELEGATED DESIGN

- A. Delegated Design: See Section 01 3000 - Administrative Requirements.
- B. Engage a qualified professional engineer, as defined in Section 01 4000 - Quality Requirements, to design pipe and tube railings.

2.02 SUSTAINABLE PRODUCT REQUIREMENTS

- A. See Section 01 6000 - Product Requirements.
- B. VOC Content Restrictions: Products in this section to not exceed VOC content limits specified in Section 01 6116 - Volatile Organic Compound (VOC) Content Restrictions.
- C. CDPH: Products to comply with CAL (CDPH SM) .
- D. Recycled Content: Products in this Section to meet minimum recycled content thresholds specified in Section 016000.

2.03 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Railings, including attachment to building construction, withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:
 - 1. Handrails and Top Rails of Guards:
 - a. Uniform load of 50 lbf/ ft. applied in any direction.
 - 1) Concentrated load of 200 lbf applied in any direction.
 - 2) Uniform and concentrated loads need not be assumed to act concurrently.
 - 2. Infill of Guards:
 - a. Concentrated load of 50 lbf applied horizontally on an area of 1 sq. ft.
 - 1) Infill load and other loads need not be assumed to act concurrently.
- B. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.
 - 1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

2.04 REGULATORY REQUIREMENTS

- A. California:
 - 1. Railings and handrails to comply with CBC Section 11B-505:
 - a. Top of gripping surfaces of handrails shall be 34 inches minimum and 38 inches maximum vertically above walking surfaces, stair nosings, and ramp surfaces. Handrails shall be at a consistent height above such surfaces.
 - b. Clearance between handrail gripping surfaces and adjacent surfaces shall be 1-1/2 inches minimum. Handrail may be located in a recess if the recess is 3 inches maximum deep and 18 inches minimum clear above the top of the handrail.
 - c. Handrail gripping surfaces shall be continuous along their length and shall not be obstructed along their tops or sides. The bottoms of handrail gripping surfaces shall not be obstructed for more than 20 percent of their length. Where provided, horizontal projections shall occur 1-1/2 inches minimum below the bottom of the handrail gripping surfaces.
 - d. Handrail gripping surfaces with a circular cross section shall have an outside diameter of 1-1/4 inches minimum and 2 inches maximum.

- e. Handrail gripping surfaces with a non-circular cross section shall have an outside dimension of 4 inches minimum and 6-1/4 inches maximum, and a cross-sectional dimension of 2-1/4 inches maximum.
- f. Handrail gripping surfaces and any surfaces adjacent to them shall be free of sharp or abrasive elements and shall have rounded edges.
- g. Handrails shall not rotate within their fittings.
- h. Handrail gripping surfaces shall extend beyond and in the same direction of stair flights and ramp runs in accordance with CBC Section 11B-505.10. Such extensions are not required for continuous handrails at the inside turn of switchback or dogleg stairs and ramps.
- i. 2 inches minimum high curb or a barrier shall be provided to prevent the passage of a 4 inches diameter sphere rolling off the sides of a ramp surface. Such a curb or a barrier shall be continuous and uninterrupted along the length of a ramp. CBC Section 11B-405.9.2.

2.05 RAILINGS - GENERAL REQUIREMENTS

- A. Design, fabricate, and test railing assemblies in accordance with the most stringent requirements of applicable local code.
- B. Allow for expansion and contraction of members and building movement without damage to connections or members.
- C. Dimensions: See drawings for configurations and heights.
- D. 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.
- E. Provide welding fittings 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.

2.06 STEEL RAILING SYSTEM

- A. Steel Tube: ASTM A500/A500M Grade B cold-formed structural tubing.
- B. Steel Pipe: ASTM A53/A53M Grade B Schedule 40, black finish.
- C. Welding Fittings: Factory- or shop-welded from matching pipe or tube; seams continuously welded; joints and seams ground smooth.
- D. Exposed Fasteners: No exposed bolts or screws.
- E. Galvanizing: In accordance with requirements of ASTM A123/A123M. See Section 050511 - Surface Preparation and Finishing of Metals, for additional information.
- F. Shop and Touch-Up Primer: SSPC-Paint 15, complying with VOC limitations of authorities having jurisdiction.
- G. Finish:
 - 1. AAMA 2605-compliant superior coating. See 050513 - Shop-Applied Coatings for Metal, for additional information.

2.07 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 or embedded in masonry with setting templates, for installation as work of other sections.
- C. Apply one coat of bituminous paint to concealed aluminum surfaces that will be in contact with cementitious or dissimilar materials.

3.03 INSTALLATION

- A. Install in accordance with manufacturer's instructions and approved shop drawings.
- B. Install components plumb and level, accurately fitted, free from distortion or defects, with tight joints.
- C. Anchor railings securely to structure.
- D. Field weld anchors as indicated on shop drawings. Touch-up welds with primer. Grind welds smooth.

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

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SECTION 064100
ARCHITECTURAL WOOD CASEWORK

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Specially fabricated cabinet units.
- B. Countertops.
- C. Hardware.

1.02 RELATED REQUIREMENTS

- A. Section 123600 - Countertops.

1.03 DEFINITIONS

- A. High-Pressure Decorative Laminate Types, per NEMA LD 3:
 - 1. General Purpose Types:
 - a. HGS: Horizontal, 1.2 mm nominal thickness. Suitable for all applications except those requiring post-forming.
 - b. HGL: Horizontal, 1.0 mm nominal thickness. Suitable for flat countertops, with lower levels of impact and radiant-heat resistance than Grade HGS.
 - c. VGS: Vertical, 0.7 mm nominal thickness. Suitable for all vertical applications except those requiring post-forming.
 - d. VGL: Vertical, 0.5 mm nominal thickness. Suitable for vertical applications with lower impact resistance than Grade VGS.
 - 2. Postforming Types: Applications with curves such as integral backsplashes or front radii utilizing curves up to 1/2 inch radius.
 - a. HGP: Horizontal, 1.0 mm nominal thickness.
 - b. VGP: Vertical, 0.7 mm nominal thickness.
 - 3. Flame Retardant Types: Capable of providing flame retardant characteristics as determined by test methods required by authority having jurisdiction.
 - a. SGF: 1.5 mm nominal thickness.
 - b. HGF: Horizontal, 1.2 mm nominal thickness.
 - c. VGF: Vertical, 0.8 mm nominal thickness.
 - 4. High Wear Type: Increased surface wear resistance applications.
 - a. HDH: 3 mm nominal thickness.
 - b. HDM: 1.5 mm nominal thickness.
 - c. HDS: 1.2 mm nominal thickness.
 - 5. Specific Purpose Type: Heavy-duty applications.
 - a. HSH: 3 mm nominal thickness.
 - b. HSM: 1.5 mm nominal thickness.
 - 6. Compact Laminate Type:
 - a. CGS Type 1: 2 to 6 mm nominal thickness.
 - b. CGS Type 2: Thicker than 6 mm and self-supporting.
 - 7. Cabinet Liner Type: Inside faces of cabinets only.
 - a. CLS: 0.5 mm nominal thickness.

8. Backer Type: Backing sheet without a decorative face, for concealed surfaces, to prevent warping.
 - a. BKH: 1.2 mm nominal thickness.
 - b. BKM: 1 mm nominal thickness.
 - c. BKV: 0.7 mm nominal thickness.
 - d. BKL: 0.5 mm nominal thickness.

1.04 REFERENCE STANDARDS

- A. ANSI A208.2 - Medium Density Fiberboard (MDF) for Interior Applications; 2022.
- B. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2024.
- C. AWI/AWMAC/WI (AWS) - Architectural Woodwork Standards, 2nd Edition; 2014, with Errata (2016).
- D. AWMAC/WI (NAAWS) - North American Architectural Woodwork Standards; 2021, with Errata.
- E. BHMA A156.9 - Cabinet Hardware; 2020.
- F. HPVA HP-1 - American National Standard for Hardwood and Decorative Plywood; 2024.
- G. IAPMO Z124 - Plastic Plumbing Fixtures; 2022, with Editorial Revision.
- H. ISFA 2-01 - Classification and Standards for Solid Surfacing Material; 2013.
- I. ISFA 3-01 - Classification and Standards for Quartz Surfacing Material; 2013.
- J. NEMA LD 3 - High-Pressure Decorative Laminates; 2005.

1.05 ADMINISTRATIVE REQUIREMENTS

- A. Preinstallation Meeting: Convene a preinstallation meeting not less than two weeks before starting work of this section; require attendance by all affected installers.
 1. See Section 013000 - Administrative Requirements, for additional requirements.

1.06 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Sustainable Product Data: See Section 01 6000 - Product Requirements and Section 01 6116 - Volatile Organic Compound (VOC) Content Restrictions.
 1. VOC content restrictions data.
 2. Life cycle data.
 3. Sustainable wood data.
 4. Regional product data.
- 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).
 3. Include certification program label.
- D. Product Data: Provide data for hardware accessories.
- E. Samples: Submit actual samples of architectural cabinet construction, minimum 12 inches square, illustrating proposed cabinet substrate and finish.
- F. Samples: Submit actual sample items of proposed pulls, hinges, shelf standards, and locksets, demonstrating hardware design, quality, and finish.
- G. Field Quality Control Reports: As specified in Part 3 of this Section.

1.07 QUALITY ASSURANCE

- A. Fabricator Qualifications: Company specializing in fabricating the products specified in this section with minimum five years of documented experience.
 - 1. Accredited participant in the specified certification program.
 - 2. Single Source Responsibility: Provide and install this work from single fabricator.
- B. Quality Certification:
 - 1. Provide labels or certificates indicating that the installed work complies with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS) requirements for grade or grades specified.
 - 2. Provide designated labels on shop drawings as required by certification program.
 - 3. Provide designated labels on installed products as required by certification program.

1.08 MOCK-UPS

- A. Provide mock-up of typical base cabinet, wall cabinet, and countertop, including hardware, finishes, and plumbing accessories.
- B. See Section 014000 - Quality Requirements for additional requirements.
- C. Locate where directed.

1.09 DELIVERY, STORAGE, AND HANDLING

- A. See Section 01 6000 - Product Requirements.
- B. Deliver materials to Project site labeled with manufacturer's name, date of manufacture, approval or listing agency markings, and directions for storing.
- C. Protect materials from physical damage and from deterioration by sunlight, soiling, and other sources.
- D. Protect units from moisture damage. Store in a dry location.
- E. See Section 01 7419 - Construction Waste Management and Disposal, for packaging waste requirements.

1.10 FIELD CONDITIONS

- A. Field Measurements: Verify actual dimensions by field measurement before fabrication. Show recorded measurements on shop drawings.
- B. During and after installation of custom cabinets, maintain temperature and humidity conditions in building spaces at same levels planned for occupancy.

1.11 WARRANTY

- A. See Section 01 6000 - Product Requirements and Section 01 7800 - Closeout Submittals for additional warranty requirements.
- B. Provide manufacturer's standard warranty for each product.

PART 2 PRODUCTS

2.01 SUSTAINABLE PRODUCT REQUIREMENTS

- A. See Section 01 6000 - Product Requirements.
- B. VOC Content Restrictions: Products in this section to not exceed VOC content limits specified in Section 01 6116 - Volatile Organic Compound (VOC) Content Restrictions.

- C. Life Cycle: Products in this section to have LCA as specified in Section 016000.
- D. Sustainable Wood: Products in this Section to meet sustainable wood requirements specified in Section 016000.
- E. Regional Content: Products in this Section to meet regional requirements specified in Section 016000.

2.02 REGULATORY REQUIREMENTS

- A. Operable parts for all accessible casework shall comply with CBC Section 11B-309.
 - 1. Provide U-shaped pulls or touch latches at all accessible casework.

2.03 CABINETS

- A. Quality Standard: Custom Grade, in accordance with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS), unless noted otherwise.
- B. Wood Veneer Faced Cabinet:
 - 1. Exposed Surfaces: HPVA HP-1 Grade A, Ash, plain sliced, random-matched.
 - 2. Semi-Exposed Surfaces: HPVA HP-1 Grade B, Ash, plain sliced, random-matched.
 - 3. Concealed Surfaces: Manufacturer's option.
- C. Plastic Laminate Faced Cabinets: Custom grade.

2.04 WOOD-BASED COMPONENTS

- A. Wood fabricated from timber recovered from riverbeds or otherwise abandoned is permitted, unless otherwise noted, provided it is clean and free of contamination; identify source; provide lumber re-graded by an inspection service accredited by the American Lumber Standard Committee, Inc.

2.05 PANEL CORE MATERIALS

- A. Medium Density Fiberboard (MDF): Composite panel composed of cellulosic fibers, additives, and bonding system; cured under heat and pressure; comply with ANSI A208.2.

2.06 HARDWOOD PLYWOOD PANELS

- A. Hardwood Plywood: Plywood manufactured for nonstructural decorative applications; consisting of faces and backs applied to a variety of core types; comply with HPVA HP-1.
 - 1. Woodwork Quality Standard: Panels complying with specified woodwork quality standard.

2.07 THERMALLY FUSED LAMINATE PANELS

- A. Thermally Fused Laminate (TFL): Melamine- or polyester-resin-saturated decorative papers; for fusion to composite wood substrates under heat and pressure.
 - 1. Test in accordance with NEMA LD 3 Section 3.
 - 2. Panel Core Substrate: Particleboard.
 - 3. Color: White.

2.08 LAMINATE MATERIALS

- A. High Pressure Decorative Laminate (HPDL): NEMA LD 3, types as recommended for specific applications.
- B. Provide specific types as follows:
 - 1. Horizontal Surfaces: HGS, 0.048 inch nominal thickness.

2. Vertical Surfaces: VGS, 0.028 inch nominal thickness.
3. Post-Formed Horizontal Surfaces: HGP, 0.039 inch nominal thickness.
4. Post-Formed Vertical Surfaces: VGP, 0.028 inch nominal thickness.
5. Flame Retardant Surfaces: HGF, 0.048 inch nominal thickness.
6. Laminate Backer: BKL, 0.020 inch nominal thickness, undecorated; for application to concealed backside of panels faced with high pressure decorative laminate.

2.09 COUNTERTOPS

- A. Countertops: See Section 123600 - Countertops.
- B. Quality Standard: Custom Grade, in accordance with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS), unless noted otherwise.
- C. Plastic Laminate Countertops: High-pressure decorative laminate (HPDL) sheet bonded to substrate.
 1. Laminate Sheet: NEMA LD 3, Grade HGS, 0.048 inch nominal thickness.
 - a. Manufacturers:
 - 1) Arborite.
 - 2) Formica.
 - 3) Panolam.
 - 4) Wilsonart.
 - 5) Substitutions: See Section 01 2500 - Substitution Procedures.
 - b. Surface Burning Characteristics: Flame spread index of 25, maximum; smoke developed index of 450, maximum; when tested in accordance with ASTM E84.
 - c. Wear Resistance: In addition to specified grade, comply with NEMA LD 3 High Wear Grade requirements for wear resistance.
 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.
- D. Chemical-Resistant Plastic Laminate Countertops: Chemical-resistant high-pressure decorative laminate (HPDL) sheet bonded to substrate.
 1. Laminate Sheet: NEMA LD 3 Grade HGL, 0.039 inch nominal thickness.
 - a. Manufacturers:
 - 1) Formica.
 - 2) Panolam.
 - 3) Wilsonart.
 - 4) Substitutions: See Section 01 2500 - Substitution Procedures.
 - b. Surface Burning Characteristics: Flame spread index of 25, maximum; smoke developed index of 450, maximum; when tested in accordance with ASTM E84.
 - c. NSF approved for food contact.
 - d. Wear Resistance: In addition to specified grade, comply with NEMA LD 3 High Wear Grade requirements for wear resistance.
 2. Exposed Edge Treatment: Front edge substrate built up to minimum 1-1/4 inch thick with raised radiused edge, integral coved backsplash with radiused top edge.
- E. Wood Countertops: One-piece, glued-laminated under pressure.
 1. Thickness: 1-1/4 inch, minimum.
 2. Construction (Butcher Block): Maximum 1/2 inch thick strips glued perpendicular to surface.
 3. Species: Maple; clear grade.
 4. Exposed Edges: Rounded to approximately 3/8 inch radius.
 5. Back and End Splashes: Same material, same construction; 3/4 inch thick, square edges.

6. Finish: Sanded smooth; two coat boiled linseed oil rubbed in with 48 hours between coats.
- F. Solid Surfacing Countertops: Solid surfacing sheet or plastic resin casting over continuous substrate.
1. Flat Sheet Thickness: 1/4 inch, minimum.
 2. Solid Surfacing Sheet and Plastic Resin Castings: Complying with ISFA 2-01 and NEMA LD 3; acrylic or polyester resin, mineral filler, and pigments; homogenous, non-porous and capable of being worked and repaired using standard woodworking tools; no surface coating; color and pattern consistent throughout thickness.
 - a. Manufacturers
 - 1) Aristech Surfaces.
 - 2) DuPont.
 - 3) Formica.
 - 4) LX Hausys.
 - 5) Meganite.
 - 6) Staron (Lotte Chemical).
 - 7) Wilsonart.
 - 8) Substitutions: See Section 01 2500 - Substitution Procedures.
 - b. Surface Burning Characteristics: Flame spread index of 25, maximum; smoke developed index of 450, maximum; when tested in accordance with ASTM E84.
 - c. NSF approved for food contact.
 - d. Sinks and Bowls: Integral castings; minimum 3/4 inch wall thickness; comply with IAPMO Z124.
 - e. Finish on Exposed Surfaces: Matte, gloss rating of 5 to 20.
 - f. Color/Pattern Family: Solid color, light colors.
 - g. Color and Pattern: As indicated on drawings.
 - h. Color and Pattern: As selected by Architect from manufacturer's full line.
 3. Other Components Thickness: 1/2 inch, minimum.
 4. Exposed Edge Treatment: Built up to minimum 1-1/4 inch thick; square edge; use marine edge at sinks.
 5. Exposed Edge Treatment: Hardwood nosing as indicated on drawings; natural spar varnish finish.
 6. Back and End Splashes: Same sheet material, square top; minimum 4 inches high.
 7. Skirts: As indicated on drawings.
- G. 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) Cambria.
 - 2) Cosentino North America.
 - 3) Daltile.
 - 4) LX Hausys.
 - 5) Radianz (Lotte Chemical).
 - 6) Seieffe.
 - 7) Terrazzo & Marble Supply.
 - 8) Transolid.
 - 9) Substitutions: See Section 01 2500 - Substitution Procedures.

2.10 ACCESSORIES

- A. Adhesive: Type recommended by fabricator to suit application.
- B. ABS Edge Banding: Extruded ABS, convex shaped, chlorine-free; of width to match component thickness.
 - 1. Manufacturers:
 - a. Egger.
 - b. Formica.
 - c. PRI Edgebanding.
 - d. Surteco.
 - e. Substitutions: See Section 01 2500 - Substitution Procedures.
 - 2. Texture: Smooth.
 - 3. Thickness: 2 mm.
 - 4. Color: Match casework.
 - 5. Locations:
 - a. All exposed plywood edges.
 - b. All exposed shelf edges.
- C. Fasteners: Size and type to suit application.
- D. 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.
- E. Concealed Joint Fasteners: Threaded steel.
- F. Grommets: Standard plastic or painted metal grommets for cut-outs, in color as selected by Architect.

2.11 HARDWARE

- A. Cabinet Hardware: Comply with BHMA A156.9 for hardware types and grades indicated below:
 - 1. Product Grade: Grade 2.
- B. Metal Z-Shaped Wall Cabinet Support Clips: Paired, cleated, structural anchorage components applied to back of cabinets and walls for wall cabinet mounting.
- C. Adjustable Shelf Supports: Standard side-mounted system using recessed metal shelf standards or multiple holes for pin supports and coordinated self rests, polished chrome finish, for nominal 1 inch spacing adjustments.
- D. Countertop Support Brackets: See Section 123600 - Countertops.
- E. Drawer and Door Pulls: "U" shaped wire pull, steel with chrome finish, 4 inch centers.
- F. Keyed Cabinet Locks: Keyed cylinder, two keys per lock, master keyed, steel with chrome finish.
- G. Cabinet Catches and Latches:
 - 1. Type: Push latch.
- H. Drawer Slides:
 - 1. Type: Full extension with overtravel.
 - 2. Static Load Capacity: Heavy Duty grade.
 - 3. Mounting: Side mounted.
 - 4. Stops: Integral type.
 - 5. Features: Provide self closing/stay closed type.
- I. Soft-Close, Door and Drawer Adjustable Dampers:
 - 1. Manufacturers:
 - a. Grass America.

- b. Titus Cabinet Hardware.
 - c. Substitutions: See Section 01 2500 - Substitution Procedures.
- J. Hinges: European style concealed self-closing type, steel with nickel-plated finish.
- K. Elbow Catches: BHMA A156.9, B03023; coordinate with locks and latches at pairs of doors; active leaf shall have lock and inactive leaf shall have elbow catch. Ives #215, plated cast iron.
- L. Drawer Stops: Provide stops to prevent drawer fronts from hitting face of cabinet.
- M. Aluminum Slides for Sliding Glass Doors: BHMA A156.9, B07063.
- N. Paper Slots: 17 inches (432 mm) long by 1-3/4 inches (45mm) wide by 1 inch (25mm) deep; color as selected from manufacturer's standard colors, molded-plastic, paper-slot liner with 1/4 inch lip.

2.12 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. Provide cutouts for plumbing fixtures. Verify locations of cutouts from on-site dimensions. Prime paint cut edges.

2.13 SHOP FINISHING

- A. Sand work smooth and set exposed nails and screws.
- B. For opaque finishes, apply wood filler in exposed nail and screw indentations and sand smooth.
- C. On items to receive transparent finishes, use wood filler matching or blending with surrounding surfaces and of types recommended for applied finishes.
- D. 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. System - 11, Polyurethane, Catalyzed.
 - b. Stain: As selected by Architect.
 - c. Sheen: Flat.

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. Install work in accordance with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS) requirements for grade indicated.
- B. Set and secure custom cabinets in place, assuring that they are rigid, plumb, and level.
- C. Use fixture attachments in concealed locations for wall mounted components.
- D. Use concealed joint fasteners to align and secure adjoining cabinet units.
- E. Carefully scribe casework abutting other components, with maximum gaps of 1/32 inch. Do not use additional overlay trim for this purpose.
- F. Secure cabinets to floor using appropriate angles and anchorages.
- G. Countersink anchorage devices at exposed locations. Conceal with solid wood plugs of species to match surrounding wood; finish flush with surrounding surfaces.

3.03 COUNTERTOP INSTALLATION

- A. Install vanities in accordance with manufacturer's instructions and approved shop drawings
- B. Securely attach countertops to cabinets using concealed fasteners. Make flat surfaces level; shim where required.
- C. Attach plastic laminate countertops using screws with minimum penetration into substrate board of 5/8 inch.
- D. Attach wood countertops using screws with minimum penetration into substrate board of 5/8 inch.
- E. Apply sealer products in accordance with manufacturer's written instructions.
- F. Seal joint between back/end splashes and vertical surfaces.

3.04 FIELD QUALITY CONTROL

- A. See Section 01 4000 - Quality Requirements, for additional requirements.
- B. Inspections: Provide inspections of installed Work through AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS) program certifying that woodwork, including installation, complies with requirements of the Standard and grade specified.
 - 1. Architectural woodwork will be considered defective if it does not pass tests and inspections.
 - 2. Additional tests and inspections, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
 - 3. Inspection entity shall prepare and submit report of inspection.
 - 4. Submit Field Quality Control reports to Architect.

3.05 ADJUSTING

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

3.06 CLEANING

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

END OF SECTION

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SECTION 068316
FIBERGLASS REINFORCED PANELING (FRP)

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Fiberglass reinforced plastic panels.
- B. Trim.

1.02 REFERENCE STANDARDS

- A. 9 CFR 416.2 - Regulatory Requirements Under the Federal Meat Inspection Act and the Poultry Products Inspection Act, Part 416-Sanitation; current edition.
- B. ASTM D256 - Standard Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics; 2023, with Editorial Revision.
- C. ASTM D3273 - Standard Test Method for Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber; 2021.
- D. ASTM D5319 - Standard Specification for Glass-Fiber Reinforced Polyester Wall and Ceiling Panels; 2022.
- E. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2024.
- F. CAL (CDPH SM) - Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers Version 1.2; 2017.
- G. FM 4880 - Examination Standard for Class 1 Fire Rating of Building Panels or Interior Finish Materials; 2022.
- H. ISO 846 - Plastics - Evaluation of the Action of Microorganisms; 2019.

1.03 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: For each item to be installed. Provide data on specified products, describing physical and performance characteristics; including sizes, patterns and colors available; and installation instructions.
- C. Sustainable Product Data: See Section 01 6000 - Product Requirements and Section 01 6116 - Volatile Organic Compound (VOC) Content Restrictions.
 - 1. VOC content restrictions data.
 - 2. CAL (CDPH SM) compliance data.
- D. Samples: Submit three samples 4 by 4 inches in size, or manufacturer's standard sample size, illustrating material and surface design of panels.
- E. Warranty.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. See Section 01 6000 - Product Requirements.
- B. Store panels flat, indoors, on a clean, dry surface. Remove packaging and allow panels to acclimate to room temperature for 48 hours prior to installation.

- C. See Section 01 7419 - Construction Waste Management and Disposal, for packaging waste requirements.

1.05 WARRANTY

- A. See Section 01 6000 - Product Requirements and Section 01 7800 - Closeout Submittals for additional warranty requirements.
- B. Provide manufacturer's standard warranty for each product.

PART 2 PRODUCTS

2.01 SUSTAINABLE PRODUCT REQUIREMENTS

- A. See Section 01 6000 - Product Requirements.
- B. VOC Content Restrictions: Products in this section to not exceed VOC content limits specified in Section 01 6116 - Volatile Organic Compound (VOC) Content Restrictions.
- C. CDPH: Products to comply with CAL (CDPH SM) .

2.02 MANUFACTURERS

- A. Fiberglass Reinforced Plastic Panels:
 - 1. Crane Composites.
 - 2. Marlite.
 - 3. Nudo.
 - 4. Panolam.
 - 5. Substitutions: See Section 01 2500 - Substitution Procedures.

2.03 PANEL SYSTEMS

- A. Wall Panels:
 - 1. Products: See Finish Schedule on the Architectural drawings.
 - 2. Products:
 - a. .
 - b. Substitutions: See Section 01 2500 - Substitution Procedures.
 - 3. Panel Size: 4 by 8 feet.
 - 4. Panel Thickness: 0.10 inch.
 - 5. Surface Design: Smooth.
 - 6. Color: As selected by Architect.
 - 7. Attachment Method: Adhesive only, sealant joints, no trim.

2.04 MATERIALS

- A. Panels: Fiberglass reinforced plastic (FRP), complying with ASTM D5319.
 - 1. Surface Burning Characteristics: Maximum flame spread index of 25 and smoke developed index of 450; when system tested in accordance with ASTM E84.
 - 2. Class 1 fire rated when tested in accordance with FM 4880.
 - 3. Mold Resistance: Score of 10, when tested in accordance with ASTM D3273.
 - 4. Impact Strength: Greater than 6 ft lb force per inch, when tested in accordance with ASTM D256.
 - 5. Sanitation and Cleanability: Comply with 9 CFR 416.2.
 - 6. Biological Resistance: Rating of 0, when tested in accordance with ISO 846.

- B. Trim: Aluminum; color coordinating with panel.
- C. Adhesive: Type recommended by panel manufacturer.
- D. Sealant: Type recommended by panel manufacturer; color as selected by Architect.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify existing conditions and substrate flatness before starting work.
- B. Verify that substrate conditions are ready to receive the work of this section.

3.02 INSTALLATION - WALLS

- A. Install panels in accordance with manufacturer's instructions.
- B. Cut and drill panels with carbide tipped saw blades, drill bits, or snips.
- C. Apply adhesive to the back side of the panel using trowel as recommended by adhesive manufacturer.
- D. Apply panels to wall with seams plumb and pattern aligned with adjoining panels.
- E. Install panels with manufacturer's recommended gap for panel field and corner joints.
- F. Place trim on panel before fastening edges, as required.
- G. Fill channels in trim with sealant before attaching to panel.
- H. Install trim with adhesive and screws or nails, as required.
- I. Seal gaps at floor, ceiling, and between panels with applicable sealant to prevent moisture intrusion.
- J. Remove excess sealant after paneling is installed and prior to curing.

3.03 PROTECTION

- A. See Section 01 7000 - Execution and Closeout Requirements, for additional requirements.
- B. Provide barrier or other delineation to prevent damage to installed Work from subsequent construction activities.

END OF SECTION

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SECTION 070150.19
PREPARATION FOR RE-ROOFING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Demolition of existing roofing system in preparation for entire new roofing system specified in another Section.

1.02 REFERENCE STANDARDS

- A. PS 1 - Structural Plywood; 2023.
- B. PS 2 - Performance Standard for Wood Structural Panels; 2018.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordinate with affected mechanical and electrical work associated with roof penetrations.
- B. Preinstallation Meeting: Convene minimum 2 weeks before starting work of this section.
 - 1. See Section 01 3000 - Administrative Requirements, for additional information.
 - 2. Attendees:
 - a. Architect.
 - b. Contractor.
 - c. Owner.
 - d. Installer.
 - e. Roofing system manufacturer's field representative.
 - 3. Meeting Agenda: Provide agenda to participants prior to meeting in preparation for discussions on the following:
 - a. Removal and installation schedule.
 - b. Necessary preparatory work.
 - c. Protection before, during, and after roofing system installation.
 - d. Removal of existing roofing system.
 - e. Installation of new roofing system.
 - f. Temporary roofing and daily terminations.
 - g. Transitions and connection to and with other work.
 - h. Inspections and testing of installed systems.
- C. Schedule work to coincide with commencement of installation of new roofing system.

1.04 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Demolition Drawings: Indicate extent of roofing to be removed and substrate to remain.

1.05 COORDINATION

- A. Coordinate components of existing roof system to remain, if any, with requirements of new roofing system. Verify with new roof manufacturer that use of existing items will support specified warranty.

1.06 QUALITY ASSURANCE

- A. Materials Removal Company Qualifications: Company specializing in performing work of type specified with at least three years of documented experience.
 - 1. Comply with EPA notification regulations prior to start of roofing removal work.
 - 2. Comply with removal and disposal regulations of local authorities having jurisdiction (AHJ).

1.07 DELIVERY, STORAGE, AND HANDLING

- A. See Section 017419 - Construction Waste Management and Disposal for packaging waste requirements.
- B. Ensure storage and staging of materials does not exceed static and dynamic load-bearing capacities of roof decking.

1.08 FIELD CONDITIONS

- A. Do not remove existing roofing membrane when weather conditions threaten the integrity of building contents or intended continued occupancy.
- B. Maintain continuous temporary protection prior to and during installation of new roofing system.
- C. Provide notice at least three days before starting activities that will affect normal building operations.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Temporary Roofing Protection Materials:
 - 1. Contractor's responsibility to select appropriate materials for temporary protection of roofing areas as determined necessary for this work.
 - 2. Plastic Sheeting: Provide polyethylene sheets; use weights to retain sheeting in position.
 - 3. OSB Sheathing: Oriented strand board (OSB) wood structural panel; PS 2.
 - a. Grade: Sheathing.
 - b. Bond Classification: Exposure 1 OSB.
 - c. Performance Category: 5/8.
 - d. Span Rating: 24/16.
 - e. Edges: Square.
 - 4. Plywood Sheathing: PS 1, Grade C-D, Exposure I.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that existing roof surface has been cleared of materials being removed from existing roofing system and ready for next phase of work as required.

3.02 PREPARATION

- A. Sweep roof surface clean of loose matter.
- B. Remove loose refuse and dispose of properly off-site.

3.03 MATERIAL REMOVAL

- A. Remove only existing roofing materials that can be replaced with new materials the same day.
- B. Remove components as shown on the approved demolition drawings.

3.04 PROTECTION

- A. Provide temporary protective sheeting over uncovered deck surfaces.
- B. Provide for surface drainage from sheeting to existing drainage facilities.
- C. Do not permit traffic over unprotected or repaired deck surface.

END OF SECTION

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SECTION 070553
FIRE AND SMOKE ASSEMBLY IDENTIFICATION

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Identification markings for fire and smoke rated partitions, and fire rated walls.

1.02 RELATED REQUIREMENTS

- A. Section 099123 - Interior Painting: Paint finish.

1.03 REFERENCE STANDARDS

- A. ICC (IBC) - International Building Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.04 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Schedule: Completely define scope of proposed marking, and indicate location of affected walls and partitions, and number of markings.

1.05 FIELD CONDITIONS

- A. Do not install painted markings when ambient temperature is lower than recommended by coating manufacturer.

PART 2 PRODUCTS

2.01 FIRE AND SMOKE ASSEMBLY IDENTIFICATION

- A. Regulatory Requirements: Comply with "Marking and Identification" requirements of "Fire-Resistance Ratings and Fire Tests" chapter of CBC.
- B. Applied Fire and Smoke Assembly Identification: Identification markings applied to partition with paint and a code compliant stencil. See Section 099123 for products.

PART 3 EXECUTION

3.01 PREPARATION

- A. See Section 099123 for substrate preparation for painted markings.

3.02 INSTALLATION

- A. Locate markings as required by CBC.
- B. Install applied markings in accordance with Section 099123.
- C. Install neatly, with horizontal edges level.

- D. Protect from damage until Date of Substantial Completion; repair or replace damaged markings.

END OF SECTION

**SECTION 072100
THERMAL INSULATION**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Thermal insulation.

1.02 RELATED REQUIREMENTS

- A. Section 014113.11 - Regulatory Requirements - Global Warming Potential (GWP).
- B. Section 098100 - Acoustic Insulation.

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 C518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus; 2021.
- B. ASTM C553 - Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications; 2024.
- 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; 2024.
- 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; 2024.
- G. ASTM E136 - Standard Test Method for Assessing Combustibility of Materials Using a Vertical Tube Furnace at 750 Degrees C; 2024c.
- H. CAL (CDPH SM) - Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers Version 1.2; 2017.
- I. NFPA 285 - Standard Fire Test Method for Evaluation of Fire Propagation Characteristics of Exterior Wall Assemblies Containing Combustible Components; 2025.

1.05 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Global Warming Potential (GWP): Environmental product declaration (EPD) to identify GWP less than or equal to maximum allowable value. See 014113.11 - Regulatory Requirements - Global Warming Potential (GWP) for additional information.
- C. Product Data: For each item to be installed. Provide data on product characteristics, performance criteria, and product limitations.
- D. Sustainable Product Data: See Section 01 6000 - Product Requirements and Section 01 6116 - Volatile Organic Compound (VOC) Content Restrictions.
 - 1. CAL (CDPH SM) compliance data.
 - 2. Life cycle data.
 - 3. Recycled content data.
 - 4. VOC content restrictions data.
- E. Samples for Verification: Submit three samples 6 by 6 inches in size illustrating insulation.
- F. Manufacturer's Installation Instructions: Include information on special environmental conditions required for installation and installation techniques.

1.06 COORDINATION

- A. Fire-Rated Assemblies: Confirm insulation products within fire-rated assemblies meet fire-rated assembly requirements.
 - 1. Substitutions will not be permitted when proprietary products are required to meet fire-rating requirements.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. See Section 01 6000 - Product Requirements.
- B. Deliver materials to Project site in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, approval or listing agency markings, and directions for storing.
- C. Protect materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources. Store in a dry location.
- D. Comply with manufacturer's written instructions for handling, storing, and protecting during installation.
- E. See Section 01 7419 - Construction Waste Management and Disposal, for packaging waste requirements.

1.08 FIELD CONDITIONS

- A. Do not install insulation adhesives when temperature or weather conditions are detrimental to successful installation.

1.09 WARRANTY

- A. See Section 01 6000 - Product Requirements and Section 01 7800 - Closeout Submittals for additional warranty requirements.
- B. Provide manufacturer's standard warranty for each product.

PART 2 PRODUCTS

2.01 SUSTAINABLE PRODUCT REQUIREMENTS

- A. See Section 01 6000 - Product Requirements.
- B. VOC Content Restrictions: Products in this section to not exceed VOC content limits specified in Section 01 6116 - Volatile Organic Compound (VOC) Content Restrictions.
- C. CDPH: Products to comply with CAL (CDPH SM) .
- D. Life Cycle: Products in this section to have LCA as specified in Section 016000.
- E. Recycled Content: Products in this Section to meet minimum recycled content thresholds specified in Section 016000.
- F. All XPS insulation types to be manufactured without the use of CFCs, HCFCs, and HFC-134a blowing agent.

2.02 PERFORMANCE REQUIREMENTS

- A. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E84 by a qualified testing agency. Products to be identified with appropriate markings of applicable testing agency.
- B. Fire-Test-Response Characteristics: Provide foam plastic continuous insulation assemblies with the following fire-test-response characteristics, as determined by testing identical panels and system components per test method indicated below by UL or another testing and inspecting agency acceptable to authorities having jurisdiction. Identify products with appropriate markings of applicable testing agency.
 - 1. Intermediate-Scale Multistory Fire Test: Tested mockup, representative of completed wall assembly of which foam plastic continuous insulation is a part, complies with NFPA 285 for test method and required fire-test-response characteristics of exterior non-load-bearing wall assemblies.

2.03 REGULATORY REQUIREMENTS

- A. Light- and Heavy-Density Mineral Wool Board Insulation: Global Warming Potential (GWP) less than or equal to maximum allowable value. See Section 014113.11 - Regulatory Requirements - Global Warming Potential (GWP), for additional information.

2.04 APPLICATIONS

- A. Insulation in Metal Framed Walls: Batt insulation with no vapor retarder.
- B. Roof Insulation:
- C. Interior Partition Acoustic Insulation: See Section 098100 - Acoustic Insulation.

2.05 MINERAL FIBER BLANKET INSULATION MATERIALS

- A. Mineral Wool Blanket Thermal Insulation: Flexible or semi-rigid preformed insulation, complying with ASTM C665.
 - 1. Flame Spread Index: 25 or less, when tested in accordance with ASTM E84.
 - 2. Smoke Developed Index: 450 or less, when tested in accordance with ASTM E84.
 - 3. Thermal Resistance: R-value of 4.3 minimum at 1 inch thickness.
 - 4. Products:
 - a. Johns Manville; Mineral Wool TempControl Batts: www.jm.com/#sle.
 - b. ROCKWOOL; COMFORTBATT: www.rockwool.com/#sle.
 - c. Thermafiber, Inc; SAFB FF: www.thermafiber.com/#sle.

- d. Substitutions: See Section 01 2500 - Substitution Procedures.

2.06 GLASS-FIBER INSULATION MATERIALS

- A. Unfaced, Glass-Fiber Blanket Insulation, Type I: ASTM C665, Type I (blankets without membrane facing).
1. R-Value (ASTM C518): R19 min at walls and R30 min underside of roof.
 2. Maximum flame spread and smoke-developed indexes of 25 and 50, respectively, and passing ASTM E136 for combustion characteristics.
 3. Products:
 - a. CertainTeed; CertaPro Acousta Therm.
 - b. Johns Manville; Formaldehyde-Free Fiberglass.
 - c. Knauf; Ecobatt Unfaced Insulation.
 - d. Owens Corning; EcoTouch Pink Fiberglass Insulation.
 - e. Substitutions: See Section 01 2500 - Substitution Procedures.

2.07 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: Are required for application.
 3. Temperature Resistance: Range of minus 40 to 212 degrees F.
- B. Protection Board for Below Grade Insulation: , thick.
- C. Adhesive: Type recommended by insulation manufacturer for application.

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.

3.02 INSTALLATION, GENERAL

- A. Comply with insulation manufacturer's written instructions applicable to products and applications indicated.
- B. Install insulation that is undamaged, dry, and unsoiled and that has not been left exposed to ice, rain, or snow at any time.
- C. Extend insulation to envelop entire area to be insulated. Cut and fit tightly around obstructions and fill voids with insulation. Remove projections that interfere with placement.
- D. Provide sizes to fit applications indicated and selected from manufacturer's standard thicknesses, widths, and lengths. Apply single layer of insulation units to produce thickness indicated unless multiple layers are otherwise shown or required to make up total thickness.

3.03 BATT INSTALLATION

- A. Install insulation 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.

3.04 PROTECTION

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

END OF SECTION

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**SECTION 072500
WEATHER BARRIERS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Water-Resistive Barrier: Under exterior wall cladding, over sheathing or other substrate; not air tight or vapor retardant.
- B. Vapor Retarders: Materials to make exterior walls, joints between exterior walls and roof, and joints around frames of openings in exterior walls water vapor resistant and air tight.
- C. Air Barriers: Materials that form a system to stop passage of air through exterior walls, joints between exterior walls and roof, and joints around frames of openings in exterior walls.

1.02 RELATED REQUIREMENTS

- A. Section 075216-Modified Bituminous Membrane Roofing: Vapor retarder installed as part of roofing system.
- B. Section 092116 - Gypsum Board Assemblies: Water-resistive barrier under exterior cladding.

1.03 DEFINITIONS

- A. Weather Barrier: Assemblies that form either water-resistive barriers, air barriers, or vapor retarders.
- B. Water-Resistive Barrier: Water-shedding barrier made of material that is moisture resistant, to the degree specified, intended to be installed to shed water without sealed seams.

1.04 REFERENCE STANDARDS

- A. AATCC Test Method 127 - Test Method for Water Resistance: Hydrostatic Pressure; 2018, with Editorial Revision (2019).
- B. ASTM D1970/D1970M - Standard Specification for Self-Adhering Polymer Modified Bituminous Sheet Materials Used as Steep Roofing Underlayment for Ice Dam Protection; 2021.
- C. ICC-ES AC308 - Acceptance Criteria for Water-Resistive Barriers; 2016, with Editorial Revision (2021).

1.05 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data on material characteristics.
- C. Shop Drawings: Provide drawings of special joint conditions.
- D. Manufacturer's Installation Instructions: Indicate preparation.

1.06 MOCK-UP

- A. Install air barrier, vapor retarder, and water-resistive barrier materials in mock-up.

1.07 FIELD CONDITIONS

- A. Maintain temperature and humidity recommended by the materials manufacturers before, during and after installation.

PART 2 PRODUCTS

2.01 WEATHER BARRIER ASSEMBLIES

- A. Water-Resistive Barrier: Provide on exterior walls under exterior cladding.
 - 1. Under Portland cement stucco, use two separate layers of building paper.
 - 2. Under siding or Metal Panels use fluid-applied coating. See Section 072726 Fluid Applied Air Barrier

2.02 WATER-RESISTIVE BARRIER MATERIALS (NEITHER AIR BARRIER OR VAPOR RETARDER)

- A. Building Paper: Asphalt-saturated Kraft building paper complying with requirements of ICC-ES AC308 Grade D.
 - 1. Water Penetration Resistance: Withstand a water head of 21 inches, minimum, for minimum of five hours, when tested in accordance with AATCC Test Method 127.
 - 2. Manufacturers:
 - a. Fortifiber Building Systems Group; Super Jumbo Tex 60 Minute: www.fortifiber.com/#sle.
 - b. Fortifiber Building Systems Group; HydroTex: www.fortifiber.com/#sle.
 - c. Substitutions: See Section 016000 - Product Requirements.

2.03 ACCESSORIES

- A. Flexible Flashing: Self-adhesive sheet flashing complying with ASTM D1970/D1970M, except slip resistance requirement is waived if not installed on a roof.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that surfaces and conditions are ready to accept the work of this section.

3.02 PREPARATION

- A. Remove projections, protruding fasteners, and loose or foreign matter that might interfere with proper installation.
- B. Clean and prime substrate surfaces to receive adhesives in accordance with manufacturer's instructions.

3.03 INSTALLATION

- A. Install materials in accordance with manufacturer's instructions.
- B. Water-Resistive Barriers: Install continuous barrier over surfaces indicated, with sheets lapped to shed water but with seams not sealed.
- C. Air Barriers: Install continuous air tight barrier over surfaces indicated, with sealed seams and with sealed joints to adjacent surfaces.
- D. Mechanically Fastened Sheets - On Exterior:

1. Install sheets shingle-fashion to shed water, with seams generally horizontal.
 2. Overlap seams as recommended by manufacturer but at least 6 inches.
 3. Overlap at outside and inside corners as recommended by manufacturer but at least 12 inches.
 4. Install water-resistive barrier over jamb flashings.
 5. Install air barrier and vapor retarder UNDER jamb flashings.
 6. Install head flashings under weather barrier.
 7. At openings to be filled with frames having nailing flanges, wrap excess sheet into opening; at head, seal sheet over flange and flashing.
- E. Self-Adhered Sheets:
1. Prepare substrate in manner recommended by sheet manufacturer; fill and tape joints in substrate and between dissimilar materials.
 2. Lap sheets shingle-fashion to shed water and seal laps air tight.
 3. Once sheets are in place, press firmly into substrate with resilient hand roller; ensure that laps are firmly adhered with no gaps or fishmouths.
 4. Use same material, or other material approved by sheet manufacturer for the purpose, to seal to adjacent construction and as flashing.
 5. At wide joints, provide extra flexible membrane allowing joint movement.
- F. Openings and Penetrations in Exterior Weather Barriers:
1. Install flashing over sills, covering entire sill frame member, extending at least 5 inches onto weather barrier and at least 6 inches up jambs; mechanically fasten stretched edges.
 2. At openings to be filled with frames having nailing flanges, seal head and jamb flanges using a continuous bead of sealant compressed by flange and cover flanges with sealing tape at least 4 inches wide; do not seal sill flange.
 3. At openings to be filled with non-flanged frames, seal weather barrier to each side of opening framing, using flashing at least 9 inches wide, covering entire depth of framing.
 4. At head of openings, install flashing under weather barrier extending at least 2 inches beyond face of jambs; seal weather barrier to flashing.
 5. At interior face of openings, seal gap between window/door frame and rough framing, using joint sealant over backer rod.
 6. Service and Other Penetrations: Form flashing around penetrating item and seal to weather barrier surface.

3.04 FIELD QUALITY CONTROL

- A. See Section 014000 - Quality Requirements, for additional requirements.
- B. Coordination of ABAA Tests and Inspections:
1. Provide testing and inspection required by ABAA QAP.
 2. Notify in ABAA writing of schedule for air barrier work. Allow adequate time for testing and inspection.
 3. Cooperate with ABAA testing agency.
 4. Allow access to air barrier work areas and staging.
 5. Do not cover air barrier work until tested, inspected, and accepted.

3.05 PROTECTION

- A. Do not leave materials exposed to weather longer than recommended by manufacturer.
- B. Do not leave paper- or felt-based barriers exposed to weather for longer than one week.

END OF SECTION

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**SECTION 072726
FLUID APPLIED AIR BARRIER**

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section includes fluid-applied, vapor-permeable membrane air barriers for behind metal wall panels.
- B. Related Requirements:

1.03 DEFINITIONS

- A. Air-Barrier Material: A primary element that provides a continuous barrier to the movement of air.
- B. Air-Barrier Accessory: A transitional component of the air barrier that provides continuity.
- C. Air-Barrier Assembly: The collection of air-barrier materials and accessory materials applied to an opaque wall, including joints and junctions to abutting construction, to control air movement through the wall.

1.04 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.
 - 1. Review air-barrier requirements and installation, special details, mockups, air-leakage and bond testing, air-barrier protection, and work scheduling that covers air barriers.

1.05 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include manufacturer's written instructions for evaluating, preparing, and treating substrate; technical data; and tested physical and performance properties of products.

1.06 INFORMATIONAL SUBMITTALS

- A. Product Certificates: From air-barrier manufacturer, certifying compatibility of air barriers and accessory materials with Project materials that connect to or that come in contact with the barrier.
- B. Product Test Reports: For each air-barrier assembly, for tests performed by a qualified testing agency.

1.07 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.
 - 1. Retain subparagraph below if ABAA's Quality Assurance Program is required. Verify availability of ABAA-licensed contractors before retaining.

2. Installer shall be licensed by ABAA according to ABAA's Quality Assurance Program and shall employ ABAA-certified installers and supervisors on Project.
- B. Mockups: Build mockups to set quality standards for materials and execution and for preconstruction testing.
 1. Indicate portion of wall represented by mockup on Drawings or draw mockup as separate element.
 2. Build integrated mockups of exterior wall assembly , 150 sq. ft. (14 sq. m), incorporating backup wall construction, external cladding, window, storefront, door frame and sill, insulation, ties and other penetrations, and flashing to demonstrate surface preparation, crack and joint treatment, application of air barriers, and sealing of gaps, terminations, and penetrations of air-barrier assembly.
 - a. Generally retain first subparagraph below if requiring preconstruction testing.
 - b. Coordinate construction of mockups to permit inspection by Owner's testing agency of air barrier before external insulation and cladding are installed.
 - c. Include junction with roofing membrane, building corner condition, and foundation wall intersection.
 - d. If Architect determines mockups do not comply with requirements, reconstruct mockups and apply air barrier until mockups are approved.
 3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 4. Retain subparagraph below if the intention is to make an exception to the default requirement in Section 014000 "Quality Requirements" for demolishing and removing mockups.
 5. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.08 PRECONSTRUCTION TESTING

- A. Preconstruction Testing Service: Owner will engage a qualified testing agency to perform preconstruction testing on field mockups.
- B. Mockup Testing: Air-barrier assemblies shall comply with performance requirements indicated, as evidenced by reports based on mockup testing by a qualified testing agency.
 1. Adhesion Testing: Mockups will be tested for minimum air-barrier adhesion of 30 lbf/sq. in. (207 kPa) according to ASTM D 4541.
 2. Notify Architect seven days in advance of the dates and times when mockups will be tested.

1.09 DELIVERY, STORAGE, AND HANDLING

- A. Remove and replace liquid materials that cannot be applied within their stated shelf life.
- B. Protect stored materials from direct sunlight.

1.10 FIELD CONDITIONS

- A. Environmental Limitations: Apply air barrier within the range of ambient and substrate temperatures recommended by air-barrier manufacturer.
 1. Protect substrates from environmental conditions that affect air-barrier performance.
 2. Do not apply air barrier to a damp or wet substrate or during snow, rain, fog, or mist.

PART 2 - PRODUCTS

2.01 MATERIALS, GENERAL

2.02 PERFORMANCE REQUIREMENTS

- A. General: Air barrier shall be capable of performing as a continuous vapor-permeable air barrier and as a liquid-water drainage plane flashed to discharge to the exterior incidental condensation or water penetration. Air-barrier assemblies shall be capable of accommodating substrate movement and of sealing substrate expansion and control joints, construction material changes, penetrations, and transitions at perimeter conditions without deterioration and air leakage exceeding specified limits.

2.03 VAPOR-PERMEABLE MEMBRANE AIR-BARRIER

- A. Fluid-Applied, Vapor-Permeable Membrane Air and Water Barrier:
 - 1. Products: Subject to compliance with requirements, provide the following or approved equal:
 - a. Silicone Membrane:
 - 1) GE, Momentive Performance Materials, Inc.; SEC 2600 Sil Shield AWB (Basis of Design).
 - 2. Physical and Performance Properties:
 - a. Air Permeance: Maximum 0.00001 L/Pa m²s of surface area at 6.3 psf pressure difference; ASTM E 2178.
 - b. Vapor Permeance: Minimum 10.5 perms (320 ng/Pa x s x sq. m); ASTM E 96/E 96M.
 - c. Elongation value in "Ultimate Elongation" Subparagraph below is based on lowest stated value of listed products.
 - d. Ultimate Elongation: Minimum 542 percent; ASTM D 2370

2.04 ACCESSORY MATERIALS

- A. General: Accessory materials recommended by air-barrier manufacturer to produce a complete air-barrier assembly and compatible with primary air-barrier material.
- B. Primer: Liquid waterborne primer as recommended for substrate by air-barrier material manufacturer.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.
 - 1. Verify that substrates are sound and free of oil, grease, dirt, excess mortar, or other contaminants.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 SURFACE PREPARATION

- A. Clean, prepare, treat, and seal substrate according to manufacturer's written instructions. Provide clean, dust-free, and dry substrate for air-barrier application.
- B. Mask off adjoining surfaces not covered by air barrier to prevent spillage and overspray affecting other construction.

- C. Remove fins, ridges, mortar, and other projections and fill honeycomb, aggregate pockets, holes, and other voids in concrete with substrate-patching membrane.
- D. At changes in substrate plane, apply sealant or termination mastic beads at sharp corners and edges to form a smooth transition from one plane to another.
- E. Cover gaps in substrate plane and form a smooth transition from one substrate plane to another with stainless-steel sheet mechanically fastened to structural framing to provide continuous support for air barrier.

3.03 JOINT TREATMENT

- A. Gypsum Sheathing: Fill joints greater than 1/4 inch (6 mm) with sealant according to ASTM C 1193 and air-barrier manufacturer's written instructions. Apply first layer of fluid air-barrier material at joints. Tape joints with joint reinforcing strip after first layer is dry. Apply a second layer of fluid air-barrier material over joint reinforcing strip.

3.04 TRANSITION STRIP INSTALLATION

- A. General: Install strips, transition strips, and accessory materials according to air-barrier manufacturer's written instructions to form a seal with adjacent construction and maintain a continuous air barrier.
 - 1. Coordinate the installation of air barrier with installation of roofing membrane and base flashing to ensure continuity of air barrier with roofing membrane.
 - 2. Install butyl modified bituminous strip on roofing membrane or base flashing so that a minimum of 3 inches (75 mm) of coverage is achieved over each substrate.
- B. Apply primer to substrates at required rate and allow it to dry. Limit priming to areas that will be covered by fluid air-barrier material on same day. Reprime areas exposed for more than 24 hours.
 - 1. Prime glass-fiber-surfaced gypsum sheathing with number of prime coats needed to achieve required bond, with adequate drying time between coats.
- C. Connect and seal exterior wall air-barrier material continuously to roofing-membrane air barrier, concrete below-grade structures, floor-to-floor construction, exterior glazing and window systems, glazed curtain-wall systems, storefront systems, exterior louvers, exterior door framing, and other construction used in exterior wall openings, using accessory materials.
- D. At end of each working day, seal top edge of strips and transition strips to substrate with termination mastic.
- E. Apply joint sealants forming part of air-barrier assembly within manufacturer's recommended application temperature ranges. Consult manufacturer when sealant cannot be applied within these temperature ranges.
- F. Wall Openings: Prime concealed, perimeter frame surfaces of windows, curtain walls, storefronts, and doors. Apply preformed silicone-sealant extrusion so that a minimum of 3 inches (75 mm) of coverage is achieved over each substrate. Maintain 3 inches (75 mm) of full contact over firm bearing to perimeter frames with not less than 1 inch (25 mm) of full contact.
 - 1. Preformed Silicone-Sealant Extrusion: Set in full bed of silicone sealant applied to walls, frame, and air-barrier material.
- G. Fill gaps in perimeter frame surfaces of windows, curtain walls, storefronts, and doors, and miscellaneous penetrations of air-barrier material with foam sealant.
- H. Seal strips and transition strips around masonry reinforcing or ties and penetrations with termination mastic.
- I. Seal top of through-wall flashings to air barrier with an additional 6-inch- (150-mm-) wide, counterflashing strip.

- J. Seal exposed edges of strips at seams, cuts, penetrations, and terminations not concealed by metal counterflashings or ending in reglets with termination mastic.
- K. Repair punctures, voids, and deficient lapped seams in strips and transition strips. Slit and flatten fishmouths and blisters. Patch with transition strips extending 6 inches (150 mm) beyond repaired areas in strip direction.

3.05 FLUID AIR-BARRIER MEMBRANE INSTALLATION

- A. General: Apply fluid air-barrier material to form a seal with strips and transition strips and to achieve a continuous air barrier according to air-barrier manufacturer's written instructions. Apply fluid air-barrier material within manufacturer's recommended application temperature ranges.
 - 1. Apply primer to substrates at required rate and allow it to dry.
 - 2. Limit priming to areas that will be covered by fluid air-barrier material on same day. Reprime areas exposed for more than 24 hours.
 - 3. Prime glass-fiber-surfaced gypsum sheathing with number of prime coats needed to achieve required bond, with adequate drying time between coats.
- B. Membrane Air Barriers: Apply a continuous unbroken air-barrier membrane to substrates according to the following thickness. Apply air-barrier membrane in full contact around protrusions such as masonry ties.
 - 1. Vapor-Permeable Membrane Air Barrier: Total dry film thickness as recommended in writing by manufacturer to meet performance requirements, but not less than 17-mil dry film thickness, applied in one or more equal coats.
- C. Apply strip and transition strip over cured air-barrier material overlapping 3 inches (75 mm) onto each surface according to air-barrier manufacturer's written instructions.
- D. Do not cover air barrier until it has been tested and inspected by Owner's testing agency.
- E. Correct deficiencies in or remove air barrier that does not comply with requirements; repair substrates and reapply air-barrier components.

3.06 FIELD QUALITY CONTROL

- A. Coordinate test and inspection requirements in this article with Owner's testing agency.
- B. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- C. Inspections: Air-barrier materials, accessories, and installation are subject to inspection for compliance with requirements. Inspections may include the following:
 - 1. Continuity of air-barrier system has been achieved throughout the building envelope with no gaps or holes.
 - 2. Continuous structural support of air-barrier system has been provided.
 - 3. Site conditions for application temperature and dryness of substrates have been maintained.
 - 4. Maximum exposure time of materials to UV deterioration has not been exceeded.
 - 5. Surfaces have been primed, if applicable.
 - 6. Laps in strips and transition strips have complied with minimum requirements and have been shingled in the correct direction (or mastic has been applied on exposed edges), with no fishmouths.
 - 7. Termination mastic has been applied on cut edges.
 - 8. Strips and transition strips have been firmly adhered to substrate.
 - 9. Compatible materials have been used.
 - 10. Transitions at changes in direction and structural support at gaps have been provided.

11. Connections between assemblies (air-barrier and sealants) have complied with requirements for cleanliness, surface preparation and priming, structural support, integrity, and continuity of seal.
 12. All penetrations have been sealed.
- D. Tests: As determined by Owner's testing agency from among the following tests:
1. Qualitative Air-Leakage Testing: Air-barrier assemblies will be tested for evidence of air leakage according to ASTM E 1186, smoke pencil with pressurization or depressurization.
 2. Quantitative Air-Leakage Testing: Air-barrier assemblies will be tested for air leakage according to ASTM E 783.
 3. Adhesion Testing: Air-barrier assemblies will be tested for minimum air-barrier adhesion of 30 lbf/sq. in. (207 kPa) according to ASTM D 4541 for each 600 sq. ft. (56 sq. m) of installed air barrier or part thereof.
- E. See Section 014000 "Quality Requirements" for retesting and reinspecting requirements and Section 017000 "Execution" for requirements for correcting the Work.
- F. Air barriers will be considered defective if they do not pass tests and inspections.
1. Apply additional air-barrier material, according to manufacturer's written instructions, where inspection results indicate insufficient thickness.
 2. Remove and replace deficient air-barrier components for retesting as specified above.
- G. Repair damage to air barriers caused by testing; follow manufacturer's written instructions.

3.07 CLEANING AND PROTECTION

- A. Protect air-barrier system from damage during application and remainder of construction period, according to manufacturer's written instructions.
1. Protect air barrier from exposure to UV light and harmful weather exposure as required by manufacturer. If exposed to these conditions for more than 30 days, remove and replace air barrier or install additional, full-thickness, air-barrier application after repairing and preparing the overexposed membrane according to air-barrier manufacturer's written instructions.
 2. Protect air barrier from contact with incompatible materials and sealants not approved by air-barrier manufacturer.
- B. Clean spills, stains, and soiling from construction that would be exposed in the completed work using cleaning agents and procedures recommended by manufacturer of affected construction.
- C. Remove masking materials after installation.

END OF SECTION 072726

SECTION 075216.13
SBS MODIFIED BITUMINOUS MEMBRANE ROOFING, COLD-APPLIED

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Styrene-butadiene-styrene (SBS) modified bituminous membrane roofing system on metal deck, including but not limited to:
 - a. Roof insulation.
 - b. Roof insulation cover board.
 - c. SBS-modified bituminous membrane roofing.
 - d. Granule-surfaced SBS-modified bituminous membrane cap sheet.
 - e. Acrylic coating system.

1.02 DEFINITIONS

- A. Roofing Terminology: Refer to ASTM D1079 "Standard Terminology Relating to Roofing and Waterproofing" and applicable edition of NRCA's "The NRCA Roofing Manual: Membrane Roof Systems" and NRCA's Glossary for definition of terms related to roofing work in this Section.

1.03 REFERENCE STANDARDS

- A. ANSI FM 4474 - Standard for Evaluating the Simulated Wind Uplift Resistance of Roof Assemblies; 2010.
- B. ASCE 7 - Minimum Design Loads and Associated Criteria for Buildings and Other Structures; Most Recent Edition Cited by Referring Code or Reference Standard.
- C. ASTM C165 - Standard Test Method for Measuring Compressive Properties of Thermal Insulations; 2023.
- D. ASTM C203 - Standard Test Methods for Breaking Load and Flexural Properties of Block-Type Thermal Insulation; 2022.
- E. ASTM C208 - Standard Specification for Cellulosic Fiber Insulating Board; 2022.
- F. ASTM C518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus; 2021.
- G. ASTM C661 - Standard Test Method for Indentation Hardness of Elastomeric-Type Sealants by Means of a Durometer; 2015 (Reapproved 2022).
- H. ASTM C794 - Standard Test Method for Adhesion-in-Peel of Elastomeric Joint Sealants; 2018 (Reapproved 2022).
- I. ASTM C920 - Standard Specification for Elastomeric Joint Sealants; 2018 (Reapproved 2024).
- J. ASTM C1289 - Standard Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board; 2025.
- K. ASTM D93 - Standard Test Methods for Flash Point by Pensky-Martens Closed Cup Tester; 2020.
- L. ASTM D412 - Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers--Tension; 2016 (Reapproved 2021).
- M. ASTM D751 - Standard Test Methods for Coated Fabrics; 2019.

Sbs Modified Bituminous Membrane Roofing, Cold-
Applied

- N. ASTM D903 - Standard Test Method for Peel or Stripping Strength of Adhesive Bonds; 1998 (Reapproved 2025).
- O. ASTM D1079 - Standard Terminology Relating to Roofing and Waterproofing; 2020.
- P. ASTM D1621 - Standard Test Method for Compressive Properties of Rigid Cellular Plastics; 2016 (Reapproved 2023).
- Q. ASTM D2240 - Standard Test Method for Rubber Property--Durometer Hardness; 2015 (Reapproved 2021).
- R. ASTM D2370 - Standard Test Method for Tensile Properties of Organic Coatings; 2016 (Reapproved 2021).
- S. ASTM D3746 - Standard Test Method for Impact Resistance of Bituminous Roofing Systems; 2022.
- T. ASTM D3960 - Standard Practice for Determining Volatile Organic Compound (VOC) Content of Paints and Related Coatings; 2005 (Reapproved 2018).
- U. ASTM D4272 - Standard Test Method for Total Energy Impact of Plastic Films by Dart Drop; 2015.
- V. ASTM D5034 - Standard Test Method for Breaking Strength and Elongation of Textile Fabrics (Grab Test); 2021.
- W. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2024.
- X. ASTM E108 - Standard Test Methods for Fire Tests of Roof Coverings; 2020a.
- Y. ASTM E1980 - Standard Practice for Calculating Solar Reflectance Index of Horizontal and Low-Sloped Opaque Surfaces; 2024.
- Z. ASTM G154 - Standard Practice for Operating Fluorescent Ultraviolet (UV) Lamp Apparatus for Exposure of Nonmetallic Materials; 2023.
- AA. ASTM G155 - Standard Practice for Operating Xenon Arc Lamp Apparatus for Exposure of Materials; 2021.
- BB. CRRC-1 - CRRC-1 Roof Product Rating Program Manual; 2024.
- CC. UL 580 - Standard for Tests for Uplift Resistance of Roof Assemblies; Current Edition, Including All Revisions.
- DD. UL 790 - Standard for Standard Test Methods for Fire Tests of Roof Coverings; Current Edition, Including All Revisions.
- EE. UL 1897 - Uplift Tests for Roof-Covering Systems; Underwriters Laboratories Inc.; Current Edition, Including All Revisions.

1.04 PREINSTALLATION MEETINGS

- A. Preinstallation Roofing Conference: Conduct conference at Project site
 - 1. Meet with Owner, Architect, roofing Installer, roofing system manufacturer's representative, and installers whose work interfaces with or affects roofing, including installers of roof accessories and roof-mounted equipment.
 - 2. Review drawings and specifications.
 - 3. Review methods and procedures related to roofing installation, including manufacturer's written instructions.
 - 4. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
 - 5. Examine substrate conditions and finishes for compliance with requirements, including flatness and fastening.
 - 6. Review structural loading limitations of roof deck during and after roofing.

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7. Review base flashings, special roofing details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that will affect roofing system.
8. Review temporary protection requirements for roofing system during and after installation.
9. Review roof observation and repair procedures after roofing installation.

1.05 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
 1. Product Test Reports for Solar Reflectance: For roof materials, indicating that roof materials comply with Solar Reflectance Index requirement.
- B. Shop Drawings: For roofing system. Include plans, elevations, sections, details, and attachments to other work. Provide roof plan showing orientation and types of roof deck, orientation of membrane roofing, and fastening spacings and patterns for mechanically fastened components.
 1. Base flashings and built-up terminations.
 - a. Indicate details meet requirements of NRCA required by this Section.
 2. Tapered insulation, including slopes.
 3. Crickets, saddles, and tapered edge strips, including slopes.
 4. Insulation fastening patterns for corner, perimeter, and field-of-roof locations.
- C. Samples for Verification: For the following products:
 1. Sheet roofing materials.

1.06 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer, Manufacturer, and Roofing Inspector.
 1. Include letter from Manufacturer written for this Project indicating approval of Installer.
- B. Contractor's Product Certificate: Submit signed certification, on company letterhead, indicating products intended for Work of this Section, including product names and numbers and manufacturers' names, with statement indicating that products to be provided meet the requirements of the Contract Documents.
- C. Manufacturer Certificates:
 1. Submit evidence of compliance with requirements specified in "Performance Requirements" Article.
 2. Product Compatibility: Indicate manufacturer has verified compatibility of roofing system components, including but not limited to: Roofing membrane, flashing sheets, adhesives and sealants.
- D. Warranties: Unexecuted sample copies of special warranties.
- E. Field Quality Control Reports: Reports of Roofing Inspector. Include weather conditions, description of work performed, tests performed, defective work observed, and corrective actions required and carried out.
 1. Submit reports within 24 hours after inspection.
- F. Manufacturer's Instructions: Submit copy of manufacturer's written installation instructions for specified roofing system.

1.07 CLOSEOUT SUBMITTALS

- A. Maintenance Data: To include in maintenance manuals.
- B. Warranties: Executed copies of warranties.

1.08 QUALITY ASSURANCE

- A. Installer Qualifications: An employer of workers trained and certified by manufacturer, including a full-time on-site supervisor with a minimum of five years' experience installing products comparable to those specified, able to communicate verbally with Contractor, Architect, and employees, and qualified by the manufacturer to install manufacturer's product and furnish warranty of type specified.
- B. Manufacturer Qualifications: Approved manufacturer with roofing systems comparable to those specified for this Project, with minimum five years' experience in manufacture of comparable products in successful use in similar applications, and able to furnish warranty with provisions matching specified requirements.
 - 1. Approval of Other Manufacturers and Comparable Products: Submit the following in accordance with project substitution requirements, within time allowed for substitution review:
 - a. Contractor's Product Certificate: Submit notarized certificate, indicating products intended for Work of this Section, including product names and numbers and manufacturer names, with statement indicating that products to be provided meet the requirements of the Contract Documents.
 - b. Product data, including certified independent test data indicating compliance with requirements.
 - c. Samples of each component.
 - d. Sample submittal from similar project.
 - e. Project references: Minimum of five installations of specified products not less than five years old, with Owner contact information.
 - f. UL listing.
 - g. Nemo wind uplift report.
 - h. Sample warranty.
 - 2. Substitutions following award of contract are not allowed except as stipulated in Division 01 General Requirements.
 - 3. Approved manufacturers must meet separate requirements of Submittals Article.
- C. Roofing Inspector Qualifications: A technical representative of manufacturer not engaged in the sale of products and experienced in the installation and maintenance of the specified roofing system, qualified to perform roofing observation and inspection specified in Field Quality Control Article, to determine Installer's compliance with the requirements of this Project, and approved by the manufacturer to issue warranty certification. The Roofing Inspector shall be one of the following:
 - 1. An authorized full-time technical employee of the manufacturer.
 - 2. An independent party certified as a Registered Roof Observer by the International Institute of Building Enclosure Consultants (formerly the Roof Consultants Institute) retained by the Contractor or the Manufacturer and approved by the Manufacturer.
- D. Manufacturer's Installation Instructions: Obtain and maintain on-site manufacturer's written recommendations and instructions for installation of products.

1.09 DELIVERY, STORAGE, AND HANDLING

- A. Deliver roofing materials to Project site in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, approval or listing agency markings, and directions for storing and mixing with other components.
- B. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by roofing system manufacturer. Protect stored liquid material from direct sunlight.

1. Discard and legally dispose of liquid material that cannot be applied within its stated shelf life.
- C. Protect roof insulation materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources. Store in a dry location. Comply with insulation manufacturer's written instructions for handling, storing, and protecting during installation.
- D. Handle and store roofing materials and place equipment in a manner to avoid permanent deflection of deck.

1.10 PROJECT / FIELD CONDITIONS

- A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit roofing system to be installed according to manufacturer's written instructions and warranty requirements.
- B. Daily Protection: Coordinate installation of roofing so insulation and other components of roofing system not permanently exposed are not subjected to precipitation or left uncovered at the end of the workday or when rain is forecast.
 1. Provide tie-offs at end of each day's work to cover exposed roofing and insulation with a course of roofing sheet securely in place with joints and edges sealed.
 2. Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of roofing.
 3. Remove temporary plugs from roof drains at end of each day.
 4. Remove and discard temporary seals before beginning work on adjoining roofing.

1.11 WARRANTY

- A. Manufacturer's Warranty: Roof System Manufacturer's standard form in which Manufacturer agrees to repair or replace components of roofing system that fail in materials or workmanship within warranty period, as follows.
 1. Form of Warranty: Manufacturer's standard warranty form.
 2. Scope of Warranty: Work of this Section and including sheet metal details and termination details installed by the roof system Installer and approved by the Roof System Manufacturer.
 3. Warranty Period: 30 years from date of completion.
- B. Manufacturer Inspection Services: By manufacturer's technical representative, to report maintenance responsibilities to Owner necessary for preservation of Owner's warranty rights. The cost of manufacturer's inspections is included in the Contract Sum.
 1. Inspections to occur in following years: 2, 5, 10, 15, 20 and 25 following completion.
- C. Installer Warranty: Installer's warranty signed by Installer, as follows.
 1. Form of Warranty: Form acceptable to Roofing Manufacturer and Owner.
 2. Scope of Warranty: Work of this Section.
 3. Warranty Period: 2 years from date of completion.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Basis of Design: The roof system specified in this Section is based upon products of Tremco CPG Incorporated or Equal.
 1. Other Manufacturers - Submit equal products for review under Section 012500 Substitutions.
 - a. Garland

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- b. GAF
 - c. Johns Manville
 - d. CertainTeed
- B. Source Limitations: Obtain components for roofing system from same manufacturer as membrane roofing or manufacturer approved by membrane roofing manufacturer.

2.02 PERFORMANCE REQUIREMENTS

- A. General Performance: Installed membrane roofing and base flashings shall withstand specified uplift pressures, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Membrane roofing and base flashings shall remain watertight.
 - 1. Accelerated Weathering: Roofing system shall withstand 2000 hours of exposure when tested according to ASTM G152, ASTM G154, or ASTM G155.
 - 2. Impact Resistance: Roof membrane shall resist impact damage when tested according to ASTM D3746/D3746M, ASTM D4272/D4272M, or the "Resistance to Foot Traffic Test" in FM Approvals 4470.
- B. Roofing System Design: Provide roofing system that is identical to systems that have been successfully tested by a qualified testing and inspecting agency in accordance with ANSI FM 4474, UL 580, or UL 1897, and to resist uplift pressures calculated in accordance with ASCE 7 and applicable code.
 - 1. Zone 1 (Field-of-Roof) Uplift Pressure: 12.3 psf.
 - 2. Zone 2 (Perimeter) Uplift Pressure: 16.3 psf, located within 12 feet of roof perimeter.
 - 3. Zone 3 (Corners) Uplift Pressure: 22.2 psf, located within 4 feet of roof outside corner.
- C. SPRI Wind Design Standard: Manufacture and install roof edge flashings tested according to ANSI/SPRI ES-1.
- D. Flashings and Fastening: Provide base flashings, perimeter flashings, detail flashings and component materials and installation techniques that comply with requirements and recommendations of the following:
 - 1. NRCA Roofing Manual (Sixth Edition) for construction details and recommendations.
 - 2. SMACNA Architectural Sheet Metal Manual (Seventh Edition) for construction details.
- E. Exterior Fire-Test Exposure: ASTM E108 or UL 790, Class A; for application and roof slopes indicated, as determined by testing identical membrane roofing materials by a qualified testing agency. Materials shall be identified with appropriate markings of applicable testing agency.
- F. Energy Performance: Roofing system shall have an initial solar reflectance index of not less than 0.70 and an emissivity of not less than 0.75 when tested according to CRRC-1.
- G. Granule Loss: Not more than 0.4 g when calculated according to ASTM D5147, based on testing identical products by a qualified testing agency.

2.03 MATERIALS, GENERAL

- A. Material Compatibility: Roofing materials shall be compatible with one another and adjacent materials under conditions of service and application required, as demonstrated by roof membrane manufacturer based on testing and field experience.

2.04 ROOFING MEMBRANE MATERIALS

- A. Base-Ply Sheet:
 - 1. SBS/RET/Urethane-modified asphalt coated polyester reinforced high elongation sheet, smooth surfaced, ASTM D6164 Type I Grade S.
 - a. Basis of design product: Tremco, POWERply Endure 200 Smooth.

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- b. Tensile Strength at 77 deg. F (25 deg. C), minimum, ASTM D5147: Machine direction 130 lbf/in (22 kN/m) ; cross machine direction; 110 lbf (19 kN/m).
 - c. Tear Strength at 77 deg. F (25 deg. C), minimum, ASTM D5147: Machine direction 160 lbf (700 N); cross machine direction; 130 lbf (575 N).
 - d. Elongation at 77 deg. F (25 deg. C), minimum, ASTM D5147: Machine direction, 55 percent; cross machine direction, 60 percent.
 - e. Low Temperature Flex, maximum, ASTM D5147: -40 deg. F (-40 deg. C).
 - f. Thickness, minimum, ASTM D5147: 0.094 inch.
 - B. SBS Modified Bituminous Membrane Granule-Surfaced Cap Sheet:
 - 1. SBS/RET/Urethane-modified asphalt-coated polyester-reinforced sheet, white granular surfaced, fire-resistant, ASTM D6164 Type II Grade G.
 - a. Basis of design product: Tremco, POWERply Endure 200 FR.
 - b. Tensile Strength at 77 deg. F (25 deg. C), minimum, ASTM D5147: Machine direction 130 lbf/in (22 kN/m); Cross machine direction 110 lbf/in (19 kN/m).
 - c. Tear Strength at 77 deg. F (25 deg. C), minimum, ASTM D5147: Machine direction, 160 lbf (710 N); Cross machine direction 140 lbf (620 N).
 - d. Elongation at 77 deg. F (25 deg. C), minimum, ASTM D5147: Machine direction 55 percent; Cross machine direction 60 percent.
 - e. Low Temperature Flex, maximum, ASTM D5147: -40 deg. F (-40 deg. C).
 - f. Thickness, minimum, ASTM D5147: 0.150 inch.
 - C. Flashing Sheet:
 - 1. Thermoplastic PVC/TPA sheet, internally fabric reinforced, Energy Star qualified, CRRC listed, and California Title 24 Energy Code compliant, ASTM D4434 Type IV.
 - a. Tensile Strength at 0 deg. F (-18 deg. C), minimum, ASTM D751: 300 lbf/in (1330 N).
 - b. Tear Strength at 77 deg. F (25 deg. C), minimum, ASTM D751: 100 lbf (440 N).
 - c. Elongation at 0 deg. F (-18 deg. C), minimum at fabric break, ASTM D751: 25 percent machine direction, 25 percent cross-machine direction.
 - d. Minimum Thickness, nominal, ASTM D751: 0.045 inch.
 - e. Color: White.
 - f. Solar Reflectance Index (SRI), ASTM E1980: 108 (White, initial) 84 (White, 3-year aged).
 - g. Recycled Content, minimum: 25 percent pre-consumer.
 - D. Fluid-Applied Flashing Material:
 - 1. Polyurethane Roof Coating System Base Coat: Bio-based, low-odor low-VOC two-part, for use with a compatible top coat.
 - a. Combustion Characteristics, UL 790: Maintains combustion characteristics of existing roof system.
 - b. Volatile Organic Compounds (VOC), maximum, ASTM D3960: 1 g/L.
 - c. Accelerated Weathering, 5000 hours, ASTM G154: Pass.
 - d. Hardness, Shore A, minimum, ASTM D2240: 80.
 - e. Solids, by volume, ASTM D2697: 100 percent.
 - f. Bio-Based Content, Minimum: 70 percent.
 - g. Minimum Thickness, Base Coat reinforced over Granular Surfaced MB: 64 mils 0.06 inch wet.
 - 2. Polyurethane roof coating system top coat, bio-based low-odor low-VOC two-part, for application over compatible base coat.
 - a. Combustion Characteristics, UL 790: Maintains combustion characteristics of existing roof system.
 - b. Volatile Organic Compounds (VOC), maximum, ASTM D3960: 6 g/L.
 - c. Solar Reflectance Index (SRI), ASTM E1980: For white, not less than 103.

- d. Accelerated Weathering, 5000 hours, ASTM G154: Pass.
 - e. Hardness, Shore A, minimum, ASTM D2240: 81.
 - f. Solids, by volume, ASTM D2697: 100 percent.
 - g. Bio-Based Content, Minimum: 60 percent.
 - h. Minimum Thickness, reinforced system: 32 mils 0.03 inch wet.
 - i. Color: White.
- 3. Polyester Reinforcing Fabric: 100 percent stitch-bonded mildew-resistant polyester fabric intended for reinforcement of compatible fluid-applied membranes and flashings.
 - a. Tensile Strength, Minimum, ASTM D5034 (2-inch): MD - 110 lbs (49.8 kg); XMD - 60 lbs (27.2 kg) avg.
 - b. Elongation, Minimum, ASTM D5034 (1-inch): MD - 25 percent; XMD - 100 percent.
 - c. Tear Strength, Minimum, ASTM D5587: MD - 20 lbs (9.0 kg) avg; XMD - 20 lbs (9.0 kg) avg.
 - d. Weight: 3 oz./sq. yd (102 g/sq. m).
- E. Detail Fabric:
 - 1. Woven Glass Fiber Mesh, Vinyl-Coated: Non-shrinking, non-rotting, vinyl-coated woven glass mesh for reinforcing flashing seams, membrane laps, and other roof system detailing.
 - a. Tensile strength, 70 deg. F, min ASTM D146: Warp, 65 lbf/in (285 N); fill, 75 lbf/in (310 N).

2.05 COLD-APPLIED ADHESIVE MATERIALS

- A. General: Adhesive and sealant materials recommended by roofing system manufacturer for intended use and compatible with roofing membrane.
 - 1. Liquid-type auxiliary materials shall comply with VOC limits of authorities having jurisdiction.
- B. Modified Bituminous Base-Ply and Cap Sheet Adhesive:
 - 1. Cold-applied roofing adhesive and surfacer, one-part, formulated for compatibility and use with specified roofing membranes and flashings.
 - a. Volatile Organic Compounds (VOC), maximum, ASTM D6511: 250 g/L.
 - b. Nonvolatile Content, minimum, ASTM D6511: 72 percent.
 - c. Flash Point, minimum, ASTM D93: 100 degrees Fahrenheit.
- C. Flashing Sheet Adhesive:
 - 1. Bonding adhesive, contact-type solvent-based low VOC, for bonding TPA non-fleece-backed single ply membranes and flashings to substrates.
 - a. VOC, maximum, ASTM D3960: 200 g/L.

2.06 AUXILIARY ROOFING MATERIALS

- A. General: Auxiliary materials recommended by roofing system manufacturer for intended use and compatible with roofing membrane.
- B. Asphalt Roofing Cement / Mastic:
 - 1. Seam Sealer and Patching Sealer: Acrylic elastomeric sealer, single-component, high solids, low-VOC, formulated for compatibility and use with specified roofing and wall substrates.
 - a. Volatile Organic Compounds (VOC), maximum, ASTM D3960: 50 g/L.
 - b. Tensile Strength, minimum, ASTM D412: 450 psi.
 - c. Hardness, Shore A: 45.
 - d. Elongation, minimum, ASTM D412: 300 percent.
 - e. Impact Resistance, minimum: 160 inch/lb (18 kN/m).

2. Roof Cement, Asphalt-Based: ASTM D4586, Type II, Class I, fibrated roof cement formulated for use in installation and repair of asphalt ply and modified bitumen roofing plies and flashings; UL-classified for fire resistance.
 - a. Volatile Organic Compounds (VOC), maximum, ASTM D3960: 190 g/L.
 - b. Non-Volatile Matter, ASTM D4586: 85 percent.
 - c. Resistance to sag ASTM D4586: 1/8 inch. (0.12 inch).
- C. Stripping Adhesive / Sealer:
 1. Cold-applied roofing surfacing adhesive, one-part white solar reflective low-volatile polymeric, formulated for compatibility and use with specified roofing membranes and flashings.
 - a. Volatile Organic Compounds (VOC), maximum, ASTM D6511: 250 g/L.
 - b. Nonvolatile content, minimum ASTM D6511: 70 percent.
- D. Joint Sealant: Elastomeric joint sealant compatible with roofing materials, with movement capability appropriate for application.
 1. Joint Sealant, Polyurethane: ASTM C920, Type S, Grade NS, Class 50 single-component moisture curing sealant, formulated for compatibility and use in dynamic and static joints; paintable.
 - a. Volatile Organic Compounds (VOC), maximum, ASTM D3960: 40 g/L.
 - b. Hardness, Shore A, ASTM C661: 40.
 - c. Adhesion to Concrete, ASTM C794: 35 pli.
 - d. Tensile Strength, ASTM D412: 350 psi.
 - e. Color: White.
- E. Miscellaneous Accessories: Provide miscellaneous accessories recommended by roofing system manufacturer.

2.07 ROOF INSULATION MATERIALS

- A. Roof Insulation, General: Preformed roof insulation boards manufactured or approved by roofing manufacturer, selected from manufacturer's standard sizes suitable for application, of thicknesses indicated.
 1. Tapered Insulation: Provide factory-tapered insulation boards fabricated to slope of 1/4 inch per 12 inches unless otherwise indicated by valleys.
 2. Provide preformed saddles, crickets, tapered edge strips, and other insulation shapes where indicated for sloping to drain. Fabricate to slopes indicated, not less than two times the roof slope.
- B. Roof Insulation:
 1. Board Insulation, Polyisocyanurate: CFC- and HCFC- free, with recycled content glass-fiber mat facer on both major surfaces, ASTM C1289 Type II Class 1.
 - a. Compressive Strength, ASTM D1621: Grade 2: 20 psi.
 - b. Conditioned Thermal Resistance at 75 deg. F (24 deg. C): 14.4 at 2.5 inches thick.

2.08 ROOF INSULATION ACCESSORIES

- A. Insulation Cover Board:
 1. Board Insulation, Cellulosic-fiber: With water-resistant binders, non-asphaltic primer coated on four sides and chemically treated for deterioration, ASTM C208, Type II, Grades 1 and 2.
 - a. Compressive strength, ASTM C165: 15 lbf/sq. in.
 - b. Thermal resistance at 75 deg. F 75.2 degrees Fahrenheit.) ASTM C518: R 1.3.
 - c. Recycled content, pre-consumer: 20 percent.
 - d. Rapidly renewable content: 6 percent.

- e. Thickness: 1/2 inch.
- B. Roof Insulation Adhesive:
 - 1. Urethane adhesive, bead-applied, low-rise two-component solvent-free low odor, formulated to adhere roof insulation to substrate.
 - a. Flame Spread Index, ASTM E84: 10.
 - b. Smoke Developed Index, ASTM E84: 30.
 - c. Volatile Organic Compounds (VOC), maximum, ASTM D3960: 0 g/L.
 - d. Tensile Strength, minimum, ASTM D412: 250 psi.
 - e. Peel Adhesion, minimum, ASTM D903: 17 lbf/in (2.50 kN/m).
 - f. Flexibility, 70 deg. F (39 deg. C), ASTM D816: Pass.
- C. Insulation Cant Strips: ASTM C208, Type II, Grade 1, cellulosic-fiber insulation board.
- D. Tapered Edge Strips: ASTM C208, Type II, Grade 1, cellulosic-fiber insulation board.
- E. Substrate Joint Tape: 6- or 8-inch- (150- or 200-mm-) wide, coated, glass fiber.
- F. Insulation Fasteners: Factory-coated steel fasteners and metal plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening roof insulation and cover boards to substrate, and acceptable to roofing system manufacturer.

2.09 SURFACING MATERIALS

- A. Acrylic Emulsion Coating Material:
 - 1. Acrylic Roof Coating, Elastomeric: ASTM D6083, applied as base coat plus finish coat over prepared and primed roof surfaces.
 - a. Volatile Organic Compounds (VOC), maximum, ASTM D3960: 50 g/L.
 - b. Tensile Strength at 73 deg. F (23 deg. C), minimum, ASTM D2370: 250 psi.
 - c. Elongation at 73 deg. F (23 deg. C), minimum, ASTM D2370: 350 percent.
 - d. Flexibility at -15 degrees Fahrenheit, ASTM D522: Pass 1/2 inch mandrel bend after 1000 hrs. accelerated weathering.
 - e. Solids by weight, minimum ASTM D1644: 60 percent.
 - f. Solids by volume, minimum ASTM D2697: 50 percent.
 - g. Color, Top Coat: White.
 - h. Minimum Thickness over BUR and MB: 24 mils 0.02 inch wet each coat for base and finish coats.
 - i. Solar Reflectance Index (SRI), white, ASTM E1980: 105 initial; 100 3-Year aged.

2.10 WALKWAYS

- A. Walkway Material:
 - 1. Walkway pads, ceramic-granule-surfaced reinforced asphaltic composition slip-resisting pads, manufactured as a traffic pad for foot traffic, 1/2 inch thick minimum.
 - a. Flexural Strength at max. load, minimum, ASTM C203: 218 psi.
 - b. Granule adhesion (weight loss), maximum, ASTM D4977: 1.1 gram.
 - c. Impact Resistance at 77 deg. F (25 deg. C), ASTM D3746: No Damage to Roof.
 - d. Pad Size: 36 by 48 inch (914 by 1220 mm).

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with the following requirements and other conditions affecting performance of roofing system:

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1. Verify that roof openings and penetrations are in place and curbs are set and braced and that roof drain bodies are securely clamped in place.
2. Verify that substrate is sound and dry.
3. Steel Roof Deck:
 - a. Verify that deck is securely fastened with no projecting fasteners and with no adjacent units in excess of 1/16 inch out of plane relative to adjoining deck.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Clean substrate of dust, debris, moisture, and other substances detrimental to roofing installation according to roofing system manufacturer's written instructions. Remove sharp projections.
- B. Prevent materials from entering and clogging roof drains and conductors and from spilling or migrating onto surfaces of other construction. Remove roof-drain plugs when no work is taking place or when rain is forecast.

3.03 INSTALLATION, GENERAL

- A. Install roofing system in accordance with manufacturer's written instructions, approved shop drawings, and Contract Documents.
- B. Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of roofing system at the end of the workday or when rain is forecast. Remove and discard temporary seals before beginning work on adjoining roofing

3.04 ROOFING INSTALLATION DETAILS

- A. NRCA Installation Details: Install roofing system in accordance with applicable NRCA Manual Plates and NRCA recommendations; modify as required to comply with manufacturer's approved details and perimeter fastening requirements.

3.05 INSULATION INSTALLATION

- A. Comply with roofing manufacturer's written instructions for installing roof insulation.
- B. Coordinate installing membrane roofing system components, so insulation is not exposed to precipitation or left exposed at the end of the workday
- C. Cant Strips: Install and secure preformed 45-degree cant strips at junctures of built-up roofing with vertical surfaces or angle changes greater than 45 degrees.
- D. Tapered Insulation and Crickets: Install tapered insulation under area of roofing to conform to slopes indicated.
 1. Where crickets are indicated or required to provide positive slope to drain, make slope of crickets minimum of two times the roof slope, not less than 1/4 inch in 12 inches.
- E. Install insulation with long joints of insulation in a continuous straight line with end joints staggered between rows, abutting edges and ends between boards. Fill gaps exceeding 1/4 inch with insulation.
 1. Cut and fit insulation within 1/4 inch of nailers, projections, and penetrations.
- F. Install insulation under area of roofing to achieve required thickness. Where overall insulation thickness is 2.7 inches or greater, install two or more layers with joints of each succeeding layer staggered from joints of previous layer a minimum of 6 inches in each direction.
 1. Insulation Drain Sumps: Tapered insulation sumps, not less than 2 by 2 feet, sloped to roof drain.

- a. Sump to maximum depth of not more than 1 inch less than the Project-stipulated continuous insulation thickness based upon code requirements.
 - b. Maintain minimum 1 inch insulation thickness at low point.
- G. Trim surface of insulation where necessary at roof drains so completed surface is flush and does not restrict flow of water.
- H. Install tapered edge strips at perimeter edges of roof that do not terminate at vertical surfaces.
- I. Mechanically Fastened and Adhered Insulation Application Method: Install first layer of insulation to deck using mechanical fasteners specifically designed and sized for fastening specified board-type roof insulation to deck type.
 1. Fasten first layer of insulation to resist uplift pressure at corners, perimeter, and field of roof.
 2. Set each subsequent layer of insulation in ribbons of bead-applied insulation adhesive, firmly pressing and maintaining insulation in place.
- J. Install cover boards over insulation with long joints in continuous straight lines with end joints staggered between rows. Offset joints of insulation below a minimum of 6 inches in each direction. Loosely butt cover boards together. Tape joints if required by roofing manufacturer.
 1. Set cover board in ribbons of bead-applied insulation adhesive, firmly pressing and maintaining cover in place.

3.06 COLD-APPLIED ROOFING MEMBRANE INSTALLATION, GENERAL

- A. Install roofing membrane system according to roofing system manufacturer's written instructions and applicable recommendations in NRCA's "Quality Control and Quality-assurance Guidelines for the Application of Membrane Roofing" and as follows:
- B. Start installation of roofing membrane in presence of roofing system manufacturer's technical personnel.
- C. Cooperate with testing agencies engaged or required to perform services for installing roofing system.
- D. Coordinate installation of roofing system so insulation and other components of the roofing membrane system not permanently exposed are not subjected to precipitation or left uncovered at the end of the workday or when rain is forecast.
 1. Provide tie-offs at end of each day's work to cover exposed roofing membrane sheets and insulation with a course of coated felt set in compatible roofing cement/mastic, with joints and edges sealed.
 - a. Comply with roofing membrane manufacturer's instructions and details for waterstop/daily tie-in; utilize staggered layout and unadhered, removable "deadman" insulation boards.
 2. Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of roofing.
 3. Remove temporary plugs from roof drains at end of each day.
 4. Remove and discard temporary seals before beginning work on adjoining roofing.
- E. Substrate-Joint Penetrations: Prevent roofing asphalt and adhesives from penetrating substrate joints, entering building, or damaging roofing system components or adjacent building construction.

3.07 BASE-PLY SHEET INSTALLATION

- A. Install lapped modified bituminous roofing membrane base-ply sheet according to roofing manufacturer's written instructions, starting at low point of roofing system. Extend roofing membrane sheets over and terminate beyond cants, installing as follows:
 1. Adhere to substrate in cold-applied adhesive.

Sbs Modified Bituminous Membrane Roofing, Cold-
Applied

3.08 SBS-MODIFIED BITUMINOUS MEMBRANE INSTALLATION

- A. Install modified bituminous roofing membrane cap sheet according to roofing manufacturer's written instructions, starting at low point of roofing system. Extend roofing membrane sheets over and terminate beyond eaves, installing as follows:
 - 1. Unroll roofing membrane sheets and allow them to relax for minimum time period required by manufacturer.
 - 2. Embed each sheet in cold-applied membrane adhesive applied at rate required by roofing manufacturer.
- B. Laps: Accurately align roofing membrane sheets, without stretching, and maintain uniform side and end laps. Stagger end laps. Install roofing membrane sheets so side and end laps shed water. Completely bond and seal laps, leaving no voids.
 - 1. Repair tears and voids in laps and lapped seams not completely sealed.
 - 2. Granular Cap Sheet Laps: Apply roofing granules to cover exuded bead at laps.

3.09 FLASHING AND STRIPPING INSTALLATION

- A. Base Flashing Installation, General: Install base flashing over eave strips and other sloped and vertical surfaces, at roof edges, and at penetrations through roof; secure to substrates according to roofing system manufacturer's written instructions, and as follows:
 - 1. Extend base flashing up walls and parapets and 6 inches onto field of built-up roofing.
- B. Flashing Sheet Installation: Adhere flashing sheet to substrate in cold-applied adhesive. Apply cold-applied flashing sheet adhesive to back of flashing sheet if recommended by roofing manufacturer.
 - 1. Flashing Sheet Top Termination: Mechanically fasten top of base flashing securely at terminations with a termination bar and butyl tape.
 - 2. Flashing Sheet Bottom Termination: Adhere flashing sheet to roofing membrane in continuous bed of cold-applied adhesive.
 - a. Elastomeric Flashing Sheet: Heat weld vertical flashing joints. Seal bottom termination of base flashing by adhering to roofing membrane with cold-applied adhesive and sealing flashing-to-membrane joint with joint sealant.
- C. Fluid-Applied Flashing Application: Apply base coat with embedded fabric reinforcement and top coat at penetrations in accordance with manufacturer's written instructions. Install fluid-applied flashings after cap adhesive cure time.
 - 1. Apply base coat to achieve minimum wet mil coating thickness indicated in Part 2 product listing, unless greater thickness is recommended by manufacturer.
 - 2. Apply top coat over flashing base coat and spread coating evenly to achieve minimum wet mil coating thickness indicated in Part 2 product listing, unless greater thickness is recommended by manufacturer.
 - 3. Seal top termination of base flashing with a continuous bead of joint sealant.
- D. Install stripping, according to roofing manufacturer's written instructions, where metal flanges and edgings are set on modified bituminous membrane roofing.
- E. Roof Drains: Set metal flashing in bed of compatible mastic/adhesive sealer on completed base-ply membrane. Cover metal flashing with roofing membrane stripping plies extending 12 inches and 24 inches beyond edge of metal flashing onto field of roofing membrane. Clamp roofing membrane, metal flashing, and stripping into roof-drain clamping ring.

3.10 SURFACING INSTALLATION

- A. Acrylic Emulsion Coating:

1. Apply acrylic emulsion coating to prepared roofing membrane, with number of coats, thickness of application, and application method as recommended in writing by coating manufacturer.

3.11 WALKWAY INSTALLATION

- A. Walkways, General: Install walkways according to roofing manufacturer's written instructions.
 1. Install walkways at following locations:
 - a. Where indicated on Drawings.
- B. Walkway Pads: Install walkway pads per manufacturer's written instructions.
 1. Set walkway pads in manufacturer's recommended, acrylic adhesive.

3.12 FIELD QUALITY CONTROL

- A. Roofing Inspector: Contractor shall engage a qualified roofing inspector to perform roof tests and inspections and to prepare test reports.
 1. Engage a qualified roofing inspector for daily inspections to perform roof tests and inspections and produce daily reports. Roofing Inspector's quality assurance inspections shall comply with criteria established in NRCA's "Quality Control and Quality-assurance Guidelines for the Application of Membrane Roofing Systems."
- B. Final Roof Inspection: Arrange for roofing system manufacturer's technical personnel to inspect roofing installation at commencement and upon completion.
 1. Notify Architect and Owner 48 hours in advance of date and time of inspection.
- C. Repair or remove and replace components of built-up roofing where test results or inspections indicate that they do not comply with specified requirements.
 1. Additional testing and inspecting, at Contractor's expense, will be performed to determine if replaced or additional work complies with specified requirements.

3.13 PROTECTING AND CLEANING

- A. Protect roofing system from damage and wear during remainder of construction period. When remaining construction will not affect or endanger roofing, inspect roofing for deterioration and damage, describing its nature and extent in a written report, with copies to Architect and Owner.
- B. Correct deficiencies in or remove roofing system that does not comply with requirements, repair substrates, and repair or reinstall roofing system to a condition free of damage and deterioration at time of Substantial Completion and according to warranty requirements.
- C. Clean overspray and spillage from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION

SECTION 076200
SHEET METAL FLASHING AND TRIM

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Sheet metal flashing.
- B. Fabricated sheet metal items.

1.02 RELATED REQUIREMENTS

1.03 REFERENCE STANDARDS

- A. AAMA 2605 - Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels (with Coil Coating Appendix); 2022.
- B. ANSI/SPRI/FM 4435/ES-1 - Test Standard for Edge Systems Used with Low Slope Roofing Systems; 2022.
- C. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2023.
- D. ASTM A666/A666M - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar; 2024.
- E. ASTM A755/A755M - Standard Specification for Steel Sheet, Metallic Coated by the Hot-Dip Process and Prepainted by the Coil-Coating Process for Exterior Exposed Building Products; 2018.
- F. ASTM A792/A792M - Standard Specification for Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process; 2023.
- G. ASTM B209/B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2021a.
- H. ASTM C920 - Standard Specification for Elastomeric Joint Sealants; 2018 (Reapproved 2024).
- I. ASTM D4586/D4586M - Standard Specification for Asphalt Roof Cement, Asbestos-Free; 2007 (Reapproved 2018).
- J. NRCA (RM) - The NRCA Roofing Manual; 2025.
- K. SMACNA (ASMM) - Architectural Sheet Metal Manual; 2012.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Preinstallation Meeting: Convene minimum 2 weeks before starting work of this section.
 - 1. See Section 01 3000 - Administrative Requirements, for additional information.

1.05 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements for submittal procedures.
- B. Sustainable Product Data: See Section 01 6000 - Product Requirements and Section 01 6116 - Volatile Organic Compound (VOC) Content Restrictions.
 - 1. VOC content restrictions data.

- 2. Recycled content data.
- C. Shop Drawings: Indicate material profile, jointing pattern, jointing details, fastening methods, flashings, terminations, and installation details.
 - 1. Include identification of material, thickness, weight, and finish for each item.
- D. Samples: Submit two samples, 4 by 4 inches in size, illustrating metal finish color.
- E. Qualification Statements: For fabricator and installer.
- F. Field Quality Control Reports: As specified in Part 3 of this Section.

1.06 QUALITY ASSURANCE

- A. Fabricator and Installer Qualifications: Company specializing in sheet metal work with minimum five years of documented experience.
 - 1. For fabricated copings and roof edge flashings that are ANSI/SPRI/FM 4435/ES-1 tested, shop is to be listed as able to fabricate required details as tested and approved.
- B. Mockups: See Section 01 4000 - Quality Requirements.
 - 1. Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for fabrication and installation.
 - 2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 - 3. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. See Section 01 6000 - Product Requirements.
- B. See Section 017419 - Construction Waste Management and Disposal for packaging waste requirements.
- C. Stack material to prevent twisting, bending, and abrasion, and to provide ventilation. Slope metal sheets to ensure drainage.
- D. Prevent contact with materials that could cause discoloration or staining.

PART 2 PRODUCTS

2.01 SUSTAINABLE PRODUCT REQUIREMENTS

- A. See Section 01 6000 - Product Requirements.
- B. VOC Content Restrictions: Products in this section to not exceed VOC content limits specified in Section 01 6116 - Volatile Organic Compound (VOC) Content Restrictions.
- C. Recycled Content: Products in this Section to meet minimum recycled content thresholds specified in Section 016000.

2.02 PERFORMANCE REQUIREMENTS

- A. Sheet metal flashing and trim assemblies, including cleats, anchors, and fasteners, are to withstand wind loads, structural movement, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Completed sheet metal flashing and trim are not to rattle, leak, or loosen, and are to remain watertight.
- B. Sheet Metal Standard for Flashing and Trim: Comply with NRCA (RM) and SMACNA (ASMM).

- C. SPRI Wind Design Standard: Design, fabricate, and install copings and roof edge flashings tested in accordance with ANSI/SPRI/FM 4435/ES-1 and capable of resisting design pressures as shown on the Structural drawings.

2.03 SHEET MATERIALS

- A. Galvanized Steel: ASTM A653/A653M, with G90/Z275 zinc coating; minimum 24-gauge, 0.0239-inch thick base metal.
- B. Stainless Steel: ASTM A666/A666M, Type 304 alloy, soft temper, 28 gauge, 0.0156 inch thick; smooth No. 4 - Brushed finish.

2.04 PREFINISHED ALUMINUM SHEETS

- A. Description: Factory-applied coating systems applied to aluminum flat sheet substrates by coil coating process prior to fabrication, on both exposed side and on unexposed side.
- B. Aluminum Sheet Substrates: ASTM B209/B209M, alloy and temper as recommended by manufacturer for application.
- C. Superior Performance Organic Coating System: Provide thermally cured 70-percent PVDF fluoropolymer systems in accordance with AAMA 2605.
 - 1. Shop-Applied Coating Finish: See Section 050513 - Shop-Applied Coatings for Metal, for additional information.

2.05 PREFINISHED METALLIC-COATED STEEL SHEETS

- A. Description: Factory-applied coating systems applied to metallic-coated steel sheet substrates by coil coating process prior to fabrication, on exposed side and on unexposed side.
- B. Comply with ASTM A755/A755M.
- C. Metallic-Coated Steel Sheet Substrates:
 - 1. Zinc-Coated, Galvanized, Steel Sheets: Commercial steel sheets, galvanized by hot-dip process; comply with ASTM A653/A653M; coating designation G90.
 - 2. Aluminum-Zinc-Alloy-Coated Steel Sheets: Commercial steel sheets, alloy-coated by hot-dip process; comply with ASTM A792/A792M; coating designation AZ50.
- D. Superior Performance Organic Coating System: Provide thermally cured 70-percent PVDF fluoropolymer systems in accordance with AAMA 2605.
 - 1. Shop-Applied Coating Finish: See Section 050513 - Shop-Applied Coatings for Metal, for additional information.

2.06 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.

2.07 FABRICATED PARAPET COPING AND ROOF EDGE FLASHING

- A. Parapet Copings: Formed metal coping with galvanized steel anchors or support cleats for capping parapet wall; watertight. Butt type joints with concealed splice plates; mechanically fastened. Exposed coping fasteners at backside of parapet only.

1. Material: 0.04-inch thick, formed aluminum.
 2. Material: 24-gauge, 0.024-inch thick, galvanized steel.
 3. Profile: As shown on the Architectural drawings.
 4. Curved Application: Factory fabricated in true radius.
- B. Metal Roof Edging and Fascia: Continuous metal edge member serving as termination of roof membrane and retainer for metal fascia; watertight with no exposed fasteners; mounted to roof edge nailer.
1. Material: 0.04-inch thick, formed aluminum.
 2. Material: 24-gauge, 0.024-inch thick, galvanized steel.
 3. Profile: As shown on the Architectural drawings.
 4. Curved Applications: Factory modified.
- C. Anchor or Support Cleats: 20-gauge, 0.036-inch thick prepunched galvanized cleat with 12-inch wide stainless steel spring mechanically locked to cleat at 72 inches on center.
- D. Special Shaped Components: Provide factory-fabricated pieces necessary for complete installation, including miters, corners, intersections, curves, pier caps, and end caps; minimum 14-inch long legs on corner, intersection, and end pieces.

2.08 FABRICATED PENETRATION 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.

2.09 ACCESSORIES

- A. General: Provide materials and types of fasteners, solder, welding rods, protective coatings, separators, sealants, and other miscellaneous items as required for complete flashing and sheet metal installation and recommended by manufacturer of primary sheet metal unless otherwise indicated.
- B. Fasteners: Stainless steel.
- C. Primer Type: Zinc chromate.
- D. Sealants: See 079200 - Joint Sealants.
- E. Concealed Sealants: Non-curing butyl sealant.
- F. Exposed Sealants: ASTM C920; elastomeric sealant, with minimum movement capability as recommended by manufacturer for substrates to be sealed; color to match adjacent material.
- G. Asphalt Roof Cement: ASTM D4586/D4586M, Type I, asbestos-free.
- H. Reglets: Surface-mounted type, galvanized steel; face and ends covered with plastic tape.

2.10 FABRICATION

- A. General: Custom fabricate flashing and sheet metal to comply with recommendations in SMACNA (ASMM) "Architectural Sheet Metal Manual" that apply to design, dimensions, geometry, metal thickness, and other characteristics of item indicated. Fabricate items at the shop to greatest extent possible.
1. Obtain field measurements for accurate fit before shop fabrication.
 2. Form flashing and sheet metal without excessive oil canning, buckling, and tool marks and true to line and levels indicated, with exposed edges folded back to form hems.
 3. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces exposed to view.

- B. Sealed Joints: Form nonexpansion but movable joints in metal to accommodate elastomeric sealant.
- C. Expansion Provisions: Where lapped expansion provisions cannot be used, form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with butyl sealant concealed within joints.
- D. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal.
- E. Seams: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with elastomeric sealant unless otherwise recommended by sealant manufacturer for intended use.

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. Install surface mounted reglets true to lines and levels, and seal top of reglets with sealant.
- C. 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. Apply plastic cement compound between metal flashings and felt flashings.
- B. Fit flashings tight in place; make corners square, surfaces true and straight in planes, and lines accurate to profiles.
- C. Exterior Flashing Receivers: Install in accordance with manufacturer's recommendations, and in proper relationship with adjacent construction, and as follows:
 - 1. Secure receiver at perimeter of wall opening with adhesives or fasteners.
 - 2. Place flashing into receiver channel.
 - 3. Secure flashing with receiver clip.
- D. Seal metal joints watertight.

3.04 FIELD QUALITY CONTROL

- A. See Section 01 4000 - Quality Requirements, for additional requirements.
- B. Owner to engage a qualified testing agency to perform tests and inspections.
 - 1. Sheet metal flashing and trim will be considered defective if they do not pass tests and inspections.
 - 2. Additional tests and inspections, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
 - 3. Testing and inspecting agency to prepare reports and deliver to Owner or Contractor.
 - 4. Submit field quality control reports to Architect.
- C. Inspections:

1. Inspection will involve surveillance of work during installation to ascertain compliance with specified requirements.

END OF SECTION

**SECTION 077200
ROOF HATCHES WITH FOLDING ALUMINUM GUARD RAIL SYSTEM**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Metal roof hatches with integral curbs and folding aluminum guard rail system.

1.02 RELATED SECTIONS

- A. Section 05 12 00 - Structural Steel Framing: Roof structure and opening support.

1.03 REFERENCES

- A. OSHA 1910.23: Ladders.

1.04 SUBMITTALS

- A. Submit under provisions of Section 013000.
- B. Manufacturer's data sheets on each product to be used, including:
 - 1. Preparation instructions and recommendations.
 - 2. Storage and handling requirements and recommendations.
 - 3. Installation methods.
- C. Shop Drawings for Roof Hatches with Folding Aluminum Guard Rail System:
 - 1. Plan and section of stair installation.
 - 2. Indicate rough opening dimensions for ceiling and/or roof openings.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Store roof hatch with folding aluminum guard rail system until installation inside under cover in manufacturer's unopened packaging. If stored outside, store under a tarp or suitable cover.

1.06 WARRANTY

- A. Limited Warranty: Five years against defective material and workmanship, covering parts only. Defective parts, as deemed by the manufacturer, will be replaced at no charge, freight excluded, upon inspection at manufacturer's plant.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Acceptable Manufacturer: Precision Ladders, LLC, which is located at: P. O. Box 2279; Morristown, TN 37816-2279; Toll Free Tel: 800-225-7814; Tel: 423-586-2265; Fax: 423-586-2091; Web: www.PrecisionLadders.com or approved equal.
- B. Requests for substitutions will be considered in accordance with provisions of Section 016000.

2.02 METAL ROOF HATCHES WITH INTEGRAL CURB AND FOLDING ALUMINUM GUARD RAIL SYSTEM

- A. Metal Roof Hatches with Integral Curb and Folding Aluminum Guard Rail System and Components: Curb, cover, pressure control, hardware, finishes and folding aluminum guard rail system.
1. Models: PH-A2630-C [PH-A 2'6" x 3'0" (762 mm x 914 mm)] for an aluminum roof hatch. Roof Hatch with Folding Guard Rail System as manufactured by Precision Ladders, LLC.
 2. Capacity: Cover shall be reinforced to support a minimum live load of 40 psf (195kg/m²) with a maximum deflection of .67% of the span and a 20 psf (97 kg/m²) wind uplift for galvanized steel (Model PH-G) and aluminum (Model PH-A) roof hatches. Folding Aluminum Guard Rail System shall support a load of 200 lbs applied in any direction.
 3. Performance Characteristics: Operation of the cover shall be smooth and easy with controlled operation throughout the entire arc of opening and closing. Operation of the cover shall not be affected by temperature. Entire hatch shall be weather tight with fully welded corner joints on cover and curb.
 4. Performance Standard: Unit shall comply with OSHA 1910.23, OSHA 1910.28 and OSHA 1910.29.
- B. Components:
1. Curb
 - a. Formed from 14 gauge galvanized steel of lock forming quality per ASTM A-525 with G90 coating (.090 Aluminum H-14 3003 on aluminum models).
 - b. Sheathed with 1" (25 mm) of rigid fiber board insulation.
 - c. Height of 12" (305 mm) unless indicated otherwise on drawings.
 - d. 4" (102 mm) integral flange for securing to roof.
 - e. Hinges connecting curb to door shall be 1/8" (3.175 mm), 2 piece formed steel with 3/8 (9.525 mm) pivot pin.
 - f. Extruded rubber gasket within a 20 gauge extruded aluminum track shall be securely attached to the frame to make the unit weathertight.
 2. Cover
 - a. Formed from 14 gauge galvanized steel of lockforming quality per ASTM A-525 with G90 coating (.090 Aluminum H-14 3003 on aluminum models).
 - b. Liner shall be 22 gauge galvanized steel with G90 coating (.040 Aluminum H-14 3003 on aluminum models).
 - c. Insulation between cover and liner to be 1" (25 mm) thick U.L. plain fiberglass 0.75# density.
 - d. Lid shall be reinforced as required with 11 ga. steel channel (.090 Aluminum H-14 3003 on aluminum models).
 - e. A one point cab lock is to be provided with a built-in inside handle on units with a length of 4' 6" (1372 mm) or less. On units of greater length, a 2 point slam lock will be used.
 - f. Exterior of cover shall be devoid of hardware with the exception of the outside handle.
 - g. Outside handle shall be vinyl coated, steel T-handle.
 - h. Automatic hold-open device shall be formed from 3/16" (4.76 mm) steel flat bar and 1/2" (12.7 mm) diameter steel round stock with a vinyl grip.
 - i. Padlock provisions provided on both interior and exterior of unit.
 - j. Extruded rubber gasket shall be securely attached to the liner, thus providing a weather-tight seal.
 3. Pressure Control: Opening/closing assistance/resistance shall be provided with spring-loaded pressure intensifiers consisting of a telescoping tube; the top (outer) tube shall be 1 5/16" (33.34 mm), bottom (inner) tube shall be 1 1/2" (38.1 mm). Tubes shall be cadmium plated and chromate-sealed.

4. Hardware: Corrosion resistant hardware and fasteners is standard.
5. Finish: Mill finish aluminum on Roof Hatch. Mill finish aluminum on the folding aluminum guard rail system.
6. Folding Aluminum Guard Rail System:
 - a. Vertical and horizontal rails: Aluminum (6005-T5) 1-1/4" (32 mm) schedule 40 pipe with 1-5/8" (42 mm) OD.
 - b. Brackets: 1-1/4" x 1/8" (32 mm by 4 mm) aluminum square tubing.
 - c. Self-closing gate: Aluminum (6005-T5) 1-1/4" (32 mm) schedule 40 pipe with 1-5/8" (42 mm) OD hinged on open side.

2.03 FABRICATION

- A. Completely fabricate roof hatch with folding aluminum guard rail system ready for installation before shipment to the site.
- B. Do Not Disassemble.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Do not begin installation until rough opening and structural support have been properly prepared.
- B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.
- C. Examine materials upon arrival at site. Notify the carrier and manufacturer of any damage.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions and approved submittals.

3.03 PROTECTION

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

END OF SECTION

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**SECTION 078100
APPLIED FIRE PROTECTION**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Spray-applied fire-resistive materials (SFRM).

1.02 DEFINITIONS

- A. SFRM: Sprayed fire-resistive material.
- B. Concealed: Fire-resistive materials applied to surfaces that are concealed from view behind other construction when the Work is completed and have not been defined as exposed.
- C. Exposed: Fire-resistive materials applied to surfaces that are exposed to view when the Work is completed. Typical locations include:
 - 1. Spaces that are accessible through suspended ceilings.
 - 2. Elevator shafts.
 - 3. Machine rooms.
 - 4. Mechanical rooms.
 - 5. Air-handling plenums.
 - 6. Locations that are identified as exposed on the Drawings.
- D. Density of Sprayed Fire-Resistive Materials: The weight per unit volume of SFRM.
 - 1. Low Density: 15 to 21 pounds per cubic foot minimum.
 - 2. Medium Density: 22 to 39 pounds per cubic foot minimum.
 - 3. High Density: 40 pounds per cubic foot minimum.

1.03 REFERENCE STANDARDS

- A. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2024.
- B. ASTM E136 - Standard Test Method for Assessing Combustibility of Materials Using a Vertical Tube Furnace at 750 Degrees C; 2024c.
- C. ASTM E605/E605M - Standard Test Methods for Thickness and Density of Sprayed Fire-Resistive Material (SFRM) Applied to Structural Members; 2019 (Reapproved 2023).
- D. ASTM E736/E736M - Standard Test Method for Cohesion/Adhesion of Sprayed Fire-Resistive Materials Applied to Structural Members; 2019 (Reapproved 2023).
- E. ASTM E759/E759M - Standard Test Method for Effect of Deflection on Sprayed Fire-Resistive Material Applied to Structural Members; 1992 (Reapproved 2023).
- F. ASTM E760/E760M - Standard Test Method for Effect of Impact on Bonding of Sprayed Fire-Resistive Material Applied to Structural Members; 1992 (Reapproved 2023).
- G. ASTM E859/E859M - Standard Test Method for Air Erosion of Sprayed Fire-Resistive Materials (SFRMs) Applied to Structural Members; 2023.
- H. ASTM E937/E937M - Standard Test Method for Corrosion of Steel by Sprayed Fire-Resistive Material (SFRM) Applied to Structural Members; 1993 (Reapproved 2023).
- I. ASTM G21 - Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi; 2015, with Editorial Revision (2021).

- J. CAL (CDPH SM) - Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers Version 1.2; 2017.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordinate with placement of ceiling hanger tabs, mechanical component hangers, and electrical components.
- B. Preinstallation Meeting: Convene one week before starting work of this section.
 - 1. See Section 01 3000 - Administrative Requirements, for additional information.

1.05 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittals procedures.
- B. Product Data: Provide data indicating product characteristics and performance criteria.
- C. Sustainable Product Data: See Section 01 6000 - Product Requirements and Section 01 6116 - Volatile Organic Compound (VOC) Content Restrictions.
 - 1. VOC content restrictions data.
 - 2. CAL (CDPH SM) compliance data.
- D. Shop Drawings: Framing plans or schedules, or both, indicating the following:
 - 1. Extent of fire protection for each construction and fire-resistance rating.
 - 2. Applicable fire-resistance design designations of a qualified testing and inspecting agency acceptable to authorities having jurisdiction.
 - 3. Minimum sprayed fire-resistive material thicknesses needed to achieve required fire-resistance rating of each structural component and assembly.
 - 4. Treatment of sprayed fire-resistive material after application.
- E. Manufacturer's Certificate: Certify that applied fireproofing products meet or exceed requirements of Contract Documents.
- F. Test Reports: From ICC (Evaluation Service Report) or similar. Reports from reputable independent testing agencies for proposed products, indicating compliance with specified criteria, conducted under conditions similar to those on project, as follows:
 - 1. Bond strength.
 - 2. Bond impact.
 - 3. Compressive strength.
 - 4. Fire tests using substrate materials similar those on project.
- G. Manufacturer's Installation Instructions: Indicate special procedures and conditions requiring special attention.
- H. Manufacturer's Qualification Statement.
- I. Installer's Qualification Statement.
- J. Preconstruction Testing Reports: As specified in Part 1 of this Section.
- K. Field Quality Control Reports: As specified in Part 3 of this Section.

1.06 QUALITY ASSURANCE

- A. Qualifications: See Section 01 4000 - Quality Requirements.
 - 1. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than five years of documented experience.
 - 2. Installer Qualifications: Company specializing in performing work of the type specified with at least five years of documented experience, and approved by manufacturer

1.07 MOCK-UP

- A. Mock-ups: See Section 01 4000 - Quality Requirements.
- B. Build mock-up to verify selections made under submittals, demonstrate aesthetic effects, set quality standards for materials and execution, and for preconstruction testing.
 - 1. See Preconstruction Testing article immediately below for additional information.
- C. Comply with project requirements for .
- D. Locate where directed by Architect.
- E. Examine installation within one hour of application to determine variances from specified requirements due to shrinkage, temperature, and humidity.
- F. Where shrinkage and cracking are evident, adjust mixture and method of application as necessary; remove materials and re-construct mock-up.
- G. Mock-up may remain as part of the Work if it passes preconstruction testing as specified below, and if undisturbed at time of Substantial Completion.

1.08 PRECONSTRUCTION TESTING

- A. Preconstruction Testing: See Section 01 4000 - Quality Requirements.
- B. Owner to engage a qualified testing agency to perform preconstruction testing on field mockups of applied fire protection.
 - 1. Applied fire protection will be considered defective if they do not pass tests and inspections.
 - 2. Additional tests and inspections, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
 - a. Do not install product on the Project until passing test is achieved.
 - 3. Testing and inspecting agency to prepare reports and deliver to Owner or Contractor.
 - 4. Submit preconstruction testing reports to Architect.
- C. Tests:
 - 1. Preconstruction Adhesion and Compatability Testing: Test for compliance with requirements for specified performance and test methods.
 - a. Bond Strength: Test for cohesive and adhesive strength according to ASTM E736/E736M. Provide bond strength indicated in referenced fire-resistance design, but not less than minimum specified in Part 2.
 - b. Density: Test for density according to ASTM E605/E605M. Provide density indicated in referenced fire-resistance design, but not less than minimum specified in Part 2.
 - c. Verify that manufacturer, through its own laboratory testing or field experience, attests that primers or coatings are compatible with fireproofing.
 - d. Schedule sufficient time for testing and analyzing results to prevent delaying the Work.
 - e. For materials failing tests, obtain applied-fireproofing manufacturer's written instructions for corrective measures including the use of specially formulated bonding agents or primers.

1.09 DELIVERY, STORAGE, AND HANDLING

- A. See Section 01 6000 - Product Requirements.
- B. Deliver materials to Project site in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, approval or listing agency markings, and directions for storing.
- C. Protect materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources. Store in a dry location.

- D. Comply with manufacturer's written instructions for handling, storing, and protecting during installation.
- E. See Section 01 7419 - Construction Waste Management and Disposal, for packaging waste requirements.

1.10 FIELD CONDITIONS

- A. Do not apply fireproofing when temperature of substrate material and surrounding air is below 40 degrees F or when temperature is predicted to be below said temperature for 24 hours after application.
- B. Provide ventilation in areas to receive fireproofing during application and 24 hours afterward, to dry applied material.
- C. Provide temporary enclosure to prevent spray from contaminating air.

1.11 WARRANTY

- A. See Section 017800 - Closeout Submittals, for additional warranty requirements.
- B. Correct defective Work within a two year period after Date of Substantial Completion.
 - 1. Include coverage for fireproofing to remain free from cracking, checking, dusting, flaking, spalling, separation, and blistering.
 - 2. Reinstall or repair failures that occur within warranty period.

PART 2 PRODUCTS

2.01 SUSTAINABLE PRODUCT REQUIREMENTS

- A. See Section 01 6000 - Product Requirements.
- B. VOC Content Restrictions: Products in this section to not exceed VOC content limits specified in Section 01 6116 - Volatile Organic Compound (VOC) Content Restrictions.
- C. CDPH: Products to comply with CAL (CDPH SM) .

2.02 PERFORMANCE REQUIREMENTS

- A. Bond Strength: Provide sprayed fire-resistive materials with the following minimum bond strength:
 - 1. Non-high rise buildings up to 75 feet tall: 150 psf minimum.
 - 2. High-rise buildings between 75 and 420 feet tall: 430 psf minimum.
 - 3. High-rise buildings greater than 420 feet tall: 1,000 psf minimum.
- B. Combustion Characteristics: ASTM E136.

2.03 MANUFACTURERS

- A. Applied Fire Protection:
 - 1. Carboline.
 - 2. GCP Applied Technologies.
 - 3. Isolatek International.
 - 4. Southwest Fireproofing Products.
 - 5. Substitutions: See Section 01 2500 - Substitution Procedures.

2.04 APPLIED FIRE PROTECTION ASSEMBLIES

- A. Provide assemblies as indicated on drawings.

2.05 MATERIALS

- A. Applied Fire Protection Material for Interior Applications, Concealed: Manufacturer's standard factory mixed material, which when combined with water is capable of providing indicated fire resistance, and complying with following requirements:
1. Composition: Gypsum-based; not mineral-fiber-based.
 2. Bond Strength: 150 pounds per square foot, minimum, when tested in accordance with ASTM E736/E736M when set and dry.
 3. Dry Density: Minimum average density of 15 lb/cu ft, with minimum individual density of any test sample of 14 lb/cu ft, when tested in accordance with ASTM E605/E605M.
 4. Compressive Strength: 8.33 pounds per square inch, minimum.
 5. Effect of Impact on Bonding: No cracking, spalling or delamination, when tested in accordance with ASTM E760/E760M.
 6. Corrosivity: No evidence of corrosion, when tested in accordance with ASTM E937/E937M.
 7. Air Erosion Resistance: Weight loss of 0.025 g/sq ft, maximum, when tested in accordance with ASTM E859/E859M after 24 hours.
 8. Surface Burning Characteristics: Maximum flame spread index of 0 (zero) and maximum smoke developed index of 0 (zero), when tested in accordance with ASTM E84.
 9. Effect of Deflection: No cracking, spalling, or delamination, when tested in accordance with ASTM E759/E759M.
 10. Fungal Resistance: No growth after 28 days when tested according to ASTM G21.
 11. Products:
 - a. Carbolite; Southwest Type 5GP.
 - b. GCP Applied Technologies; Monokote MK-6: www.gcpat.com/#sle.
 - c. Isolatek International Corp.; Cafco 300 Series.
 - d. Substitutions: See Section 01 2500 - Substitution Procedures.
- B. Applied Fire Protection Material Exposed to Damage or Moisture: Manufacturer's standard factory mixed material, which when combined with water is capable of providing indicated fire resistance, and complying with following requirements:
1. Recommended by manufacturer for permanent exterior exposure.
 2. Composition: Portland cement-based; not mineral fiber-based.
 3. Bond Strength: 1,000 psf, minimum, when tested in accordance with ASTM E736/E736M when set and dry.
 4. Dry Density: 21 lb/cu ft, minimum, when tested in accordance with ASTM E605/E605M.
 5. Effect of Impact on Bonding: No cracking, spalling or delamination, when tested in accordance with ASTM E760/E760M.
 6. Corrosivity: No evidence of corrosion, when tested in accordance with ASTM E937/E937M.
 7. Air Erosion Resistance: Weight loss of 0.025 g/sq ft, maximum, when tested in accordance with ASTM E859/E859M after 24 hours.
 8. Surface Burning Characteristics: Maximum flame spread index of 0 (zero) and maximum smoke developed index of 0 (zero), when tested in accordance with ASTM E84.
 9. Fungal Resistance: No growth after 28 days when tested according to ASTM G21.
 10. Products:
 - a. Carbolite; Southwest Type 7 HD.
 - b. GCP Applied Technologies; Monokote Z-106/HY: www.gcpat.com/#sle.
 - c. Substitutions: See Section 01 2500 - Substitution Procedures.

2.06 ACCESSORIES

- A. General: Provide accessory materials that are compatible with fireproofing and substrates and are approved by UL or another testing and inspecting agency acceptable to authorities having jurisdiction for use in fire-resistance designs indicated.
- B. Primer Adhesive: Of type recommended by applied fire protection manufacturer.
- C. Sealer: Transparent-drying, water-dispersible, tinted protective coating recommended in writing by fireproofing manufacturer for each fire-resistance design.
 - 1. Products:
 - a. GCP Applied Technologies; Firebond Concentrate.
 - b. Isolatek International; Cafco Bond-Seal.
 - c. Substitutions: See Section 01 2500 - Substitution Procedures.
 - 2. Recommended for the following locations:
 - a. Elevator shafts.
 - b. Mechanical rooms.
 - c. Air shafts.
 - d. Locations of high velocity air flow.
 - e. Locations of high vibration.
 - f. Corrosive environments.
- D. Topcoat: Tinted protective coating for high abuse applications. Suitable for application over applied fireproofing; of type recommended in writing by fireproofing manufacturer for each fire-resistance design.
 - 1. Cement-Based Topcoat: Factory-mixed, cementitious hard-coat formulation for trowel or spray application over SFRM.
 - a. Products:
 - 1) Carbolite; Hardcoat 4500.
 - 2) Isolatek International; Fendolite M-II/Fendolite TG.
 - 3) Substitutions: See Section 01 2500 - Substitution Procedures.
- E. Metal Lath: Expanded metal lath; minimum weight of 1.7 psf, galvanized finish.
- F. Water: Clean, potable.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that surfaces are ready to receive fireproofing. Repair existing fireproofing using same method as original installation or trowel installation techniques recommended by manufacturer.
- B. Verify that clips, hangers, supports, sleeves, and other items required to penetrate fireproofing are in place.
- C. Verify that ducts, piping, equipment, or other items that would interfere with application of fireproofing have not been installed.
- D. Verify that voids and cracks in substrate have been filled.
- E. Verify that projections have been removed where fireproofing will be exposed to view as a finish material.

3.02 PREPARATION

- A. Perform tests as recommended by fireproofing manufacturer in applications where adhesion of fireproofing to substrate is in question.

- B. Remove incompatible materials that could effect bond by scraping, brushing, scrubbing, or sandblasting.
- C. Prepare substrates to receive fireproofing in strict accordance with instructions of fireproofing manufacturer.
- D. Protect surfaces not scheduled for fireproofing and equipment from damage by overspray, fall-out, and dusting.
- E. Close off and seal duct work in areas where fireproofing is being applied.

3.03 APPLICATION

- A. Install metal lath over structural members as indicated or as required by UL Assembly Design Numbers.
- B. Apply primer adhesive in accordance with manufacturer's instructions.
- C. Apply fireproofing in uniform thickness and density as necessary to achieve required ratings.
- D. In exposed locations, trowel surface smooth and form square edges, using tools and procedures recommended by fireproofing manufacturer.

3.04 FIELD QUALITY CONTROL

- A. See Section 01 4000 - Quality Requirements, for additional requirements.
- B. Owner to engage a qualified testing agency to perform tests and inspections.
 - 1. Applied fire protection will be considered defective if it does not pass tests and inspections.
 - 2. Additional tests and inspections, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
 - 3. Testing and inspecting agency to prepare reports and deliver to Owner or Contractor.
 - 4. Submit field quality control reports to Architect.
- C. Tests and inspections of completed Work will be performed in successive stages. Do not proceed with application of fireproofing for the next area until test results for previously completed applications of fireproofing show compliance with requirements. Tested values must equal or exceed values as specified and as indicated and required for approved fire-resistance design.
- D. Inspect installed fireproofing after application and curing for integrity, prior to its concealment.
- E. Ensure that actual thicknesses, densities, and bond strengths meet requirements for specified ratings and requirements of authorities having jurisdiction (AHJ).
- F. Repair or replace applied fireproofing at locations where test results indicate fireproofing does not meet specified requirements.
- G. Re-inspect installed fireproofing for integrity of fire protection, after installation of subsequent Work.

3.05 CLEANING

- A. Remove excess material, overspray, droppings, and debris.
- B. Remove fireproofing from materials and surfaces not required to be fireproofed.
- C. At exposed fireproofing, clean surfaces that have become soiled or stained, using manufacturer's recommended procedures.

END OF SECTION

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**SECTION 078400
FIRESTOPPING**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Firestopping systems.

1.02 REFERENCE STANDARDS

- A. ASTM E119 - Standard Test Methods for Fire Tests of Building Construction and Materials; 2024.
- B. ASTM E814 - Standard Test Method for Fire Tests of Penetration Firestop Systems; 2023a.
- C. ASTM E1966 - Standard Test Method for Fire-Resistive Joint Systems; 2015 (Reapproved 2019).
- D. ASTM E2174 - Standard Practice for On-Site Inspection of Installed Firestop Systems; 2024.
- E. ASTM E2393 - Standard Practice for On-Site Inspection of Installed Fire Resistive Joint Systems and Perimeter Fire Barriers; 2024.
- F. ASTM E2307 - Standard Test Method for Determining Fire Resistance of Perimeter Fire Barriers Using Intermediate-Scale, Multi-story Test Apparatus; 2023b.
- G. ASTM E2837 - Standard Test Method for Determining the Fire Resistance of Continuity Head-of-Wall Joint Systems Installed between Rated Wall Assemblies and Nonrated Horizontal Assemblies; 2023a.
- H. CAL (CDPH SM) - Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers Version 1.2; 2017.
- I. ITS (DIR) - Directory of Listed Products; Current Edition.
- J. FM (AG) - FM Approval Guide; Current Edition.
- K. UL 2079 - Standard for Tests for Fire Resistance of Building Joint Systems; Current Edition, Including All Revisions.
- L. UL (DIR) - Online Certifications Directory; Current Edition.
- M. UL (FRD) - Fire Resistance Directory; Current Edition.

1.03 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide data on product characteristics, performance ratings, and limitations.
- C. Sustainable Product Data: See Section 01 6000 - Product Requirements and Section 01 6116 - Volatile Organic Compound (VOC) Content Restrictions.
 - 1. VOC content restrictions data.
 - 2. CAL (CDPH SM) compliance data.
- D. Evaluation Service Reports: From ICC or similar. Show compliance with specified requirements.
- E. Manufacturer's Installation Instructions: Indicate preparation and installation instructions.
- F. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

- G. Manufacturer's qualification statement.
- H. Installer's qualification statement.

1.04 COORDINATION

- A. Coordinate construction of openings and penetrating items to ensure that penetration firestopping is installed according to specified requirements.
- B. Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate penetration firestopping.

1.05 QUALITY ASSURANCE

- A. Qualifications: See Section 01 4000 - Quality Requirements.
 - 1. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
 - 2. Installer Qualifications: Company specializing in performing the work of this section and:
 - a. Trained by manufacturer.
 - b. Verification of minimum five years documented experience installing work of this type.
 - c. Licensed by local authorities having jurisdiction (AHJ).
 - 3. Preinstallation Meetings: See Section 01 3000 - Administrative Requirements.
 - a. Convene minimum 2 weeks before starting work of this Section.

1.06 MOCK-UPS

- A. See Section 014000 - Quality Requirements for additional requirements.
- B. Install one firestopping assembly representative of each fire rating design required on project.
 - 1. Where one design may be used for different penetrating items or in different wall constructions, install one assembly for each different combination.
 - 2. Where firestopping is intended to fill a linear opening, install at least 1 linear foot of firestopping.
- C. Obtain approval of authorities having jurisdiction (AHJ) before proceeding.
- D. If accepted, mock-up will represent minimum standard for this work.
- E. If accepted, mock-up may remain as part of this work. Remove and replace mock-ups not accepted.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. See Section 01 6000 - Product Requirements.
- B. Deliver materials to Project site in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, approval or listing agency markings, and directions for storing.
- C. Protect materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources. Store in a dry location.
- D. Comply with manufacturer's written instructions for handling, storing, and protecting during installation.
- E. See Section 01 7419 - Construction Waste Management and Disposal, for packaging waste requirements.

1.08 FIELD CONDITIONS

- A. Comply with firestopping manufacturer's recommendations for temperature and conditions during and after installation; maintain minimum temperature before, during, and for days after installation of materials.
- B. Provide ventilation in areas where solvent-cured materials are being installed.

1.09 WARRANTY

- A. See Section 01 6000 - Product Requirements and Section 01 7800 - Closeout Submittals for additional warranty requirements.
- B. Provide manufacturer's standard warranty for each product.

PART 2 PRODUCTS

2.01 SUSTAINABLE PRODUCT REQUIREMENTS

- A. See Section 01 6000 - Product Requirements.
- B. VOC Content Restrictions: Products in this section to not exceed VOC content limits specified in Section 01 6116 - Volatile Organic Compound (VOC) Content Restrictions.
- C. CDPH: Products to comply with CAL (CDPH SM) .

2.02 PERFORMANCE REQUIREMENTS

- A. Fire Testing: Provide firestopping assemblies of designs that provide the scheduled fire ratings when tested in accordance with methods indicated.
 - 1. Listing in UL (FRD), FM (AG), or ITS (DIR) will be considered as constituting an acceptable test report.
 - 2. Valid evaluation report published by ICC Evaluation Service, Inc. (ICC-ES) at www.icc-es.org will be considered as constituting an acceptable test report.
 - 3. Submission of actual test reports is required for assemblies for which none of the above substantiation exists.

2.03 MANUFACTURERS

- A. Firestopping Manufacturers:
 - 1. 3M Fire Protection Products.
 - 2. A/D Fire Protection Systems.
 - 3. Hilti.
 - 4. HoldRite.
 - 5. RectorSeal.
 - 6. Specified Technologies Inc. (STI).
 - 7. Tremco.
 - 8. Substitutions: See Section 01 2500 - Substitution Procedures.

2.04 MATERIALS

- A. Primers, Sleeves, Forms, Insulation, Packing, Stuffing, and Accessories: Provide type of materials as required for tested firestopping assembly.

2.05 FIRESTOPPING ASSEMBLY REQUIREMENTS

- A. Perimeter Fire Containment Firestopping: Use system that has been tested according to ASTM E2307 to have fire resistance F Rating equal to required fire rating of floor assembly.
 - 1. Movement: Provide systems that have been tested to show movement capability as indicated.
 - 2. Temperature Rise: Provide systems that have been tested to show T Rating as indicated.
 - 3. Air Leakage: Provide systems that have been tested to show L Rating as indicated.
 - 4. Where floor assembly is not required to have a fire rating, provide systems that have been tested to show L Rating as indicated.
- B. Head-of-Wall (HW) Joint System Firestopping at Joints Between Fire-Rated Wall Assemblies and Non-Rated Horizontal Assemblies: Use system that has been tested according to ASTM E2837 to have fire resistance F Rating equal to required fire rating of wall assembly.
 - 1. Movement: Provide systems that have been tested to show movement capability as indicated.
- C. Floor-to-Floor (FF), Floor-to-Wall (FW), Head-of-Wall (HW), and Wall-to-Wall (WW) Joints, Except Perimeter, Where Both Are Fire-Rated: Use system that has been tested according to ASTM E1966 or UL 2079 to have fire resistance F Rating equal to required fire rating of the assembly in which the joint occurs.
 - 1. Movement: Provide systems that have been tested to show movement capability as indicated.
 - 2. Air Leakage: Provide systems that have been tested to show L Rating as indicated.
 - 3. Watertightness: Provide systems that have been tested to show W Rating as indicated.
 - 4. Listing by FM (AG), ITS (DIR), UL (DIR), or UL (FRD) in their certification directories will be considered evidence of successful testing.
- D. Through Penetration Firestopping: Use system that has been tested according to ASTM E814 to have fire resistance F Rating equal to required fire rating of penetrated assembly.
 - 1. Temperature Rise: Provide systems that have been tested to show T Rating as indicated.
 - 2. Air Leakage: Provide systems that have been tested to show L Rating as indicated.
 - 3. Watertightness: Provide systems that have been tested to show W Rating as indicated.
 - 4. Listing by FM (AG), ITS (DIR), UL (DIR), or UL (FRD) in their certification directories will be considered evidence of successful testing.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify openings are ready to receive the work of this section.

3.02 PREPARATION

- A. Clean substrate surfaces of dirt, dust, grease, oil, loose material, or other materials that could adversely affect bond of firestopping material.
- B. Remove incompatible materials that could adversely affect bond.
- C. Install materials to prevent liquid material from leakage.

3.03 INSTALLATION

- A. Install materials in manner described in fire test report and in accordance with manufacturer's instructions, completely closing openings.
- B. Do not cover installed firestopping until inspected by Owner's Independent Testing Agency.

- C. Do not cover installed firestopping until inspected by authorities having jurisdiction.
- D. Install labeling required by code.

3.04 IDENTIFICATION

- A. Identify firestopping with preprinted metal or plastic labels, attached with mechanical fasteners or self-adhering type labels with adhesives capable of permanently bonding labels to surfaces on which labels are placed.
- B. Information: Include the following information on labels:
 - 1. The words "Warning - Penetration Firestopping - Do Not Disturb. Notify Building Management of Any Damage".
 - 2. Contractor's name, address, and phone number.
 - 3. Designation of applicable testing and inspecting agency.
 - 4. Date of installation.
 - 5. Manufacturer's name.
 - 6. Installer's name.
- C. Location: Attach labels permanently to surfaces adjacent to and within 6 inches of firestopping edge so labels will be visible to anyone seeking to remove penetrating items or firestopping systems.
 - 1. Exception: If penetration or joint is visible, coordinate alternative locations acceptable to Authority Having Jurisdiction and LPA.

3.05 FIELD QUALITY CONTROL

- A. See Section 01 4000 - Quality Requirements, for additional requirements.
- B. Independent Testing Agency: Inspection agency employed and paid by Owner, will examine penetration firestopping in accordance with ASTM E2174 and ASTM E2393.
- C. Repair or replace penetration firestopping and joints at locations where inspection results indicate firestopping or joints do not meet specified requirements.

3.06 CLEANING

- A. Clean adjacent surfaces of firestopping materials.

3.07 PROTECTION

- A. Protect adjacent surfaces from damage by material installation.

END OF SECTION

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SECTION 079200 JOINT SEALANTS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Joint sealants.
- B. Joint backings and accessories.

1.02 RELATED REQUIREMENTS

- A. Section 016116 - Volatile Organic Compound (VOC) Restrictions: Additional requirements for sealants and primers.
- B. Section 088000 - Glazing: Sealants installed as part of glazing assemblies.
- C. Section 092116 - Gypsum Board Assemblies: Sealing acoustical and sound-rated walls and ceilings.

1.03 DEFINITIONS

- A. Refer to ASTM C920 for additional information.
 - 1. Type S: Single-component.
 - 2. Type M: Multi-component.
 - 3. Grade P: Pourable or self-leveling, for horizontal applications.
 - 4. Grade NS: Non-sag or gunnable, for vertical applications.
 - 5. Class 100/50: Accepts at least 100 percent increase and 50 percent decrease of joint width.
 - 6. Class 50: Accepts at least 50 percent increase and decrease of joint width.
 - 7. Class 35: Accepts at least 35 percent increase and decrease of joint width.
 - 8. Class 25: Accepts at least 25 percent increase and decrease of joint width.
 - 9. Class 12-1/2: Accepts at least 12-1/2 percent increase and decrease of joint width.
 - 10. Use T1: Designed for pedestrian and vehicular traffic areas, with a high durometer (hardness).
 - 11. Use T2: Designed for pedestrian and vehicular traffic areas, with a lower durometer (hardness).
 - 12. Use NT: Designed for non-traffic areas.
 - 13. Use I: Designed to be continuously submerged in liquid (immersion service).
 - 14. Use M: Designed for use with mortar.
 - 15. Use G: Designed for use with glass. See Section 088000 - Glazing.
 - 16. Use A: Designed for use with aluminum.
 - 17. Use O: Designed for use on non-standard (other) substrates.

1.04 REFERENCE STANDARDS

- A. ASTM C661 - Standard Test Method for Indentation Hardness of Elastomeric-Type Sealants by Means of a Durometer; 2015 (Reapproved 2022).
- B. ASTM C794 - Standard Test Method for Adhesion-in-Peel of Elastomeric Joint Sealants; 2018 (Reapproved 2022).
- C. ASTM C834 - Standard Specification for Latex Sealants; 2017 (Reapproved 2023).

- D. ASTM C920 - Standard Specification for Elastomeric Joint Sealants; 2018 (Reapproved 2024).
- E. ASTM C1087 - Standard Test Method for Determining Compatibility of Liquid-Applied Sealants with Accessories Used in Structural Glazing Systems; 2023.
- F. ASTM C1193 - Standard Guide for Use of Joint Sealants; 2025.
- G. ASTM C1248 - Standard Test Method for Staining of Porous Substrate by Joint Sealants; 2022.
- H. ASTM C1311 - Standard Specification for Solvent Release Sealants; 2022.
- I. ASTM C1330 - Standard Specification for Cylindrical Sealant Backing for Use with Cold Liquid-Applied Sealants; 2023.
- J. ASTM C1521 - Standard Practice for Evaluating Adhesion of Installed Weatherproofing Sealant Joints; 2019 (Reapproved 2020).
- K. ASTM D2240 - Standard Test Method for Rubber Property--Durometer Hardness; 2015 (Reapproved 2021).
- L. CAL (CDPH SM) - Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers Version 1.2; 2017.

1.05 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, hardness, cure time, and color availability.
 - 2. List of backing materials approved for use with the specific product.
 - 3. Substrates that product is known to satisfactorily adhere to and with which it is compatible.
 - 4. Substrates the product should not be used on.
 - 5. Substrates for which use of primer is required.
 - 6. Substrates for which laboratory adhesion and/or compatibility testing is required.
- C. Sustainable Product Data: See Section 01 6000 - Product Requirements and Section 01 6116 - Volatile Organic Compound (VOC) Content Restrictions.
 - 1. CAL (CDPH SM) compliance data.
 - 2. VOC content restrictions data.
- D. Installation instructions, including precautions, limitations, and recommended backing materials and tools.
- E. Sample product warranty.
- F. 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.
- G. Color Cards for Selection: Where sealant color is not specified, submit manufacturer's color cards showing standard colors available for selection.
- H. 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.
- I. Preconstruction Laboratory Test Reports: Submit at least four weeks prior to start of installation.
- J. Installation Plan: Submit at least four weeks prior to start of installation.
- K. Preinstallation Field Adhesion Test Plan: Submit at least two weeks prior to start of installation.

- L. Preinstallation Field Adhesion Test Reports: Submit filled out Preinstallation Field Adhesion Test Reports log within 10 days after completion of tests; include bagged test samples and photographic records.
- M. Installation Log: Submit filled-out log for each length or instance of sealant installed.
- N. Executed warranty.

1.06 QUALITY ASSURANCE

- A. Qualifications: See Section 01 4000 - Quality Requirements.
 - 1. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
 - 2. Installer Qualifications: Company specializing in performing the work of this section and with at least three years of documented experience.
- B. Preinstallation Meetings: See Section 01 3000 - Administrative Requirements.
 - 1. Convene minimum 2 weeks before starting work of this Section.
- C. Mock-ups: See Section 01 4000 - Quality Requirements.
 - 1. Build mockups to verify selections made under sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.
 - 2. Approved mock-ups may remain as part of the completed Work if undisturbed at time of Substantial Completion.
- D. Preconstruction Laboratory Testing: Arrange for sealant manufacturer(s) to test each combination of sealant, substrate, backing, and accessories.
 - 1. See Section Section 01 4000 - Quality Requirements, for additional information.
 - 2. Adhesion Testing: In accordance with ASTM C794.
 - 3. Compatibility Testing: In accordance with ASTM C1087.
 - 4. Stain Testing: In accordance with ASTM C1248; required for stone and masonry substrates.
 - 5. Allow sufficient time for testing to avoid delaying the work.
 - 6. Deliver sufficient samples to manufacturer for testing.
 - 7. Report manufacturer's recommended corrective measures, if any, including primers or techniques not indicated in product data submittals.
 - 8. Testing is not required if sealant manufacturer provides data showing previous testing, not older than 24 months, that shows satisfactory adhesion, lack of staining, and compatibility.
- E. Installation Plan: Include schedule of sealed joints, including the following:
 - 1. Joint width indicated in Contract Documents.
 - 2. Joint depth indicated in Contract Documents; to face of backing material at centerline of joint.
 - 3. Approximate date of installation, for evaluation of thermal movement influence.
 - 4. Installation Log Form: Include the following data fields, with known information filled out.
 - a. Location on project.
 - b. Substrates.
 - c. Sealant used.
 - d. Stated movement capability of sealant.
 - e. Primer to be used, or indicate no primer is used.
 - f. Size and actual backing material used.
 - g. Date of installation.
 - h. Name of installer.
 - i. Actual joint width; provide space to indicate maximum and minimum width.
 - j. Actual joint depth to face of backing material at centerline of joint.
 - k. Air temperature.

- F. Preinstallation Field Adhesion Test Plan: Include destructive field adhesion testing of one sample of each combination of sealant type and substrate, except interior acrylic latex sealants, and include the following for each tested sample.
 - 1. Identification of testing agency.
 - 2. Preinstallation Field Adhesion Test Log Form: Include the following data fields, with known information filled out.
 - a. Test date.
 - b. Copy of test method documents.
 - c. Age of sealant upon date of testing.
 - d. Test results, modeled after the sample form in the test method document.
 - e. Indicate use of photographic record of test.
- G. Field Adhesion Test Procedures:
 - 1. Allow sealants to fully cure as recommended by manufacturer before testing.
 - 2. Have a copy of the test method document available during tests.
 - 3. Take photographs or make video records of each test, with joint identification provided in the photos/videos; for example, provide small erasable whiteboard positioned next to joint.
 - 4. Record the type of failure that occurred, other information required by test method, and the information required on the Field Quality Control Log.
 - 5. When performing destructive tests, also inspect the opened joint for proper installation characteristics recommended by manufacturer, and report any deficiencies.
 - 6. If any combination of sealant type and substrate does not show evidence of minimum adhesion or shows cohesion failure before minimum adhesion, report results to Architect.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. See Section 01 6000 - Product Requirements.
- B. Deliver materials to Project site in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, approval or listing agency markings, and directions for storing.
- C. Protect materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources. Store in a dry location.
- D. Comply with manufacturer's written instructions for handling, storing, and protecting during installation.
- E. See Section 01 7419 - Construction Waste Management and Disposal, for packaging waste requirements.

1.08 FIELD CONDITIONS

- A. Do not proceed with installation of joint sealants under the following conditions:
 - 1. When ambient and substrate temperature conditions are outside limits permitted by joint sealant manufacturer, or are below 40 degrees F.
 - 2. When joint substrates are wet.
 - 3. Where joint widths are less than those allowed by joint sealant manufacturer for applications indicated.
 - 4. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

1.09 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 SUSTAINABLE PRODUCT REQUIREMENTS

- A. See Section 01 6000 - Product Requirements.
- B. VOC Content Restrictions: Products in this section to not exceed VOC content limits specified in Section 01 6116 - Volatile Organic Compound (VOC) Content Restrictions.
- C. CDPH: Products to comply with CAL (CDPH SM) .

2.02 JOINT SEALANTS - GENERAL

- A. Color of Exposed Joint Sealants: As selected by Architect from manufacturer's full range.
- B. Source Limitations: Obtain each type of joint sealant from single source from single manufacturer.

2.03 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 100 percent and minus 50 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. Hardness Range: 15 to 35, Shore A, when tested in accordance with ASTM C661.
 - 5. Products:
 - a. Dow; DOWSIL 790 Silicone Building Sealant: www.dow.com/#sle.
 - b. Dow; DOWSIL 791 Silicone Weatherproofing Sealant: www.dow.com/#sle.
 - c. Dow; DOWSIL 795 Silicone Building Sealant: www.dow.com/#sle.
 - d. Momentive Performance Materials, Inc/GE Silicones; SCS9000 SilPruf NB - Non-Staining Silicone Weatherproofing Sealant: www.siliconeforbuilding.com/#sle.
 - e. Pecora Corporation; Pecora 890 NST (Non-Staining Technology): www.pecora.com/#sle.
 - f. Tremco Commercial Sealants & Waterproofing; Spectrem 1: www.tremcosealants.com/#sle.
 - g. Substitutions: See Section 01 2500 - Substitution Procedures.
 - 6. Locations:
 - a. Joints in cast-in-place concrete.
 - b. Control and expansion joints in unit masonry.
 - c. Joints in dimension stone cladding.
 - d. Joints in exterior insulation and finish systems.
 - e. Joints between metal panels.
 - f. Joints between different materials listed above.
 - g. Perimeter joints between materials listed above and frames of doors, windows, aluminum storefront and curtain wall, and louvers.

- B. Mildew-Resistant Silicone Sealant: ASTM C920, Grade NS, Uses M and A; single component, mildew resistant, acid-curing; not expected to withstand continuous water immersion or traffic.
1. Color: White.
 2. Products:
 - a. Dowsil; 786 Mildew Resistant.
 - b. GE Advanced Materials - Silicones; Sanitary SCS1700.
 - c. Pecora Corporation; Pecora 898 NST (Non-Staining Technology): www.pecora.com/#sle.
 - d. Sika Corporation; Sikasil GP: www.usa.sika.com/#sle.
 - e. Tremco; Tremsil 200 Sanitary.
 - f. Substitutions: See Section 01 2500 - Substitution Procedures.
 3. Locations:
 - a. Interior sealant joints between plumbing fixtures and adjoining walls, floors, and counters.
 - b. Interior sealant joints subject to moisture.
- C. Acrylic Emulsion Latex: Water-based; ASTM C834, single component, nonstaining, nonbleeding, nonsagging; not intended for exterior use.
1. Grade: ASTM C834; Grade 0 Degrees F (Minus 18 Degrees C).
 2. Products:
 - a. Bostik; Siliconized Acrylic Caulk.
 - b. Pecora Corporation; AC-20 +Silicone: www.pecora.com/#sle.
 - c. Sherwin-Williams Company; 850A Acrylic Latex Caulk: www.sherwin-williams.com/#sle.
 - d. Tremco Commercial Sealants & Waterproofing; Tremflex 834: www.tremcosealants.com/#sle.
 - e. Substitutions: See Section 01 2500 - Substitution Procedures.
- D. Butyl Sealant: Solvent-based; ASTM C1311; single component, nonsag; not expected to withstand continuous water immersion or traffic.
1. Hardness Range: 10 to 30, Shore A, when tested in accordance with ASTM C661.
 2. Service Temperature Range: Minus 13 to 180 degrees F.
 3. Products:
 - a. Pecora Corporation; Pecora BC-158 Butyl Rubber Sealant: www.pecora.com/#sle.
 - b. Sherwin-Williams Company; Storm Blaster All Season Sealant: www.sherwin-williams.com/#sle.
 - c. Substitutions: See Section 01 2500 - Substitution Procedures.
 4. Locations:
 - a. Roof panel rib sealant.
 - b. Termination bars.
- E. Noncuring Butyl Sealant: Solvent-based, single component, nonsag, nonskinning, nonhardening, nonbleeding; nonvapor permeable; intended for fully concealed applications.
1. Products:
 - a. Pecora Corporation; Pecora BA-98 Non-Skinning Butyl Sealant: www.pecora.com/#sle.
 - b. Tremco Commercial Sealants & Waterproofing; Acoustical/Curtainwall Sealant: www.tremcosealants.com/#sle.
 - c. Substitutions: See Section 01 2500 - Substitution Procedures.

2.04 SELF-LEVELING JOINT SEALANTS

- A. Self-Leveling Polyurethane Sealant: ASTM C920, Grade P, Uses M and A; single or multicomponent; explicitly approved by manufacturer for traffic exposure; not expected to withstand continuous water immersion.
 - 1. Movement Capability: Plus and minus 25 percent, minimum.
 - 2. Hardness Range: 35 to 55, Shore A, when tested in accordance with ASTM C661.
 - 3. Service Temperature Range: Minus 40 to 180 degrees F.
 - 4. Products:
 - a. Master Builders Solutions; MasterSeal SL 2.
 - b. Sherwin-Williams Company; Stampede 2SL Polyurethane Sealant: www.sherwin-williams.com/#sle.
 - c. Sika Corporation; Sikaflex-2c SL: www.usa.sika.com/#sle.
 - d. Substitutions: See Section 01 2500 - Substitution Procedures.
 - 5. Locations:
 - a. Control and expansion joints in brick pavers.
 - b. Isolation and control joints in cast-in-place concrete slabs.
 - c. Joints in stone paving units.
 - d. Tile control and expansion joints.
 - e. Joints between materials listed above.
- B. Self-Leveling Polyurethane Sealant for Continuous Water Immersion: Polyurethane; ASTM C920, Grade P, Uses M and A; single component; explicitly approved by manufacturer for traffic exposure and continuous water immersion.
 - 1. Movement Capability: Plus and minus 25 percent, minimum.
 - 2. Hardness Range: 35 to 55, Shore A, when tested in accordance with ASTM C661.
 - 3. Service Temperature Range: Minus 40 to 180 degrees F.
 - 4. Products:
 - a. Sika Corporation; Sikaflex-2c SL: www.usa.sika.com/#sle.
 - b. W. R. Meadows, Inc; POURTHANE SL: www.wrmeadows.com/#sle.
 - c. Substitutions: See Section 01 2500 - Substitution Procedures.
- C. Semi-Rigid Self-Leveling Polyurea Joint Filler: Two-component, 100 percent solids, UV-resistant; intended for filling cracks and control joints not subject to significant movement; rigid enough to support concrete edges under traffic.
 - 1. Durometer Hardness, Type A: 85, minimum, after seven days when tested in accordance with ASTM D2240.
 - 2. Joint Depth: Provide product suitable for joints from 1/8 inch to 1 inch in depth excluding space for backer rod.
 - 3. Products:
 - a. ARDEX Engineered Cements; ARDEX ARDISEAL RAPID PLUS: www.ardexamericas.com/#sle.
 - b. Euclid Chemical Company; EUCO QWIKjoint UVR: www.euclidchemical.com/#sle.
 - c. Metzger McGuire; Edge-Pro.
 - d. SASE; FlexJoint 85.
 - e. VersaFlex; SL/85.
 - f. Substitutions: See Section 01 2500 - Substitution Procedures.
 - 4. Locations:
 - a. Exposed sawcuts and non-moving control joints in concrete slabs subject to heavy loads.

2.05 GLAZING SEALANTS

2.06 ACOUSTICAL JOINT SEALANTS

- A. See Section 092116 - Gypsum Board Assemblies.

2.07 ACCESSORIES

- A. Sealant Backing, General: Provide sealant backings of material that are nonstaining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.
1. Sealant Backing Manufacturers:
 - a. Adfast.
 - b. Alcot Plastics.
 - c. Nomaco.
 - d. W.R. Meadows.
 - e. Substitutions: See Section 01 2500 - Substitution Procedures
- B. Sealant Backing Rod, Closed-Cell Type:
1. Cylindrical flexible sealant backings complying with ASTM C1330 Type C.
 2. Size: 25 to 50 percent larger in diameter than joint width.
- C. Preformed Extruded Silicone Joint Seal: Pre-cured low-modulus silicone extrusion, in sizes to fit applications indicated on drawings, combined with a neutral-curing liquid silicone sealant for bonding joint seal to substrates.
1. Size: As recommended by manufacturer for Project conditions.
 2. Thickness: 0.78 inch, with ridges along outside bottom edges for bonding area.
 3. Color: As selected by Architect.
 4. Products:
 - a. Tremco Commercial Sealants & Waterproofing; Spectrem Simple Seal: www.tremcosealants.com/#sle.
 - b. Substitutions: See Section 01 2500 - Substitution Procedures.
- D. Preformed Extruded Polyurethane Joint Seal: Medium-modulus, preformed polyurethane extrusion used to bridge joints under elastomeric wall coatings, in sizes to fit applications indicated on drawings, combined with polyurethane sealant for bonding joint seal to substrates.
1. Size: As recommended by manufacturer for Project conditions.
 2. Thickness: 0.051 inch, with ridges along outside bottom edges for bonding area.
 3. Color: As selected by Architect.
 4. Products:
 - a. Dayton Superior.
 - b. Emseal (Sika).
 - c. Tremco.
 - d. Willseal.
 - e. Substitutions: See Section 01 2500 - Substitution Procedures.
- E. Backing (Bond-Breaker) Tape: Self-adhesive polyethylene tape with surface that sealant will not adhere to and recommended by tape and sealant manufacturers for specific application.
1. Manufacturers:
 - a. 3M.
 - b. Berry Plastics Corporation.
 - c. C.R. Laurence.
 - d. Scapa Tapes North America.
 - e. Valley Industrial Products.

- F. Masking Tape: Self-adhesive, nonabsorbent, nonstaining, removable without adhesive residue, and compatible with surfaces adjacent to joints and sealants.
- G. Joint Cleaner: Noncorrosive and nonstaining type, type recommended by sealant manufacturer; compatible with joint forming materials.
- H. 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. Do not exceed pot life of material as documented in writing by manufacturer.
- C. Provide joint sealant installations complying with ASTM C1193.
- D. Measure joint dimensions and size joint backers to achieve width-to-depth ratio, neck dimension, and surface bond area as recommended by manufacturer.
- 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.
- I. Concrete Floor Joint Filler: After full cure, shave joint filler flush with top of concrete slab.

3.04 FIELD QUALITY CONTROL

- A. See Section 014000 - Quality Requirements for additional requirements.
- B. Owner to engage a qualified testing agency to perform tests and inspections.
 - 1. Joint sealants will be considered defective if they do not pass tests and inspections.
 - 2. Additional tests and inspections, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
 - 3. Testing and inspecting agency to prepare reports and deliver to Owner or Contractor.

4. Submit field quality control reports to Architect.
- C. Tests:
 1. Field Adhesion Testing: Test joint sealants in accordance with Method A, Tail Procedure, in ASTM C1521.
 - a. Perform 10 tests for the first 1,000 linear feet of joint, for each kind of sealant and joint substrate.
 - b. Perform 1 test for each 1,000 linear feet of joint thereafter, or one test per each floor per elevation.
- D. Remove and replace failed portions of sealants using same materials and procedures as indicated for original installation.
- E. Repair destructive test location damage immediately after evaluation and recording of results.

3.05 PROTECTION

- A. See Section 01 7000 - Execution and Closeout Requirements, for additional requirements.
- B. Protect joint sealants during and after curing period from contact with contaminating substances or damage from subsequent construction activities.

END OF SECTION

SECTION 081113
HOLLOW METAL DOORS AND FRAMES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Hollow metal doors and frames.

1.02 RELATED REQUIREMENTS

- A. Section 087100 - Door Hardware.
- B. Section 088000 - Glazing: Glass for doors and borrowed lites.

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; 2024.
- C. ANSI/SDI A250.6 - Recommended Practice for Hardware Reinforcing on Standard Steel Doors and Frames; 2024.
- D. ANSI/SDI A250.8 - Specifications for Standard Steel Doors and Frames (SDI-100); 2023.
- E. ANSI/SDI A250.10 - Test Procedure and Acceptance Criteria for Prime Painted Steel Surfaces for Steel Doors and Frames; 2020.
- F. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2023.
- G. 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; 2024.
- H. ASTM A1011/A1011M - Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength; 2023.
- I. CAL (CDPH SM) - Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers Version 1.2; 2017.
- J. ICC A117.1 - Accessible and Usable Buildings and Facilities; 2017.
- K. ITS (DIR) - Directory of Listed Products; Current Edition.
- L. NAAMM HMMA 840 - Guide Specifications for Receipt, Storage and Installation of Hollow Metal Doors and Frames; 2024.
- M. NAAMM HMMA 861 - Guide Specifications for Commercial Hollow Metal Doors and Frames; 2014.
- N. NFPA 80 - Standard for Fire Doors and Other Opening Protectives; 2025.
- O. NFPA 105 - Standard for Smoke Door Assemblies and Other Opening Protectives; 2025.
- P. NFPA 252 - Standard Methods of Fire Tests of Door Assemblies; 2022.
- Q. SDI 117 - Manufacturing Tolerances for Standard Steel Doors and Frames; 2023.
- R. UL (DIR) - Online Certifications Directory; Current Edition.

- S. UL 10C - Standard for Positive Pressure Fire Tests of Door Assemblies; Current Edition, Including All Revisions.
- T. UL 1784 - Standard for Air Leakage Tests of Door Assemblies; Current Edition, Including All Revisions.

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. Sustainable Product Data: See Section 01 6000 - Product Requirements and Section 01 6116 - Volatile Organic Compound (VOC) Content Restrictions.
 - 1. VOC content restrictions data.
 - 2. CAL (CDPH SM) compliance data.
 - 3. Life cycle data.
 - 4. Recycled content data.
- D. Shop Drawings: Details of each opening, showing elevations, glazing, frame profiles, and any indicated finish requirements.
- E. Samples: Submit two samples of metal, 2 by 2 inches in size, showing factory finishes, colors, and surface texture.
- F. Installation Instructions: Manufacturer's published instructions, including any special installation instructions relating to this project.

1.05 QUALITY ASSURANCE

- A. Qualifications: See Section 01 4000 - Quality Requirements.
 - 1. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than five years documented experience.
 - 2. Manufacturer Qualifications: Provide hollow metal doors and frames from SDI Certified manufacturer: <https://steeldoor.org/sdi-certified/#sle>.
 - 3. Installer Qualifications: Company specializing in performing work of the type specified and with at least three years of documented experience.
- B. Maintain at project site copies of reference standards relating to installation of products specified.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. See Section 01 6000 - Product Requirements.
- B. Comply with NAAMM HMMA 840 or ANSI/SDI A250.8 (SDI-100) in accordance with specified requirements.
- C. Protect with resilient packaging; avoid humidity build-up under coverings; prevent corrosion and adverse effects on factory applied painted finish.
- D. See Section 01 7419 - Construction Waste Management and Disposal, for packaging waste requirements.

1.07 WARRANTY

- A. See Section 01 6000 - Product Requirements and Section 01 7800 - Closeout Submittals for additional warranty requirements.
- B. Provide manufacturer's standard warranty for each product.

PART 2 PRODUCTS

2.01 SUSTAINABLE PRODUCT REQUIREMENTS

- A. See Section 01 6000 - Product Requirements.
- B. VOC Content Restrictions: Products in this section to not exceed VOC content limits specified in Section 01 6116 - Volatile Organic Compound (VOC) Content Restrictions.
- C. CDPH: Products to comply with CAL (CDPH SM) .
- D. Life Cycle: Products in this section to have LCA as specified in Section 016000.
- E. Recycled Content: Products in this Section to meet minimum recycled content thresholds specified in Section 016000.

2.02 MANUFACTURERS

- A. Hollow Metal Doors and Frames:
 - 1. Ceco Door (Assa A
 - 2. Curries (Assa Abloy).
 - 3. DCI Hollow Metal Frames.
 - 4. Deansteel.
 - 5. DKS Doors.
 - 6. Krieger Specialty Products.
 - 7. Republic Doors and Frames (Allegion).
 - 8. Steelcraft (Allegion).
 - 9. Stiles Custom Metal.
 - 10. Substitutions: See Section 01 2500 - Substitution Procedures.

2.03 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. Glazed Lights: Non-removable stops on non-secure side; sizes and configurations as indicated on drawings. Style: Manufacturer's standard.
- 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.

2.04 HOLLOW METAL DOORS

- A. Door Finish: Factory-primed and shop-finished.
- B. Exterior Doors: Thermally insulated.
 - 1. Based on SDI Standards: ANSI/SDI A250.8 (SDI-100).
 - a. Level 2 - Heavy-duty.
 - b. Physical Performance Level B, 500,000 cycles; in accordance with ANSI/SDI A250.4.
 - c. Model 1 - Full Flush.
 - d. Door Face Metal Thickness: 18 gauge, 0.042 inch, minimum.

- e. Zinc Coating: A60/ZF180 galvanized coating; ASTM A653/A653M.
- 2. Door Core Material: Manufacturers standard core material/construction and in compliance with requirements.
- 3. Door Thickness: 1-3/4 inches, nominal.
- 4. Door Face Sheets: Flush.
- 5. Weatherstripping: Refer to Section 087100 - Door Hardware.
- C. Interior Doors, Non-Fire-Rated:
 - 1. Based on SDI Standards: ANSI/SDI A250.8 (SDI-100).
 - a. Level 1 - Standard-duty.
 - b. Physical Performance Level C, 250,000 cycles; in accordance with ANSI/SDI A250.4.
 - c. Model 1 - Full Flush.
 - d. Door Face Metal Thickness: 20 gauge, 0.032 inch, minimum.
 - 2. Door Core Material: Manufacturers standard core material/construction and in compliance with requirements.
 - 3. Door Thickness: 1-3/4 inches, nominal.
 - 4. Door Face Sheets: Flush.
- D. Fire-Rated Interior Doors:
 - 1. Based on SDI Standards: ANSI/SDI A250.8 (SDI-100).
 - a. Level 1 - Standard-duty.
 - b. Physical Performance Level C, 250,000 cycles; in accordance with ANSI/SDI A250.4.
 - c. Model 1 - Full Flush.
 - d. Door Face Metal Thickness: 20 gauge, 0.032 inch, minimum.
 - 2. Fire Rating: As indicated on drawings, tested in accordance with UL 10C and NFPA 252 ("positive pressure fire tests").
 - 3. Provide units listed and labeled by UL (DIR) or ITS (DIR).
 - a. Attach fire rating label to each fire rated unit.
 - 4. Smoke and Draft Control Doors (Indicated with letter "S" on Drawings and/or Door Schedule): Self-closing or automatic closing doors in accordance with NFPA 80 and NFPA 105, with fire-resistance-rated wall construction rated the same or greater than the fire-rated doors, and the following:
 - a. Maximum Air Leakage: 3.0 cfm/sq ft of door opening at 0.10 inch w.g. pressure, when tested in accordance with UL 1784 at both ambient and elevated temperatures.
 - b. Gasketing: Provide gasketing or edge sealing as necessary to achieve leakage limit.
 - c. Label: Include the "S" label on fire-rating label of door.
 - 5. Door Core Material: Manufacturers standard core material/construction in compliance with requirements.
 - 6. Door Thickness: 1-3/4 inches, nominal.
 - 7. Door Face Sheets: Flush.

2.05 HOLLOW METAL FRAMES

- A. Comply with standards and/or custom guidelines as indicated for corresponding door in accordance with applicable door frame requirements.
- B. Frame Finish: Factory primed and shop finished.
- C. Exterior Door Frames: Face welded type.
 - 1. Galvanizing: Components hot-dipped zinc-iron alloy-coated (galvanized) in accordance with ASTM A653/A653M, with A40/ZF120 coating.
 - 2. Frame Metal Thickness: 18 gauge, 0.042 inch, minimum.
 - 3. Weatherstripping: Separate, see Section 087100.
- D. Interior Door Frames, Non-Fire Rated: Knock-down type.

1. Frame Metal Thickness: 18 gauge, 0.042 inch, minimum.
- E. Door Frames, Fire-Rated: Face welded type.
 1. Fire Rating: Same as door, labeled.
 2. Frame Metal Thickness: 18 gauge, 0.042 inch, minimum.
- F. Frames for Wood Doors: Comply with frame requirements in accordance with corresponding door.
- G. Frames in Masonry Walls: Size to suit masonry coursing with head member 4 inches high or as otherwise necessary to fill opening without cutting masonry units.
- H. Frames Wider than 48 inches: Reinforce with steel channel fitted tightly into frame head, flush with top.

2.06 FINISHES

- A. Primer: Rust-inhibiting, complying with ANSI/SDI A250.10, door manufacturer's standard.
- B. Exterior Doors Paint Finish: See Section 099113 - Exterior Painting.
- C. Interior Doors Paint Finish: See Section 099123 - Interior Painting.

2.07 ACCESSORIES

- A. Louvers: Roll formed steel with overlapping frame; finish same as door components ; factory-installed.
 1. In Fire-Rated Doors: UL (DIR) or ITS (DIR) listed fusible link louver, same rating as door.
 2. Style: Standard straight slat blade.
- B. Door Window Frames: Door window frames with glazing securely fastened within door opening.
 1. Frame Material: 18 gauge, 0.0478 inch, galvanized steel.
- C. Glazing: As specified in Section 088000, shop-installed.

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. Install fire rated units in accordance with NFPA 80.
- C. Coordinate frame anchor placement with wall construction.
- D. Install door hardware as specified in Section 087100.
 1. Comply with recommended practice for hardware placement of doors and frames in accordance with ANSI/SDI A250.6 or NAAMM HMMA 861.
- E. Comply with glazing installation requirements of Section 088000.
- F. Touch up damaged factory finishes.

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.

END OF SECTION

SECTION 081416
FLUSH WOOD DOORS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Flush wood doors.

1.02 RELATED REQUIREMENTS

- A. Section 081113 - Hollow Metal Doors and Frames.
- B. Section 088000 - Glazing.

1.03 REFERENCE STANDARDS

- A. AWI (QCP) - Quality Certification Program; Current Edition.
- 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. CAL (CDPH SM) - Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers Version 1.2; 2017.
- E. NFPA 80 - Standard for Fire Doors and Other Opening Protectives; 2025.
- F. NFPA 101 - Life Safety Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- G. NFPA 105 - Standard for Smoke Door Assemblies and Other Opening Protectives; 2025.
- H. NFPA 252 - Standard Methods of Fire Tests of Door Assemblies; 2022.
- I. UL 10C - Standard for Positive Pressure Fire Tests of Door Assemblies; Current Edition, Including All Revisions.
- J. UL 1784 - Standard for Air Leakage Tests of Door Assemblies; Current Edition, Including All Revisions.
- K. WI (CCP) - Certified Compliance Program (CCP); Current Edition.

1.04 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Indicate door core materials and construction; veneer species, type and characteristics.
- C. Sustainable Product Data: See Section 01 6000 - Product Requirements and Section 01 6116 - Volatile Organic Compound (VOC) Content Restrictions.
 - 1. VOC content restrictions data.
 - 2. CAL (CDPH SM) compliance data.
 - 3. Life cycle data.
 - 4. Sustainable wood data.
 - 5. Recycled content data.
- D. 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.

1. Provide information as required by AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS).
- E. Samples: Submit two samples of door veneer, 4 by 4 inches in size illustrating wood grain, stain color, and sheen.
- F. Certificate: Submit labels and certificates required by quality assurance and quality control programs.
- G. Manufacturer's Installation Instructions: Indicate special installation instructions.
- H. Installer's qualification statement.
- I. Field Quality Control Reports: As specified in Part 3 of this Section.
- J. Warranty, executed in Owner's name.

1.05 QUALITY ASSURANCE

- A. Qualifications: See Section 01 4000 - Quality Requirements.
 1. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section, with not less than five years of documented experience.
 - a. Company with at least one project within past five years with value of woodwork within at least 20 percent of cost of woodwork for this project.
 - b. Accredited participant in the specified certification program prior to the commencement of fabrication and throughout the duration of the project.
 2. Installer Qualifications: Company specializing in performing work of the type specified in this section, with not less than three years of documented experience and approved by manufacturer.

1.06 FIELD CONDITIONS

- A. Do not deliver or install doors until spaces are enclosed and weathertight, wet-work in spaces is complete and dry, and HVAC system is operating and maintaining temperature and relative humidity at levels designed for building occupants for the remainder of construction period.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. See Section 01 6000 - Product Requirements.
- B. Package, deliver and store doors in accordance with specified quality standard.
- C. Accept doors on site in manufacturer's packaging, and inspect for damage.
- D. 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.
- E. See Section 01 7419 - Construction Waste Management and Disposal, for packaging waste requirements.

1.08 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 SUSTAINABLE PRODUCT REQUIREMENTS

- A. See Section 01 6000 - Product Requirements.
- B. VOC Content Restrictions: Products in this section to not exceed VOC content limits specified in Section 01 6116 - Volatile Organic Compound (VOC) Content Restrictions.
- C. CDPH: Products to comply with CAL (CDPH SM) .
- D. Life Cycle: Products in this section to have LCA as specified in Section 016000.
- E. Sustainable Wood: Products in this Section to meet sustainable wood requirements specified in Section 016000.
- F. Recycled Content: Products in this Section to meet minimum recycled content thresholds specified in Section 016000.

2.02 PERFORMANCE REQUIREMENTS

- A. Woodwork Quality Assurance Program:
 - 1. Comply with AWI (QCP) or WI (CCP) woodwork association quality assurance service / program in accordance with requirements for work specified in this section.
 - 2. Provide labels indicating that the installed work complies with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS) requirements for grade or grades specified.
 - 3. Provide designated labels on shop drawings as required by quality assurance program.
 - 4. Provide designated labels on installed products as required by quality assurance program.
 - 5. Submit documentation upon completion of installation that verifies this work is in compliance with specified requirements.
- B. Fire-Rated Wood Door and Frame Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction, for fire-protection ratings and temperature-rise limits indicated on Drawings, based on testing at positive pressure in accordance with UL 10C or NFPA 252.
 - 1. Oversize Fire-Rated Door Assemblies: For units exceeding sizes of tested assemblies, provide certification by a qualified testing agency that doors comply with standard construction requirements for tested and labeled fire-rated door assemblies except for size.
 - 2. Temperature-Rise Limit: At vertical exit enclosures and exit passageways, provide doors that have a maximum transmitted temperature end point of not more than 450 deg F above ambient after 30 minutes of standard fire-test exposure.
- C. Smoke- and Draft-Control Door Assemblies: Listed and labeled for smoke and draft control by a qualified testing agency acceptable to authorities having jurisdiction, based on testing in accordance with UL 1784 and installed in compliance with NFPA 105.

2.03 MANUFACTURERS

- A. Flush Wood Doors:
 - 1. Eggers Industries.
 - 2. Haley Brothers.
 - 3. Masonite Architectural.
 - 4. Oregon Door.
 - 5. Vancouver Door Company.
 - 6. VT Industries.
 - 7. Substitutions: See Section 01 2500 - Substitution Procedures.

2.04 DOORS AND PANELS

- A. Doors: See drawings for locations and additional requirements.
 - 1. Quality Standard: Custom Grade, Heavy Duty performance, in accordance with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS).
 - a. Extra Heavy Duty:
 - 1) Classrooms.
 - 2) Public bathrooms.
 - 3) Janitor's closets.
 - 4) Assembly spaces.
 - 5) Exits.
 - 6) Patient rooms.
 - 2. Wood Veneer Faced Doors: 5-ply unless otherwise indicated.
 - 3. High Pressure Decorative Laminate (HPDL) 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. Smoke and Draft Control Doors (Indicated as "S" on Drawings): In addition to required fire rating, provide door assemblies tested in accordance with UL 1784 with maximum air leakage of 3.0 cfm per sq ft of door opening at 0.10 inch wg pressure at both ambient and elevated temperatures for "S" label; if necessary, provide additional gasketing or edge sealing.
 - 4. High pressure decorative laminate (HPDL) finish as indicated on drawings.

2.05 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.

2.06 DOOR FACINGS

- A. Veneer Facing for Transparent Finish: Red oak, veneer grade in accordance with quality standard indicated, plain sliced (flat cut), with book match between leaves of veneer, running match of spliced veneer leaves assembled on door or panel face.
 - 1. Vertical Edges: Same species as face veneer.
- B. Veneer Facing for Opaque Finish: Medium density overlay (MDO), in compliance with indicated quality standard, or any closed-grain hardwood of mill option.

2.07 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.
 - 1. Exception: Doors to be field finished.
- E. Provide edge clearances in accordance with the quality standard specified.

2.08 FINISH - WOOD VENEER DOORS

- A. Quality Standard Grade: Match door construction.
- B. Stain: Match Architect's sample.
- C. Finish System:
 - 1. System 11: Catalyzed polyurethane.
- D. Sheen: Satin.

2.09 FINISH - OPAQUE DOORS

- A. Quality Standard Grade: Match door construction.
- B. Paint Finish for Exterior Wood Doors: See 099113 - Exterior Painting.
- C. Paint Finish for Interior Wood Doors: See 099123 - Interior Painting.
- D. Finish work in accordance with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS), Section 5 - Finishing for grade specified and as follows:

2.10 ACCESSORIES

- A. Hollow Metal Door Frames: See Section 081113 - Hollow Metal Doors and Frames.
- B. Metal Louvers:
 - 1. Material and Finish: Roll formed steel; pre-painted finish to color as selected.
- C. Door Window Frames: Door window frames with glazing securely fastened within door opening.
 - 1. Frame Material: 18 gauge, 0.0478 inch, galvanized steel.
- D. Glazing: See Section 088000 - Glazing.
- E. Glazing Stops: Wood, of same species as door facing, butted corners; prepared for countersink style tamper proof screws.

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.
- F. Install door louvers plumb and level.

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 FIELD QUALITY CONTROL

- A. See Section 01 4000 - Quality Requirements, for additional requirements.
- B. Owner to engage a qualified testing agency to perform tests and inspections.
 - 1. Flush wood doors will be considered defective if they do not pass tests and inspections.
 - 2. Additional tests and inspections, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
 - 3. Testing and inspecting agency to prepare reports and deliver to Owner or Contractor.
 - 4. Submit field quality control reports to Architect.
- C. Inspections:
 - 1. Provide inspection of installed Work through AWI's Quality Certification Program or WI's Certified Compliance Program, certifying that wood doors and frames, including installation, comply with requirements of AWI/AWMAC/WI (AWS) for the specified grade.
 - 2. Fire-Rated Door Inspections: Inspect each fire-rated door in accordance with NFPA 80, Section 5.2.
 - 3. Egress Door Inspections: Inspect each door equipped with panic hardware, each door equipped with fire exit hardware, each door located in an exit enclosure, each electrically controlled egress door, and each door equipped with special locking arrangements in accordance with NFPA 101, Section 7.2.1.15.

3.05 ADJUSTING

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

END OF SECTION

SECTION 083100
ACCESS DOORS AND PANELS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Access doors and frames for walls and ceilings.
- B. Floor access doors and frames.

1.02 DEFINITIONS:

- A. See Section 050511 - Surface Preparation and Finishing of Metals, for the following definitions:
 - 1. Metallic-coated.

1.03 REFERENCE STANDARDS

- A. ANSI A326.3 - American National Standard Test Method for Measuring Dynamic Coefficient of Friction of Hard Surface Flooring Materials; 2021.
- B. ANSI H35.2 - American National Standard Dimensional Tolerances for Aluminum Mill Products; 2017.
- C. ASTM A36/A36M - Standard Specification for Carbon Structural Steel; 2019.
- D. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2023.
- E. ASTM A283/A283M - Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates; 2024.
- F. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2023.
- G. ASTM A666/A666M - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar; 2024.
- H. ASTM A786/A786M - Standard Specification for Hot-Rolled Carbon, Low-Alloy, High-Strength Low-Alloy, and Alloy Steel Floor Plates; 2015 (Reapproved 2021).
- I. ASTM A879/A879M - Standard Specification for Steel Sheet, Zinc Coated by the Electrolytic Process for Applications Requiring Designation of the Coating Mass on Each Surface; 2022.
- J. 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; 2024.
- K. ASTM B209/B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2021a.
- L. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes; 2021.
- M. ASTM B632/B632M - Standard Specification for Aluminum-Alloy Rolled Tread Plate; 2024.
- N. ASTM D4541 - Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers; 2022.

- O. ASTM F2329 - Standard Specification for Zinc Coating, Hot-Dip, Requirements for Application to Carbon and Alloy Steel Bolts, Screws, Washers, Nuts, and Special Threaded Fasteners; 2015.
- P. NFPA 80 - Standard for Fire Doors and Other Opening Protectives; 2025.
- Q. NFPA 252 - Standard Methods of Fire Tests of Door Assemblies; 2022.
- R. NFPA 288 - Standard Methods of Fire Tests of Horizontal Fire Door Assemblies Installed in Horizontal Fire Resistance-Rated Assemblies; 2022.
- S. UL 10B - Standard for Fire Tests of Door Assemblies; Current Edition, Including All Revisions.

1.04 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal requirements.
- B. Product Data: For each item to be installed.
- C. Sustainable Product Data: See Section 01 6000 - Product Requirements and Section 01 6116 - Volatile Organic Compound (VOC) Content Restrictions.
 - 1. VOC content restrictions data.
 - 2. CAL (CDPH SM) compliance data.
 - 3. Recycled content data.
- D. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
- E. Samples: For each door face material
- F. Manufacturer's installation instructions.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. See Section 01 6000 - Product Requirements.
- B. Deliver materials to Project site in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, approval or listing agency markings, and directions for storing.
- C. Protect materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources. Store in a dry location.
- D. See Section 01 7419 - Construction Waste Management and Disposal, for packaging waste requirements.

1.06 WARRANTY

- A. See Section 01 6000 - Product Requirements and Section 01 7800 - Closeout Submittals for additional warranty requirements.
- B. Provide manufacturer's standard warranty for each product.

PART 2 PRODUCTS

2.01 SUSTAINABLE PRODUCT REQUIREMENTS

- A. See Section 01 6000 - Product Requirements.
- B. VOC Content Restrictions: Products in this section to not exceed VOC content limits specified in Section 01 6116 - Volatile Organic Compound (VOC) Content Restrictions.
- C. CDPH: Products to comply with CAL (CDPH SM) .

- D. Recycled Content: Products in this Section to meet minimum recycled content thresholds specified in Section 016000.

2.02 PERFORMANCE REQUIREMENTS

- A. Fire-Rated Access Doors and Frames: Units complying with NFPA 80 tested according to the following test method:
 - 1. NFPA 252 or UL 10B for fire-rated access door assemblies installed vertically.
 - 2. NFPA 288 for fire-rated access door assemblies installed horizontally.

2.03 MANUFACTURERS

- A. Manufacturers:
 - 1. Acudor.
 - 2. Babcock-Davis.
 - 3. Bauco.
 - 4. Best Access Doors.
 - 5. Cendrex.
 - 6. Elmdor / Stoneman.
 - 7. J.L. Industries (Activar).
 - 8. Larsen's Manufacturing.
 - 9. Nystrom.
 - 10. Substitutions: Section 01 2500 - Substitution Procedures.
- B. Source Limitations: Furnish products produced by single manufacturer and obtained from single supplier.

2.04 ACCESS DOORS AND PANELS, GENERAL

- A. Access Door and Panel Size: As shown on the Architectural drawings or as required for access. Confirm each size with Architect.

2.05 ACCESS DOORS FOR WALLS AND CEILINGS

- A. Flush Access Doors with Exposed Flanges: Face of door flush with frame, with exposed flange and concealed hinge.
 - 1. Products:
 - a. Bauco; Softline.
 - b. Elmdor / Stoneman; DW Series Drywall Access Doors.
 - c. Nystrom; Architectural Access Door.
 - d. Substitutions: See Section 01 2500 - Substitution Procedures.
 - 2. Physical Properties:
 - a. Uncoated steel sheet, nominal 0.060 inch, 16 gage.
 - 1) Finish: Factory prime.
 - b. Metallic-coated steel sheet, nominal 0.064 inch, 16 gage.
 - 1) Finish: Factory prime.
 - c. Stainless steel, nominal 0.062 inch, 16 gage.
 - 1) Finish: No. 4.
 - d. Frame Material: Same material, thickness, and finish of door.
 - e. Hinges: Manufacturer's standard.
 - f. Hardware: Latch.
- B. Flush Access Doors with Concealed Flanges: Face of door flush with frame; with concealed flange for gypsum board and plaster installation, with concealed hinge.

1. Products:
 - a. Gypsum:
 - 1) Elmdor / Stoneman; DWB Series Drywall Bead Access Door.
 - b. Plaster:
 - 1) Elmdor / Stoneman; ML Series Metal Lath Access Door.
 2. Physical Properties:
 - a. Uncoated steel sheet, nominal 0.060 inch, 16 gage.
 - 1) Finish: Factory prime.
 - b. Metallic-coated steel sheet, nominal 0.064 inch, 16 gage.
 - 1) Finish: Factory prime.
 - c. Stainless steel, nominal 0.062 inch, 16 gage.
 - 1) Finish: No. 4.
 - d. Frame Material: Same material, thickness, and finish of door.
 - e. Hinges: Manufacturer's standard.
 - f. Hardware: Latch.
- C. Recessed Access Doors: Door face recessed for gypsum board, plaster, and acoustical tile infill; with concealed flange installation, and with concealed hinge.
1. Products:
 - a. Gypsum Board:
 - 1) Bauco; Bauco Plus II.
 - 2) Elmdor / Stoneman; ADW Series Drywall Aluminum Access Door.
 - 3) Nystrom; Recessed Access Door.
 - b. Plaster:
 - 1) Elmdor / Stoneman; AP Series Acoustical Plaster Access Door.
 - c. Acoustical Tile:
 - 1) Elmdor / Stoneman; AT Series Acoustical Tile Access Door.
 2. Physical Properties:
 - a. Uncoated steel sheet, nominal 0.060 inch, 16 gage.
 - 1) Finish: Factory prime.
 - b. Metallic-coated steel sheet, nominal 0.064 inch, 16 gage.
 - 1) Finish: Factory prime.
 - c. Stainless steel, nominal 0.062 inch, 16 gage.
 - 1) Finish: No. 4.
 - d. Frame Material: Same material, thickness, and finish of door.
 - e. Hinges: Manufacturer's standard.
 - f. Hardware: Latch.
- D. Interior Flush Gypsum Fiberglass Reinforced (GFR) Access Doors: Face of door flush with frame, for gypsum board installation.
1. Products:
 - a. Elmdor / Stoneman; GFG Series.
 - b. Nystrom; Concealed Hinged Access Door GFRS.
 2. Physical Properties:
 - a. Door and Frame Material: Unpainted glass-fiber-reinforced gypsum, with frames reinforced for hardware and fastenings.
 - b. Corners: Square.
 - c. Hardware: Latch.
 3. Location:
- E. Fire-Rated, Flush Access Doors with Exposed Flanges: Door face flush with frame, with a core of mineral-fiber insulation enclosed in sheet metal, with exposed flange, self-closing door, and concealed hinge.

1. Products:
 - a. Elmdor / Stoneman; FR / FRC Series.
 - b. Nystrom; Fire-Rated Access Door.
 2. Physical Properties:
 - a. Fire-Resistance Rating: Not less than that of adjacent construction.
 - b. Temperature-Rise Rating: 450 degrees F at the end of 30 minutes.
 - c. Uncoated steel sheet, nominal 0.060 inch, 16 gage.
 - 1) Finish: Factory prime.
 - d. Metallic-coated steel sheet, nominal 0.064 inch, 16 gage.
 - 1) Finish: Factory prime.
 - e. Stainless steel, nominal 0.062 inch, 16 gage.
 - 1) Finish: No. 4.
 - f. Frame Material: Same material, thickness, and finish of door.
 - g. Hinges: Manufacturer's standard.
 - h. Hardware: Latch.
 3. Location:
- F. Flush Gasketed Access Doors: Face of door flush with frame, with gasket, exposed flange, and concealed hinge.
1. Products:
 - a. Bauco; Bauco Plus.
 - b. Elmdor / Stoneman; GD Series.
 - c. Nystrom; Gasketed Access Door, GT Series.
 2. Physical Properties:
 - a. Uncoated steel sheet, nominal 0.060 inch, 16 gage.
 - 1) Finish: Factory prime.
 - b. Metallic-coated steel sheet, nominal 0.064 inch, 16 gage.
 - 1) Finish: Factory prime.
 - c. Stainless steel, nominal 0.062 inch, 16 gage.
 - 1) Finish: No. 4.
 - d. Frame Material: Same material, thickness, and finish of door.
 - e. Gasket: Manufacturer's standard.
 - f. Hinges: Manufacturer's standard.
 - g. Hardware: Latch.
 3. Location:
 - a. At laboratory, pressurized, and climate-controlled rooms.

2.06 FLOOR ACCESS DOORS AND FRAMES

- A. Floor Doors, General: Equip each door with adjustable counterbalancing springs, heavy-duty hold-open arm that automatically locks door open at 90 degrees, release handle with red vinyl grip that allows for one-handed closure, and recessed lift handle.
- B. Aluminum Floor Door: Extruded-aluminum angle frame with 1/4-inch- thick, diamond-pattern, aluminum tread plate door.
 1. Basis of Design Product:
 - a. Nystrom; Non-Drainable Diamond Tread Floor Door.
 2. Physical Properties:
 - a. Opening: Single-leaf.
 - b. Watertight: No.
 - c. Loading Capacity: 150-lbf/sq. ft. pedestrian live load.
 3. Location:

- C. Watertight Aluminum Floor Door: Extruded-aluminum gutter frame with NPS 1-1/2 (DN 40) drainage coupling and 1/4-inch thick, diamond-pattern, aluminum tread plate door.
 - 1. Basis of Design Product:
 - a. Nystrom; Water Tight Diamond Tread Well Hatch.
 - 2. Physical Properties:
 - a. Opening: Single-leaf.
 - b. Watertight: Yes.
 - c. Loading Capacity: 150-lbf/sq. ft. pedestrian live load.
 - 3. Location:
- D. Steel Angle-Frame Floor Door: Structural steel frame with 3/16 inch or 1/4 inch thick diamond-pattern-steel tread plate door.
 - 1. Basis of Design Product:
 - a. Acudor; FA-300.
 - 2. Physical Properties:
 - a. Opening: Single-leaf.
 - b. Watertight: No.
 - c. Loading Capacity: 150-lbf/sq. ft. pedestrian live load.
 - d. Fire-Resistance Rating: Not less than that of adjacent construction.
 - 1) Finish: Manufacturer's standard, yellow, with wording "FIRE DOOR - DO NOT STORE MATERIALS ON SURFACE".
 - 3. Location:
- E. Watertight Steel Gutter-Frame Floor Door: Structural steel channel frame forming gutter with NPS 1-1/2 (DN 40) drainage coupling and 3/16 inch or 1/4 inch thick diamond-pattern-steel tread plate door.
 - 1. Basis of Design Product:
 - a. Acudor; A-FPS.
 - 2. Physical Properties:
 - a. Opening: Single-leaf.
 - b. Watertight: Yes.
 - c. Loading Capacity: 150-lbf/sq. ft. pedestrian live load.
 - d. Fire-Resistance Rating: Not less than that of adjacent construction.
 - 1) Finish: Manufacturer's standard, yellow, with wording "FIRE DOOR - DO NOT STORE MATERIALS ON SURFACE".
 - 3. Location:

2.07 HARDWARE

- A. Hinges: Heavy-duty, with stainless steel pins.
- B. Latch: Stainless-steel slam latch.
- C. Lock: Keyed deadbolt lock.
 - 1. Lock Preparation: Prepare door panel to accept cylinder specified in 087100 - Door Hardware.
- D. Hardware Material: Manufacturer's standard.
- E. Insulation: Manufacturer's standard.
- F. Safety Accessories: Safety chain.

2.08 MATERIALS

- A. Steel Plates, Shapes, and Bars: ASTM A36/A36M.

- B. Rolled-Steel Floor Plate: ASTM A786/A786M, rolled from plate complying with ASTM A36/A36M or ASTM A283/A283M, Grade C or D.
- C. Steel Sheet: Uncoated or electrolytic zinc coated, ASTM A879/A879M, with cold-rolled steel sheet substrate complying with ASTM A1008/A1008M, Commercial Steel (CS), exposed.
- D. Metallic-Coated Steel Sheet: ASTM A653/A653M, Commercial Steel (CS), Type B; with minimum G60 (Z180) or A60 (ZF180) metallic coating.
- E. Stainless-Steel Sheet, Strip, Plate, and Flat Bars: ASTM A666/A666M, Type 304. Remove tool and die marks and stretch lines or blend into finish.
- F. Aluminum Extrusions: ASTM B221, Alloy 6063-T6.
- G. Aluminum-Alloy Rolled Tread Plate: ASTM B632/B632M, Alloy 6061-T6.
- H. Aluminum Sheet: ASTM B209/B209M, alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, and with not less than strength and durability properties of Alloy 5005-H15; with minimum sheet thickness according to ANSI H35.2.
- I. Frame Anchors: Same type as door face.
- J. Inserts, Bolts, and Anchor Fasteners: Hot-dip galvanized steel according to ASTM A153/A153M or ASTM F2329.

2.09 FINISHES

- A. Stainless Steel Finish: See 050511 - Surface Preparation and Finishing of Metals.
- B. Exterior Paint Finish: See Section 099113 - Exterior Painting.
- C. Interior Paint Finish: See Section 099123 - Interior Painting.

2.10 FABRICATION

- A. General: Provide access door and frame assemblies manufactured as integral units ready for installation.
- B. Metal Surfaces: For metal surfaces exposed to view in the completed Work, provide materials with smooth, flat surfaces without blemishes. Do not use materials with exposed pitting, seam marks, roller marks, rolled trade names, or roughness.
- C. Doors and Frames: Grind exposed welds smooth and flush with adjacent surfaces. Furnish attachment devices and fasteners of type required to secure access doors to types of supports indicated.
- D. Recessed Access Doors: Form face of panel to provide recess for application of applied finish. Reinforce panel as required to prevent buckling.
- E. Latching Mechanisms: Furnish number required to hold doors in flush, smooth plane when closed.
 - 1. For cylinder locks, furnish two keys per lock and key all locks alike.
 - 2. For recessed panel doors, provide access sleeves for each locking device. Furnish plastic grommets and install in holes cut through finish.
- F. Extruded Aluminum: After fabrication, apply manufacturer's standard protective coating on aluminum that will come in contact with concrete.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's written instructions and approved shop drawings.

- B. Install doors flush with adjacent finish surfaces or recessed to receive finish material.

3.02 ADJUSTING

- A. Adjust doors and hardware, after installation, for proper operation.
- B. Remove and replace doors and frames that are warped, bowed, or otherwise damaged.

END OF SECTION

SECTION 084313
ALUMINUM-FRAMED STOREFRONTS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Aluminum-framed storefront.
- B. Aluminum entrance doors and frames.

1.02 RELATED REQUIREMENTS

- A. Section 088000 - Glazing: Glass and glazing accessories.

1.03 REFERENCE STANDARDS

- A. AAMA CW-10 - Care and Handling of Architectural Aluminum from Shop to Site; 2015.
- B. AAMA 503 - Voluntary Specification for Field Testing of Newly Installed Storefronts, Curtain Walls and Sloped Glazing Systems; 2014.
- C. AAMA 609 & 610 - Cleaning and Maintenance Guide for Architecturally Finished Aluminum (Combined Document); 2015.
- D. AAMA 2605 - Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels (with Coil Coating Appendix); 2022.
- E. ASCE 7 - Minimum Design Loads and Associated Criteria for Buildings and Other Structures; Most Recent Edition Cited by Referring Code or Reference Standard.
- F. ASTM A36/A36M - Standard Specification for Carbon Structural Steel; 2019.
- G. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2024.
- 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. 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; 2019.
- K. 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).
- L. ASTM E331 - Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference; 2000 (Reapproved 2023).
- M. ASTM E783 - Standard Test Method for Field Measurement of Air Leakage Through Installed Exterior Windows and Doors; 2002 (Reapproved 2018).
- N. ASTM E1105 - Standard Test Method for Field Determination of Water Penetration of Installed Exterior Windows, Skylights, Doors, and Curtain Walls, by Uniform or Cyclic Static Air Pressure Difference; 2015 (Reapproved 2023).

- O. CAL (CDPH SM) - Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers Version 1.2; 2017.
- P. SSPC-Paint 20 - Zinc-Rich Coating (Type I - Inorganic, and Type II - Organic); 2019.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordinate with installation of other components that comprise the exterior enclosure.
- B. Preinstallation Meeting: Conduct a preinstallation meeting minimum 2 weeks before starting work of this section; require attendance by all affected installers.
 - 1. See Section 01 3000 - Administrative Requirements for additional information.

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. Sustainable Product Data: See Section 01 6000 - Product Requirements and Section 01 6116 - Volatile Organic Compound (VOC) Content Restrictions.
 - 1. VOC content restrictions data.
 - 2. CAL (CDPH SM) compliance data.
 - 3. Life cycle data.
 - 4. Recycled content data.
- D. 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. Include design engineer's stamp or seal on shop drawings for attachments and anchors.
- E. Delegated Design Documents: See Section 01 3000 - Administrative Requirements.
 - 1. Provide design documentation prepared by Contractor's Licensed Professionals.
- F. Manufacturer's installation instructions.
- G. Field Quality Control Submittals: Report of field testing for water penetration and air leakage.
- H. Designer's qualification statement.
- I. Manufacturer's qualification statement.
- J. Installer's qualification statement.

1.06 COORDINATION

- A. Register Project with aluminum-framed storefront manufacturer.

1.07 QUALITY ASSURANCE

- A. Qualifications: See Section 01 4000 - Quality Requirements.
- B. Designer Qualifications: Design structural support framing components under direct supervision of a Professional Structural Engineer experienced in design of this Work and licensed in the State in which the Project is located.
- C. Manufacturer Qualifications: Company specializing in performing work of type specified and with at least five years of experience.
 - 1. Provide certified glass products through ANSI accredited certifications that include plant audits and independent laboratory performance testing.
 - a. Insulating Glass Certification Council (IGCC).
 - b. Safety Glazing Certification Council (SGCC).

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

1.08 MOCK-UPS

- A. See Section 014000 - Quality Requirements for additional requirements.
- B. Build mockups to verify selections made under sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.
- C. Locate where directed by Architect.
- D. Mock-up may remain as part of work.

1.09 DELIVERY, STORAGE, AND HANDLING

- A. See Section 01 6000 - Product Requirements.
- B. Deliver materials to Project site in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, approval or listing agency markings, and directions for storing.
- C. Protect materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources. Store in a dry location.
- D. Handle products of this section in accordance with AAMA CW-10.
- E. Protect finished aluminum surfaces with wrapping. Do not use adhesive papers or sprayed coatings that bond to aluminum when exposed to sunlight or weather.
- F. See Section 01 7419 - Construction Waste Management and Disposal, for packaging waste requirements.

1.10 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.

1.11 WARRANTY

- A. See Sections 016000 - Product Requirements and 017800 - Closeout Submittals for additional warranty requirements.
- B. Correct defective Work within a five year period after Date of Substantial Completion.
- C. Provide 10 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 20 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 DELEGATED DESIGN

- A. Delegated Design: See Section 01 3000 - Administrative Requirements.
- B. Engage a qualified professional engineer, as defined in Section 01 4000 - Quality Requirements, to design aluminum-framed storefront assemblies.
- C. Design aluminum-framed systems, including comprehensive engineering analysis by a professional engineer registered in the State of California, using performance requirements and design criteria indicated.

2.02 PERFORMANCE REQUIREMENTS

- A. General Performance: Comply with performance requirements specified, as determined by testing of aluminum-framed storefront systems representing those indicated for this Project without failure due to defective manufacture, fabrication, installation, or other defects in construction.
 - 1. Aluminum-framed entrance and storefront systems to withstand movements of supporting structure, including, but not limited to, twist, column shortening, long-term creep, and deflection from uniformly distributed and concentrated live loads.
 - 2. Failure also includes the following:
 - a. Thermal stresses transferring to building structure.
 - b. Glass breakage.
 - c. Noise or vibration created by wind and thermal and structural movements.
 - d. Loosening or weakening of fasteners, attachments, and other components.
 - e. Failure of operating units.
- B. 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.
 - 1. Design Wind Loads: As shown on the Structural drawings. Comply with requirements of ASCE 7.
 - 2. Member Deflection: Limit member deflection to 1/175 in any direction, with full recovery of glazing materials.
 - 3. Seismic Loads: As indicated on Drawings, in accordance with the CBC.
- C. Water Penetration Resistance on Manufactured Assembly: No uncontrolled water on interior face, when tested in accordance with ASTM E331 at pressure differential of 10 psf.
- D. 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.

2.03 MANUFACTURERS

- A. Aluminum-Framed Storefronts:
 - 1. Arcadia.
 - 2. Commercial Architectural Products.
 - 3. C.R. Laurence.
 - 4. Efco.
 - 5. Kawneer.
 - 6. Manko Window Systems.
 - 7. Oldcastle BuildingEnvelope.
 - 8. Trulite.
 - 9. YKK AP.
 - 10. Substitutions: See Section 01 2500 - Substitution Procedures.

2.04 ALUMINUM-FRAMED STOREFRONT

- A. Aluminum-Framed Storefront: Factory fabricated, factory finished aluminum framing members with infill, and related flashings, anchorage and attachment devices.
 - 1. Basis of Design Product:
 - a. TC470 Arcadia or Equal
 - b. Substitutions: See Section 01 2500 - Substitution Procedures.
 - 2. Construction: Thermally broken.
 - 3. System: Stick system.
 - 4. Glazing: Type GL-1 Exterior and GL-2 Interior Non Rated, GL-3 Interior Rated"

- a. See Section 088000 - Glazing, for additional information.
5. Glazing Position: Front-set.
6. Finish: Superior performing organic coatings compliant with AAMA 2605.
 - a. See Section 050513 - Shop-Applied Coatings for Metal, for additional information.
 - b. Factory finish all surfaces that will be exposed in completed assemblies.
 - c. Touch-up surfaces cut during fabrication so that no natural aluminum is visible in completed assemblies, including joint edges.
7. Finish Color: Custom Color per Plan.
8. 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.
9. 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.
10. 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.
11. Movement: Allow for movement between storefront and adjacent construction, without damage to components or deterioration of seals.
12. Perimeter Clearance: Minimize space between framing members and adjacent construction while allowing expected movement.
13. Maintain continuous air barrier and/or vapor retarder seal throughout assembly, primarily in line with inside pane of glazing and inner sheet of infill panel, and heel bead of glazing compound.

2.05 COMPONENTS

- A. Aluminum Framing Members: Tubular aluminum sections, thermally broken with interior section insulated from exterior, drainage holes and internal weep drainage system.
 1. Glazing Stops: Flush.
- B. Swing Doors: Glazed aluminum.
 1. Manufacturer: Same as aluminum framing system.
 2. Construction: Thermally broken.
 3. Thickness: 1-3/4 inches.
 4. Top Rail: 5 inches wide.
 5. Vertical Stiles: ____ inches wide.
 6. Bottom Rail: 10 inches wide.
 7. Glazing Stops: Square.
 8. Finish: Same as storefront.

2.06 MATERIALS

- A. Extruded Aluminum: ASTM B221 (ASTM B221M).
- B. Structural Steel Sections: ASTM A36/A36M; galvanized in accordance with requirements of ASTM A123/A123M.
 1. Shop prime with products in 051200 - Structural Steel Framing.
- C. Structural Supporting Anchors Attached to Structural Steel: Design for bolted attachment.
- D. Structural Supporting Anchors Attached to Reinforced Concrete Members: Design for welded attachment to weld plates embedded in concrete.
- E. Fasteners: Stainless steel.

- F. Metal Flashing: See 076200 - Sheet Metal Flashing and Trim.
- G. Glazing Sealants: See Section 088000 - Glazing for the following:
 - 1. Weatherseal sealant.
 - 2. Sill sealant.
 - 3. Structural sealant.
- H. Sealant for Setting Thresholds: Non-curing butyl type.
- I. Glazing Accessories: See Section 088000.
- J. Touch-Up Primer for Galvanized Steel Surfaces: SSPC-Paint 20, zinc rich.

2.07 FINISHES

- A. Shop-Applied Coating Finish: See Section 050513 - Shop-Applied Coatings for Metal, for additional information.

2.08 HARDWARE

- A. See Section 087100 - Door Hardware.

2.09 FABRICATION

- A. Form or extrude aluminum shapes before finishing.
- B. Fabricate components that, when assembled, have the following characteristics:
 - 1. Profiles that are sharp, straight, and free of defects or deformations.
 - 2. Accurately fitted joints with ends coped or mitered.
 - 3. Physical and thermal isolation of glazing from framing members.
 - 4. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.
 - 5. Provisions for field replacement of glazing from interior.
 - 6. Fasteners, anchors, and connection devices that are concealed from view to greatest extent possible.
- C. Entrance Door Frames: Reinforce as required to support loads imposed by door operation and for installing entrance door hardware.
- D. Entrance Doors: Reinforce doors as required for installing entrance door hardware.
- E. Entrance Door Hardware Installation: Factory install entrance door hardware to the greatest extent possible. Cut, drill, and tap for factory-installed entrance door hardware before applying finishes.
- F. After fabrication, clearly mark components to identify their locations in Project according to Shop 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. Install hardware using templates provided.
- J. Install glass and infill panels using glazing method required to achieve performance criteria; see Section 088000.
- K. Touch-up minor damage to factory applied finish; replace components that cannot be satisfactorily repaired.

3.03 FIELD QUALITY CONTROL

- A. See Section 01 4000 - Quality Requirements, for additional requirements.
- B. Owner to engage a qualified testing agency to perform tests and inspections.
 - 1. Aluminum-framed storefront assemblies will be considered defective if they do not pass tests and inspections.
 - 2. Additional tests and inspections, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
 - 3. Testing and inspecting agency to prepare reports and deliver to Owner or Contractor.
 - 4. Submit field quality control reports to Architect.
- C. Provide services of storefront manufacturer's field representative to observe for proper installation of system and submit report.
- D. Tests:
 - 1. Provide field testing of installed storefront system in accordance with AAMA 503 during construction process and before installation of interior finishes.
 - a. Perform a minimum of two tests in each designated area as indicated on drawings.
 - b. Conduct tests in each area prior to 10 percent and 50 percent completion of this work.
 - 2. Field test for water penetration in accordance with ASTM E1105 with uniform static air pressure difference (Procedure A) not less than 4.18 psf.
 - a. Maximum allowable rate of water penetration in 15-minute test is 0.5 ounce that is not contained in an area with provisions to drain to exterior, or collected on surface of interior horizontal framing member.
 - 3. Field test for air leakage in accordance with ASTM E783 with uniform static air pressure difference of 1.57 psf.

3.04 ADJUSTING

- A. Adjust operating hardware and sash for smooth operation.

3.05 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, and take care to remove dirt from corners and to wipe surfaces clean.
- C. Upon completion of installation, thoroughly clean aluminum surfaces in accordance with AAMA 609 & 610.

3.06 PROTECTION

- A. Provide barrier or other delineation to prevent damage to installed Work from subsequent construction activities.

END OF SECTION

**SECTION 086223
TUBULAR SKYLIGHTS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Tubular skylights.

1.02 REFERENCE STANDARDS

- A. AAMA/WDMA/CSA 101/I.S.2/A440 - North American Fenestration Standard/Specification for Windows, Doors, and Skylights; 2022, with Errata (2023).
- B. ASCE 7 - Minimum Design Loads and Associated Criteria for Buildings and Other Structures; Most Recent Edition Cited by Referring Code or Reference Standard.
- C. ASTM A240/A240M - Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications; 2024b.
- D. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2023.
- E. ASTM B209/B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2021a.
- F. ASTM D635 - Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position; 2022.
- G. ASTM D1929 - Standard Test Method for Determining Ignition Temperature of Plastics; 2023.
- H. ASTM D2843 - Standard Test Method for Density of Smoke from the Burning or Decomposition of Plastics; 2022.
- I. ASTM D4802 - Standard Specification for Poly(Methyl Methacrylate) Acrylic Plastic Sheet; 2016.
- J. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2024.
- K. ASTM E108 - Standard Test Methods for Fire Tests of Roof Coverings; 2020a.
- L. 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).
- M. ASTM E331 - Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference; 2000 (Reapproved 2023).
- N. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- O. UL 790 - Standard for Standard Test Methods for Fire Tests of Roof Coverings; Current Edition, Including All Revisions.

1.03 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: For each item to be installed.
 - 1. Preparation instructions and recommendations.

2. Storage and handling requirements and recommendations.
3. Installation methods.
4. ICC-ES evaluation report.
- C. Shop Drawings: Indicate configurations, dimensions, locations, fastening methods, and installation details.
 1. Include diagrams for power, signal, and control wiring.
- D. Performance Validation: Provide specified performance validation before submitting shop drawings or starting fabrication.
- E. Test Reports: Independent testing agency reports verifying compliance with specified performance requirements.
- F. Manufacturer's qualification statement.
- G. Installer's qualification statement.
- H. Warranty.

1.04 QUALITY ASSURANCE

- A. Qualifications: See Section 01 4000 - Quality Requirements.
- B. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with not less than ten years documented experience.
- C. Installer Qualifications: Company specializing in performing work of the type specified and with at least three years documented experience and approved by manufacturer.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. See Section 01 6000 - Product Requirements.
- B. Store products in manufacturer's unopened packaging until ready for installation.
- C. Protect materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources. Store in a dry location.
- D. See Section 01 7419 - Construction Waste Management and Disposal, for packaging waste requirements.

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.

1.07 WARRANTY

- A. See Section 017800 - Closeout Submittals for additional warranty requirements.
- B. Manufacturer Warranty: Provide 10-year manufacturer warranty for tubular skylights. Complete forms in Owner's name and register with manufacturer.
- C. Manufacturer Warranty: Provide 3-year manufacturer warranty for electrical parts. Complete forms in Owner's name and register with manufacturer.

PART 2 PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Performance Standard: Comply with AAMA/WDMA/CSA 101/I.S.2/A440 for definitions and minimum standards of performance, materials, components, accessories, and fabrication unless more stringent requirements are indicated.
 - 1. Product Type: Tubular Daylighting Device, Closed Ceiling (TDDCC).
 - 2. Performance Grade (PG): Equivalent to or greater than specified design pressure.
 - 3. Design Pressure (DP): As shown on the Structural drawings.
 - 4. Label Requirements: Certify and label each product with names of manufacturer and labeling agency and AAMA/WDMA/CSA 101/I.S.2/A440 product designation, performance grade, and test specimen size equal to or greater than the size of the product.
- B. Design and size components to withstand dead and live loads caused by positive and negative wind pressure acting normal to plane of tubular skylight without breakage or permanent damage to any parts, when tested in accordance with ASTM E330/E330M.
 - 1. No permanent deflection in excess of 0.2 percent of span.
- C. Air Infiltration: Maximum 0.10 cu ft/min sq ft per unit area of outside frame dimension at 6.27 psf pressure differential when tested in accordance with ASTM E283.
- D. Water Resistance: No uncontrolled water leakage at 6.27 psf pressure differential with water rate of 5 gallons/h/sf, when tested in accordance with ASTM E331; design to ensure that water will not accumulate inside assembly.
- E. Thermal Movement: Fabricate to allow for thermal movement resulting from temperature differential from minus 30 to 180 degrees F.
- F. Flammability: Non-metal parts complying with the following:
 - 1. Roof-Top Components: Class B when tested in accordance with ASTM E108 or UL 790.
 - 2. Self-Ignition Temperature: Greater than 650 degrees F, when tested in accordance with ASTM D1929.
 - 3. Smoke Developed Index: Maximum of 450, when tested in accordance with ASTM E84; or maximum rating of 75, when tested in accordance with ASTM D2843.
- G. Combustibility (ASTM D635):
 - 1. Light Transmitting Parts: Minimum 2.5 inches/min (ICC Class CC-2).
 - 2. Light Transmitting Parts: Burning extent of 1 inch or less (ICC Class CC-1), in the thickness intended for use.
 - 3. Non-Light Transmitting Parts: Minimum 2.5 inches/min (ICC Class CC-2).
- 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.
- I. Fall-Protection Performance: Installed assemblies are capable of safely supporting the greater of 400 lbs or twice the weight of employees, equipment, and materials that may be imposed on any 1 sq. foot of the assembly at any time.

2.02 MANUFACTURERS

- A. Manufacturers:
 - 1. DayLite.
 - 2. Solatube.
 - 3. Sunoptics.
 - 4. Tubular Skylight Inc.
 - 5. Velux America.
 - 6. Substitutions: See Section 01 2500 - Substitution Procedures.

- B. Source Limitations: Furnish products produced by single manufacturer and obtained from single supplier.

2.03 TUBULAR SKYLIGHTS

- A. Tubular Skylights: Transparent roof-mounted skylight dome and curb, reflective tube, and ceiling level diffuser assembly, transferring sunlight to interior spaces.
1. Products:
 - a. Basis of Design - SolaMaster 750 DS-0 or 750DS-C per plan on curb.
 - b. Substitutions: See Section 01 2500 - Substitution Procedures.
 - B. Roof Assemblies: Transparent, UV and impact resistant dome with flashing base supporting dome and top of tube.
 1. Acrylic Glazing: ASTM D4802, thermoformable, monolithic sheet, category as standard with manufacturer, Finish 1 (smooth or polished), Type UVF (formulated with UV absorber); and Class CC2 based on testing in accordance with ASTM D635.
 - a. Color: Colorless, transparent.
 2. Polycarbonate Glazing: Thermoformable, extruded monolithic sheets, UV resistant, burglar-resistance rated in accordance with UL 972; with average impact strength of 12 to 16 ft-lb/in. of width when tested in accordance with ASTM D256, Test Method A (Izod); and Class CC1 based on testing in accordance with ASTM D635.
 - a. Color: As selected by Architect from manufacturer's full range.
 3. Base Material: Sheet steel, galvanized, ASTM A653/A653M, 24 gauge, 0.0239 inch thick, minimum.
 4. Flashing Extensions: Provide manufacturer's standard adaptors or extensions for tile applications and slopes greater than 8:12.
 5. Dome Ring: Attached to top of base section; 0.090 inch nominal thickness injection molded high impact ABS; to prevent thermal bridging between base flashing and tubing and channel condensed moisture out of tubing; weather seal of medium density pile weather stripping.
 - C. Reflective Tube: ASTM B209/B209M aluminum sheet, thickness between 0.015 inch and 0.020 inch.
 1. Interior Finish: Exposed interior surfaces of high reflectance specular finish; specular reflectance of 92, total reflectance 95 percent.
 2. Tube Diameter: As indicated on drawings.
 3. Tube Configuration and Length: As indicated on the drawings.
 - D. Diffuser Assemblies: Supporting light transmitting surface at bottom termination of tube, with compression seal to minimize condensation and bug or dirt infiltration.
 1. Ceiling Ring: Edge trim for ceiling opening; injection molded high impact ABS.
 2. Diffuser Trim: Edge and attachment trim for diffuser lens; injection molded high impact ABS.
 3. Lens: Prismatic lens design to maximize light output and diffusion.
 4. Lens Material: Acrylic plastic.
 5. Visible Light Transmission (VLT): 90 percent, minimum.
 6. Seal: Closed cell EPDM foam rubber.

2.04 ACCESSORIES

- A. Fasteners: Same material as metals being fastened, non-magnetic steel, non-corrosive metal of type recommended by manufacturer, or injection molded nylon.
- B. Sealant: Elastomeric, silicone or polyurethane; compatible with materials being sealed.
- C. Security Bars: Manufacturer's standard ASTM A240/A240M 0.375 inch Type 304 stainless steel bar across flashing diameter opening.

- D. Daylight Dimmer: Electro-mechanically actuated daylight valve; for universal input voltages ranging between 90 and 277 V at 50 or 60 Hz; actuator rated at 0.1 amp per unit; controlled by low voltage, series circuited, 4 conductor, size 22 cable, and low voltage DC DP/DT switch; providing daylight output between 2 and 100 percent.

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.

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. Install in accordance with manufacturer's written instructions.
- B. Set roof assembly flashing in continuous bead of sealant.
- C. Seal joints exposed to weather in accordance with sealant manufacturer's written instructions.
- D. Conduct field test for water tightness; conduct water test in presence of Architect. Correct defective work and re-test until satisfactory.

3.04 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

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SECTION 08 71 00
DOOR HARDWARE

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Door hardware
 - 2. Storefront and entrance door hardware.
- B. Related Divisions:
 - 1. Division 08 – door hardware installation
 - 2. Division 07 – sealant at exterior thresholds
 - 3. Division 08 – metal doors and frames, interior aluminum frames, wood doors, integrated security systems, specialty doors, storefront and glazed curtainwall systems.
 - 4. Division 21 – fire and life safety systems
 - 5. Division 28 – security access systems
- C. Specific Omissions: Hardware for the following is specified or indicated elsewhere.
 - 1. Windows.
 - 2. Cabinets, including open wall shelving and locks.
 - 3. Signs, except where scheduled.
 - 4. Toilet accessories, including grab bars.
 - 5. Installation.
 - 6. Rough hardware.
 - 7. Conduit, junction boxes & wiring.

1.2 REFERENCES:

- A. Use date of standard in effect as of Bid date.
 - 1. American National Standards Institute
 - a) ANSI 156.18 – Materials and Finishes.
 - b) ICC/ANSI A117.1 - 1998 – Specifications for making buildings and facilities usable by physically handicapped people. [omit for CA work – not applicable]
 - 2. BHMA – Builders Hardware Manufacturers Association
 - 3. 2022 California Building Code
 - a) Chapter 11B – Accessibility To Public Buildings, Public Accommodations, Commercial Buildings and Public Housing
 - 4. DHI – Door and Hardware Institute
 - 5. NFPA – National Fire Protection Association
 - a) NFPA 80 2022 Edition – Standard for Fire Doors and Other Opening Protectives.
 - b) NFPA 105 – Smoke and Draft Control Door Assemblies
 - c) NFPA 252 – Fire Tests of Door Assemblies
 - 6. UL – Underwriters Laboratories

- a) UL10C – Positive Pressure Fire Tests of Door Assemblies.
 - b) UL 305 – Panic Hardware
- 7. WHI – Warnock Hersey Incorporated State of California Building Code
- 8. Local applicable codes
- 9. SDI – Steel Door Institute
- 10. WI – Woodwork Institute
- 11. AWI – Architectural Woodwork Institute
- 12. NAAMM – National Association of Architectural Metal Manufacturers
- B. Abbreviations
 - 1. Manufacturers: see table at 2.1.A of this section
 - 2. Finishes: see 2.7 of this section.

1.3 SUBMITTALS & SUBSTITUTIONS

- A. SUBMITTALS: Submit six copies of schedule per D. Only submittals printed one sided will be accepted and reviewed. Organize vertically formatted schedule into “Hardware Sets” with index of doors and headings, indicating complete designations of every item required for each door or opening. Minimum 10pt font size. Include following information:
 - 1. Type, style, function, size, quantity and finish of hardware items.
 - 2. Use BHMA Finish codes per ANSI A156.18.
 - 3. Name, part number and manufacturer of each item.
 - 4. Fastenings and other pertinent information.
 - 5. Location of hardware set coordinated with floor plans and door schedule.
 - 6. Explanation of abbreviations, symbols, and codes contained in schedule.
 - 7. Mounting locations for hardware.
 - 8. Door and frame sizes, materials and degrees of swing.
 - 9. List of manufacturers used and their nearest representative with address and phone number.
 - 10. Catalog cuts.
- B. Bid and submit manufacturer’s updated/improved item if scheduled item is discontinued.
- C. Deviations: Highlight, encircle or otherwise identify deviations from “Schedule of Finish Hardware” on submittal with notations clearly designating those portions as deviating from this section.
- D. If discrepancy between drawings and scheduled material in this section, bid the more expensive of the two choices, note the discrepancy in the submittal and request direction from Architect for resolution.
- E. Substitutions per Division 1. Include product data and indicate benefit to the Project. Furnish operating samples on request.
- F. Furnish as-built/as-installed schedule with closeout documents, including keying schedule, riser and point-to-point wiring diagrams, manufacturers’ installation, adjustment and maintenance information, and supplier’s final inspection report.

1.4 QUALITY ASSURANCE:

- A. Qualifications:

1. Hardware supplier: direct factory contract supplier who employs a certified architectural hardware consultant (AHC), available at reasonable times during course of work for project hardware consultation to Owner, Architect and Contractor.
 - a) Responsible for detailing, scheduling and ordering of finish hardware. Detailing implies that the submitted schedule of hardware is correct and complete for the intended function and performance of the openings.
- B. Hardware: Free of defects, blemishes and excessive play. Obtain each kind of hardware (latch and locksets, exit devices, hinges and closers) from one manufacturer.
- C. Exit Doors: Operable from inside with single motion without the use of a key or special knowledge or effort.
- D. Fire-Rated Openings: NFPA 80 compliant. Hardware UL10C (positive pressure) compliant for given type/size opening and degree of label. Provide proper latching hardware, non-flaming door closers, approved-bearing hinges, and resilient seals. Coordinate with wood door section for required intumescent seals. Furnish openings complete.
- E. Furnish hardware items required to complete the work in accordance with specified performance level and design intent, complying with manufacturers' instructions and code requirements.
- F. Pre-Installation Meetings: Initiate and conduct with supplier, installer and related trades, coordinate materials and techniques, and sequence complex hardware items and systems installation. Include manufacturers' representatives of locks, panic hardware and door closers in the meetings. Convene prior to commencement of related work.

1.5 DELIVERY, STORAGE AND HANDLING:

- A. Delivery: coordinate delivery to appropriate locations (shop or field).
 1. Permanent keys and cores: secured delivery direct to Owner's representative.
- B. Acceptance at Site: Items individually packaged in manufacturers' original containers, complete with proper fasteners and related pieces. Clearly mark packages to indicate contents, locations in hardware schedule and door numbers.
- C. Storage: Provide securely locked storage area for hardware, protect from moisture, sunlight, paint, chemicals, dust, excessive heat and cold, etc.

1.6 PROJECT CONDITIONS AND COORDINATION:

- A. Where exact types of hardware specified are not adaptable to finished shape or size of members requiring hardware, provide suitable types having as nearly as practical the same operation and quality as type specified, subject to Architect's approval.

- B. Coordination: Coordinate hardware with other work. Furnish hardware items of proper design for use on doors and frames of the thickness, profile, swing, security and similar requirements indicated, as necessary for proper installation and function, regardless of omissions or conflicts in the information on the Contract Documents. Furnish related trades with the following information:
 - 1. Location of embedded and attached items to concrete.
 - 2. Location of wall-mounted hardware, including wall stops.
 - 3. Location of finish floor materials and floor-mounted hardware.
 - 4. At masonry construction, coordinate with the anchoring and hollow metal supplier prior to frame installation by placing a strip of insulation, wood, or foam, on the back of the hollow metal frame behind the rabbet section for continuous hinges, as well as at rim panic hardware strike locations, silencers, coordinators, and door closer arm locations. When the frame is grouted in place, the backing will allow drilling and tapping without dulling or breaking the installer's bits.
- C. Check Shop Drawings for doors and entrances to confirm that adequate provisions will be made for proper hardware installation.
- D. Environmental considerations: segregate unused recyclable paper and paper product packaging, uninstalled metals, and plastics, and have these sent to a recycling center.
- E. Prior to submittal, carefully inspect existing conditions to verify finish hardware required to complete Work, including sizes, quantities, existing hardware scheduled for re-use, and sill condition material. If conflict between the specified/scheduled hardware and existing conditions, submit request for direction from Architect. Include date of jobsite visit in the submittal.
 - 1. Submittals prepared without thorough jobsite visit by qualified hardware expert will be rejected as non-compliant.

1.7 WARRANTY:

- A. Part of respective manufacturers' regular terms of sale. Provide manufacturers' written warranties.
- B. Include factory order numbers with close-out documents
- C. Minimum warranties:

1.	Locksets:	Three years
2.	Extra Heavy Duty Cylindrical Lock:	Seven Years
3.	Exit Devices:	Three years mechanical One year electrical
4.	Closers:	Thirty years mechanical Two years electrical
5.	Hinges:	One year
6.	Other Hardware	Two years

1.8 COMMISSIONING:

- A. Conduct these tests prior to request for certificate of substantial completion:
 - 1. With installer present, test door hardware operation with climate control system and stairwell pressurization system both at rest and while in full operation.
 - 2. With installer, access control contractor and electrical contractor present, test electrical, electronic and electro-pneumatic hardware systems for satisfactory operation.
 - 3. With installer and electrical contractor present, test hardware interfaced with fire/life-safety system for proper operation and release.

1.9 REGULATORY REQUIREMENTS:

- A. Locate latching hardware between 34 inches to 44 inches above the finished floor, per 2022 California Building Code, Section 11B-404.2.7.
 - 1. Panic hardware: locate between 36 inches to 44 inches above the finished floor.
- B. Handles, pull, latches, locks, other operable parts:
 - 1. Readily openable from egress side with one hand and without tight grasping, tight pinching, or twisting of the wrist to operate. 2022 California Building Code Section 11B-309.4.
 - 2. Force required to activate the operable parts: 5.0 pounds maximum, per 2022 California Building Code Section 11B-309.4.
- C. Adjust doors to open with not more than 5.0-pounds pressure to open at exterior doors and 5.0-pounds at interior doors. As allowed per 2022 California Building Code Section 11B-404.2.9, local authority may increase the allowable pressure for fire doors to achieve positive latching, but not to exceed 15-pounds.
 - 1. Exception: exterior doors' pressure-to-open may be increased to 8.5-pounds if: at a single location, and one of a bank of eight leafs or fraction of eight, and one leaf of this bank is fitted with a low- or high-energy operator.
- D. Low-energy powered doors: comply with ANSI/BHMA A156.19. Reference: 2022 California Building Code Section 11B-404.2.9, Exception 2.
 - 1. Where powered door serves an occupancy of 100 or more, provide back-up battery power or stand-by generator power, capable of supporting a minimum of 100 cycles.

2. Actuators, vertical bar type: minimum 2-inches wide, 30-inches high, bottom located minimum 5-inches above floor or ground, top located minimum 35-inches above floor or ground. Displays International Symbol of Accessibility, per 2022 California Building Code Section 11B-703.7.
 3. Actuators, plate type: use two at each side of the opening. Minimum 4-inches diameter or 4-inches square. Displays International Symbol of Accessibility, per 2022 California Building Code Section 11B-703.7. Locate centerline of lower plate between 7- and 8-inches above floor or ground, and upper plate between 30- and 44-inches above floor or ground.
 4. Actuator location: conspicuously located, clear and level floor/ground space for forward or parallel approach.
- E. Adjust door closer sweep periods so that from an open position of 90 degrees, the door will take at least 5 seconds to move to a point 12 degrees from the latch, measured to the landing side of the door, per 2022 California Building Code Section 11B-404.2.7.
1. Spring hinges: adjust for 1.5 seconds minimum for 70 degrees to fully-closed.
- F. Smooth surfaces at bottom 10 inches of push sides of doors, facilitating push-open with wheelchair footrests, per 2022 California Building Code Section 11B-404.2.10.
2. Applied kickplates and armor plates: bevel the left and right edges; free of sharp or abrasive edges.
 3. Tempered glass doors without stiles: bottom rail may be less than 10 inches if top leading edge is tapered 60 degrees minimum.
- G. Door opening clear width no less than 32 inches, measured from face of frame stop, or edge of inactive leaf of pair of doors, to door face with door opened to 90 degrees. Hardware projection not a factor in clear width if located above 30 inches and below 80 inches, and the hardware projects no more than 4 inches. 2022 California Building Code Section 11B-404.2.3.
4. Exception: doors not requiring full passage through the opening, that is, to spaces less than 24 inches in depth, may have the clear opening width reduced to 20 inches. Example: shallow closets.
 5. Door closers and overhead stops: not less than 78 inches above the finished floor or ground, per 2022 California Building Code 11B-307.4.
- H. Thresholds: floor or landing no more than 0.50 inches below the top of the threshold of the doorway, per 2022 California Building Code Section 11B-404.2.5. Vertical rise no more than 0.25 inches, change in level between 0.25 inches and 0.50 inches: beveled to slope no greater than 1:2 (50 percent slope). 2022 California Building Code Section 11B-303.2 & ~.3.
- I. Floor stops: Do not locate in path of travel. Locate no more than 4 inches from walls, per DSA Policy #99-08 (Access).
- J. Pairs of doors with independently-activated hardware both leafs: limit swing of right-hand or right-hand-reverse leaf to 90 degrees to protect persons reading wall-mounted tactile signage, per 2022 California Building Code Section 11B-703.4.2.

- K. Door and door hardware encroachment: when door is swung fully-open into means-of-egress path, the door may not encroach/project more than 7 inches into the required exit width, with the exception of door release hardware such as lockset levers or panic hardware. These hardware items must be located no less than 34-inches and no more than 48-inches above the floor/ground. 2022 California Building Code, Section 1005.7.1.
1. In I-2 occupancies, latch release hardware is not permitted to project in the required exit width, regardless of its mounting height, per 2022 California Building Code, Section 1005.7.1 at Exception 1.

PART 2 PRODUCTS

2.1 MANUFACTURERS:

- A. Listed acceptable alternate manufacturers: these will be considered; submit for review products with equivalent function and features of scheduled products.

ITEM:	MANUFACTURER:	ACCEPTABLE ALTERNATE:
Hinges	(IVE) Ives	Bommer
Continuous Hinges	(IVE) Ives	Select
Pivots	(IVE) Ives	Rixson
Key System	(MED) Medeco	Owner standard
Mechanical Locks	(YAL) Yales	Owner standard
Exit Devices	(VON) Von Duprin	Owner standard
Closers	(LCN) LCN	Owner standard
Auto Flush Bolts	(TRM) Trimco	DCI, Ives
Coordinators	(TRM) Trimco	DCI, Ives
Silencers	(TRM) Trimco	Ives, ABH
Push & Pull Plates	(TRM) Trimco	Ives, ABH
Kickplates	(TRM) Trimco	Ives, ABH
Stops & Holders	(TRM) Trimco	Ives, ABH
Overhead Stops	(GLY) Glynn-Johnson	ABH
Thresholds	(ZER) Zero	NGP, Reese
Seals & Bottoms	(ZER) Zero	NGP, Reese
Key Cabinets	(LUN) Lund	TelKee
Aluminum Door Locks	(ADA) Adams Rite	None

A. Manufacturers and their abbreviations used in this schedule:

ADA	Adams Rite
BES	Best Locking Systems
C/R	Corbin Russwin
CUR	Curran Engineering Company of Van Nuys, CA
DHS	Door & Hardware Systems, Inc.
DOR	Dor-O-Matic
DRM	Dorma
FAL	Falcon
FOR	Forms and Surfaces
GLY	Glynn-Johnson Hardware
HAF	Hafele
HAG	Hager Hinge Co
HEN	Henderson
IVE	H. B. Ives
KEE	Keedex
KNC	K. N. Crowder
LCN	LCN Closers
LUN	Lund
MAR	Markar
MED	Medeco
MON	Monarch
NGP	National Guard Products
NOR	Norton
PEM	Pemko
PRE	Precision
REE	Reese
RIC	Richards-Wilcox
RIX	Rixson
SAR	Sargent
SBH	Specialized Builders Hardware
SCE	Schlage Electronics
SCH	Schlage Lock Company
SEL	Select
TRI	Trimco Manufacturing
VON	Von Duprin
YAL	Yale
ZER	Zero International

2.2 HINGING METHODS:

- A. Drawings typically depict doors at 90 degrees, doors will actually swing to maximum allowable. Use wide-throw conventional or continuous hinges as needed up to 8 inches in width to allow door to stand parallel to wall for true 180-degree opening. Advise architect if 8-inch width is insufficient.
- B. Conform to manufacturer's published hinge selection standard for door dimensions, weight and frequency, and to hinge selection as scheduled. Where manufacturer's standard exceeds the scheduled product, furnish the heavier of the two choices, notify Architect of deviation from scheduled hardware.

- C. Conventional Hinges: Steel or stainless steel pins and approved bearings. Hinge open widths minimum, but of sufficient throw to permit maximum door swing.
 - 1. Outswinging exterior doors: non-ferrous with non-removable (NRP) pins and security studs.
 - 2. Non-ferrous material exteriors and at doors subject to corrosive atmospheric conditions.
- D. Continuous Hinges:
 - 1. Geared-type aluminum.
 - a) Use wide-throw units where needed for maximum degree of swing, advise architect if commonly available hinges are insufficient.
 - b) If units are used at storefront openings, color-coordinate hinge finish with storefront color. Custom anodizing and custom powdercoat finishes subject to Architect approval.
 - 2. Pinned steel/stainless steel type: continuous stainless steel, 0.25-inch diameter stainless-steel hinge pin.
 - a) Use engineered application-specific wide-throw units as needed to provide maximum swing degree of swing, advise architect if required width exceeds 8 inches.
- E. Pivots: high-strength forged bronze or stainless steel, tilt-on precision bearing and bearing pin.
 - 1. Bottom and intermediate pivots: adjustability of minus 0.063 inch, plus 0.125 inch.
- F. Floor Closers: hydraulically controlled, cement case, maximum degree dead stop permitted by trim or adjacent structure. Special pins, floor pans and longer spindles when needed to accommodate floor and jamb conditions.

2.3 LOCKSETS, LATCHSETS, DEADBOLTS:

- A. Mortise Locksets and Latchsets: as scheduled.
 - 1. Chassis: cold-rolled steel, handing field-changeable without disassembly.
 - 2. Universal lock case – 10 functions in one case.
 - 3. Floating mounting tabs automatically adjusts to fit a beveled door edge.
 - 4. Latchbolts: 0.75 inch throw stainless steel anti-friction type.
 - 5. Lever Trim: through-bolted, accessible design, cast lever or solid extruded bar type levers as scheduled. Filled hollow tube design unacceptable.
 - a) Spindles: security design independent breakaway. Breakage of outside lever does not allow access to inside lever's hubworks to gain wrongful entry.
 - b) Inside lever applied by screwless shank mounting – no exposed trim mount screws.
 - c) Levers rotate up or down for ease of use.
 - d) Vandalgard locks: locked lever freely rotates down while remaining securely locked. This feature prevents damage to internal lock components when subjected to excessive force.

6. Furnish solid cylinder collars with wave springs. Wall of collar to cover rim of mortise cylinder.
 7. Turnpieces: accessible offset turn-lever design not requiring pinching or twisting motions to operate.
 8. Deadbolts: stainless steel 1-inch throw.
 9. Electric operation: Manufacturer-installed continuous duty solenoid.
 10. Strikes: 16 gage curved steel, bronze or brass with 1 inch deep box construction, lips of sufficient length to clear trim and protect clothing.
 11. Scheduled Lock Series and Design: Yales 5400LN series
 12. Certifications:
 - a) ANSI A156.13, 1994, Grade 1 Operational, Grade 1 Security.
 - b) ANSI/ASTM F476-84 Grade 31 UL Listed.
 13. Accessibility: Require not more than 5 lb to retract the latchbolt or deadbolt, or both, per CBC 2022 11B-404.2.7 and 11B-309.4.
- B. Extra Heavy Duty Cylindrical Locks and Latches: as scheduled.
1. Chassis: cylindrical design, corrosion-resistant plated cold-rolled steel, through-bolted.
 2. Locking Spindle: stainless steel, integrated spring and spindle design.
 3. Latch Retractors: forged steel. Balance of inner parts: corrosion-resistant plated steel, or stainless steel.
 4. Latchbolt: solid steel.
 5. Backset: 2.75 inches typically, more or less as needed to accommodate frame, door or other hardware.
 6. Lever Trim: accessible design, independent operation, spring-cage supported, minimum 2.00 inches clearance from lever mid-point to door face.
 7. Electric operation: Manufacturer-installed continuous duty solenoid.
 8. Strikes: 16 gage curved steel, bronze or brass with 1.00 inch deep box construction, lips of sufficient length to clear trim and protect clothing.
 9. Lock Series and Design: Yales AU series, "LN" design.
 10. Certifications:
 - a) ANSI A156.2, 1994, Series 4000, Grade 1.
 - b) UL listed for A label and lesser class single doors up to 4 feet x 8 feet.
 11. Accessibility: Require not more than 5 lb to retract the latchbolt or deadbolt, or both, per CBC 2022 11B-404.2.7 and 11B-309.4

2.4 EXIT DEVICES / PANIC HARDWARE

- A. General features:
1. Independent lab-tested 1,000,000 cycles.
 2. Push-through push-pad design. No exposed push-pad fasteners, no exposed cavities when operated. Return stroke fluid dampeners and rubber bottoming dampeners, plus anti-rattle devices.
 3. Deadlocking latchbolts, 0.75 inch projection.
 4. End caps: impact-resistant, flush-mounted. No raised edges or lips to catch carts or other equipment.
 5. No exposed screws to show through glass doors.
 6. Non-handed basic device design with center case interchangeable with all functions, no extra parts required to effect change of function.

7. Releasable in normal operation with 15-pound maximum operating force per UBC Standard 10-4, and with 32-pound maximum pressure under 250-pound load to the door.
8. Exterior doors scheduled with XP-series devices: Static load force resistance of at least 2000 pounds.
9. Accessibility: Require not more than 5 lb to retract the latchbolt, per CBC 2022 11B-404.2.7 and 11B-309.4.
 - a) Mechanical method: Von Duprin "AX-" feature, where touchpad directly retracts the latchbolt with 5 lb or less of force.
 - b) Electrical method: Von Duprin's "RX-QEL-", where lightly pressing the touchpad with 5 lb or less of force closes an electric switch, activating quiet electric latch retraction.

B. Specific features:

1. Non-Fire Rated Devices: cylinder dogging.
2. Lever Trim: breakaway type, forged brass or bronze escutcheon min. 0.130 inch thickness, compression spring drive, match lockset lever design.
3. Rod and latch guards with sloped full-width kickplates for doors fitted with surface vertical rod devices with bottom latches.
4. Fire-Labeled Devices: UL label indicating "Fire Exit Hardware". Vertical rod devices less bottom rod (LBR) unless otherwise scheduled.
5. Inpact recessed devices: 1.25 inch projection when push-pad is depressed. Sloped metal end caps to deflect carts, etc. No pinch points to catch skin between touchbar and door.
6. Delayed Egress Devices: Function achieved within single exit device component, including latch, delayed locking device, request-to-exit switch, nuisance alarm, remote alarm, key switch, indicator lamp, relay, internal horn, door position input, external inhibit input plus fire alarm input. NFPA 101 "Special Locking Arrangement" compliant.
7. Electrically Operated Devices: Single manufacturer source for electric latch retraction devices, electrically controlled trim, power transfers, power supplies, monitoring switches and controls.
8. Removable Mullions: Removable with single turn of building key. Securely reinstalled without need for key. Furnish storage brackets for securely stowing the mullion away from the door when removed.
9. VON DUPRIN 98 series

C. Surface Closers: [4041]

1. Full rack-and-pinion type cylinder with removable non-ferrous cover and cast iron body. Double heat-treated pinion shaft, single piece forged piston, chrome-silicon steel spring.
2. ISO 2000 certified. Units stamped with date-of-manufacture code.
3. Independent lab-tested 10,000,000 cycles.
4. Non-sized, non-handed, and adjustable. Place closer inside building, stairs, and rooms.
5. Plates, brackets and special templating when needed for interface with particular header, door and wall conditions and neighboring hardware.
6. Adjust doors to open with not more than 5.0-pounds pressure to open at exterior doors and 5.0-pounds at interior doors. As allowed per 2019 California Building Code Section 11B-404.2.9, local authority may increase the allowable pressure for fire doors to achieve positive latching, but not to exceed 15-pounds.

- a) Exception: exterior doors' pressure-to-open may be increased to 8.5-pounds if: at a single location, and one of a bank of eight leaves or fraction of eight, and one leaf of this bank is fitted with a low- or high-energy operator.
- 7. Separate adjusting valves for closing speed, latching speed and backcheck, fourth valve for delayed action where scheduled.
- 8. Extra-duty arms (EDA) at exterior doors scheduled with parallel arm units.
- 9. Exterior door closers: tested to 100 hours of ASTM B117 salt spray test, furnish data on request.
- 10. Exterior doors: seasonal adjustments not required for temperatures from 120 degrees F to -30 degrees F, furnish checking fluid data on request.
- 11. Non-flaming fluid, will not fuel door or floor covering fires.
- 12. Pressure Relief Valves (PRV) not permitted.

2.7 OTHER HARDWARE

- A. Automatic Flush Bolts: Low operating force design.
- B. Overhead Stops: Non-plastic mechanisms and finished metal end caps. Field-changeable hold-open, friction and stop-only functions.
- C. Kick Plates: Four beveled edges, .050 inches minimum thickness, height and width as scheduled. Sheet-metal screws of bronze or stainless steel to match other hardware.
- D. Door Stops: Provide stops to protect walls, casework or other hardware.
 - 1. Unless otherwise noted in Hardware Sets, provide floor type with appropriate fasteners. Where floor type cannot be used, provide wall type. If neither can be used, provide overhead type.
 - 2. Locate overhead stops for maximum possible opening. Consult with Owner for furniture locations. Minimum: 90deg stop / 95deg deadstop. Note degree of opening in submittal.
- E. Automatic door bottoms: low operating force units. Doors with automatic door bottoms plus head and jamb seals cannot require more than two pounds operating force to open when closer is disconnected.
 - 1. Include automatic type door bottoms, as opposed to fixed sweeps, at stairs and elevator lobbies to allow fine-tuning of pressurization systems.
- F. Thresholds: As scheduled and per details. Comply with CBC 2022 11B-404.2.5. Substitute products: certify that the products equal or exceed specified material's thickness. Proposed substitutions: submit for approval.
 - 2. Saddle thresholds: 0.125 inches minimum thickness.
 - 3. Exteriors: Seal perimeter to exclude water and vermin. Use sealant complying with requirements in Division 7 "Thermal and Moisture Protection". Minimum 0.25 inch diameter fasteners and lead expansion shield anchors, or Red-Head #SFS-1420 (or approved equivalent) Flat Head Sleeve Anchors. National Guard Products' "COMBO" or Pemko Manufacturing's "FHSL".

4. Fire-rated openings, 90-minutes or less duration: use thresholds to interrupt floor covering material under the door where that material has a critical radiant flux value less than 0.22 watts per square centimeter, per NFPA 253. Use threshold unit as scheduled. If none scheduled, include a 0.25in high 5in wide saddle in the bid, and request direction from Architect.
 5. Fire-rated openings, 3-hour duration: Thresholds, where scheduled, to extend full jamb depth.
 6. Acoustic openings: Set units in full bed of Division-7-compliant, leave no air space between threshold and substrate.
 7. Plastic plugs with wood or sheet metal screws are not an acceptable substitute for specified fastening methods.
 8. Fasteners: Generally, exposed screws to be Phillips or Robertson drive. Pinned TORX drive at high security areas. Flat head sleeve anchors (FHSL) may be slotted drive. Sheet metal and wood screws: full-thread. Sleeve nuts: full length to prevent door compression.
- G. Through-bolts: Do not use. Coordinate with wood doors; ensure provision of proper blocking to support wood screws for mounting panic hardware and door closers. Coordinate with metal doors and frames; ensure provision of proper reinforcement to support machine screws for mounting panic hardware and door closers.
1. Exception: surface-mounted overhead stops, holders, and friction stays.
- H. Silencers: Interior hollow metal frames, 3 for single doors, 4 for pairs of doors. Leave no unfilled/uncovered pre-punched silencer holes. Intent: door bears against silencers, seals make minimal contact with minimal compression – only enough to effect a seal.

2.8 FINISH:

- A. Generally: BHMA 626 Satin Chromium
1. Areas using BHMA 626: furnish push-plates, pulls and protection plates of BHMA 630, Satin Stainless Steel, unless otherwise scheduled.
- B. Door closers: factory powder coated to match other hardware, unless otherwise noted.
1. Provide satin-chrome plated arms, tracks and covers where scheduled bright metallic powder coat (MTLPC) not available.
- C. Finish designators used in appended hardware schedule:

2.9 KEYING REQUIREMENTS:

- A. Key System: existing Medeco system. Initiate and conduct meeting(s) with Owner to determine system structure, furnish Owner's written approval of the system; do not order keys or cylinders without written confirmation of actual requirements from the Owner. Furnish temporary construction-keyed and permanent cylinders. Contractor to demonstrate to the Owner that temporary keys no longer operate the locking cylinders at the end of the project.
- B. Contact the District Locksmith with Fullerton Joint Union High School District for keying requirements. Keying system shall be coordinated with the District and approved by District's representative in writing. Where interchangeable core systems are used, provide temporary cores for construction keying.

- C. Key system shall be Medeco, M3 key system, LFIC cylinder.
- D. Initiate and conduct meeting with the owner to determine system keyway, keybow style, structure, Furnish District's written approval of the system.
- E. For protection of the District, key cylinders at the factory of the cylinder manufacturer where permanent records are maintained. Permanently inscribe each key with number that identifies cylinder manufacturer key symbol, and notation "DO NOT DUPLICATE".
- F. Permanent keys and cylinder cores shall be delivered only to District's representative. Permanent cores to be installed by the District and removed construction cores will be returned to the Hardware Supplier for credit.
- G. Keying Schedule: Submit three copies of separate detailed schedule indicating clearly how the District's final instructions on keying of lock have been fulfilled.

PART 3 - EXECUTION

3.1 ACCEPTABLE INSTALLERS:

- A. Can read and understand manufacturers' templates, suppliers' hardware schedule and printed installation instructions. Can readily distinguish drywall screws from manufacturers' furnished fasteners. Available to meet with manufacturers' representatives and related trades to discuss installation of hardware.

3.2 PREPARATION:

- A. Ensure that walls and frames are square and plumb before hardware installation. Make corrections before commencing hardware installation. Installation denotes acceptance of wall/frame condition.
- A. Locate hardware per SDI-100 and applicable building, fire, life-safety, accessibility, and security codes.
 - 1. Notify Architect of code conflicts before ordering material.
 - 1. Locate latching hardware between 34 inches to 44 inches above the finished floor, per California Building Code 2022, Section 1008.1.9.2 and 11B-404.2.7.
 - 2. Locate panic hardware between 36 inches to 44 inches above the finished floor.
 - 3. Where new hardware is to be installed near existing doors/hardware scheduled to remain, match locations of existing hardware.
- B. Overhead stops: before installing, determine proposed locations of furniture items, fixtures, and other items to be protected by the overhead stop's action.
- C. Existing frames and doors to be retrofitted with new hardware:
 - 1. Field-verify conditions and dimensions prior to ordering hardware. Fill existing hardware cut outs not being reused by the new hardware. Remove existing hardware not being reused, return to Owner unless directed otherwise.
 - 2. Remove existing floor closers not scheduled for reuse, fill cavities with non-shrinking concrete and finish smooth.

3. Cut and weld existing steel frames currently prepared with 2.25 inch height strikes. Cut an approximate 8 inch section from the strike jamb and weld in a reinforced section to accommodate specified hardware's strike.
4. Patch and weld flush filler pieces into existing door hardware preparations in steel doors and frames, leave surfaces smooth.
5. Glue in solid wood block fillers to fill cut outs in existing wood doors, sand surfaces smooth. Alternatively, use an approved epoxy-based wood filler product, submit product data for approval.

3.3 INSTALLATION

- A. Install hardware per manufacturer's instructions and recommendations. Do not install surface-mounted items until finishes have been completed on substrate. Set units level, plumb and true to line and location. Adjust and reinforce attachment substrate for proper installation and operation. Remove and reinstall or replace work deemed defective by Architect.
 1. Gaskets: install jamb-applied gaskets before closers, overhead stops, rim strikes, etc; fasten hardware over and through these seals. Install sweeps across bottoms of doors before astragals, cope sweeps around bottom pivots, trim astragals to tops of sweeps.
 2. When hardware is to be attached to existing metal surface and insufficient reinforcement exists, use RivNuts, NutSerts or similar anchoring device for screws.
 3. Use manufacturers' fasteners furnished with hardware items, or submit Request for Substitution with Architect.
 4. Replace fasteners damaged by power-driven tools.
- B. Locate floor stops no more that 4 inches from walls and not within paths of travel. See paragraph 2.2 regarding hinge widths, door should be well clear of point of wall reveal. Point of door contact no closer to the hinge edge than half the door width. Where situation is questionable or difficult, contact Architect for direction.
- C. Core concrete for exterior door stop anchors. Set anchors in approved non-shrink grout.
- D. Locate overhead stops for minimum 90 degrees at rest and for maximum allowable degree of swing.
- E. Drill pilot holes for fasteners in wood doors and/or frames.
- F. Lubricate and adjust existing hardware scheduled to remain. Carefully remove and give to Owner items not scheduled for reuse.
- G. Field-verify existing conditions and measurements prior to ordering hardware. Fill existing hardware cut outs not being used by the new hardware.
- H. Remove existing hardware not being reused. Tag and bag removed hardware, turn over to Owner.
- I. Where existing wall conditions will not allow door to swing using the scheduled hinges, provide wide-throw hinges and if needed, extended arms on closers.
- J. Provide manufacturer's recommended brackets to accommodate the mounting of closers on doors with flush transoms.

3.4. ADJUSTING

- A. Adjust and check for proper operation and function. Replace units, which cannot be adjusted to operate freely and smoothly.
 - 1. Hardware damaged by improper installation or adjustment methods: repair or replace to Owner's satisfaction.
 - 2. Adjust doors to fully latch with no more than 1 pound of pressure.
 - a) Door closer valves: turn valves clockwise until at bottom – do not force. Turn valves back out one and one-half turns and begin adjustment process from that point. Do not force valves beyond three full turns counterclockwise.
 - 3. Adjust delayed-action closers on fire-rated doors to fully close from fully-opened position in no more than 10 seconds.
 - 4. Adjust door closers per 1.9 this section.
- B. Inspection of fire door assemblies and means-of-egress panic-hardware doors: Per 2016 NFPA-80 5.2.1: hire an independent third-party inspection service to prepare a report listing these doors, and include a statement that there are zero deficiencies with the fire-rated assemblies and the openings with panic hardware.
- C. Fire-rated doors:
 - 1. Wood doors: adjust to 0.125 inches clearance at heads, jambs, and meeting stiles.
 - 2. Steel doors: adjust to 0.063 inches minimum to 0.188 inches maximum clearance at heads, jambs, and meeting stiles.
 - 3. Adjust wood and steel doors to 0.75 inches maximum clearance (undercut) above threshold or finish floor material under door.
- D. Final inspection: Installer to provide letter to Owner that upon completion installer has visited the Project and has accomplished the following:
 - 1. Has re-adjusted hardware.
 - 2. Has evaluated maintenance procedures and recommend changes or additions, and instructed Owner's personnel.
 - 3. Has identified items that have deteriorated or failed.
 - 4. Has submitted written report identifying problems.

3.5 DEMONSTRATION:

- A. Demonstrate mechanical hardware and electrical, electronic and pneumatic hardware systems, including adjustment and maintenance procedures.

3.6 PROTECTION/CLEANING:

- A. Cover installed hardware, protect from paint, cleaning agents, weathering, carts/barrows, etc. Remove covering materials and clean hardware just prior to substantial completion.
- B. Clean adjacent wall, frame and door surfaces soiled from installation / reinstallation process.

3.7 SCHEDULE OF FINISH HARDWARE

- A. See door schedule in drawings for hardware set assignments.

- B. Do not order material until submittal has been reviewed, stamped, and signed by Architect's door hardware consultant.

Note: include "Maintenance Materials" set at end of hardware sets, include:

- As-built hardware schedule
- Copies of warranty information for each hardware type
 - Include a requirement for factory order numbers, needed by Owner if claim needs to be made.
- Binder of catalog cuts or complete catalog sections of items used, installation and maintenance/adjustment information.
- Collection of tools that were included with the hardware: wrenches, drivers, etc.

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Legend:

 Link to catalog cut sheet

 Electrified Opening

Hardware Group No. 001

For use on Door #(s):

421-B 423-A 426-A 428-A

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
1	EA	CONT. HINGE	224XY		628	IVE
1	EA	PANIC HARDWARE	CDSI-PA-AX-98-NL-OP-110MD		626	VON
1	EA	MORTISE CYL TURN	09-904 114 XB11-720		626	SCH
1	EA	MEDECO IC CORE	CAMPUS STANDARD - MEDECO LFIC		626	MED
1	EA	RIM CYLINDER	CAMPUS STANDARD - MEDECO		625	MED
1	EA	ANTI VANDAL PULL	1097 VD98-99 (NL-OP)		630	TRM
1	EA	OH STOP	100S		630	GLY
1	EA	SURFACE CLOSER	4040XP EDA WMS		689	LCN
1	EA	KICK PLATE	K0050 10" X 2" LDW		630	TRM
1	EA	GASKETING	188SBK PSA		BK	ZER
1	EA	DOOR SWEEP	39A		A	ZER
1	EA	THRESHOLD	547A OR AS DETAILED		A	ZER

NEW CYLINDER TO MATCH EXISTING CAMPUS STANDARD - CONSULT CAMPUS LOCKSMITH
EXISTING MEDECO KEYING SYSTEM

Hardware Group No. 002

For use on Door #(s):

422-A 422-B 425-A 425-B

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
1	EA	CONT. HINGE	224XY		628	IVE
1	EA	INTRUDE CLASSROOM LOCK	AU5418LN		626	YAL
2	EA	MEDECO IC CORE	CAMPUS STANDARD - MEDECO LFIC		626	MED
1	EA	OH STOP	100S		630	GLY
1	EA	SURFACE CLOSER	4040XP REG OR PA AS REQ WMS		689	LCN
1	EA	KICK PLATE	K0050 10" X 2" LDW		630	TRM
1	EA	GASKETING	188SBK PSA		BK	ZER

NEW CYLINDER TO MATCH EXISTING CAMPUS STANDARD - CONSULT CAMPUS LOCKSMITN
EXISTING MEDECO KEYING SYSTEM
INTRUDER CLASSROOM LOCK FUNCTION

Hardware Group No. 003

For use on Door #(s):

420

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
1	EA	CONT. HINGE	224XY		628	IVE
1	EA	INTRUDE CLASSROOM LOCK	AU5418LN		626	YAL
2	EA	MEDECO IC CORE	CAMPUS STANDARD - MEDECO LFIC		626	MED
1	EA	OH STOP	100S		630	GLY
1	EA	SURFACE CLOSER	4040XP EDA WMS		689	LCN
1	EA	KICK PLATE	K0050 10" X 2" LDW		630	TRM
1	EA	GASKETING	188SBK PSA		BK	ZER

NEW CYLINDER TO MATCH EXISTING CAMPUS STANDARD - CONSULT CAMPUS LOCKSMITN
EXISTING MEDECO KEYING SYSTEM
INTRUDER CLASSROOM LOCK FUNCTION

Hardware Group No. 004

For use on Door #(s):

421-A 423-B 426-B 428-B

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
1	EA	CONT. HINGE	224XY		628	IVE
1	EA	FIRE EXIT HARDWARE	PA-AX-98-L-F-2SI-06		626	VON
1	EA	MEDECO IC CORE	CAMPUS STANDARD - MEDECO LFIC		626	MED
1	EA	RIM CYLINDER	CAMPUS STANDARD - MEDECO		625	MED
1	EA	RIM CYL THUMBTURN	XB11-979		626	SCH
1	EA	OH STOP	100S		630	GLY
1	EA	SURFACE CLOSER	4040XP EDA WMS		689	LCN
1	EA	KICK PLATE	K0050 10" X 2" LDW		630	TRM
1	EA	GASKETING	188SBK PSA		BK	ZER

NEW CYLINDER TO MATCH EXISTING CAMPUS STANDARD - CONSULT CAMPUS LOCKSMITN
EXISTING MEDECO KEYING SYSTEM

Hardware Group No. 005

For use on Door #(s):

424

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
1	EA	CONT. HINGE	224XY		628	IVE
1	EA	STOREROOM LOCK	AU5405LN		626	YAL
2	EA	MEDECO IC CORE	CAMPUS STANDARD - MEDECO LFIC		626	MED
1	EA	SURFACE CLOSER	4040XP REG OR PA AS REQ WMS		689	LCN
1	EA	KICK PLATE	K0050 10" X 2" LDW		630	TRM
1	EA	FLOOR STOP	1211		626	TRM
1	EA	GASKETING	188SBK PSA		BK	ZER

NEW CYLINDER TO MATCH EXISTING CAMPUS STANDARD - CONSULT CAMPUS LOCKSMITN
EXISTING MEDECO KEYING SYSTEM

Hardware Group No. 006

For use on Door #(s):

431

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
1	EA	CONT. HINGE	224XY		628	IVE
1	EA	STOREROOM LOCK	AU5405LN		626	YAL
2	EA	MEDECO IC CORE	CAMPUS STANDARD - MEDECO LFIC		626	MED
1	EA	SURFACE CLOSER	4040XP SCUSH WMS		689	LCN
1	EA	KICK PLATE	K0050 10" X 2" LDW		630	TRM
1	EA	GASKETING	188SBK PSA		BK	ZER

NEW CYLINDER TO MATCH EXISTING CAMPUS STANDARD - CONSULT CAMPUS LOCKSMITH
EXISTING MEDECO KEYING SYSTEM

Hardware Group No. 007

For use on Door #(s):

426-C 428-C

Provide each PR door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
2	EA	CONT. HINGE	224XY		628	IVE
2	SET	AUTO FLUSH BOLT	3800 SERIES		626	TRM
1	EA	STOREROOM LOCK	AU5405LN		626	YAL
1	EA	ACCESSIBLE STOREROOM LOCK	L9081T 03A		626	SCH
1	EA	MEDECO IC CORE	CAMPUS STANDARD - MEDECO LFIC		626	MED
2	EA	DUST PROOF STRIKE	82		630	TRM
1	EA	COORDINATOR X FILLER BAR X BRACKETS	3094 SERIES		600	TRM
2	EA	MOUNTING BRACKET	3095/3096		689	TRM
2	EA	SURFACE CLOSER	4040XP SCUSH		689	LCN
2	EA	KICK PLATE	K0050 10" X 1" LDW		630	TRM
1	EA	GASKETING	188SBK PSA		BK	ZER
1	EA	ASTRAGAL	BY DOOR MANUFACTURER			B/O

NEW CYLINDER TO MATCH EXISTING CAMPUS STANDARD - CONSULT CAMPUS LOCKSMITH
EXISTING MEDECO KEYING SYSTEM

Hardware Group No. 008

For use on Door #(s):

433A

Provide each PR door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR

EXISTING DOOR, FRAME AND HARDWARE TO REMAIN AND REUSE - FIELD VERIFY EXISTING
CONDITION

Hardware Group No. 009

For use on Door #(s):

433

Provide each PR door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
2	EA	CONT. HINGE	224XY		628	IVE
1	EA	REMOVABLE MULLION	4954-STAB-MT54		689	VON
1	EA	PANIC HARDWARE	CDSI-PA-AX-98-EO		626	VON
1	EA	PANIC HARDWARE	CDSI-PA-AX-98-NL-OP-110MD		626	VON
2	EA	MORTISE CYLINDER	CAMPUS STANDARD - MEDECO		626	MED
1	EA	RIM CYLINDER	CAMPUS STANDARD - MEDECO		625	MED
1	EA	VANDAL TRIM	1097 HA SP FC		630	TRM
1	EA	VANDAL TRIM	1097 HA SP NC		630	TRM
1	EA	DOOR PULL	VR910 DT		630	IVE
1	EA	DOOR PULL	VR910 NL		630	IVE
2	EA	OH STOP	100S		630	GLY
2	EA	SURFACE CLOSER	4040XP EDA		689	LCN
1	EA	THRESHOLD	547A-223		A	ZER

WEATHER SEAL , EDGE SEAL AND DOOR BOTTOM TO BE PROVIDED BY ALUMINUM DOOR AND FRAME MANUFACTURER

NEW CYLINDER TO MATCH EXISTING CAMPUS STANDARD - CONSULT CAMPUS LOCKSMITH
EXISTING MEDECO KEYING SYSTEM

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 014113.11 - Regulatory Requirements - Global Warming Potential (GWP).

1.03 REFERENCE STANDARDS

- A. 16 CFR 1201 - Safety Standard for Architectural Glazing Materials; Current Edition.
- B. ANSI Z97.1 - American National Standard for Safety Glazing Materials Used in Buildings - Safety Performance Specifications and Methods of Test; 2015 (Reaffirmed 2020).
- C. ASCE 7 - Minimum Design Loads and Associated Criteria for Buildings and Other Structures; Most Recent Edition Cited by Referring Code or Reference Standard.
- D. ASTM C864 - Standard Specification for Dense Elastomeric Compression Seal Gaskets, Setting Blocks, and Spacers; 2005 (Reapproved 2019).
- E. ASTM C920 - Standard Specification for Elastomeric Joint Sealants; 2018 (Reapproved 2024).
- F. ASTM C1036 - Standard Specification for Flat Glass; 2025.
- G. ASTM C1048 - Standard Specification for Heat-Strengthened and Fully Tempered Flat Glass; 2025.
- H. ASTM C1172 - Standard Specification for Laminated Architectural Flat Glass; 2024.
- I. ASTM C1184 - Standard Specification for Structural Silicone Sealants; 2023.
- J. ASTM C1193 - Standard Guide for Use of Joint Sealants; 2025.
- K. ASTM C1376 - Standard Specification for Pyrolytic and Vacuum Deposition Coatings on Flat Glass; 2021a.
- L. ASTM E1300 - Standard Practice for Determining Load Resistance of Glass in Buildings; 2024.
- M. ASTM E2190 - Standard Specification for Insulating Glass Unit Performance and Evaluation; 2019.
- N. BS EN 14179-1 - Glass in Building - Heat Soaked Thermally Toughened Soda Lime Silicate Safety Glass - Part 1: Definition and Description; 2016.
- O. CAL (CDPH SM) - Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers Version 1.2; 2017.
- P. GANA (GM) - GANA Glazing Manual; 2022.
- Q. GANA (SM) - GANA Sealant Manual; 2008.
- R. IGMA TM-3000 - North American Glazing Guidelines for Sealed Insulating Glass Units for Commercial & Residential Use; 1990 (Reaffirmed 2016).
- S. NFRC 100 - Procedure for Determining Fenestration Product U-factors; 2023.

- T. NFRC 200 - Procedure for Determining Fenestration Product Solar Heat Gain Coefficient and Visible Transmittance at Normal Incidence; 2023.
- U. NFRC 300 - Test Method for Determining the Solar Optical Properties of Glazing Materials and Systems; 2023.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Preinstallation Meeting: Convene a preinstallation meeting minimum 2 weeks before starting work of this section; require attendance by each of the affected installers.
 - 1. See Section 01 3000 - Administrative Requirements, for additional

1.05 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Global Warming Potential (GWP): Environmental product declaration (EPD) to identify GWP less than or equal to maximum allowable value. See 014113.11 - Regulatory Requirements - Global Warming Potential (GWP), for additional information.
- C. Product Data: For each item to be installed.
- D. Sustainable Product Data: See Section 01 6000 - Product Requirements and Section 01 6116 - Volatile Organic Compound (VOC) Content Restrictions.
 - 1. CAL (CDPH SM) compliance data.
 - 2. Recycled content data.
 - 3. VOC content restrictions data.
- E. Product Data on Glazing Compounds and Accessories: Provide chemical, functional, and environmental characteristics, limitations, special application requirements, and identify available colors.
- F. Samples: Submit two samples 6 by 6 inch in size, or manufacturer's standard sample size, of glass units.
- G. Samples: Submit 6 inch long bead of glazing sealant, color as selected.
- H. Certificate: Certify that products of this section meet or exceed specified requirements.
- I. Manufacturer's qualification statement.
- J. Installer's qualification statement.
- K. Warranty Documentation: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.

1.06 QUALITY ASSURANCE

- A. Perform Work in accordance with GANA (GM), GANA (SM), GANA (LGRM), and IGMA TM-3000 for glazing installation methods. Maintain one copy on site.
- B. Qualifications: See Section 01 4000 - Quality Requirements.
 - 1. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum five years of documented experience.
 - a. Provide certified glass products through ANSI accredited certifications that include plant audits and independent laboratory performance testing.
 - b. Insulating Glass Certification Council (IGCC).
 - c. Safety Glazing Certification Council (SGCC).
 - 2. Installer Qualifications: Company specializing in performing work of the type specified and with at least 5 years documented experience.
 - a. Provide company, field supervisors, and installers that hold active ANSI accredited certifications in appropriate categories for work specified.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. See Section 01 6000 - Product Requirements.
- B. Deliver materials to Project site in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, approval or listing agency markings, and directions for storing.
- C. Protect materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources. Store in a dry location.
- D. Comply with manufacturer's written instructions for handling, storing, and protecting during installation.
- E. See Section 01 7419 - Construction Waste Management and Disposal, for packaging waste requirements.

1.08 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.

1.09 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.
- D. Heat Soaked Tempered Glass: Provide a ten (10) year manufacturer warranty to include coverage for spontaneous breakage of fully tempered glass caused by nickel sulfide (NiS) inclusions.

PART 2 PRODUCTS

2.01 SUSTAINABLE PRODUCT REQUIREMENTS

- A. See Section 01 6000 - Product Requirements.
- B. VOC Content Restrictions: Products in this section to not exceed VOC content limits specified in Section 01 6116 - Volatile Organic Compound (VOC) Content Restrictions.
- C. CDPH: Products to comply with CAL (CDPH SM) .
- D. Recycled Content: Products in this Section to meet minimum recycled content thresholds specified in Section 016000.

2.02 REGULATORY REQUIREMENTS

- A. Flat Glass: Global Warming Potential (GWP) less than or equal to maximum allowable value. See Section 014113.11 - Regulatory Requirements - Global Warming Potential (GWP), for additional information.

2.03 MANUFACTURERS

- A. Glass Manufacturers:
 - 1. Cardinal Glass Industries.

2. Gardner Glass.
 3. Guardian Glass.
 4. Ornilux.
 5. Pilkington North America.
 6. Saint Gobain.
 7. Schott.
 8. Vitro Architectural Glass.
 9. Walker Glass.
 10. Substitutions: See Section 01 2500 - Substitution Procedures.
- B. Glass Fabricators:
1. General Glass International (GGI).
 2. Standard Bent Glass.
 3. Tecnoglass.
 4. Thompson Innovative Glass.
 5. Trulite Glass & Aluminum Solutions.
 6. Viracon.
 7. Substitutions: See Section 01 2500 - Substitution Procedures.

2.04 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. Design Wind Pressures: As shown on the Structural drawings.
 2. Comply with ASTM E1300 for design load resistance of glass type, thickness, dimensions, and maximum lateral deflection of supported glass.
 3. Seismic Loads: Design and size glazing components to withstand seismic loads and sway displacement in accordance with the requirements of ASCE 7
 4. 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.
 5. 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:
- 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-Value: 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.

2.05 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. Fully Tempered Safety Glass: Complies with ANSI Z97.1 or 16 CFR 1201 criteria for safety glazing used in hazardous locations.
 5. Heat-Soak Testing (HST): Provide HST of fully tempered glass used on canopy, point-supported, spider wall, high-risk, sloping overhead, horizontal overhead, free-standing glass protective barrier, or other demanding applications of project, to reduce risks of spontaneous breakage due to nickel sulfide (NiS) induced fractures in accordance with BS EN 14179-1.
 6. Impact Resistant Safety Glass: Complies with ANSI Z97.1 - Class B, or 16 CFR 1201 - Category I criteria.
 7. Thicknesses: As indicated; provide greater thickness as required for exterior glazing wind load design.
- B. Laminated Glass: Float glass laminated in accordance with ASTM C1172.
1. Laminated Safety Glass: Complies with ANSI Z97.1 - Class B or 16 CFR 1201 - Category I impact test requirements.
 2. Interlayers: Refer to Laminated Glass Interlayers article below.

2.06 INSULATING GLASS UNITS

- A. 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. Warm-Edge Spacer: Fabricator's standard.
 4. Spacer Color: Black.
 5. 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.
 6. Purge interpane space with dry air, hermetically sealed.
- B. GL-1 Insulating Glass Units: Vision glass, double glazed.
1. Applications: Exterior glazing unless otherwise indicated.
 2. Space between lites filled with argon.
 3. Outboard Lite: Fully tempered float glass, 1/4 inch thick, minimum.
 - a. Tint: Clear.
 - b. Coating: Low-E (passive type), on #2 surface.
 4. Warm-edge spacer.
 5. Inboard Lite: Fully tempered float glass, 1/4 inch thick, minimum.
 - a. Tint: Clear.
 6. Total Thickness: 1 inch.
 7. Thermal Transmittance (U-Value), Summer - Center of Glass: _____, nominal.
 8. Visible Light Transmittance (VLT): 64 percent, nominal.
 9. Solar Heat Gain Coefficient (SHGC): .70, nominal.

2.07 GLAZING UNITS

- A. GL-2 - 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.

2.08 GLAZING COMPOUNDS

- A. Definitions: See Section 079200 - Joint Sealants.
- B. Color, General: As selected by Architect from manufacturer's full range.
- C. Manufacturers:
 - 1. Bostik.
 - 2. Dow Corning / Dowsil.
 - 3. GE Silicones.
 - 4. Momentive Performance Materials.
 - 5. Pecora.
 - 6. Tremco.
 - 7. Substitutions: See Section 01 2500 - Substitution Procedures.
- D. Butyl Sealant: Single component; ASTM C920 Grade NS, Class 12-1/2, Uses M and A, Shore A hardness of 10 to 20; black color.
- E. Polysulfide Sealant: Two component; chemical curing, nonsagging type; ASTM C920 Type M, Grade NS, Class 25, Uses M, A, and G; with cured Shore A hardness range of 15 to 25; color as selected.
- F. Silicone Sealant: Neutral curing; capable of water immersion without loss of properties; nonbleeding, nonstaining, ASTM C920 Type S, Grade NS, Class 50, Use NT.
 - 1. Products:
 - a. Dowsil; 795 Silicone Building Sealant.
 - b. GE Silicones; SCS2000 SilPruf.
 - c. Pecora; 895NST Silicone.
 - d. Tremco; Spectrum 2.
 - 2. Locations:
 - a. Typical use.
 - b. Perimeter at smooth substrates, including glass, metals, and coated metals.
 - c. Wet sealing of glass components within frames.
 - d. Non-structural internal components of window system, including end dams and internal seals.
- G. Silicone Sealant: Single component; neutral curing; capable of water immersion without loss of properties; nonbleeding, nonstaining, ASTM C920 Type S or M, Grade NS, Class 25, Use NT.
 - 1. Products:
 - a. Dowsil; 983 Structural Glazing Sealant Base and Curing Agent.
 - b. GE Silicones; SSG4000 UltraGlaze.
 - c. Pecora; AVB Silicone.
 - d. Tremco; Tremsil 600.
 - 2. Locations:
 - a. Non-structural internal components of window system, including end dams and internal seals.
- H. Structural Glazing Sealants: ASTM C1184, high-modulus, neutral-cure silicone formulation that is specifically formulated and tested for use as structural sealant and approved by structural-sealant manufacturer for use in opening system indicated, for 2-and 4-sided structural glazing. Product to be compatible with system components with which it comes in contact.
 - 1. Shop-Applied Products:
 - a. Dowsil; 983 Structural Glazing Sealant.
 - b. GE Silicones; SSG4650
 - c. Pecora; 985 Silicone.
 - d. Tremco; Proglaze II.
 - e. Substitutions: See Section 01 2500 - Substitution Procedures.

2. Field-Applied Products:
 - a. Dowsil; 795 Silicone Building Sealant, 995 Silicone Structural Sealant.
 - b. GE Silicones; SSG4000AC UltraGlaze.
 - c. Pecora; 895 NST Silicone.
 - d. Tremco; Proglaze SSG.
 - e. Substitutions: See Section 01 2500 - Substitution Procedures.

2.09 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.
- 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 immediately 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 INSTALLATION - DRY GLAZING METHOD (TAPE AND GASKET SPLINE GLAZING)

- A. Application - Exterior Glazed: Set glazing infills from the exterior of the building.
- B. Cut glazing tape to length; install on glazing pane. Seal corners by butting tape and sealing junctions with butyl sealant.
- C. Place setting blocks at 1/4 points with edge block no more than 6 inch from corners.
- D. Rest glazing on setting blocks and push against fixed stop with sufficient pressure to attain full contact.
- E. Install removable stops without displacing glazing spline. Exert pressure for full continuous contact.
- F. Carefully trim protruding tape with knife.

3.06 INSTALLATION - DRY GLAZING METHOD (TAPE AND TAPE)

- A. Application - Interior Glazed: Set glazing infills from the interior of the building.
- B. Cut glazing tape to length and set against permanent stops, projecting 1/16 inch above sight line.
- C. Place setting blocks at 1/4 points with edge block no more than 6 inch from corners.
- D. Rest glazing on setting blocks and push against tape for full contact at perimeter of pane or unit.
- E. Place glazing tape on free perimeter of glazing in same manner described above.
- F. Install removable stop without displacement of tape. Exert pressure on tape for full continuous contact.
- G. Carefully trim protruding tape with knife.

3.07 INSTALLATION - WET GLAZING METHOD (SEALANT AND SEALANT)

- A. Application - Exterior Glazed: Set glazing infills from the exterior of the building.
- B. Place setting blocks at 1/4 points and install glazing pane or unit.
- C. Install removable stops with glazing centered in space by inserting spacer shims both sides at 24 inch intervals, 1/4 inch below sight line.
- D. Fill gaps between glazing and stops with glazing type sealant to depth of bite on glazing, but not more than 3/8 inch below sight line to ensure full contact with glazing and continue the air and vapor seal.
- E. Apply sealant to uniform line, flush with sight line. Tool or wipe sealant surface smooth.

3.08 INSTALLATION - PRESSURE GLAZED SYSTEMS

- A. Application - Exterior Glazed: Set glazing infills from exterior side of 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 pressure plates without displacing glazing gasket; exert pressure for full continuous contact.
- E. Install cover plate.

3.09 INSTALLATION - STRUCTURAL SILICONE GLAZING

- A. Application - Factory (Shop) Glazed: Follow basic guidelines of structural silicone glazing for glazing application.
 - 1. Two-Sided Structural: Glass structurally adhered to vertical mullions with horizontal sides captured in glazing pockets.
 - 2. Four-Sided Structural: Glass with four sides structurally adhered to horizontal and vertical metal back-up mullion.
- B. Provide design review of the glazing system and project details, adhesion testing, proper surface preparation, training and a quality service program.
- C. Provide only structural silicone sealant, tested and manufactured for structural glazing.

3.10 INSTALLATION - PLASTIC FILM

- A. Install plastic film with adhesive, applied in accordance with film manufacturer's instructions.
- B. Place without air bubbles, creases or visible distortion.
- C. Install film tight to perimeter of glass and carefully trim film with razor sharp knife. Provide 1/16 inch to 1/8 inch gap at perimeter of glazed panel unless otherwise required. Do not score the glass.

3.11 FIELD QUALITY CONTROL

- A. See Section 014000 - Quality Requirements for additional requirements.
- B. Glass and Glazing product manufacturers to provide field surveillance of the installation of their products.
- C. Monitor and report installation procedures and unacceptable conditions.

3.12 CLEANING

- A. See Section 017419 - Construction Waste Management and Disposal, for additional requirements.
- B. Remove excess glazing materials from finish surfaces immediately after application using solvents or cleaners recommended by manufacturers.
- C. Remove nonpermanent labels immediately after glazing installation is complete.
- D. Clean glass and adjacent surfaces after sealants are fully cured.
- E. 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.

3.13 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

**SECTION 090561
COMMON WORK RESULTS FOR FLOORING PREPARATION**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. This section applies to floors identified in Contract Documents that are receiving the following types of floor coverings:
 - 1. Traffic coatings.
 - 2. Resilient tile and sheet.
 - 3. Broadloom carpet.
 - 4. Carpet tile.
 - 5. Thin-set ceramic tile and stone tile.
 - 6. Resinous matrix terrazzo flooring.
 - 7. Fluid-applied flooring.
- B. Patching compounds.
- C. Concrete moisture vapor emission (MVE) control systems.

1.02 PRICE AND PAYMENT PROCEDURES

- A. Unit Price for Concrete Moisture Vapor Emission (MVE) Control System: Do not include the cost of the MVE control system in the base bid; state on the bid form the unit price per square foot for the MVE control system, installed, in the event such remediation is required.

1.03 DEFINITIONS

- A. MVE: Moisture vapor emission.
- B. MVER: Moisture vapor emission rate.
- C. MVE Control System: Fluid-applied, resin-based, membrane-forming system that controls the moisture-vapor-emission rate of high-moisture, interior concrete to prepare it for floor covering installation.

1.04 REFERENCE STANDARDS

- A. ASTM C109/C109M - Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 50 mm [2 in.] Cube Specimens); 2024.
- B. ASTM C472 - Standard Test Methods for Physical Testing of Gypsum, Gypsum Plasters, and Gypsum Concrete; 2020.
- C. ASTM D7234 - Standard Test Method for Pull-Off Strength of Coatings on Concrete Using Portable Pull-Off Adhesion Testers; 2022.
- D. ASTM E96/E96M - Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials; 2024a.
- E. ASTM F710 - Standard Practice for Preparing Concrete Floors to Receive Resilient Flooring; 2022.
- F. ASTM F1869 - Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride; 2023.

- G. ASTM F2170 - Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs Using in situ Probes; 2019a.
- H. ASTM F3010 - Standard Practice for Two-Component Resin Based Membrane-Forming Moisture Mitigation Systems for Use Under Resilient Floor Coverings; 2018.
- I. ASTM F3010 - Standard Practice for Two-Component Resin Based Membrane-Forming Moisture Mitigation Systems for Use Under Resilient Floor Coverings; 2018.
- J. CAL (CDPH SM) - Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers Version 1.2; 2017.
- K. CAL (CDPH SM) - Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers; 2017.

1.05 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Floor Covering and Adhesive Manufacturers' Product Literature: For each specific combination of substrate, floor covering, and adhesive to be used; showing:
 - 1. Moisture and alkalinity (pH) limits and test methods.
 - 2. Manufacturer's required bond/compatibility test procedure.
- C. Concrete Moisture Vapor Emission (MVE) Control Systems Product Data: Manufacturer's published data on each product to be used for remediation.
 - 1. Manufacturer's qualification statement.
 - 2. Certificate: Manufacturer's certification of compatibility with types of flooring applied over remedial product.
 - 3. Test reports indicating compliance with specified performance requirements, performed by nationally recognized independent testing agency.
 - 4. Manufacturer's installation instructions.
 - 5. Specimen Warranty: Copy of warranty to be issued by coating manufacturer and certificate of underwriter's coverage of warranty.
- D. Sustainable Product Data: See Section 01 6000 - Product Requirements and Section 01 6116 - Volatile Organic Compound (VOC) Content Restrictions.
 - 1. VOC content restrictions data.
 - 2. CAL (CDPH SM) compliance data.
- E. Preinstallation Testing Reports: As specified in Part 3 of this Section.
 - 1. Description of areas tested; include floor plans and photographs if helpful.
 - 2. Summary of conditions encountered.
 - 3. Moisture and alkalinity (pH) test reports.
 - 4. Copies of specified test methods.
 - 5. Recommendations for remediation of unsatisfactory surfaces.
 - 6. Product data for recommended remedial coating.
 - 7. Certificate: Include certification of accuracy by authorized official of testing agency.
 - 8. Submit report not more than two business days after conclusion of testing.
- F. Field Quality Control Reports: As specified in Part 3 of this Section.

1.06 COORDINATION

- A. Moisture Testing: Confirm with flooring manufacturer if anhydrous calcium chloride test, internal relative humidity test, or both, are required to meet warranty requirements of flooring products. Refer to
- B. Compatibility: Confirm with flooring manufacturers that MVE control system is compliant with all products to be installed.

- C. Coordinate scheduling of cleaning and testing, so that preliminary cleaning has been completed for at least 24 hours prior to testing.

1.07 QUALITY ASSURANCE

- A. Moisture and alkalinity (pH) testing will be performed by an independent testing agency employed and paid by Owner. Refer to Part 3 of this Section for additional information.
- B. Contractor's Responsibility Relating to Independent Agency Testing:
 - 1. Provide access for and cooperate with testing agency.
 - 2. Confirm date of start of testing at least 10 days prior to actual start.
 - 3. Allow at least 4 business days on site for testing agency activities.
 - 4. Achieve and maintain specified ambient conditions.
 - 5. Notify Owner when specified ambient conditions have been achieved and when testing will start.
- C. Qualifications: See Section 01 4000 - Quality Requirements.
 - 1. Manufacturer Qualifications: Employs factory-trained personnel who are available for consultation and Project-site inspection.
 - 2. MVE Control System Installer Qualifications: Company specializing in performing work of the type specified in this Section, trained by or employed by coating manufacturer, and able to provide at least 3 project references showing at least 3 years' experience installing moisture emission coatings.
- D. Preinstallation Meetings: See Section 01 3000 - Administrative Requirements.
 - 1. Convene minimum 2 weeks before starting work of this Section.

1.08 DELIVERY, STORAGE, AND HANDLING

- A. See Section 01 6000 - Product Requirements.
- B. Deliver materials to Project site in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, approval or listing agency markings, and directions for storing.
- C. Protect materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources. Store in a dry location.
- D. Comply with manufacturer's written instructions for handling, storing, and protecting during installation.
- E. Keep materials from freezing.
- F. See Section 01 7419 - Construction Waste Management and Disposal, for packaging waste requirements.

1.09 FIELD CONDITIONS

- A. Environmental Limitations: Comply with MVE control system manufacturer's written instructions for substrate and ambient temperatures, humidity, ventilation, and other conditions affecting system installation.
 - 1. Store system components in a temperature-controlled environment and protected from weather and at ambient temperature of not less than 65 deg F and not more than 85 deg F at least 48 hours before use.
 - 2. Maintain ambient temperature and relative humidity in installation areas within range recommended in writing by MVE-control system manufacturer, but not less than 65 deg F or more than 85 deg F and not less than 40 or more than 60 percent relative humidity, for 48 hours before installation, during installation, and for 48 hours after installation unless longer period is recommended in writing by manufacturer.

3. Install MVE-control systems where concrete surface temperatures will remain a minimum of 5 deg F higher than the dew point for ambient temperature and relative humidity conditions in installation areas for 48 hours before installation, during installation, and for 48 hours after installation unless longer period is recommended in writing by manufacturer.

1.10 WARRANTY

- A. See Section 01 6000 - Product Requirements and Section 01 7800 - Closeout Submittals for additional warranty requirements.
- B. Provide manufacturer's standard warranty for each product.

PART 2 PRODUCTS

2.01 SUSTAINABLE PRODUCT REQUIREMENTS

- A. See Section 01 6000 - Product Requirements.
- B. VOC Content Restrictions: Products in this section to not exceed VOC content limits specified in Section 01 6116 - Volatile Organic Compound (VOC) Content Restrictions.
- C. CDPH: Products to comply with CAL (CDPH SM) .

2.02 PERFORMANCE REQUIREMENTS

- A. Moisture Vapor Emission (MVE) Control System Capabilities: Capable of suppressing MVE without failure where installed on concrete that exhibits the following conditions:
 1. Moisture Vapor Emission Rate (MVER): Maximum 30 lb of water/1000 sq. ft. when tested according to ASTM F1869.
 2. Relative Humidity: Maximum 100 percent when tested according to ASTM F2170 using in situ probes.
- B. Water-Vapor Transmission: Through MVE-control system, maximum 0.02 perm (1.15 ng/Pa x s x sq. m) when tested according to ASTM E96/E96M.
- C. Tensile Bond Strength: For MVE-control system, greater than 200 psi with failure in the concrete according to ASTM D7234.

2.03 PATCHING COMPOUNDS

- A. Patching Compound: Floor covering manufacturer's recommended product, suitable for conditions, and compatible with adhesive and floor covering. In the absence of any recommendation from flooring manufacturer, provide a product with the following characteristics:
 1. Cementitious moisture-, mildew-, and alkali-resistant compound, compatible with floor, floor covering, and floor covering adhesive, and capable of being feathered to nothing at edges.
 2. Compressive Strength: 3000 psi, minimum, after 28 days, when tested in accordance with ASTM C109/C109M or ASTM C472, whichever is appropriate.

2.04 MOISTURE VAPOR EMISSION (MVE) CONTROL SYSTEMS

- A. Concrete Moisture Vapor Emission (MVE) Control Systems: Single- or multi-layer coating or coating /overlay combination intended by its manufacturer to resist water vapor transmission to degree sufficient to meet flooring manufacturer's emission limits, resistant to the level of alkalinity (pH) found, and suitable for adhesion of flooring without further treatment.

1. Material: Comply with ASTM F3010.
2. Thickness: As required for application and in accordance with manufacturer's installation instructions.
3. Substrate Primer: Provide MVE control system manufacturer's concrete-substrate primer if required for system indicated by substrate conditions.
4. Products:
 - a. Advanced Moisture Control; Vapor-Green FC.
 - b. ARDEX Engineered Cements; ARDEX MC RAPID.
 - c. Aquafin; Vaportight Coat-SG3.
 - d. Custom Building Products; TechMVC Moisture Vapor and Alkalinity Barrier.
 - e. Floor Seal Technology, Inc; MES 100.
 - f. KOSTER American Corporation; KOSTER VAP I 2000 FS.
 - g. LATICRETE International, Inc; LATICRETE VAPOR BAN E.
 - h. Moxie; MFSII.
 - i. Sika; Sika MB.
 - j. Sinak; VC-5 / VECT-R.
 - k. Synthetics International; 30-FS.
 - l. Substitutions: See Section 01 2500 - Substitution Procedures.

PART 3 EXECUTION

3.01 PRELIMINARY CLEANING

- A. Concrete Substrates: Prepare and clean substrates according to MVE-control system manufacturer's written instructions to ensure adhesion of system to concrete.
- B. Clean floors of dust, solvents, paint, wax, oil, grease, asphalt, residual adhesive, adhesive removers, film-forming curing compounds, sealing compounds, alkaline salts, excessive laitance, mold, mildew, and other materials that might prevent adhesive bond.
- C. Do not use solvents or other chemicals for cleaning.

3.02 PREINSTALLATION TESTING

- A. See Section 01 4000 - Quality Requirements, for additional requirements.
- B. Owner to engage a qualified testing agency to perform tests and inspections.
 1. Concrete substrates will be considered defective if they do not pass tests and inspections.
 2. Additional tests and inspections, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
 3. Testing and inspecting agency to prepare reports and deliver to Owner or Contractor.
 4. Submit preinstallation testing reports to Architect.
- C. Tests:
 1. Alkalinity Testing: Perform pH testing according to ASTM F710. Install MVE control system in areas where pH readings are less than 7.0 and in areas where pH readings are greater than 8.5.
 2. Moisture Testing: Perform tests so that each test area does not exceed 200 square feet, and perform no fewer than three tests in each installation area and with test areas evenly spaced in installation areas. Test type(s) to be selected by testing agency. Refer to Coordination article above for additional information.
 - a. Internal Relative Humidity Test: Using in situ probes, ASTM F2170. Install MVE control system in locations where concrete substrates exhibit relative humidity level greater than 75 percent.

- b. Anhydrous Calcium Chloride Test: ASTM F1869. Install MVE control system in locations where concrete substrate MVER exceeds 3 lb of water/1000 sq. ft. in 24 hours.
- 3. Tensile-Bond-Strength Testing: For typical locations indicated to receive installation of MVE control system, install minimum 100 square feet area of MVE control system to prepared concrete substrate and test according to ASTM D7234.
 - a. Proceed with installation only where tensile bond strength is greater than 200 psi with failure in the concrete.

3.03 PREPARATION

- A. See individual floor covering section(s) for additional requirements.
- B. Comply with recommendations of testing agency.
- C. Comply with requirements and recommendations of floor covering manufacturer.
- D. Fill and smooth surface cracks, grooves, depressions, control joints and other non-moving joints, and other irregularities with patching compound.
- E. Do not fill expansion joints, isolation joints, or other moving joints.

3.04 APPLICATION OF CONCRETE MOISTURE VAPOR EMISSION (MVE) CONTROL SYSTEM

- A. Install MVE control system according to ASTM F3010 and manufacturer's written instructions.
- B. Do not exceed pot life of material as documented in writing by manufacturer.
- C. Comply with requirements and recommendations of coating manufacturer.
 - 1. Install primers as required to comply with manufacturer's written instructions.
 - 2. Produce a uniform, monolithic surface free of surface deficiencies such as pin holes, fish eyes, and voids.

3.05 FIELD QUALITY CONTROL

- A. See Section 01 4000 - Quality Requirements, for additional requirements.
- B. Owner to engage a qualified testing agency to perform tests and inspections.
 - 1. Moisture vapor emission (MVE) control systems will be considered defective if they do not pass tests and inspections.
 - 2. Additional tests and inspections, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
 - 3. Testing and inspecting agency to prepare reports and deliver to Owner or Contractor.
 - 4. Submit field quality control reports to Architect.
- C. Inspections:
 - 1. Inspect substrate preparation and installation of system components to ensure compliance with manufacturer's written instructions and to ensure that a complete MVE-control system is installed without deficiencies.
 - a. Verify that surface preparation meets requirements.
 - b. Verify that component coats and complete MVE-control-system film thicknesses comply with manufacturer's written instructions.
 - c. Verify that MVE-control-system components and installation areas that evidence deficiencies are repaired according to manufacturer's written instructions.
- D. Manufacturer's Representative to provide site monitoring and inspection services as specified in Section 01 4000.
 - 1. Manufacturer's representative to prepare site review and inspection reports and deliver to Contractor.
 - 2. Submit field quality control reports to Architect.

3.06 PROTECTION

- A. Cover prepared floors with building paper or other durable covering.

END OF SECTION

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**SECTION 092116
GYPSUM BOARD ASSEMBLIES**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Performance criteria for gypsum board assemblies.
- B. Gypsum sheathing for exterior walls and soffits.
- C. Cementitious backing board.
- D. Gypsum wallboard.
- E. Backing board.
- F. Joint treatment and accessories.
- G. Water-resistive barrier over exterior wall sheathing.
- H. Sound barrier mullion trim cap.

1.02 RELATED REQUIREMENTS

- A. Section 072500 - Air- and water-resistive barrier over sheathing.
- B. Section 092216 - Non-Structural Metal Framing.
- C. Section 098100 - Acoustic Insulation.

1.03 REFERENCE STANDARDS

- A. AISI S220 - North American Standard for Cold-Formed Steel Nonstructural Framing; 2020.
- B. ANSI A108.11 - American National Standard Specifications for Interior Installation of Cementitious Backer Units; 2023.
- C. ANSI A118.9 - American National Standard Specifications for Test Methods and Specifications for Cementitious Backer Units; 2023.
- D. ASCE 7 - Minimum Design Loads and Associated Criteria for Buildings and Other Structures; Most Recent Edition Cited by Referring Code or Reference Standard.
- E. ASTM C475/C475M - Standard Specification for Joint Compound and Joint Tape for Finishing Gypsum Board; 2017 (Reapproved 2022).
- F. ASTM C754 - Standard Specification for Installation of Steel Framing Members to Receive Screw-Attached Gypsum Panel Products; 2020.
- G. ASTM C840 - Standard Specification for Application and Finishing of Gypsum Board; 2024.
- H. ASTM C954 - Standard Specification for Steel Drill Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Steel Studs from 0.033 in. (0.84 mm) to 0.112 in. (2.84 mm) in Thickness; 2022.
- I. ASTM C1002 - Standard Specification for Steel Self-Piercing Tapping Screws for Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs; 2022.
- J. ASTM C1047 - Standard Specification for Accessories for Gypsum Wallboard and Gypsum Veneer Base; 2019.
- K. ASTM C1177/C1177M - Standard Specification for Glass Mat Gypsum Substrate for Use as Sheathing; 2024.

- L. ASTM C1178/C1178M - Standard Specification for Coated Glass Mat Water-Resistant Gypsum Backing Panel; 2024.
- M. ASTM C1280 - Standard Specification for Application of Exterior Gypsum Panel Products for Use as Sheathing; 2018 (Reapproved 2023).
- N. ASTM C1325 - Standard Specification for Fiber-Mat Reinforced Cementitious Backer Units; 2022, with Editorial Revision (2023).
- O. ASTM C1396/C1396M - Standard Specification for Gypsum Board; 2024.
- P. ASTM C1629/C1629M - Standard Classification for Abuse-Resistant Nondecorated Interior Gypsum Panel Products and Fiber-Reinforced Cement Panels; 2023.
- Q. ASTM C1658/C1658M - Standard Specification for Glass Mat Gypsum Panels; 2019, with Editorial Revision (2020).
- R. ASTM D3273 - Standard Test Method for Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber; 2021.
- S. ASTM G21 - Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi; 2015, with Editorial Revision (2021).
- T. CAL (CDPH SM) - Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers Version 1.2; 2017.
- U. GA-216 - Application and Finishing of Gypsum Panel Products; 2024.
- V. GA-226 - Application of Gypsum Board to Form Curved Surfaces; 2025.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination: Coordinate the installation of gypsum board assemblies with size, location, and installation of service utilities.

1.05 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: For each item to be installed.
- C. Sustainable Product Data: See Section 01 6000 - Product Requirements and Section 01 6116 - Volatile Organic Compound (VOC) Content Restrictions.
 - 1. CAL (CDPH SM) compliance data.
 - 2. Life cycle data.
 - 3. Recycled content data.
 - 4. VOC content restrictions data.
- D. Shop Drawings: Coordinate requirements with Section 092216 - Non-Structural Metal Framing. Indicate special details associated with fireproofing and acoustic seals.
- E. Evaluation Service Reports: Show compliance with specified requirements, including grid suspension systems.
- F. Qualification Statements: For Contractor's professional engineer, manufacturer, and installer.

1.06 COORDINATION

- A. Confirm with panel manufacturers suitability of gypsum panel products at locations subject to water and water vapor.

1.07 QUALITY ASSURANCE

- A. Qualifications: See Section 01 4000 - Quality Requirements.

1. Contractor's Professional Engineer: Experienced in providing delegated design engineering services of the kind indicated, including documentation that engineer is licensed in the State in which the project is located.
 2. Manufacturer Qualifications: Member of Steel Stud Manufacturers Association (SSMA): www.ssma.com/#sle.
 3. Installer Qualifications: Company specializing in performing work of the type specified and with at least three years of documented experience.
- B. Preinstallation Meetings: See Section 01 3000 - Administrative Requirements.
1. Convene minimum 2 weeks before starting work of this Section.
 2. Require attendance by all affected installers.
- C. Documents at Project Site: Maintain at the project site a copy of manufacturer's instructions, erection drawings, and shop drawings.

1.08 DELIVERY, STORAGE, AND HANDLING

- A. See Section 01 6000 - Product Requirements.
- B. See Section 017419 - Construction Waste Management and Disposal for packaging waste requirements.
- C. Store gypsum products and accessories indoors and keep above freezing. Elevate boards above floor, on nonwicking supports, in accordance with manufacturer's recommendations.
- D. Store metal products to prevent corrosion.

1.09 WARRANTY

- A. Provide manufacturer's standard warranty for each product.

PART 2 PRODUCTS

2.01 DELEGATED DESIGN

- A. Delegated Design: See Section 01 3000 - Administrative Requirements.
- B. Engage a qualified professional engineer, as defined in Section 01 4000 - Quality Requirements, to design metal stud wall assemblies and shaft wall assemblies. Coordinate with Section 092216 - Non-Structural Metal Framing.

2.02 SUSTAINABLE PRODUCT REQUIREMENTS

- A. See Section 01 6000 - Product Requirements.
- B. VOC Content Restrictions: Products in this section to not exceed VOC content limits specified in Section 01 6116 - Volatile Organic Compound (VOC) Content Restrictions.
- C. CDPH: Products to comply with CAL (CDPH SM) .
- D. Life Cycle: Products in this section to have LCA as specified in Section 016000.
- E. Recycled Content: Products in this Section to meet minimum recycled content thresholds specified in Section 016000.

2.03 GYPSUM BOARD ASSEMBLIES

- A. See Section 092216 - Non-Structural Metal Framing for metal studs, shaft studs, and accessories required for complete partition, ceiling, and soffit assemblies.
- B. Provide completed assemblies complying with ASTM C840 and GA-216.

1. See PART 3 for finishing requirements.
- C. Seismic Performance: Ceiling systems designed to withstand the effects of earthquake motions in accordance with ASCE 7 for Seismic Design as shown on the Structural drawings and complying with the following:
 1. Local authorities having jurisdiction.
 2. ICC-ES Evaluation Report.
- D. Grid Suspension Systems: Provide grid suspension systems in accordance with ASTM C840 and GA-216 complying with the following:
 1. ICC-ES Evaluation Report.
- E. Fire-Resistance-Rated Assemblies: Provide completed assemblies as shown on the Architectural drawings

2.04 METAL FRAMING MATERIALS

- A. See Section 092216 - Non-Structural Metal Framing.

2.05 BOARD MATERIALS

- A. Manufacturers - Gypsum-Based Board:
 1. American Gypsum.
 2. CertainTeed.
 3. Georgia-Pacific.
 4. National Gypsum.
 5. Pabco.
 6. USG.
 7. Substitutions: See Section 01 2500 - Substitution Procedures.
- B. Interior Gypsum Wallboard: Paper- and glass-mat-faced gypsum panels as defined in ASTM C1396/C1396M; sizes to minimize joints in place; ends square cut.
 1. Application: Use for interior vertical surfaces and ceilings, unless otherwise indicated.
 - a. Use exterior gypsum sheathing board for exterior applications. Refer to products below.
 2. Glass mat faced gypsum panels, as defined in ASTM C1658/C1658M, suitable for paint finish, of the same core type and thickness may be substituted for paper-faced board.
 3. 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.
 4. Thickness:
 - a. Vertical Surfaces: 5/8 inch.
 - b. Ceilings: 5/8 inch.
 - c. Multi-Layer Assemblies: Thicknesses as indicated on drawings.
 5. Interior Paper-Faced Type X Products:
 - a. Locations:
 - 1) Standard unless noted otherwise.
 - b. American Gypsum Company; FireBloc Type X Gypsum Wallboard: www.americangypsum.com/#sle.
 - c. CertainTeed Corporation; Type X Drywall: www.certainteed.com/#sle.
 - d. Georgia-Pacific Gypsum; ToughRock Fireguard X: www.gpgypsum.com/#sle.
 - e. Gold Bond Building Products, LLC provided by National Gypsum Company; Gold Bond Fire-Shield C 5/8" Gypsum Board: www.goldbondbuilding.com/#sle.
 - f. Pabco; Flame Curb.
 - g. USG Corporation; Sheetrock Brand EcoSmart Panels Firecode X 5/8 in. (15.9 mm): www.usg.com/#sle.

- h. Substitutions: See Section 01 2500 - Substitution Procedures.
- 6. Interior Paper-Faced Type C Products:
 - a. Locations:
 - 1) Where required to meet partition rating, as shown on the Architectural drawings.
 - b. American Gypsum; Firebloc Type C.
 - c. CertainTeed.; ProRoc Type C.
 - d. Georgia-Pacific; Fireguard C.
 - e. National Gypsum; Gold Bond Fire-Shield C.
 - f. Pabco; Flame Curb Type Super C.
 - g. USG; Firecode C Core.
- 7. Interior Mold-Resistant, Paper-Faced Products:
 - a. Locations:
 - 1) Drinking fountains.
 - 2) Adjacent to sinks in break rooms and similar.
 - 3) Where shown on the Architectural drawings.
 - b. American Gypsum Company; M-Bloc Type X: www.americangypsum.com/#sle.
 - c. CertainTeed Corporation; M2Tech 5/8" Type X Moisture & Mold Resistant Drywall: www.certainteed.com/#sle.
 - d. Georgia-Pacific Gypsum; ToughRock Fireguard X Mold-Guard: www.gpgypsum.com/#sle.
 - e. Gold Bond Building Products, LLC provided by National Gypsum Company; Gold Bond XP Fire-Shield Gypsum Board: www.goldbondbuilding.com/#sle.
 - f. Pabco; Mold Curb Plus.
 - g. USG Corporation; Sheetrock Brand EcoSmart Panels Mold Tough Firecode X 5/8 in. (15.9 mm): www.usg.com/#sle.
 - h. Substitutions: See Section 01 2500 - Substitution Procedures.
- 8. Interior Glass Mat Faced Products:
 - a. Locations:
 - 1) Building interior side of exterior wall assembly.
 - 2) Bathroom areas without tile.
 - 3) Where shown on the Architectural drawings.
 - b. CertainTeed Corporation; 5/8" GlasRoc Interior Type X: www.certainteed.com/#sle.
 - c. Georgia-Pacific Gypsum; DensArmor Plus: www.gpgypsum.com/#sle.
 - d. Gold Bond Building Products, LLC provided by National Gypsum Company; Gold Bond eXP Interior Extreme Fire-Shield Gypsum Panel: www.goldbondbuilding.com/#sle.
 - e. Pabco; Pabco Glass Interior.
 - f. USG Corporation; Sheetrock Brand Glass-Mat Panels Mold Tough Regular 5/8 in. (15.9 mm): www.usg.com/#sle.
 - g. Substitutions: See Section 01 2500 - Substitution Procedures.
- 9. Flexible Gypsum Board Products:
 - a. CertainTeed; 1/4 Inch Flex Drywall.
 - b. Georgia-Pacific; ToughRock Flexroc Gypsum Board.
 - c. National Gypsum; Gold Bond High Flex Gypsum Board.
 - d. Pabco; Pabco Flex.
 - e. USG; Sheetrock Brand Flexible Gypsum Panels.
- C. Interior Impact Resistant Wallboard:
 - 1. Application: High Traffic Areas, locker rooms, concessions team rooms.
 - 2. Surface Abrasion: Level 2, minimum, when tested in accordance with ASTM C1629/C1629M.
 - 3. Indentation: Level 1, minimum, when tested in accordance with ASTM C1629/C1629M.

4. Soft Body Impact: Level 3, minimum, when tested in accordance with ASTM C1629/C1629M.
 5. Hard Body Impact: Level 3, minimum, when tested in accordance with ASTM C1629/C1629M.
 6. Mold Resistance: Score of 10, when tested in accordance with ASTM D3273.
 7. Paper-Faced Type: Gypsum wallboard, as defined in ASTM C1396/C1396M.
 8. Glass Mat-Faced Type: Gypsum wallboard, as defined in ASTM C1658/C1658M.
 9. Type: Fire-resistance-rated Type X, UL or WH listed.
 10. Thickness: 5/8 inch.
 11. Edges: Tapered.
 12. Paper-Faced Products:
 - a. American Gypsum Company; M-Bloc IR Type X: www.americangypsum.com/#sle.
 - b. CertainTeed Corporation; Extreme Impact Resistant Drywall with M2Tech: www.certainteed.com/#sle.
 - c. Gold Bond Building Products, LLC provided by National Gypsum Company; Gold Bond XP Hi-Impact Gypsum Board: www.goldbondbuilding.com/#sle.
 - d. USG Corporation; Sheetrock Brand Mold Tough VHI Firecode X Panels 5/8 in. (15.9 mm): www.usg.com/#sle.
 - e. Substitutions: See Section 01 2500 - Substitution Procedures.
 13. Glass Mat Faced Products: Noncombustible, moisture-resistant gypsum core encased in a fiberglass face and back that shed water. Provide minimum 20-gauge (0.0296 inch) (0.752 mm) steel studs, as defined by the Steel Stud Manufacturers Association (SSMA). Non intended for exterior applications or constant exposure to water. Protect from immersion in water and the eroding effects of cascading water. Product is not suitable for use as a substrate for tile in wet areas such as tubs, showers, gang shower and other areas subject to direct water exposure. Refer to Gypsum Association's GA-216 reference guide, or ASTM C840 reference standard for additional installation requirements.
 - a. Gold Bond Building Products, LLC provided by National Gypsum Company; Gold Bond eXP Interior Extreme IR Gypsum Panel: www.goldbondbuilding.com/#sle.
 - b. USG Corporation; Sheetrock Brand Glass-Mat Panels Mold Tough VHI Firecode X 5/8 in. (15.9 mm): www.usg.com/#sle.
 - c. Substitutions: See Section 01 2500 - Substitution Procedures.
- D. Backing Board For Wet Areas:
1. Mold Resistance: Score of 10, when tested in accordance with ASTM D3273.
 2. ANSI Cement-Based Board: Non-gypsum-based; aggregated Portland cement panels with glass fiber mesh embedded in front and back surfaces complying with ANSI A118.9 or ASTM C1325.
 - a. Thickness: 5/8 inch.
 - b. Products:
 - 1) Custom Building Products; Wonderboard: www.custombuildingproducts.com/#sle.
 - 2) PermaBASE Building Products, LLC provided by National Gypsum Company; PermaBase Cement Board: www.goldbondbuilding.com/#sle.
 - 3) USG Corporation; Fiberock Brand Aqua-Tough AR Interior Panels Regular 5/8 in. (15.9 mm): www.usg.com/#sle.
 - 4) Substitutions: See Section 01 2500 - Substitution Procedures.
 3. Glass Mat Faced Board: Coated glass mat water-resistant gypsum backing panel as defined in ASTM C1178/C1178M.
 - a. Fire-Resistance-Rated Type: Type X core, thickness 5/8 inch.
 - b. Products:
 - 1) CertainTeed Corporation; 5/8" GlasRoc Tile Backer Type X: www.certainteed.com/#sle.

- 2) Georgia-Pacific Gypsum; DensShield Tile Backer: www.gpgypsum.com/#sle.
 - 3) Gold Bond Building Products, LLC provided by National Gypsum Company; Gold Bond eXP Fire-Shield Tile Backer: www.goldbondbuilding.com/#sle.
 - 4) USG Corporation; Durock Brand Glass-Mat Tile Backerboard 5/8 in. (15.9 mm): www.usg.com/#sle.
 - 5) Substitutions: See Section 01 2500 - Substitution Procedures.
- E. Exterior Gypsum Sheathing Board: Sizes to minimize joints in place; ends square cut.
1. Application: Exterior sheathing, unless otherwise indicated.
 2. Mold Resistance: Score of 10, when tested in accordance with ASTM D3273.
 3. Fungal Resistance: No fungal growth when tested in accordance with ASTM G21.
 4. Glass Mat Faced Sheathing: Glass mat faced gypsum substrate as defined in ASTM C1177/C1177M.
 5. 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.
 6. Type X Thickness: 5/8 inch.
 7. Edges: Square.
 8. Glass Mat Faced Products:
 - a. American Gypsum Company; M-Glass Exterior Sheathing Type X: www.americangypsum.com/#sle.
 - b. CertainTeed Corporation; GlasRoc Type X Exterior Sheathing: www.certainteed.com/#sle.
 - c. Georgia-Pacific Gypsum; DensGlass Fireguard Sheathing: www.gpgypsum.com/#sle.
 - d. Gold Bond Building Products, LLC provided by National Gypsum Company; Gold Bond eXP Fire-Shield Sheathing: www.goldbondbuilding.com/#sle.
 - e. Pabco; Pabco Glass Type X Sheathing.
 - f. USG Corporation; Securock Brand UltraLight Glass-Mat Sheathing Firecode X 5/8 in. (15.9 mm): www.usg.com/#sle.
 - g. Substitutions: See Section 01 2500 - Substitution Procedures.

2.06 ACOUSTIC INSULATION

- A. See Section 098100 - Acoustic Insulation.

2.07 GYPSUM BOARD ACCESSORIES

- A. Acoustic Sealant: Acrylic emulsion latex or water-based elastomeric sealant; do not use solvent-based non-curing butyl sealant.
1. Products:
 - a. Accumetric LLC; BOSS 826 Acoustical Sound Sealant.
 - b. Franklin International, Inc; Titebond Acoustical Smoke & Sound Sealant: www.titebond.com/#sle.
 - c. Grabber Construction Products; Acoustical Sealant GSC.
 - d. Pecora Corporation; AC-20 FTR.
 - e. Specified Technologies Inc; Smoke N Sound Acoustical Sealant: www.stifirestop.com/#sle.
 - f. USG; Sheetrock Acoustical Sealant.
 - g. Substitutions: See Section 01 2500 - Substitution Procedures.
- B. Sound Barrier Mullion Trim Cap: Extruded aluminum trim for maintaining sound barriers at intersections between gypsum walls and glazing assemblies.
1. Products:
 - a. Balco; BQSWA (SilentSeal).

- b. Emseal (Sika); QuietJoint.
 - c. Gordon Incorporated; Mullion Mate, Series 30.
 - d. Mull-It-Over Products, Inc; Mull-It-Over 55 - Classic: mullitoverproducts.com/#sle.
 - e. Substitutions: See Section 01 2500 - Substitution Procedures.
- C. Finishing Accessories: ASTM C1047, extruded aluminum alloy (6063 T5) or galvanized steel sheet ASTM A924/A924M G90, unless noted otherwise.
 - 1. Manufacturers:
 - a. Amico.
 - b. Flannery.
 - c. Fry Reglet.
 - d. Gordon.
 - e. Phillips Manufacturing.
 - f. Pittcon.
 - g. Stockton Products.
 - h. USG.
 - i. Substitutions: See Section 01 2500 - Substitution Procedures.
 - 2. Types: As detailed or required for finished appearance.
- D. Joint Materials: ASTM C475/C475M and as recommended by gypsum board manufacturer for project conditions.
 - 1. Fiberglass Tape: 2 inch wide, coated glass fiber tape for joints and corners, except as otherwise indicated.
 - 2. Paper Tape: 2 inch wide, creased paper tape for joints and corners, except as otherwise indicated.
 - 3. Joint Compound: Drying type, vinyl-based, ready-mixed.
 - 4. Joint Compound: Setting type, field-mixed.
- E. Finishing Compound: Surface coat and primer, takes the place of skim coating.
- F. Screws for Fastening of Gypsum Panel Products to Cold-Formed Steel Studs Less than 0.033 inches in Thickness and Wood Members: ASTM C1002; self-piercing tapping screws, corrosion-resistant.
- G. Screws for Fastening of Gypsum Panel Products to Steel Members from 0.033 to 0.112 inch in Thickness: ASTM C954; steel drill screws, corrosion-resistant.

PART 3 EXECUTION

3.01 EXAMINATION

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

3.02 FRAMING INSTALLATION

- A. See Section 092216 - Non-Structural Metal Framing.

3.03 ACOUSTIC ACCESSORIES INSTALLATION

- A. Acoustic Insulation: Place tightly within spaces, around cut openings, behind and around electrical and mechanical items within partitions, and tight to items passing through partitions.
- B. Acoustic Sealant: Install in accordance with manufacturer's instructions.
- C. Sound Barrier Mullion Trim Cap Installation: Install in accordance with manufacturer's instructions for installation of fire-rated mullion trim caps.

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. Exterior Sheathing: Comply with ASTM C1280. Install sheathing vertically, with edges butted tight and ends occurring over firm bearing.
- D. Cementitious Backing Board: Install over steel framing members and plywood substrate where indicated, in accordance with ANSI A108.11 and manufacturer's instructions.
- E. Installation on Metal Framing: Use screws for attachment of gypsum board except face layer of nonrated double-layer assemblies, which may be installed by means of adhesive lamination.
- F. Curved Surfaces: Apply gypsum board to curved substrates in accordance with GA-226.

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.
- D. Decorative Trim: Install at locations shown on drawings and in accordance with manufacturer's instructions.
- E. Moisture Guard Trim: Install on bottom edge of gypsum board according to manufacturer's instructions and in locations indicated on drawings.

3.06 JOINT TREATMENT

- A. Glass Mat Faced Gypsum Board and Exterior Glass Mat Faced Sheathing: Use fiberglass joint tape, embed and finish with setting type joint compound.
- B. Paper Faced Gypsum Board: Use paper joint tape, embed with drying type joint compound and finish with drying type joint compound.
- C. 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 3: Walls to receive textured wall finish.
 - 4. Level 2: In utility areas, behind cabinetry, and on backing board to receive tile finish.
 - 5. Level 1: Fire-resistance-rated wall areas above finished ceilings, whether or not accessible in the completed construction.
- D. 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.
- E. 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 TOLERANCES

- A. Maximum Variation of Finished Gypsum Board Surface from True Flatness: 1/8 inch in 10 feet in any direction.

3.08 CLEANING

- A. See Section 017000 - Execution and Closeout Requirements for additional requirements.

3.09 PROTECTION

- A. Protect installed gypsum board assemblies from subsequent construction operations.

END OF SECTION

SECTION 092216
NON-STRUCTURAL METAL FRAMING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Metal partition, ceiling, and soffit framing.
- B. Framing accessories.

1.02 RELATED REQUIREMENTS

1.03 REFERENCE STANDARDS

- A. AISI S100 - North American Specification for the Design of Cold-Formed Steel Structural Members; 2016, with Supplement (2020).
- B. AISI S220 - North American Standard for Cold-Formed Steel Nonstructural Framing; 2020.
- C. ASTM A36/A36M - Standard Specification for Carbon Structural Steel; 2019.
- D. AISI SG02-1 - North American Specification for the Design of Cold-Formed Steel Structural Members; American Iron and Steel Institute; 2001 with 2004 supplement. (replaced SG-971)
- E. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2023.
- F. ASTM A1003/A1003M - Standard Specification for Steel Sheet, Carbon, Metallic- and Nonmetallic-Coated for Cold-Formed Framing Members; 2015.
- G. ASTM C645 - Standard Specification for Nonstructural Steel Framing Members; 2018.
- H. ASTM C1007 - Standard Specification for Installation of Load Bearing (Transverse and Axial) Steel Studs and Related Accessories; 2020.
- I. ASTM C754 - Standard Specification for Installation of Steel Framing Members to Receive Screw-Attached Gypsum Panel Products; 2020.
- J. CBC Section 1614A - California Building Code; Structural Integrity.
- K. CBC Section 2504.2 - California Building Code; Vertical and Horizontal Assemblies.
- L. CBC Section 2506.2.1 - California Building Code; Gypsum Board Materials.

1.04 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Shop Drawings: Coordinate requirements with Section 092116 - Gypsum Board Assemblies.
 - 1. Indicate prefabricated work, component details, stud layout, framed openings, anchorage to structure, acoustic details, type and location of fasteners, accessories, and items of other related work.
 - 2. Describe method for securing studs to tracks, splicing, and for blocking and reinforcement of framing connections.
- C. Product Data: For each item to be installed. Provide data describing framing member materials and finish, product criteria, load charts, and limitations.
 - 1. Provide manufacturer's data on partition head to structure connectors, showing compliance with requirements.

- D. Delegated Design Documents: See Section 01 3000 - Administrative Requirements.
 - 1. Provide design documentation prepared by Contractor's Licensed Professionals.
- E. Sustainable Product Data: See Section 01 6000 - Product Requirements and Section 01 6116 - Volatile Organic Compound (VOC) Content Restrictions.
 - 1. Life cycle data.
 - 2. Recycled content data.
 - 3. VOC content restrictions data.
- F. Steel Framing Industry Association (SFIA) Certification:
 - 1. Submit documentation that metal studs and connectors used on project meet or exceed requirements of International Building Code.
 - 2. Submit current documentation of contractor and fabricator accreditation. Keep copies of each on-site during and after installation, and present upon request.
- G. Test Reports: For stud framing products that do not comply with AISI S220 or ASTM C754, provide independent laboratory reports showing maximum stud heights at required spacings and deflections.
- H. Manufacturer's installation instructions.
- I. Qualification Statements: For manufacturer and installer.
- J. Manufacturer's Installation Instructions: Indicate special procedures and perimeter conditions requiring special attention.
- K. Evaluation Reports: For steel studs and runners, slip-type head joints, firestop tracks, suspension systems, and hanger anchors from ICC-ES.

1.05 QUALITY ASSURANCE

- A. Qualifications: See Section 01 4000 - Quality Requirements.
- B. Installer Qualifications: Company specializing in performing the work of this section with minimum five years documented experience and approved by manufacturer.
- C. Manufacturer Qualifications: Member of Steel Stud Manufacturers Association (SSMA): www.ssma.com/#sle.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. See Section 01 6000 - Product Requirements.
- B. Deliver materials to Project site in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, approval or listing agency markings, and directions for storing.
- C. Protect materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources. Store in a dry location.
- D. See Section 01 7419 - Construction Waste Management and Disposal, for packaging waste requirements.

1.07 WARRANTY

- A. See Section 01 6000 - Product Requirements and Section 01 7800 - Closeout Submittals for additional warranty requirements.
- B. Provide manufacturer's standard warranty for each product.

PART 2 PRODUCTS

2.01 DELEGATED DESIGN

- A. Delegated Design: See Section 01 3000 - Administrative Requirements.
- B. Engage a qualified professional engineer, as defined in Section 01 4000 - Quality Requirements, to design metal stud wall assemblies and shaft wall assemblies. Coordinate with Section 092116 - Gypsum Board Assemblies.

2.02 SUSTAINABLE PRODUCT REQUIREMENTS

- A. See Section 01 6000 - Product Requirements.
- B. VOC Content Restrictions: Products in this section to not exceed VOC content limits specified in Section 01 6116 - Volatile Organic Compound (VOC) Content Restrictions.
- C. Life Cycle: Products in this section to have LCA as specified in Section 016000.
- D. Recycled Content: Products in this Section to meet minimum recycled content thresholds specified in Section 016000.

2.03 PERFORMANCE REQUIREMENTS

- A. Refer to Section 092116 - Gypsum Board Assemblies for additional information.

2.04 MANUFACTURERS

- A. Metal Framing, Connectors, and Accessories:
 - 1. Cemco.
 - 2. ClarkDietrich.
 - 3. Jaimes Industries.
 - 4. MarinoWare.
 - 5. R-Stud.
 - 6. Scafco.
 - 7. Simpson Strong Tie.
 - 8. Steel Construction Systems.
 - 9. Steel Network.
 - 10. Super Stud Building Products.
 - 11. Telling Industries.
 - 12. Substitutions: See Section 01 2500 - Substitution Procedures.

2.05 FRAMING MATERIALS

- A. Fire-Resistance-Rated Assemblies: Comply with applicable code and as indicated on drawings.
- B. Loadbearing Studs: As specified in Section 054000.
- C. Steel Sheet: ASTM A1003/A1003M, subject to the ductility limitations indicated in AISI S220.
 - 1. Structural Grade: As required to meet design criteria.
 - 2. Corrosion Protection Coating Designation: G40, or equivalent in accordance with AISI S220.
- D. Non-Loadbearing Framing System Components: AISI S220; sheet steel, of size and properties necessary for the spacing indicated, with maximum deflection of wall framing of L/240 at 5 psf.
 - 1. Studs: C-shaped with flat faces.
 - 2. Runners: U-shaped, sized to match studs.
 - 3. Furring: Hat-shaped sections, minimum depth of 7/8 inch.

4. Resilient Furring Channels: Single leg configuration; 1/2 inch channel depth.
 - a. Products:
 - 1) ClarkDietrich; RC Deluxe Resilient Channel: www.clarkdietrich.com/#sle.
 - 2) Substitutions: See Section 01 2500 - Substitution Procedures.
5. Resilient Sound Isolation Clips: Steel resilient clips with molded rubber isolators, attach to framing; improve noise isolation for areas between gypsum board assemblies and adjacent sources of noise.
 - a. Products:
 - 1) Acoustical Solutions; Isolation Clips for Wall and Ceilings.
 - 2) Pliteq; GenieClip.
 - 3) Substitutions: See Section 01 2500 - Substitution Procedures.
- E. Gypsum Board Ceiling Suspension Grid: ASTM C645, direct-hung system composed of main beams and cross-furring members that interlock.
 1. Products:
 - a. Armstrong; Drywall Grid Systems.
 - b. Rockfon; Chicago Metallic Drywall Grid System.
 - c. USG; Drywall Suspension System.
 - d. Substitutions: See Section 01 2500 - Substitution Procedures.
- F. Shaft Wall Studs and Accessories: AISI S220; galvanized sheet steel, of size and properties necessary to comply with ASTM C754 and specified performance requirements.
- G. Partition Head to Structure Connections: Provide mechanical anchorage devices that accommodate deflection using slotted holes, screws, and anti-friction bushings, preventing 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.
 3. Provide components UL-listed for use in UL-listed fire-resistance-rated head of partition joint systems indicated on drawings.
- H. Deflection and Firestop Track: Intumescent strip factory-applied to track flanges expands when exposed to heat or flames to provide a perimeter joint seal.
 1. Products:
 - a. ClarkDietrich; BlazeFrame Firestop Deflection Track: www.clarkdietrich.com/#sle.
 - b. Substitutions: See Section 01 2500 - Substitution Procedures.
- I. Preformed Top Track Firestop Seal:
 1. Provide components UL-listed for use in UL-listed fire-resistance-rated head of partition joint systems indicated on drawings.
 2. Products:
 - a. Hilti, Inc; Top Track Seal CFS TTS: www.us.hilti.com/#sle.
 - b. Specified Technologies Inc; SpeedFlex TTG Track Top Gasket: www.stfirestop.com/#sle.
 - c. Substitutions: See Section 01 2500 - Substitution Procedures.
- J. Non-Loadbearing Framing Accessories:
 1. Ceiling Hangers: Type and size as specified in ASTM C754 for spacing required.
 2. Partial Height Wall Framing Support: Provides stud reinforcement and anchored connection to floor.
 - a. Materials: ASTM A36/A36M formed sheet steel support member with factory-welded ASTM A1003/A1003M steel plate base.
 - b. Height: As shown on the Architectural drawings.
 - c. Products:
 - 1) ClarkDietrich; Pony Wall (PW): www.clarkdietrich.com/#sle.

- 2) Simpson Strong-Tie; RCKW Kneewall Connector: www.strongtie.com/#sle.
- 3) Substitutions: See Section 01 2500 - Substitution Procedures.
3. Bracing and Bridging: ASTM A653/A653M G90 galvanized steel; for lateral bracing of wall studs with slots for engaging on-module studs.
4. Framing Connectors: ASTM A653/A653M steel clips; secures cold rolled channel to wall studs for lateral bracing.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Verify that rough-in utilities are in proper location.

3.02 INSTALLATION, GENERAL

- A. Install components in accordance with manufacturer's written instructions and approved shop drawings.

3.03 INSTALLATION OF STUD FRAMING

- A. Install non-structural members in accordance with ASTM C754.
- B. Install structural members and connections in accordance with ASTM C1007.
- C. Comply with requirements of CBC Section 1614A and Section 2504.2.
- D. Extend partition framing to structure where indicated and to ceiling in other locations.
- E. Partitions Terminating at Ceiling: Attach ceiling runner securely to ceiling track in accordance with manufacturer's instructions.
- F. 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.
- G. Align and secure top and bottom runners at 24 inches on center.
- H. Fit runners under and above openings; secure intermediate studs to same spacing as wall studs.
- I. Install studs vertically at spacing indicated on drawings.
- J. Align stud web openings horizontally.
- K. Secure studs to tracks using crimping method. Do not weld.
- L. Fabricate corners using a minimum of three studs.
- M. Install double studs at wall openings, door and window jambs, not more than 2 inches from each side of openings.
- N. Coordinate installation of bucks, anchors, and blocking with electrical, mechanical, and other work to be placed within or behind stud framing.
- O. Sound Isolation Clips: Mechanically attach to framing or structure with fasteners recommended by clip manufacturer. Install at spacing indicated on drawings.
- P. Furring: Coordinate with sound isolation clip spacing and locations. Lap splices a minimum of 6 inches.

3.04 CEILING AND SOFFIT FRAMING

- A. Comply with requirements of ASTM C754.
- B. Comply with requirements of CBC Section 1614A.
- C. Install furring after work above ceiling or soffit is complete. Coordinate the location of hangers with other work.
- D. Install furring independent of walls, columns, and above-ceiling work.
- E. Securely anchor hangers to structural members or embed them in structural slab. Space hangers as required to limit deflection to criteria indicated. Use rigid hangers at exterior soffits.
- F. Space main carrying channels at maximum 72 inches on center, and not more than 6 inches from wall surfaces. Lap splice securely.
- G. Securely fix carrying channels to hangers to prevent turning or twisting and to transmit full load to hangers.
- H. Place furring channels perpendicular to carrying channels, not more than 2 inches from perimeter walls, and rigidly secure. Lap splices securely.
- I. Laterally brace suspension system.

3.05 TOLERANCES

- A. Maximum Variation From True Position: 1/8 inch in 10 feet.
- B. Maximum Variation From Plumb: 1/8 inch in 10 feet.

END OF SECTION

SECTION 092236
LATH

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Metal lath for cement plaster.

1.02 RELATED REQUIREMENTS

- A. Section 054000 - Cold-Formed Metal Framing: Sheathing on exterior walls.
- B. Section 083100 - Access Doors and Panels: Product requirements for metal access panels integral with metal lath.
- C. Section 092400 - Cement Plastering.

1.03 REFERENCE STANDARDS

- A. ASTM A641/A641M - Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire; 2019 (Reapproved 2025).
- B. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2023.
- C. ASTM A924/A924M - Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process; 2022a.
- D. ASTM C841 - Standard Specification for Installation of Interior Lathing and Furring; 2023.
- E. ASTM C847 - Standard Specification for Metal Lath; 2018 (Reapproved 2024).
- F. ASTM C926 - Standard Specification for Application of Portland Cement-Based Plaster; 2023a.
- G. ASTM C933 - Standard Specification for Welded Wire Lath; 2023.
- H. ASTM C954 - Standard Specification for Steel Drill Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Steel Studs from 0.033 in. (0.84 mm) to 0.112 in. (2.84 mm) in Thickness; 2022.
- I. ASTM C1002 - Standard Specification for Steel Self-Piercing Tapping Screws for Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs; 2022.
- J. ASTM C1063 - Standard Specification for Installation of Lathing and Furring to Receive Interior and Exterior Portland Cement-Based Plaster; 2024.
- K. ASTM C1861 - Standard Specification for Lathing and Furring Accessories, and Fasteners, for Interior and Exterior Portland Cement-Based Plaster; 2023a.

1.04 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data on furring and lathing components, structural characteristics, material limitations, and finish.

1.05 QUALITY ASSURANCE

- A. Installer Qualifications: Company specializing in performing the work of this section with at least three years of documented experience.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Metal Lath:
 - 1. Basis of Design Manufacturer:
 - a. Structa Wire Corp.
 - b. Substitutions: See Section 01 2500 - Substitution Procedures.
- B. Accessories:
 - 1. Alabama Metal Industries Corporation (AMICO).
 - 2. Cemco.
 - 3. ClarkDietrich.
 - 4. MarinoWare.
 - 5. Phillips Manufacturing.
 - 6. Stockton Products.
 - 7. Substitutions: See Section 01 2500 - Substitution Procedures.

2.02 FRAMING AND LATH ASSEMBLIES

- A. Provide completed assemblies with the following characteristics:
 - 1. Maximum Deflection of Vertical Assemblies: 1:360 under lateral point load of 100 lbs.
 - 2. Maximum Deflection of Horizontal Assemblies: 1:240 deflection under dead loads and wind uplift.
- B. Fire Rated Assemblies: Provide components complying with requirements for fire rated assemblies specified in the section where the plaster finish is specified.

2.03 LATH

- A. Wire Lath: ASTM C933, Class 1 Galvanized Coating complying with ASTM A641/A641M:
 - 1. Basis of Design Products:
 - a. Structa Wire Corporation; Structa Mega Lath.
 - 1) Application: Heavy duty reinforcing for commercial and institutional construction.
 - 2) Weight 1.95 lb/yd² (1.1 kg/sq.m).
 - 3) Finish - Class 1 Galvanized Coating complying with ASTM A641/A641M.
 - 4) Alternate lath to 3.4 lb/yd² diamond mesh metal lath specified in ASTM C847.
 - 5) As per IAPMO - UES 2017.
 - b. Structa Wire Corporation; V Truss Wall & Ceiling - Rib Lath.
 - 1) Application: Soffits and open frame ceilings.
 - 2) Weight 2.2 lb/yd² (1.2 kg/sq.m)
 - 3) Finish - Class 1 Galvanized Coating complying with ASTM A641/A641M.
 - 4) Alternate lath to 3.4 lb/yd² rib metal lath specified in ASTM C847.
 - 5) As per IAPMO - UES 2017
 - c. Structa Wire Corporation; V Truss Corners.
 - 1) Application: Exterior corner reinforcements.
 - 2) Available in Straight, Bullnose, Arch & One Coat profiles.
 - 3) Finish - Class 1 Galvanized Coating complying with ASTM C847.
 - 4) As per IAPMO - UES 2017.
- B. Finishing Accessories: ASTM C841 or ASTM C1063; extruded aluminum alloy (6063 T5), galvanized steel sheet ASTM A924/A924M G90, or galvanized steel wire, unless noted otherwise.
 - 1. Types: As detailed or required for finished appearance.

- C. Beads, Screeds, Joint Accessories, and Other Trim: Depth governed by plaster thickness, and maximum possible lengths.
 - 1. Material: Formed zinc, expanded metal flanges.
 - 2. Casing Beads with Weep Holes: Square edges.
 - a. Products:
 - 1) Alabama Metal Industries Corporation; E-Z Bead: www.amicoglobal.com/#sle.
 - 2) Phillips Manufacturing Co; #66 Expanded Flange Square Casing Bead: www.phillipsmfg.com/#sle.
 - 3) Stockton Products; CDB Casing Bead.
 - 4) Substitutions: See Section 01 2500 - Substitution Procedures.
 - 3. Corner Beads: Radiused corners.
 - a. Products:
 - 1) Phillips Manufacturing Co; #1 Expanded Corner Bead: www.phillipsmfg.com/#sle.
 - 2) Stockton Products; CA CornerAid and CRT CornerRite.
 - 3) Substitutions: See Section 01 2500 - Substitution Procedures.
 - 4. Base Screeds:
 - a. Material: Galvanized steel, ASTM A653/A653M, with G90/Z275 zinc coating; minimum 26-gauge, 0.0179-inch thick base metal.
 - b. Products:
 - 1) Masonry Technology Incorporated; L & R Weep Screed: www.mtidry.com/#sle.
 - 2) Stockton Products; OWS Offset Weep Screed.
 - 3) Substitutions: See Section 01 2500 - Substitution Procedures.
 - 5. Expansion Joints: Two-piece sliding type with reveal, 2 inch wide flanges.
 - a. Products:
 - 1) Stockton Products; OWC Offset Water-Resistant Expansion Channel.
 - 2) Substitutions: See Section 01 2500 - Substitution Procedures.
 - 6. Control Joints: Accordion profile with factory-installed protective tape, 2 inch flanges.
 - a. Products:
 - 1) Stockton Products; NVS Narrow V-Screed.
 - 2) Substitutions: See Section 01 2500 - Substitution Procedures.
 - 7. Soffit Vents:
 - a. Products:
 - 1) Stockton Products; Metal-SVR.
 - 2) Substitutions: See Section 01 2500 - Substitution Procedures.
 - 8. Reveal Moldings: Aluminum extruded alloy 6063 TS with chemical conversion coating, clear anodized:
 - a. Manufacturers:
 - 1) Fry Reglet.
 - 2) Substitutions: See Section 01 2500 - Substitution Procedures.
 - b. Profiles as shown on the Architectural drawings.

2.04 ACCESSORIES

- A. Tie Wire: Comply with ASTM C1861.
 - 1. Carbon Steel Wire: ASTM A641/A641M; annealed, Class 1, zinc-coated galvanized.
 - a. Wire Diameter: 18 gauge, 0.0475 inch uncoated.
- B. Fasteners: Minimum #8 Type S water head fully-threaded corrosion-resistant screws; ASTM C1002 or ASTM C954; meeting requirements of ASTM C1063.
 - 1. Metal Studs: Minimum 3/8 inch penetration.
 - 2. Wood Studs: Minimum 3/4 inch penetration.

3. Spacing:
 - a. Vertically: 7 inches on center, maximum.
 - b. Horizontally: 24 inches on center, maximum.
4. California: Comply with CBC 2507.3 and CBC 2510.

2.05 ACCESS PANELS

- A. Access Panels: See Section 083100 - Access Doors and Panels.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Verify that substrates are ready to receive work and conditions are suitable for application.
- C. For exterior plaster and stucco on stud walls, verify that water-resistive barrier has been installed over sheathing substrate completely and correctly.
- D. Do not begin until unacceptable conditions have been corrected.
- E. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.02 INSTALLATION - GENERAL

- A. Install lathing and furring for exterior and interior cement plaster in accordance with ASTM C926, ASTM C1063, and manufacturer's evaluation report for alternative installation requirements.
- B. Install lath and furring for fire-rated assemblies in accordance with requirements of assembly as indicated.

3.03 WALL FURRING INSTALLATION

- A. Install furring channels horizontally; secure with fasteners on alternate channel flanges at maximum 24 inches on center.
- B. Space furring channels maximum 16 inches on center, and not more than 4 inches away from floor and ceiling lines.
- C. Space resilient channels at maximum 24 inches on center. Place joints over framing members.

3.04 CEILING AND SOFFIT **FRAMING AND FURRING INSTALLATION**

- A. Install furring after work above ceiling or soffit is complete. Coordinate the location of hangers with other work.
- B. Install furring independent of walls, columns, and above-ceiling work.
- C. Securely anchor hangers to structural members or embed in structural slab. Space hangers as required to limit deflection to criteria indicated. Use rigid hangers at exterior soffits.
- D. Space main carrying channels at maximum 72 inch on center, and not more than 6 inches from wall surfaces. Lap splice securely.
- E. Securely fix carrying channels to hangers to prevent turning or twisting and to transmit full load to hangers.
- F. Install furring channels perpendicular to carrying channels, not more than 2 inches from perimeter walls, and rigidly secure. Lap splices securely.

- G. Reinforce openings in suspension system that interrupt main carrying channels or furring channels with lateral channel bracing. Extend bracing minimum 24 inches past each opening.
- H. Laterally brace suspension system.

3.05 CONTROL AND EXPANSION JOINT INSTALLATION

- A. Locate joints as indicated on drawings and comply with ASTM C1063.
 - 1. Area of plaster panel not to exceed 144 sq ft for vertical surfaces.
 - 2. Area of plaster panel not to exceed 100 sq ft for horizontal, curved or angled surfaces.
 - 3. Spacing between control joints not to exceed 18 ft in each direction.
 - 4. Area bounded by control joints not to exceed a length-to-width ratio of 2-1/2 to 1.
- B. Install prefabricated joint accessories in accordance with ASTM C1063.

3.06 ACCESS PANELS INSTALLATION

- A. Install access panels and rigidly secure in place.
- B. Install frames plumb and level in opening. Secure rigidly in place.
- C. Position to provide convenient access to concealed work requiring access.

3.07 LATH INSTALLATION

- A. Apply lath taut, with long dimension perpendicular to supports.
- B. Lap or nest ends of metal lath in accordance with ASTM C841.
- C. Secure end laps with tie wire where they occur between supports.
- D. Attach metal lath to metal supports at maximum 6 inches on center.
- E. Attach metal lath to concrete using wire loops. Attach anchors to backup surface; space at maximum 24 inches on center.
- F. Continuously reinforce internal angles with corner mesh, except where the metal lath returns 3 inches from corner to form the angle reinforcement; fasten at perimeter edges only.
- G. Place corner bead at external wall corners; fasten at outer edges of lath only.
- H. Place base screeds at termination of plaster areas; secure rigidly in place.
- I. Place lath vertically above each top corner and each side of door frames to 6 inches above ceiling line.
- J. Place casing beads at terminations of plaster finish. Butt and align ends. Secure rigidly in place.
- K. Place additional strip mesh diagonally at corners of lathed openings. Secure rigidly in place.

3.08 TOLERANCES

- A. Maximum Variation from True Lines and Levels: 1/8 inch in 10 feet.
- B. Maximum Variation from True Position: 1/8 inch.

END OF SECTION

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**SECTION 092400
CEMENT PLASTERING**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Cement plastering.

1.02 RELATED REQUIREMENTS

- A. Section 072500 - Weather Barriers: Water-resistive barrier.
- B. Section 092116 - Gypsum Board Assemblies: Acoustical sealing in conjunction with metal stud framing and furring for plaster.
- C. Section 092236 - Lath: Lath, furring, beads, screeds, and joint accessories for plaster base.

1.03 REFERENCE STANDARDS

- A. ASTM C150/C150M - Standard Specification for Portland Cement; 2024.
- B. ASTM C207 - Standard Specification for Hydrated Lime for Masonry Purposes; 2018.
- C. ASTM C926 - Standard Specification for Application of Portland Cement-Based Plaster; 2023a.
- D. ASTM C1063 - Standard Specification for Installation of Lathing and Furring to Receive Interior and Exterior Portland Cement-Based Plaster; 2024.
- E. ASTM D779 - Standard Test Method for Determining the Water Vapor Resistance of Sheet Materials in Contact with Liquid Water by the Dry Indicator Method; 2016.
- F. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2024.
- G. ASTM E96/E96M - Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials; 2024a.
- H. ASTM E119 - Standard Test Methods for Fire Tests of Building Construction and Materials; 2024.
- I. ICC-ES AC308 - Acceptance Criteria for Water-Resistive Barriers; 2016, with Editorial Revision (2021).

1.04 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittals procedures.
- B. Product Data: Provide data on plaster materials and trim accessories.
- C. Sustainable Product Data: See Section 01 6000 - Product Requirements and Section 01 6116 - Volatile Organic Compound (VOC) Content Restrictions.
 - 1. VOC content restrictions data.
 - 2. Life cycle data.
- D. Manufacturer's installation instructions.
- E. Evaluation Service Reports: Show compliance with specified requirements.

1.05 QUALITY ASSURANCE

- A. Qualifications: See Section 01 4000 - Quality Requirements.
- B. Installer Qualifications: Company specializing in performing the work of this section with minimum years experience.
- C. Preinstallation Meetings: See Section 01 3000 - Administrative Requirements.
 - 1. Convene minimum 2 weeks before starting work of this Section.

1.06 MOCK-UPS

- A. See Section 014000 - Quality Requirements for additional requirements.
- B. Construct mock-up of exterior and interior wall, illustrating surface finish.
 - 1. Locate where directed by Architect.
 - 2. Mock-up may remain as part of this work.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. See Section 01 6000 - Product Requirements.
- B. Deliver materials to Project site in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, approval or listing agency markings, and directions for storing.
- C. Protect materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources. Store in a dry location.
- D. Comply with manufacturer's written instructions for handling, storing, and protecting during installation.
- E. See Section 01 7419 - Construction Waste Management and Disposal, for packaging waste requirements.

1.08 FIELD CONDITIONS

- A. Comply with ASTM C926.
- B. Exterior Plaster Work: Do not apply plaster when substrate or ambient air temperature is 40 degrees F or lower, or when temperature is expected to drop below 40 degrees F within 48 hours of application.
- C. Apply and cure plaster to prevent plaster drying out during curing period. Use procedures required by climatic conditions, including moist curing, providing coverings, and providing barriers to deflect sunlight and wind.
- D. Interior Plaster Work: Maintain minimum ambient temperature of 50 degrees F during installation of plaster and until fully cured.
- E. Factory-Prepared Finish Coats: Comply with manufacturer's written instructions for environmental conditions for applying finish coats.

1.09 WARRANTY

- A. See Section 01 6000 - Product Requirements and Section 01 7800 - Closeout Submittals for additional warranty requirements.
- B. Provide manufacturer's standard warranty for each product.

PART 2 PRODUCTS

2.01 SUSTAINABLE PRODUCT REQUIREMENTS

- A. See Section 01 6000 - Product Requirements.
- B. VOC Content Restrictions: Products in this section to not exceed VOC content limits specified in Section 01 6116 - Volatile Organic Compound (VOC) Content Restrictions.
- C. Life Cycle: Products in this section to have LCA as specified in Section 016000.

2.02 PERFORMANCE REQUIREMENTS

- A. Fire-Resistance Ratings: Where indicated on Drawings, provide cement plaster assemblies identical to those of assemblies tested for fire resistance in accordance with ASTM E119 by a qualified testing agency.

2.03 CEMENT PLASTER ASSEMBLIES

- A. Refer to Architectural drawings for locations and extents of assembly types.
- B. Exterior Cement Plaster on Metal Studs.
 - 1. Substrate: Gypsum sheathing.
 - a. See Section 092116 - Gypsum Board Assemblies.
 - 2. Air barrier.
 - a. See Section 072500 Weather Barriers
 - 3. Drainage plane mat.
 - 4. Building paper bond break, 2 layers.
 - 5. Continuous rigid insulation.
 - 6. Metal lath and accessories.
 - a. See Section 092236 - Lath.
 - 7. Plaster Type: Factory prepared plaster mix.
 - a. Number of Coats: Three.
 - b. First Coat: Apply to a nominal thickness of 3/8 inch.
 - c. Second Coat: Apply to a nominal thickness of 3/8 inch.
 - d. Finish Coat: Apply to a nominal thickness of 1/8 inch.
 - 1) Finish: Acrylic.
- C. Exterior Cement Plaster on Concrete.
 - 1. Substrate: Cast-in-place and precast concrete,.
 - 2. Bonding agent, as recommended by cement plaster manufacturer.
 - 3. Metal accessories.
 - a. See Section 092236 - Lath.
 - 4. Plaster Type: Jobsite mixed plaster.
 - a. Number of Coats: Two.
 - b. First Coat: Apply to a nominal thickness of 1/4 inch.
 - c. Finish Coat: Apply to a nominal thickness of 1/8 inch.
 - 1) Finish: Acrylic.
- D. Exterior Cement Plaster on Masonry Units.
 - 1. Substrate: CMU.
 - 2. Building paper bond break.
 - 3. Metal lath and accessories.
 - a. See Section 092236 - Lath.
 - 4. Plaster Type: Jobsite mixed plaster.
 - a. Number of Coats: Two.

- b. First Coat: Apply to a nominal thickness of 1/4 inch.
- c. Finish Coat: Apply to a nominal thickness of 1/8 inch.
 - 1) Finish: Acrylic.

2.04 MANUFACTURERS

- A. Cement Plaster Material:
 - 1. Dryvit.
 - 2. LaHabra.
 - 3. Omega Products International.
 - 4. Parex USA (Sika).
 - 5. Sika.
 - 6. Sto.
 - 7. Stuc-O-Flex.
 - 8. Substitutions: See Section 01 2500 - Substitution Procedures.

2.05 FACTORY PREPARED CEMENT PLASTER

- A. Exterior Portland cement plaster system made of scratch and brown base coat, leveling coat with reinforcing mesh, and acrylic finish coat; install in accordance with ASTM C926.
- B. Premixed One-Coat Base: Mixture of Type I Portland cement complying with ASTM C150/C150M, hydrated lime complying with ASTM C207, fibers and other approved ingredients; install in accordance with ASTM C926.
 - 1. Fiber for Base Coat: Alkaline-resistant glass or polypropylene fibers, 1/2 inch long, free of contaminants, manufactured for use in portland cement plaster.
- C. Primer: Acrylic, as recommended by coating manufacturer and compatible with plaster base coat.
- D. Premixed Finish Coating: Integrally colored, acrylic coating.
- E. Water for Mixing: Potable and free of substances capable of affecting plaster set or of damaging plaster, lath, or accessories, including:
 - 1. Water containing salt, alum, or plaster residue accelerates plaster set and may cause efflorescence.
 - 2. Water containing organic or vegetable matter may retard plaster set, cause staining, and interfere with plaster bond.

2.06 ACCESSORIES

- A. Lath: See Section 092236 - Lath.
- B. Finishing Accessories: See Section 092236 - Lath.
- C. Reinforcing Mesh: 4.5 oz/sq yd alkali-resistant mesh.
- D. Rainscreen Drainage Material:
 - 1. Rainscreen Drainage Mat: Polyester or polypropylene mesh.
 - a. Thickness: 1/8 inch.
 - b. Surface Burning Characteristics: Flame spread index of 25 or less, smoke developed index of 450 or less (Class A), when tested in accordance with ASTM E84.
 - c. Seam Tape and Bug Screen: As recommended by rainscreen drainage mat manufacturer.
- E. Building Paper (Bond Break):
 - 1. Building Paper: Asphalt-saturated kraft Grade D type sheathing paper complying with ICC-ES AC38.
 - a. Water Resistance: At least 60 minutes when tested in accordance with ASTM D779.

- b. Water Vapor Permeance: 29 perms, minimum, when tested in accordance with ASTM E96/E96M using Procedure A - Desiccant Method, at 73.4 degrees F.
- c. Products:
 - 1) Henry Company; Super Jumbo Tex 60 Minute.
 - 2) Substitutions: See Section 01 2500 - Substitution Procedures

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify existing conditions are acceptable prior to starting this work.
- B. Verify masonry joints are flush and surfaces are ready to receive work of this section, and that there are no existing bituminous or water repellent coatings on masonry surfaces.
- C. Verify concrete surfaces are flat, honeycombs are filled flush, and surfaces are ready to receive work of this section, and that there are no existing bituminous, water repellent, or form release agent coatings on concrete surfaces that may be detrimental to plaster bond.
- D. Verify lath is flat, secured to substrate, and joint and surface perimeter accessories are properly in place.
- E. Verify mechanical and electrical equipment and services located within areas to receive this work have been properly tested and approved.

3.02 PREPARATION

- A. Dampen masonry surfaces to reduce excessive suction.
- B. Clean concrete surfaces of foreign matter using approved acid solutions, solvents, or detergents, and then rinse surfaces thoroughly with clean water.
- C. Roughen smooth concrete surfaces and apply bonding compound in accordance with manufacturer's written installation instructions.
- D. Apply dash bond coat of plaster to solid bases and moist cure for at least 24 hours before applying first coat of jobsite mixed plaster.

3.03 INSTALLATION, GENERAL

- A. Install cement plaster assemblies according to approved shop drawings and manufacturer's written instructions.

3.04 INSTALLATION - BUILDING PAPER (BOND BREAK)

- A. Apply building paper horizontally with upper layer lapped over lower layer at least 2 inches.
- B. Lap building paper at least 6 inches at vertical joints.
- C. Lap building paper at least 16 inches beyond vertical line of inside and outside corners in both directions.
- D. For two layer applications, start with two horizontal layers at bottom of exterior wall or structure.

3.05 INSTALLATION - RAINSCREEN DRAINAGE MATERIAL

- A. Install rainscreen drainage material and metal lath with accessories over sheathing material and water-resistive barrier with fastening system in accordance with ASTM C1063 into wood or metal studs. Install drainage material with filter fabric mortar screen to exterior.

3.06 MIXING

- A. Mix only as much plaster as can be used prior to initial set.
- B. Mix materials dry, to uniform color and consistency, before adding water.
- C. Do not retemper mixes after initial set has occurred.
- D. Protect mixtures from frost or freezing temperatures, contamination, and excessive evaporation.

3.07 APPLICATION

- A. Apply plaster in accordance with manufacturer's written instructions and comply with ASTM C926.
- B. Base Coats:
 - 1. Apply base coat(s) to fully embed lath and to specified thickness.
 - 2. Follow guidelines in ASTM C926 and manufacturer's written installation instructions for moist curing base coats and application of subsequent coats.
- C. Finish Coats:
 - 1. Primer and Acrylic Coatings:
 - a. Remove surface contaminants such as dust and dirt without damaging substrate.
 - b. Apply primer in accordance with manufacturer's instructions.
 - c. Apply finish coating in number of coats and to thickness recommended by manufacturer.

3.08 TOLERANCES

- A. Maximum Variation from True Flatness:

3.09 REPAIR

- A. Patching: Remove loose, damaged or defective plaster and replace with plaster of same composition; finish to match surrounding area.

END OF SECTION

SECTION 093000 TILING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Tile.
- B. Thresholds.
- C. Ceramic trim.
- D. Non-ceramic trim.

1.02 RELATED REQUIREMENTS

- A. Section 090561 - Common Work Results for Flooring Preparation: Concrete slab moisture and alkalinity testing and remediation procedures.
- B. Section 092116 - Gypsum Board Assemblies: Tile backer board.

1.03 DEFINITIONS

- A. General: Definitions in the ANSI A108 Series of tile installation standards and in ANSI A137.1 apply to Work of this Section unless otherwise specified.
- B. Large Format Tile: Tiles with at least one side greater than 15 inches long, per TCNA Handbook.
- C. Heavy Tile: Tile that weighs over 5 pounds per square foot.
- D. Module Size: Actual tile size plus joint width indicated.
- E. Face Size: Actual tile size, excluding spacer lugs.
- F. Dimension Stone Tile: Modular stone units less than 3/4 inch thick.
- G. Gauged Porcelain: Products compliant with ANSI A137.3 produced from clay.
 - 1. Gauged Porcelain Tile: Gauged porcelain that is 36 inches by 36 inches and smaller.
 - 2. Gauged Porcelain Panel: Gauged porcelain that is larger than 36 inches by 36 inches.
- H. Sintered Stone: Products formed by proprietary dry materials that are sintered: compacted under intense heat and pressure, without melting to the point of liquefaction.

1.04 REFERENCE STANDARDS

- A. ANSI A108.1a - American National Standard Specifications for Installation of Ceramic Tile in the Wet-Set Method, with Portland Cement Mortar; 2023.
- B. 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.
- C. 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.
- D. ANSI A108.4 - American National Standard Specifications for Installation of Ceramic Tile with Organic Adhesive or Water Cleanable Tile-Setting Epoxy Adhesive; 2023.

- E. 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.
- F. ANSI A108.6 - American National Standard Specifications for Installation of Ceramic Tile with Chemical Resistant, Water Cleanable Tile-Setting and -Grout Epoxy; 2023.
- G. ANSI A108.8 - American National Standard Specifications for Installation of Ceramic Tile with Chemical Resistant Furan Resin Mortar and Grout; 1999 (Reaffirmed 2024).
- H. ANSI A108.9 - American National Standard Specifications for Installation of Ceramic Tile with Modified Epoxy Emulsion Mortar/Grout; 2023.
- I. ANSI A108.10 - American National Standard Specifications for Installation of Grout in Tilework; 2017 (Reaffirmed 2022).
- J. ANSI A108.11 - American National Standard Specifications for Interior Installation of Cementitious Backer Units; 2023.
- K. ANSI A108.12 - Installation of Ceramic Tile with EGP (Exterior Glue Plywood) Modified Dry-Set Mortar; 2023.
- L. 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).
- M. 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.
- N. ANSI A108.20 - American National Standard Specifications for Exterior Installation of Gauged Porcelain Tiles and Gauged Porcelain Tile Panels/Slabs; 2020.
- O. ANSI A118.3 - American National Standard Specifications for Chemical Resistant, Water Cleanable Tile-Setting and -Grouting Epoxy and Water Cleanable Tile-Setting Epoxy Adhesive; 2021.
- P. ANSI A118.5 - American National Standard Specifications for Chemical Resistant Furan Mortars and Grouts for Tile Installation; 1999 (Reaffirmed 2021).
- Q. ANSI A118.7 - American National Standard Specifications for High Performance Cement Grouts for Tile Installation; 2019.
- R. ANSI A118.10 - American National Standard Specifications for Load Bearing, Bonded, Waterproof Membranes for Thin-Set Ceramic Tile and Dimension Stone Installation; 2023.
- S. ANSI A118.12 - American National Standard Specifications for Crack Isolation Membranes for Thin-Set Ceramic Tile and Dimension Stone Installation; 2014 (Reaffirmed 2024).
- T. ANSI A118.15 - American National Standard Specifications for Improved Modified Dry-Set Cement Mortar; 2023.
- U. ANSI A137.1 - American National Standard Specifications for Ceramic Tile; 2022.
- V. ANSI A137.3 - American National Standard Specification for Gauged Porcelain Tile and Gauged Porcelain Tile Panels/Slabs; 2022 .
- W. ANSI A138.1 - Green Squared American National Standard Specifications for Sustainable Ceramic Tiles, Glass Tiles, and Tile Installation Materials; 2011 (Reaffirmed 2021).
- X. ANSI A326.3 - American National Standard Test Method for Measuring Dynamic Coefficient of Friction of Hard Surface Flooring Materials; 2021.
- Y. 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 (Reapproved 2023).

- Z. ASTM C847 - Standard Specification for Metal Lath; 2018 (Reapproved 2024).
- AA. CAL (CDPH SM) - Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers Version 1.2; 2017.
- BB. TCNA (HB) - Handbook for Ceramic, Glass, and Stone Tile Installation; 2025.
- CC. TCNA (HB-GP) - Handbook for Gauged Porcelain Tiles and Gauged Porcelain Tile Panels/Slabs Installation; 2023.

1.05 ADMINISTRATIVE REQUIREMENTS

- A. Preinstallation Meeting: Convene a preinstallation meeting minimum 2 weeks before starting work of this section; require attendance by affected installers.
 - 1. See Section 01 3000 - Administrative Requirements, for additional information.

1.06 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. Sustainable Product Data: See Section 01 6000 - Product Requirements and Section 01 6116 - Volatile Organic Compound (VOC) Content Restrictions.
 - 1. VOC content restrictions data.
 - 2. CAL (CDPH SM) compliance data.
 - 3. Life cycle data.
 - 4. Recycled content data.
- D. Shop Drawings: Indicate tile layout, patterns, color arrangement, perimeter conditions, junctions with dissimilar materials, control and expansion joints, thresholds, ceramic accessories, and setting details.
- E. Samples: Mount tile and apply grout on two plywood panels, minimum 18 by 18 inches in size illustrating pattern, color variations, and grout joint size variations.
- F. Manufacturer's installation instructions.
- G. Evaluation Service Reports: From ICC or similar. Show compliance with specified requirements.
- H. Installer's Qualification Statement:
- I. Field Quality Control Reports: As specified in Part 3 of this Section.
- J. Maintenance Data: Include recommended cleaning methods, cleaning materials, and stain removal methods.
- K. 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: 1 percent of each size, color, and surface finish combination.

1.07 QUALITY ASSURANCE

- A. Qualifications: See Section 01 4000 - Quality Requirements.
- B. Manufacturer Qualifications: Company specializing in manufacturing the types of products specified in this section, with minimum five years of documented experience.
- C. Installer Qualifications:
 - 1. Company specializing in performing tile installation, with minimum of five years of documented experience.

1.08 MOCK-UPS

- A. See Section 014000 - Quality Requirements for general requirements for mock-up.
- B. Construct tile mock-up where indicated on drawings, incorporating all components specified for the location.
 - 1. Minimum size of mock-up is indicated on drawings.
 - 2. Approved mock-up may remain as part of work.

1.09 DELIVERY, STORAGE, AND HANDLING

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

1.10 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 SUSTAINABLE PRODUCT REQUIREMENTS

- A. See Section 01 6000 - Product Requirements.
- B. VOC Content Restrictions: Products in this section to not exceed VOC content limits specified in Section 01 6116 - Volatile Organic Compound (VOC) Content Restrictions.
- C. CDPH: Products to comply with CAL (CDPH SM) .
- D. Life Cycle: Products in this section to have LCA as specified in Section 016000.
- E. Green Squared: When possible, provide tiles and installation materials that comply with ANSI A138.1 requirements.

2.02 PERFORMANCE REQUIREMENTS

- A. Dynamic Coefficient of Friction (DCOF): Tile floors to be minimum 0.42, in accordance with ANSI A326.3.

2.03 REGULATORY REQUIREMENTS

- A. Ceramic tile flooring shall be stable, firm, and slip resistant. CBC Section 11B-302.1.

2.04 TILE

- A. Tile Types: Refer to Materials Schedule on the Architectural drawings.
- B. Tile Types:
 - 1. CTB-1T: (Daltile,COLOR WHEEL CLASSIC, GALAXY 1469)
 - a. Tile Size: 4" x 4"
 - b. Grout Type: High-performance.
 - c. Grout Color: TBD - full range
 - d. Grout Width: 1/8 inch.
 - 2. CTF-1: (Daltile,EYSTONES, BUFFSTONE RANGE D147)
 - a. Tile Size: 2" x 2"
 - b. Grout Type: High-performance.
 - c. Grout Color: TBD - full range

- d. Grout Width: 1/8 inch.
- 3. CTW-1: (Daltile,COLOR WHEEL CLASSIC, BISCUIT K175)
 - 1) Tile Size: 4" x 4"
 - 2) Grout Type: High-performance.
 - 3) Grout Color: TBD - full range
 - 4) Grout Width: 1/8 inch.
- 4. CTW-2: (Daltile,COLOR WHEEL CLASSIC, GALAXY 1469)
 - a. Tile Size: 4h" x 4"
 - 1) Grout Type: High-performance.
 - 2) Grout Color: TBD - full range
 - 3) Grout Width: 1/8 inch.
- C. Ceramic Mosaic Tile: ANSI A137.1 standard grade.
 - 1. Moisture Absorption: 0 to 0.5 percent as tested in accordance with ASTM C373.
- D. Glazed Wall Tile: ANSI A137.1 standard grade.
 - 1. Moisture Absorption: 7.0 to 20.0 percent as tested in accordance with ASTM C373.
- E. Porcelain Tile: ANSI A137.1 standard grade.
 - 1. Moisture Absorption: 0 to 0.5 percent as tested in accordance with ASTM C373.

2.05 TRIM AND ACCESSORIES

- A. Ceramic Trim: Matching bullnose, double bullnose, cove base, and cove ceramic shapes in sizes coordinated with field tile.
 - 1. Applications: As shown on the Architectural drawings.
 - 2. Manufacturers: Same as for tile.
- B. Non-Ceramic Trim: Satin brass anodized extruded aluminum, style and dimensions to suit application, set with tile mortar or adhesive.
 - 1. Applications: As shown on the Architectural drawings.
 - 2. Products:
 - a. Schluter-Systems; Schiene: www.schluter.com/#sle.
 - b. Substitutions: Section 01 2500 - Substitution Procedures.

2.06 THRESHOLDS

- A. General: Fabricate to sizes and profiles indicated or required to provide transition between adjacent floor finishes.
- B. Bevel edges at 1:2 slope, with lower edge of bevel aligned with or up to 1/16 inch above adjacent floor surface. Finish bevel to match top surface of threshold. Limit height of threshold to 1/2 inch or less above adjacent floor surface.
- C. Solid Surface Thresholds: Proprietary homogenous sheet material composed of acrylic resins, fire retardant filler materials, and coloring agents; honed finish; 2 inches wide by full width of wall or frame opening; 1/2 inch thick; beveled one long edge with radiused corners on top side; without holes, cracks, or open seams; color and pattern as indicated.
 - 1. Products:
 - a. Aristech Acrylics LLC; Avonite Surfaces.
 - b. Dupont; Corian and Zodiac.
 - c. Formica Corporation; Solid Surfacing.
 - d. Wilsonart; Gibraltar and Earthstone.
 - 2. Locations:
 - a. At doorways where tile terminates.
 - b. At open edges of floor tile where adjacent finish is a different height.

- c. Where shown on the Architectural drawings.

2.07 SETTING MATERIALS

- A. Provide setting and grout materials from same manufacturer.
- B. Manufacturers:
 - 1. Ardex.
 - 2. Bostik.
 - 3. Custom Building Products.
 - 4. H.B. Fuller.
 - 5. Laticrete.
 - 6. Mapei.
 - 7. Parex.
 - 8. Schluter Systems.
 - 9. Sika.
 - 10. Substitutions: See Section 01 2500 - Substitution Procedures.
- C. Improved Latex-Portland Cement Mortar Bond Coat: ANSI A118.15.
 - 1. Applications: Use this type of bond coat where Large and Heavy Tile (LHT) mortar is indicated.
 - 2. Products:
 - a. ARDEX Engineered Cements; S 28: www.ardexamericas.com/#sle.
 - b. Custom Building Products; Complete Contact-LFT Premium Rapid Setting Large Format Tile Mortar, with Multi-Surface Bonding Primer: www.custombuildingproducts.com/#sle.
 - c. H.B. Fuller Construction Products, Inc; TEC TotalFlex 150 Universal Mortar: www.tecspecialty.com/#sle.
 - d. LATICRETE International, Inc; MULTIMAX LITE: www.laticrete.com/#sle.
 - e. Mapei Corporation; Granirapid System: www.mapei.com/#sle.
 - f. Schluter-Systems; ALL-SET: www.schluter.com/#sle.
 - g. Substitutions: See Section 01 2500 - Substitution Procedures.
- D. Epoxy Adhesive and Mortar Bond Coat: ANSI A118.3.
 - 1. Applications: Where indicated on drawings.
 - 2. Products:
 - a. Custom Building Products; EBM-Lite Epoxy Bonding Mortar: www.custombuildingproducts.com/#sle.
 - b. LATICRETE International, Inc; LATICRETE LATAPOXY 300 Adhesive: www.laticrete.com/#sle.
 - c. Mapei Corporation; Kerapoxy 410: www.mapei.com/#sle.
 - d. Merkrete, by Parex USA, Inc; Merkrete Pro Epoxy: www.merkrete.com/#sle.
 - e. Sika Corp; SikaTile 350 Flex Set: www.sika.com/#sle.
 - f. Substitutions: See Section 01 2500 - Substitution Procedures.

2.08 GROUTS

- A. Provide setting and grout materials from same manufacturer.
- B. High Performance Polymer Modified Grout: ANSI A118.7 polymer modified cement grout.
 - 1. Use sanded grout for joints 1/8 inch wide and larger; use unsanded grout for joints less than 1/8 inch wide.
 - 2. Products:
 - a. ARDEX Engineered Cements; ARDEX FL: www.ardexamericas.com/#sle.

- b. Custom Building Products; Prism Color Consistent Grout: www.custombuildingproducts.com/#sle.
 - c. H.B. Fuller Construction Products, Inc; TEC AccuColor Plus Grout: www.tecspecialty.com/#sle.
 - d. LATICRETE International, Inc; LATICRETE PERMACOLOR Grout: www.laticrete.com/#sle.
 - e. Mapei Corporation; Ultracolor Plus FA: www.mapei.com/#sle.
 - f. Merkrete, by Parex USA, Inc; Merkrete Pro Grout: www.merkrete.com/sle.
 - g. Substitutions: See Section 01 2500 - Substitution Procedures.
- C. Epoxy Grout: ANSI A118.3 chemical resistant and water-cleanable epoxy grout.
- 1. Products:
 - a. ARDEX Engineered Cements; ARDEX WA: www.ardexamericas.com/#sle.
 - b. Custom Building Products; CEG-IG 100% Solids Industrial Grade Epoxy Grout: www.custombuildingproducts.com/#sle.
 - c. H.B. Fuller Construction Products, Inc; TEC AccuColor EFX Epoxy Special Effects Grout: www.tecspecialty.com/#sle.
 - d. LATICRETE International, Inc; LATICRETE SPECTRALOCK PRO Premium Grout: www.laticrete.com/#sle.
 - e. Mapei Corporation; Kerapoxy CQ: www.mapei.com/#sle.
 - f. Merkrete, by Parex USA, Inc; Merkrete Pro Epoxy: www.merkrete.com/#sle.
 - g. Sika Corp; SikaTile 825 Epoxy: www.sika.com/#sle.
 - h. Substitutions: See Section 01 2500 - Substitution Procedures.
- D. Furan Grout: ANSI A118.5 chemical resistant furan resin grout.
- 1. Products:
 - a. Custom Building Products; CEG-IG 100% Solids Industrial Grade Epoxy Grout: www.custombuildingproducts.com/#sle.
 - b. LATICRETE International, Inc; LATICRETE SPECTRALOCK 2000 IG: www.laticrete.com/#sle.
 - c. Mapei Corporation; Kerapoxy IEG CQ: www.mapei.com/#sle.
 - d. Substitutions: See Section 01 2500 - Substitution Procedures.

2.09 SEALANT AND MAINTENANCE MATERIALS

- A. Movement Joints: Refer to Article in Part 3 of this Section.
- B. Sealant: See Section 079200 - Joint Sealants.
- C. Backer Rods: Closed-cell foam polyethylene or butyl rubber, as recommended by setting material manufacturer, for use in movement joints.
 - 1. See Section 079200 - Joint Sealants, for products.
 - 2. Refer to Part 3 article "Movement Joints" for additional information.
- D. Bond Breaker Tape: For use in movement joints, to prevent 3-sided adhesion.
 - 1. See Section 079200 - Joint Sealants, for products.
 - 2. Refer to Part 3 article "Movement Joints" for additional information.
- E. Grout Sealer: Liquid-applied, moisture and stain protection for existing or new Portland cement grout.
 - 1. Composition: Water-based colorless silicone.
 - 2. Color(s): As selected by Architect from manufacturer's full line.
 - 3. Products:
 - a. STONETECH, a Division of LATICRETE International, Inc; STONETECH Heavy Duty Grout Sealer: www.laticrete.com/#sle.
 - b. Merkrete, by Parex USA, Inc; Merkrete Revive: www.merkrete.com/#sle.

- c. Substitutions: See Section 01 2500 - Substitution Procedures.
- F. Tile Sealer: Stain protection for ceramic tile and natural stone tile. Compliant with DCOF established in Performance Requirements article above.
 - 1. Products:
 - a. Custom Building Products; Aqua Mix Enrich 'N' Seal: www.custombuildingproducts.com/#sle.
 - b. Rust-Oleum Corporation; Miracle Sealants 511 H2O Plus: www.rustoleum.com/#sle.
 - c. STONETECH, a Division of LATICRETE International, Inc; STONETECH BulletProof Stone Sealer: www.laticrete.com/#sle.
 - d. Substitutions: See Section 01 2500 - Substitution Procedures.

2.10 ACCESSORY MATERIALS

- A. Concrete Floor Slab Crack Isolation Membrane: Material complying with ANSI A118.12; not intended as waterproofing.
 - 1. Crack Resistance: No failure at 1/8 inch gap, minimum.
 - 2. Fluid or Trowel Applied Type:
 - a. Material: Synthetic rubber or Acrylic.
 - b. Thickness: Per manufacturer's written installation instructions.
 - c. Products:
 - 1) H.B. Fuller Construction Products, Inc; TEC HydraFlex Waterproofing Crack Isolation Membrane: www.tecspecialty.com/#sle.
 - 2) LATICRETE International, Inc; LATICRETE FRACTURE BAN SC: www.laticrete.com/#sle.
 - 3) Mapei Corporation; Mapelastic CI: www.mapei.com/#sle.
 - 4) Merkrete, by Parex USA, Inc; Merkrete Fracture Guard: www.merkrete.com/#sle.
 - 5) Sika Corp; SikaTile 200 Fracture Guard Rapid: www.sika.com/#sle.
 - 6) Substitutions: Section 01 2500 - Substitution Procedures.
- B. Waterproofing Membrane at Floors and Walls: Specifically designed for bonding to cementitious substrate under thick mortar bed or thin-set tile; complying with ANSI A118.10.
 - 1. Crack Resistance: No failure at 1/16 inch gap, minimum; comply with ANSI A118.12.
 - 2. Fluid or Trowel Applied Type:
 - a. Material: Synthetic rubber or Acrylic.
 - b. Thickness: Per manufacturer's written installation instructions.
 - c. Products:
 - 1) LATICRETE International, Inc; LATICRETE HYDRO BAN: www.laticrete.com/#sle.
 - 2) Mapei Corporation; Mapelastic AquaDefense: www.mapei.com/#sle.
 - 3) Merkrete, by Parex USA, Inc; Merkrete Hydro Guard 1: www.merkrete.com/#sle.
 - 4) Polycoat Products; Aquatight: www.polycoatusa.com/#sle.
 - 5) Sika Corp; SikaTile 100 Moisture Guard: www.sika.com/#sle.
 - 6) USG Corporation; Durock Brand Waterproofing Membrane: www.usg.com/#sle.
 - 7) Substitutions: See Section 01 2500 - Substitution Procedures.
 - 3. Bonded Sheet Membrane Type:
 - a. Products:
 - 1) LATICRETE International, Inc; LATICRETE HYDRO BAN Sheet Membrane: www.laticrete.com/#sle.
 - 2) Mapei Corporation; Mapeguard WP 200 Membrane: www.mapei.com/#sle.
 - 3) Noble Company; NobleSeal TS: www.noblecompany.com/#sle.

- 4) Schluter-Systems; KERDI: www.schluter.com/#sle.
- 5) Substitutions: See Section 01 2500 - Substitution Procedures.
- C. Metal Lath: ASTM C847 Flat diamond mesh, of weight to suit application, galvanized finish.
- D. Backer Board: See Section 092116 - Gypsum Board Assemblies.

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.
- B. Verify that wall surfaces are smooth and flat within the tolerances specified for that type of work, are dust-free, and are ready to receive tile.
- C. Verify that subfloor surfaces are dust free and free of substances that could impair bonding of setting materials to subfloor surfaces.
- D. Concrete Substrate Verification: Substrate moisture content and alkalinity to be confirmed by testing. See Section 090561 - Common Work Results for Flooring Preparation, for additional information.
- E. Verify that required floor-mounted utilities are in correct location.

3.02 PREPARATION

- A. Protect surrounding work from damage.
- B. Vacuum clean surfaces and damp clean.
- C. Seal substrate surface cracks with filler. Level existing substrate surfaces to acceptable flatness tolerances.
- D. Install backer board in accordance with ANSI A108.11 and board manufacturer's instructions. Tape joints and corners, cover with skim coat of setting material to a feather edge.
- E. Prepare substrate surfaces for adhesive installation in accordance with adhesive manufacturer's instructions.

3.03 INSTALLATION - GENERAL

- A. Install all components in accordance with manufacturer's written instructions and approved shop drawings.
 - 1. Do not exceed pot life of material as documented in writing by manufacturer.
- B. Install tile, thresholds, and grout in accordance with applicable requirements of ANSI A108.1a through ANSI A108.20, manufacturer's instructions, TCNA (HB) or TCNA (HB-GP) recommendations, as applicable, and approved shop drawings.
- C. Lay tile to pattern indicated. Do not interrupt tile pattern through openings.
- D. Cut and fit tile to penetrations through tile, leaving sealant joint space. Form corners and bases neatly. Align floor joints.
- E. 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.
- F. Form internal angles square and external angles bullnosed.
- G. Install non-ceramic trim in accordance with manufacturer's instructions.
- H. Install thresholds where indicated.
- I. Sound tile after setting. Replace hollow sounding units.

- J. Keep control and expansion joints free of mortar, grout, and adhesive.
- K. Prior to grouting, allow installation to completely cure; minimum of 48 hours.
- L. Grout tile joints unless otherwise indicated. Use standard grout unless otherwise indicated.
- M. At changes in plane and tile-to-tile control joints, use tile sealant instead of grout, with either bond breaker tape or backer rod as appropriate to prevent three-sided bonding.

3.04 MOVEMENT JOINTS

- A. Refer to TCNA (HB), section EJ171 "Movement Joint Guidelines for Ceramic, Glass, and Stone", for graphics and additional information.
- B. Provide movement joints in each tile assembly to alleviate pressure from building movement, and reduce cracking of grout and tile. A movement joint substitutes grout for sealant, minimum 3/8 inch deep, installed on top of:
 - 1. Bond breaker tape, at thinset tile installations.
 - 2. Backer rod, at deeper mortarbed installations.
- C. Locate movement joints:
 - 1. At each room perimeter, between floor tiles and wall material.
 - 2. Vertical inside wall corners.
 - 3. Exterior: Maximum 12 feet in each direction.
 - 4. Interior: Maximum 25 feet in each direction.
 - 5. Interior, exposed to direct sunlight: Maximum 12 feet in each direction.
 - 6. Above grade concrete slab: Maximum 12 feet in each direction.
 - 7. Change in floor finish material.
 - 8. Curbs.
 - 9. Ceilings.
 - 10. Change in substrate:
 - a. Expansion joints.
 - b. Control joints.
 - c. Cold joints.
 - d. Saw-cut joints.
 - e. Isolation joints.
- D. Provide continuous waterproof membrane below movement joints.
- E. Movement Joint Width:
 - 1. Exterior, 8 foot on center: 3/8 inch.
 - 2. Exterior, 12 foot on center: 1/2 inch.
 - 3. Interior, at perimeter walls: 1/4 inch.
 - 4. Interior, other: Grout width, or 1/8 inch minimum.

3.05 INSTALLATION - FLOORS - THIN-SET METHODS

- A. Over exterior concrete substrates, install in accordance with TCNA (HB) Method F102, with high performance polymer modified grout, or as otherwise specified.
- B. Over interior concrete substrates, install in accordance with TCNA (HB) Method F113, dry-set or latex-Portland cement bond coat, with high performance polymer modified grout, or as otherwise specified.
 - 1. Use uncoupling membrane under all tile unless other underlayment is indicated.
 - 2. Where waterproofing membrane is indicated, install in accordance with TCNA (HB) Method F122, with latex-Portland cement grout.
 - 3. Where epoxy or furan grout is indicated, but not epoxy or furan bond coat, install in accordance with TCNA (HB) Method F115.

3.06 INSTALLATION - FLOORS - MORTAR BED METHODS

- A. Over exterior concrete substrates, install in accordance with TCNA (HB) Method F101, bonded, with high performance polymer modified grout, unless otherwise specified.
- B. Over interior concrete substrates, install in accordance with TCNA (HB) Method F111, with cleavage membrane, unless otherwise indicated.
 - 1. Where waterproofing membrane is indicated, install in accordance with TCNA (HB) Method F121, with high performance polymer modified grout, unless otherwise specified.
 - 2. Where epoxy or furan grout is indicated, but not epoxy or furan bond coat, install in accordance with TCNA (HB) Method F114, with cleavage membrane.
- C. Mortar Bed Thickness: 5/8 inch, unless otherwise indicated.

3.07 INSTALLATION - WALL TILE

- A. On exterior walls install in accordance with TCNA (HB) Method W244, thin-set over cementitious backer units, with waterproofing membrane.
- B. Over coated glass mat backer board on studs, install in accordance with TCNA (HB) Method W245.
- C. Over interior concrete and masonry install in accordance with TCNA (HB) Method W202, thin-set with dry-set or latex-Portland cement bond coat.

3.08 FIELD QUALITY CONTROL

- A. See Section 01 4000 - Quality Requirements, for additional requirements.
- B. Owner to engage a qualified testing agency to perform tests and inspections.
 - 1. Tile assemblies will be considered defective if they do not pass tests and inspections.
 - 2. Additional tests and inspections, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
 - 3. Testing and inspecting agency to prepare reports and deliver to Owner or Contractor.
 - 4. Submit field quality control reports to Architect.
- C. Tests:
 - 1. Slip-Resistance.
 - a. Confirm the dynamic coefficient of friction (DCOF) meets or exceeds the value in Performance Requirements article above. Test to ANSI A326.3.
 - 2. Flood Testing.
 - a. Flood test each waterproofed area for leaks, in accordance with manufacturer's recommendations, after completing and protecting waterproofing but before overlaying construction is placed.
 - 1) After flood testing, repair leaks, repeat flood tests, and make further repairs until waterproofing installation is watertight.

3.09 CLEANING

- A. Clean tile and grout surfaces.
- B. Seal tile, grout, and stone surfaces.

3.10 PROTECTION

- A. Do not permit traffic over finished floor surface for 4 days after installation.

END OF SECTION

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SECTION 095100 ACOUSTICAL CEILINGS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Acoustical panels.
- B. Metal suspension systems.

1.02 DEFINITIONS

- A. Refer to ASTM E1264 for additional information for the following:
 - 1. LR: Light Reflectance, the measurement of the luminous reflectance factor of acoustical materials for use in predicting the levels of room illumination, indicated as a percentage from 0.00 to 1.00, per ASTM E1477.
 - 2. NRC: Noise Reduction Coefficient, is the sound absorption performance of a material, indicated as a percentage from 0.00 to 1.00, per ASTM C423.
 - 3. CAC: Ceiling Attenuation Class, measures the reduction of sound reflectance through a material and over a partition through a shared plenum, per ASTM E1414/E1414M. The CAC number is equivalent to the noise level reduction, in decibels (dB). For example, a CAC of 30 will reduce transmitted sound by 30 dB.
 - 4. AC: Articulation Class, used for products in open-plan layouts, in lieu of NRC. It measures the reduction of sound reflected over a partition into adjoining workstations through a shared plenum, per ASTM E1110. AC is indicated as a range from 100 (low) to 250 (high).

1.03 REFERENCE STANDARDS

- A. ASCE 7 - Minimum Design Loads and Associated Criteria for Buildings and Other Structures; Most Recent Edition Cited by Referring Code or Reference Standard.
- B. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2023.
- C. ASTM C423 - Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method; 2023, with Editorial Revision (2024).
- D. ASTM C635/C635M - Standard Specification for Manufacture, Performance, and Testing of Metal Suspension Systems for Acoustical Tile and Lay-in Panel Ceilings; 2022.
- E. ASTM C636/C636M - Standard Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-In Panels; 2019.
- F. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2024.
- G. ASTM E580/E580M - Standard Practice for Installation of Ceiling Suspension Systems for Acoustical Tile and Lay-in Panels in Areas Subject to Earthquake Ground Motions; 2022.
- H. ASTM E1110 - Standard Classification for Determination of Articulation Class; 2019.
- I. ASTM E1264 - Standard Classification for Acoustical Ceiling Products; 2023.
- J. ASTM E1414/E1414M - Standard Test Method for Airborne Sound Attenuation Between Rooms Sharing a Common Ceiling Plenum; 2021a.
- K. ASTM E1477 - Standard Test Method for Luminous Reflectance Factor of Acoustical Materials by Use of Integrating-Sphere Reflectometers; 1998a (Reapproved 2022).

- L. CAL (CDPH SM) - Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers Version 1.2; 2017.
- M. ASCE 7 - Minimum Design Loads for buildings and Other Structures; 2010.
- N. CBC Section 1705 - California Building Code Section 1705A; Statement of Special Inspections.

1.04 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Shop Drawings: Indicate grid layout and related dimensioning.
- C. Product Data: Provide data on each item to be installed.
- D. Sustainable Product Data: See Section 01 6000 - Product Requirements and Section 01 6116 - Volatile Organic Compound (VOC) Content Restrictions.
 - 1. VOC content restrictions data.
 - 2. CAL (CDPH SM) compliance data.
 - 3. Life cycle data.
 - 4. Recycled content data.
- E. Samples: Submit two samples 4 by 4 inches in size, or manufacturer's standard sample size, illustrating material and finish of acoustical units.
- F. Samples: Submit two samples each, 10 inches long, of suspension system main runner, cross runner, and perimeter molding.
- G. Evaluation Service Reports: From ICC or similar. Show compliance with specified requirements.
- H. Manufacturer's Installation Instructions: Indicate special procedures and perimeter conditions requiring special attention.
- I. Manufacturers' qualification statement.
- J. Field Quality Control Reports: As specified in Part 3 of this Section.
- K. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 016000 - Product Requirements, for additional provisions.
 - 2. Extra Acoustical Units: Quantity equal to 5 percent of total installed.

1.05 QUALITY ASSURANCE

- A. Qualifications: See Section 01 4000 - Quality Requirements.
- B. Suspension System Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum five years documented experience.
- C. Acoustical Unit Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum five years documented experience.
- D. Preinstallation Meetings: See Section 01 3000 - Administrative Requirements.
 - 1. Convene minimum 2 weeks before starting work of this Section.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. See Section 01 6000 - Product Requirements.
- B. Deliver materials to Project site in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, approval or listing agency markings, and directions for storing.
- C. Protect materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources. Store in a dry location.

- D. Comply with manufacturer's written instructions for handling, storing, and protecting during installation.
- E. See Section 01 7419 - Construction Waste Management and Disposal, for packaging waste requirements.

1.07 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.

1.08 WARRANTY

- A. See Section 01 6000 - Product Requirements and Section 01 7800 - Closeout Submittals for additional warranty requirements.
- B. Provide manufacturer's standard warranty for each product.

PART 2 PRODUCTS

2.01 SUSTAINABLE PRODUCT REQUIREMENTS

- A. See Section 01 6000 - Product Requirements.
- B. VOC Content Restrictions: Products in this section to not exceed VOC content limits specified in Section 01 6116 - Volatile Organic Compound (VOC) Content Restrictions.
- C. CDPH: Products to comply with CAL (CDPH SM) .
- D. Life Cycle: Products in this section to have LCA as specified in Section 016000.
- E. Recycled Content: Products in this Section to meet minimum recycled content thresholds specified in Section 016000.

2.02 REGULATORY REQUIREMENTS

- A. California:
 - 1. Seismic Design: CBC Seismic Design Catagory E, including:
 - a. ASCE 7, "Minimum Design Loads for Buildings and Other Structures"; Section 13, "Seismic Design Requirements for Nonstructural Components."
 - b. Requirements of the Division of the State Architect (DSA) for seismic-resistant design and installation of ceiling suspension systems, including DSA Interpretation of Regulations, IR 25-2.
 - c. CISCA's Guidelines for Systems Requiring Seismic Restraint: Comply with CISCA's "Guidelines for Seismic Restraint of Direct-Hung Suspended Ceiling Assemblies-- Seismic Zones 3 & 4," where more stringent than CBC requirements.

2.03 MANUFACTURERS

- A. Acoustic Tiles/Panels:
 - 1. Armstrong.
 - 2. CertainTeed.
 - 3. Rockfon.
 - 4. USG.
 - 5. Substitutions: See Section 01 2500 - Substitution Procedures.

2.04 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Ceiling systems designed to withstand the effects of earthquake motions determined according to ASCE 7 for Seismic Design Category D, E, or F and complying with the following:
 - 1. Local authorities having jurisdiction.
- B. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Indicate design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency.

2.05 ACOUSTICAL UNITS

- A. Acoustical Units - General: ASTM E1264, Class A.
- B. Acoustical Panel Types: See Finish Schedule on the Architectural drawings.
- C. Acoustical Panel Types:
 - 1. Acoustical Panel Type ACT1: (Armstrong, Ultima).
 - a. Color: White.
 - b. LR: Not less than 0.85.
 - c. NRC: Not less than 0.85.
 - d. CAC: Not less than 35.
 - e. Edge / Joint Detail: Tegal.
 - f. Thickness: 1 inch.
 - g. Modular Size: 24 by 48 inches.
 - h. Suspension System: Supertine 9/16" Heavy duty

2.06 SUSPENSION SYSTEMS

- 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. Steel Grid: ASTM A653/A653M, G30 coating, unless otherwise indicated.
- B. Exposed Suspension System: Hot-dip galvanized steel grid and cap.
 - 1. Applications: Seismic.
 - 2. Structural Classification: Heavy-duty, when tested in accordance with ASTM C635/C635M.
 - 3. Profile: Tee; 9/16 inch face width.
 - 4. Finish: Baked enamel.
 - 5. Color: White.
 - 6. Products:
 - a. Armstrong 9/16" Superfine Heavy Duty Grid. Basis of Design
 - b. Certainteed Architectural; 9/16" EZ Stab Elite Narrow System: www.certainteed.com/ceilings-and-walls/#sle.
 - c. USG Corporation; Donn Brand Centricitee DXT/DXLT 9/16 inch Acoustical Suspension System: www.usg.com/#sle.
 - d. Substitutions: See Section 01 2500 - Substitution Procedures.

2.07 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. Hold-Down Clips: Manufacturer's standard clips to suit application.
- D. Seismic Clips: Manufacturer's standard clips for seismic conditions and to suit application.
- E. Seismic Bracing: Manufacturer's standard perimeter stabilizer bars, compression struts, and seismic ceiling panel clips designed to accommodate seismic forces.
- F. Perimeter Moldings: Same metal and finish as grid.
 - 1. Size: As required for installation conditions and specified Seismic Design Category.
 - 2. Angle Molding: L-shaped, for mounting at same elevation as face of grid.
- G. Gypsum Board: Fire rated type; 5/8 inch thick, ends and edges square, paper faced.
- H. Touch-up Paint: Type and color to match acoustical and grid units.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Verify that layout of hangers will not interfere with other work.

3.02 PREPARATION

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

3.03 INSTALLATION, GENERAL

- A. Install acoustical ceiling assemblies according to manufacturer's written instructions and approved shop drawings.

3.04 INSTALLATION - SUSPENSION SYSTEM

- A. Install suspension system in accordance with ASTM C636/C636M, ASTM E580/E580M, and manufacturer's instructions, and as supplemented in this section.
- B. Rigidly secure system, including integral mechanical and electrical components, for maximum deflection of 1:360.
- C. Lay out system to a balanced grid design with edge units no less than 50 percent of acoustical unit size.
- D. Perimeter Molding: Install at intersection of ceiling and vertical surfaces and at junctions with other interruptions.
 - 1. Use longest practical lengths.
- E. 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.
- F. Seismic Suspension System, Seismic Design Category C: Hang suspension system independent of walls, columns, ducts, pipes and conduit. Maintain a 3/8 inch clearance between grid ends and wall.
- G. Seismic Suspension System, Seismic Design Categories D, E, F: Hang suspension system with grid ends attached to the perimeter molding on two adjacent walls; on opposite walls, maintain a 3/4 inch clearance between grid ends and wall.

- H. 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.
- I. Do not support components on main runners or cross runners if weight causes total dead load to exceed deflection capability.
- J. Support fixture loads using supplementary hangers located within 6 inches of each corner, or support components independently.
- K. Do not eccentrically load system or induce rotation of runners.
- L. Install light fixture boxes constructed of gypsum board above light fixtures in accordance with fire rated assembly requirements and light fixture ventilation requirements.

3.05 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. Cut to fit irregular grid and perimeter edge trim.
 - 2. Make field cut edges of same profile as factory edges.
 - 3. Double cut and field paint exposed reveal edges.
- F. Where round obstructions occur, provide preformed closures to match perimeter molding.
- G. Install hold-down clips on each panel to retain panels tight to grid system; comply with fire rating requirements.
- H. Install hold-down clips on panels within 20 ft of an exterior door.

3.06 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.

3.07 FIELD QUALITY CONTROL

- A. See Section 01 4000 - Quality Requirements, for additional requirements.
- B. Owner to engage a qualified special inspector to perform tests and inspections.
 - 1. Acoustical ceiling systems will be considered defective if they do not pass tests and inspections.
 - 2. Additional tests and inspections, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
 - 3. Testing and inspecting agency to prepare reports and deliver to Owner or Contractor.
 - 4. Submit field quality control reports to Architect.
- C. Regulatory Requirements: Special tests and inspections for suspended ceiling systems and anchorages per CBC Section 1705A.3.
- D. Tests and Inspections: Completed installations of acoustical panel ceiling hangers and anchors and fasteners; in successive stages; do not proceed with installations of acoustical panel ceiling hangers for the next area until test results for previously completed installations of acoustical panel ceiling hangers show compliance with requirements.
 - 1. Extent of Each Test Area: When installation of ceiling suspension systems on each floor has reached 20 percent completion but no panels have been installed.

- a. Hanging Wire Tests: Select 1 of every 10 wire/anchor assemblies using power-actuated fasteners or postinstalled anchors to attach hangers to concrete; a test for 200 lbf (800 N) of tension.
 - b. Bracing Wire Tests: Select 1 of every 2 wire/anchor assemblies using postinstalled anchors to attach bracing wires to concrete; test for 400 lbf (1957 N) of tension along the axis of the bracing wire.
 2. When testing discovers fasteners and anchors that do not comply with requirements, testing agency will test those anchors not previously tested until 20 pass consecutively and then will resume initial testing frequency.
- E. Inspections:
1. Suspended ceiling system.

3.08 CLEANING

- A. See Section 017000 - Execution and Closeout Requirements for additional requirements.
- B. Clean surfaces.
- C. Replace damaged or abraded components.

END OF SECTION

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**SECTION 096500
RESILIENT FLOORING**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Resilient tile flooring.
- B. Resilient base.
- C. Installation accessories.

1.02 RELATED REQUIREMENTS

- A. Section 016116 - Volatile Organic Compound (VOC) Content Restrictions.
- B. Section 14210 Reference Accessible Requirements for additional access compliance requirements
- C. Section 033000 - Cast-in-Place Concrete: Restrictions on curing compounds for concrete slabs and floors.
- D. Section 090561 - Common Work Results for Flooring Preparation: Independent agency testing of concrete slabs, removal of existing floor coverings, cleaning, and preparation.

1.03 REFERENCE STANDARDS

- A. ASTM D2047 - Standard Test Method for Static Coefficient of Friction of Polish-Coated Flooring Surfaces as Measured by the James Machine, 2011.
- B. ASTM D6329 - Standard Guide for Developing Methodology for Evaluating the Ability of Indoor Materials to Support Microbial Growth Using Static Environmental Chambers; 1998 (Reapproved 2023).
- C. ASTM E648 - Standard Test Method for Critical Radiant Flux of Floor-Covering Systems Using a Radiant Heat Energy Source; 2023.
- D. ASTM F710 - Standard Practice for Preparing Concrete Floors to Receive Resilient Flooring; 2022.
- E. ASTM F1700 - Standard Specification for Solid Vinyl Floor Tile; 2020.
- F. ASTM F1861 - Standard Specification for Resilient Wall Base; 2021.
- G. BAAQMD 8-51 - Bay Area Air Quality Management District Regulation 8, Rule 51, Adhesive and Sealant Products; www.baaqmd.gov; 2002.
- H. NFPA 253 - Standard Method of Test for Critical Radiant Flux of Floor Covering Systems Using a Radiant Heat Energy Source; 2023.
- I. UL 2824 - GREENGUARD Certification Program Method for Measuring Microbial Resistance From Various Sources Using Static Environmental Chambers; Current Edition, Including All Revisions.
- J. SCAQMD 1168 - South Coast Air Quality Management District Rule No. 1168; current edition; www.aqmd.gov.

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. Shop Drawings: Indicate seaming plan.
- D. Verification Samples: Submit two samples, 12 x 12 inch in size illustrating color and pattern for each resilient flooring product specified.
- E. Certification: Prior to installation of flooring, submit written certification by flooring manufacturer and adhesive manufacturer that condition of sub-floor is acceptable.
- F. Maintenance Data: Include maintenance procedures, recommended maintenance materials, and suggested schedule for cleaning, stripping, and re-waxing.
- 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 Flooring Material: 50 square feet of each type and color.
 - 3. Extra Wall Base: 50 linear feet of each type and color.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Protect roll materials from damage by storing on end.

1.06 FIELD CONDITIONS

- A. Maintain temperature in storage area between {CH#268551} and {CH#268550}.
- B. 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.

1.07 QUALITY ASSURANCE

- A. Resilient flooring shall be stable, firm, and slip resistant. CBC Section 11B-302.1.

PART 2 PRODUCTS

2.01 TILE FLOORING

- A. Type HVT1,2 and 3 - Hybrid Vinyl Tile: Solid vinyl with color and pattern throughout thickness.
 - 1. Minimum Requirements: Comply with ASTM F1700, of Class corresponding to type specified.
 - 2. Critical Radiant Flux (CRF): Minimum 0.45 watt per square centimeter, when tested in accordance with ASTM E 648, NFPA 253, ASTM E 648, or NFPA 253.
 - 3. Mold and Microbial Resistance: Highly resistant when tested in accordance with ASTM D6329; certified in accordance with UL 2824.
 - 4. VOC Content Limits: As specified in Section 016116.
 - 5. Plank Size: 18" x 18"
 - 6. Total Thickness: 2.5mm
 - 7. Pattern: Performa - 55016 Urban ASsh Aspen W
 - 8. Manufacturers:
 - a. Johnsonite
 - b. Catalina Products - Basis of Design
 - c. Substitutions: See Section 016000 - Product Requirements.

2.02 RESILIENT BASE

- A. Type B-1 - Resilient Base: ASTM F1861, Type TS rubber, vulcanized thermoset; top set Style B, Cove.
 - 1. Height: 4 inch.
 - 2. Thickness: 0.125 inch thick.
 - 3. Finish: Matte.
 - 4. Length: Roll.
 - 5. Color: Color as selected from manufacturer's standards.
 - 6. Manufacturers:
 - a. Burke Flooring: www.burkemercer.com.
 - b. Johnsonite, a Tarkett Company: www.johnsonite.com.
 - c. Roppe Corp: www.roppe.com.
 - d. Substitutions: See Section 016000 - Product Requirements.

2.03 ACCESSORIES

- A. Subfloor Filler: White premix latex; type recommended by adhesive material manufacturer.
- B. Primers, Adhesives, and Seaming Materials: Waterproof; types recommended by flooring manufacturer.
 - 1. Provide only products having lower volatile organic compound (VOC) content than required by the more stringent of the South Coast Air Quality Management District Rule No.1168 and the Bay Area Air Quality Management District Regulation 8, Rule 51.
- C. Moldings, Transition and Edge Strips: Same material as flooring.
- D. Filler for Coved Base: Plastic.
- E. Sealer and Wax: Types recommended by flooring manufacturer.

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. Verify that wall surfaces are smooth and flat within the tolerances specified for that type of work, are dust-free, and are ready to receive resilient base.
- C. Cementitious Sub-floor Surfaces: Verify that substrates are dry enough and ready for resilient flooring installation by testing for moisture and pH.
 - 1. Test in accordance with Section 090561.
 - 2. Obtain instructions if test results are not within limits recommended by resilient flooring manufacturer and adhesive materials manufacturer.

3.02 PREPARATION

- A. Prepare floor substrates for installation of flooring in accordance with Section 090561.

3.03 INSTALLATION

- A. Starting installation constitutes acceptance of sub-floor conditions.
- B. Install in accordance with manufacturer's instructions.
- C. Spread only enough adhesive to permit installation of materials before initial set.

- D. Fit joints tightly.
- E. Set flooring in place, press with heavy roller to attain full adhesion.
- F. Where type of floor finish, pattern, or color are different on opposite sides of door, terminate flooring under centerline of door.
- G. Install edge strips at unprotected or exposed edges, where flooring terminates, and where indicated.
 - 1. Resilient Strips: Attach to substrate using adhesive.
- H. Scribe flooring to walls, columns, cabinets, floor outlets, and other appurtenances to produce tight joints.

3.04 TILE FLOORING

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

3.05 RESILIENT BASE

- A. Fit joints tightly and make vertical. Maintain minimum dimension of 18 inches between joints.
- B. Miter internal corners. At external corners, 'V' cut back of base strip to 2/3 of its thickness and fold. At exposed ends, use premolded units.
- C. Install base on solid backing. Bond tightly to wall and floor surfaces.
- D. Scribe and fit to door frames and other interruptions.

3.06 CLEANING

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

3.07 PROTECTION

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

END OF SECTION

SECTION 096813
TILE CARPETING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Tile carpeting.

1.02 REFERENCE STANDARDS

- A. ASTM D2646 - Standard Guide for Backing Fabric Characteristics of Pile Yarn Floor Coverings; 2018.
- B. ASTM D2859 - Standard Test Method for Ignition Characteristics of Finished Textile Floor Covering Materials; 2016 (Reapproved 2021).
- C. ASTM D7330 - Standard Test Method for Assessment of Surface Appearance Change in Pile Floor Coverings Using Standard Reference Scales; 2015.
- D. ASTM E648 - Standard Test Method for Critical Radiant Flux of Floor-Covering Systems Using a Radiant Heat Energy Source; 2023.
- E. CAL (CDPH SM) - Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers Version 1.2; 2017.
- F. CBC Section 1124B; Ground and Floor Surfaces.
- G. NFPA 253 - Standard Method of Test for Critical Radiant Flux of Floor Covering Systems Using a Radiant Heat Energy Source; 2023.

1.03 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: For each item to be installed. Provide data on specified products, describing physical and performance characteristics; sizes, patterns, colors available, and method of installation.
- C. Sustainable Product Data: See Section 01 6000 - Product Requirements and Section 01 6116 - Volatile Organic Compound (VOC) Content Restrictions.
 - 1. VOC content restrictions data.
 - 2. CAL (CDPH SM) compliance data.
 - 3. Life cycle data.
 - 4. Recycled content data.
- D. Shop Drawings: Indicate layout of joints.
- E. Samples: Submit two carpet tiles illustrating color and pattern design for each carpet color selected.
- F. Manufacturer's Installation Instructions: Indicate special procedures.
- G. Manufacturer's Qualification Statement.
- H. Installer's Qualification Statement.
- I. Sample warranty.
- J. 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.

1.04 QUALITY ASSURANCE

- A. Qualifications: See Section 01 4000 - Quality Requirements.
- B. Manufacturer Qualifications: Company specializing in manufacturing specified carpet tile with minimum five years documented experience.
- C. Installer Qualifications: Company specializing in installing carpet tile with minimum three years documented experience and approved by carpet tile manufacturer.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. See Section 01 6000 - Product Requirements.
- B. Deliver materials to Project site in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, approval or listing agency markings, and directions for storing.
- C. Protect materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources. Store in a dry location.
- D. Comply with manufacturer's written instructions for handling, storing, and protecting during installation.
- E. See Section 01 7419 - Construction Waste Management and Disposal, for packaging waste requirements.

1.06 FIELD CONDITIONS

- A. Ambient Conditions: Maintain ambient temperature and humidity as required by manufacturer for each product to be installed, before and after installation.
- B. Store materials in area of installation for minimum period of 24 hours prior to installation.

1.07 WARRANTY

- A. See Section 01 6000 - Product Requirements and Section 01 7800 - Closeout Submittals for additional warranty requirements.
- B. Provide manufacturer's standard warranty for each product.

PART 2 PRODUCTS

2.01 SUSTAINABLE PRODUCT REQUIREMENTS

- A. See Section 01 6000 - Product Requirements.
- B. VOC Content Restrictions: Products in this section to not exceed VOC content limits specified in Section 01 6116 - Volatile Organic Compound (VOC) Content Restrictions.
- C. CDPH: Products to comply with CAL (CDPH SM) .
- D. Life Cycle: Products in this section to have LCA as specified in Section 016000.
- E. Recycled Content: Products in this Section to meet minimum recycled content thresholds specified in Section 016000.
- F. Green Label Plus: Provide CRI Green Label Plus certified product; in lieu of labeling, independent test report showing compliance is acceptable.

2.02 PERFORMANCE REQUIREMENTS

- A. Fire-Test-Response Characteristics: For tile carpet flooring, as determined by testing identical products according to ASTM E648 or NFPA 253 by a qualified testing agency.
 - 1. Critical Radiant Flux Classification: Not less than 0.45 W/sq. cm.
- B. Appearance Retention Rating: Moderate traffic, 2.5 minimum according to ASTM D7330.
- C. Dry Breaking Strength: Not less than 100 lbf according to ASTM D2646.

2.03 REGULATORY REQUIREMENTS

- A. Carpet / Carpet Tile Flooring: CBC Section 11B-302.2
 - 1. Carpet shall be securely attached and shall have a firm cushion, pad, or backing or no cushion or pad. It shall have a level loop, textured loop, level cut pile, or level cut/uncut pile texture. Pile height shall be 1/2 inch maximum.
 - 2. Exposed edges shall be fastened to floor surfaces and shall have trim on the entire length. Carpet edges shall comply with CBC Section 11B-303.
- B. Accessibility: Comply with the requirements of CBC Section 11B-302.2 for carpet tile thickness limits, attachment requirements, backings and edge treatments.

2.04 CARPET TILE

- A. Carpet Tile Types: Refer to Materials Schedule on the Architectural drawings.
- B. Carpet Tile Types:
 - 1. CT-1: (Manufacturer; Product)
 - a. Size: 18 by 18 inches.

2.05 MATERIALS

- A. Tile Carpeting: Tufted, manufactured in one color dye lot.
 - 1. Critical Radiant Flux: Minimum of 0.22 watts/sq cm, when tested in accordance with ASTM E648 or NFPA 253.
 - 2. Surface Flammability Ignition: Pass ASTM D2859 (the "pill test").

2.06 ACCESSORIES

- A. Subfloor Filler: White premix latex; type recommended by flooring material manufacturer.
- B. Edge Strips: Embossed aluminum, color as selected by Architect.
- C. Carpet Tile Adhesive: Recommended by carpet tile manufacturer.

PART 3 EXECUTION

3.01 EXAMINATION

- A. See Section 01 7000 - Execution and Closeout Requirements.
- B. Verify that subfloor surfaces are smooth and flat within tolerances specified for that type of work and are ready to receive carpet tile.
- C. Verify that subfloor surfaces are dust-free and free of substances that could impair bonding of adhesive materials to subfloor surfaces.
- D. Concrete Substrate Verification: Substrate moisture content and alkalinity to be confirmed by testing. See Section 090561 - Common Work Results for Flooring Preparation, for additional information.

- E. 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. Vacuum clean substrate.

3.03 INSTALLATION

- A. Starting installation constitutes acceptance of subfloor conditions.
- B. Install carpet tile in accordance with manufacturer's instructions and approved shop drawings.
- 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 square 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. See Section 017000 - Execution and Closeout Requirements for additional requirements.
- B. Remove excess adhesive without damage, from floor, base, and wall surfaces.
- C. Clean and vacuum carpet surfaces.

END OF SECTION

**SECTION 097200
WALL COVERINGS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Wall covering.

1.02 RELATED REQUIREMENTS

- A. Section 016116 - Volatile Organic Compound (VOC) Restrictions.
- B. Section 099123 - Interior Painting: Preparation and priming of substrate surfaces.

1.03 REFERENCE STANDARDS

- A. ASTM D1308 - Standard Test Method for Effect of Household Chemicals on Clear and Pigmented Coating Systems; 2020.
- B. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2024.
- C. ASTM F793/F793M - Standard Classification of Wall Coverings by Use Characteristics; 2020.
- D. CAL (CDPH SM) - Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers Version 1.2; 2017.

1.04 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Sustainable Product Data: See Section 01 6000 - Product Requirements and Section 01 6116 - Volatile Organic Compound (VOC) Content Restrictions.
 - 1. VOC content restrictions data.
 - 2. CAL (CDPH SM) compliance data.
- C. Shop Drawings: Indicate wall elevations with seaming layout.
- D. Samples: Submit two samples of wall covering, 6 by 6 inches or manufacturer's standard size, illustrating color, finish, and texture.
- E. Test Reports: Indicate verification of flame and smoke ratings, when tested by UL.
- F. Manufacturer's Installation Instructions: Indicate special procedures.
- G. Maintenance Data: Submit data on cleaning, touch-up, and repair of covered surfaces.
- H. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 016000 - Product Requirements, for additional provisions.
 - 2. Extra Wall Covering Materials: 25 linear feet of each color and pattern of wall covering; store where directed.
 - 3. Package and label each roll by manufacturer, color and pattern, and destination room number.

1.05 MOCK-UPS

- A. See Section 014000 - Quality Requirements for additional requirements.

- B. Provide panel, 3 panel drops wide, full height, illustrating installed wall covering and joint seaming technique.
- C. Locate where directed by Architect.
- D. Mock-up may remain as part of the Work.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. See Section 01 6000 - Product Requirements.
- B. Inspect roll materials at arrival on site, to verify acceptability.
- C. Protect packaged adhesive from temperature cycling and cold temperatures.
- D. Do not store roll goods on end.
- E. See Section 01 7419 - Construction Waste Management and Disposal, for packaging waste requirements.

1.07 FIELD CONDITIONS

- A. Do not apply materials when surface and ambient temperatures are outside the temperature ranges required by the adhesive or wall covering product manufacturer.
- B. Maintain these conditions 24 hours before, during, and after installation of adhesive and wall covering.

PART 2 PRODUCTS

2.01 SUSTAINABLE PRODUCT REQUIREMENTS

- A. See Section 01 6000 - Product Requirements.
- B. VOC Content Restrictions: Products in this section to not exceed VOC content limits specified in Section 01 6116 - Volatile Organic Compound (VOC) Content Restrictions.
- C. CDPH: Products to comply with CAL (CDPH SM) .

2.02 PERFORMANCE REQUIREMENTS

- A. Surface Burning Characteristics: Flame spread/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E84.
- B. Chemical and Stain Resistance: No visible staining or discoloration and no damage to surface texture when tested in accordance with ASTM D1308.

2.03 WALL COVERINGS

- A. Wall Coverings:
 - 1. Products: See Finish Schedule on the Architectural drawings.
 - a. Substitutions: See Section 01 2500 - Substitution Procedures.
- B. Wall Covering: Fabric-backed vinyl roll stock.
 - 1. Products:
 - a. .
 - b. Substitutions: See Section 01 2500 - Substitution Procedures.
 - 2. Comply with ASTM F793/F793M, Category .
- C. Substrate Filler: As recommended by adhesive and wall covering manufacturers; compatible with substrate.

- D. Substrate Primer and Sealer: As recommended by wall covering manufacturer.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that substrate surfaces are ready to receive work, and comply with requirements of wall covering manufacturer.

3.02 PREPARATION

- A. Fill cracks in substrate and smooth irregularities with filler; sand smooth.
- B. Surface Appurtenances: Remove electrical plates, hardware, light fixture trim, escutcheons, and fittings prior to preparing surfaces or finishing.
- C. Surfaces: Correct defects and clean surfaces that affect work of this section. Remove existing coatings that exhibit loose surface defects.
- D. Marks: Seal with shellac those that may bleed through surface finishes.
- E. Apply one coat of primer sealer to substrate surfaces. Allow to dry. Lightly sand smooth.
- F. Vacuum clean surfaces free of loose particles.

3.03 INSTALLATION

- A. Apply adhesive and wall covering in accordance with manufacturer's instructions and approved shop drawings.
- B. Apply adhesive to wall surface immediately prior to application of wall covering.
- C. Apply wall covering smooth, without wrinkles, gaps or overlaps. Eliminate air pockets and ensure full bond to substrate surface.
- D. Butt edges tightly.
- E. Horizontal seams are not acceptable.
- F. Do not seam within 2 inches of internal corners or within 6 inches of external corners.
- G. Install wall covering before installation of bases and items attached to or spaced slightly from wall surface.
- H. Remove excess adhesive while wet from seam before proceeding to next wall covering sheet. Wipe clean with dry cloth.

3.04 CLEANING

- A. Clean wall coverings of excess adhesive, dust, dirt, and other contaminants.
- B. Reinstall wall plates and accessories removed prior to work of this section.

3.05 PROTECTION

- A. See Section 01 7000 - Execution and Closeout Requirements, for additional requirements.
- B. Provide barrier or other delineation to prevent damage to installed Work from subsequent construction activities.

END OF SECTION

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SECTION 098100
ACOUSTIC INSULATION

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Acoustic insulation for concealed locations, including
 - 1. Acoustic batt insulation.
 - 2. Sprayed acoustic insulation for miscellaneous voids.

1.02 RELATED REQUIREMENTS

- A. Section 014113.11 - Regulatory Requirements - Global Warming Potential (GWP).
- B. Section 072100 - Thermal Insulation.

1.03 REFERENCE STANDARDS

- A. ASTM C665 - Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing; 2024.
- B. ASTM D412 - Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers--Tension; 2016 (Reapproved 2021).
- C. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2024.
- D. CAL (CDPH SM) - Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers Version 1.2; 2017.

1.04 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements.
- B. Product Data: For each item to be installed.
- C. Sustainable Product Data: See Section 01 6000 - Product Requirements and Section 01 6116 - Volatile Organic Compound (VOC) Content Restrictions.
 - 1. VOC content restrictions data.
 - 2. CAL (CDPH SM) compliance data.
 - 3. Life cycle data.
 - 4. Recycled content data.
- D. Manufacturer's installation instructions.
- E. Samples: For exposed and semi-exposed insulation types, in color to be installed. Refer to Part 2 for additional information.
- F. Warranty.

1.05 COORDINATION

- A. Fire-Rated Assemblies: Confirm insulation products within fire-rated assemblies meet fire-rated assembly requirements.
 - 1. Substitutions will not be permitted when proprietary products are required to meet fire-rating requirements.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. See Section 01 6000 - Product Requirements.
- B. Protect materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources. Store in a dry location.
- C. See Section 01 7419 - Construction Waste Management and Disposal, for packaging waste requirements.

1.07 FIELD CONDITIONS

- A. Do not install insulation adhesives when temperature or weather conditions are detrimental to successful installation.

1.08 WARRANTY

- A. See Section 01 6000 - Product Requirements and Section 01 7800 - Closeout Submittals for additional warranty requirements.
- B. Provide manufacturer's standard warranty for installed products.

PART 2 PRODUCTS

2.01 SUSTAINABLE PRODUCT REQUIREMENTS

- A. See Section 01 6000 - Product Requirements.
- B. VOC Content Restrictions: Products in this section to not exceed VOC content limits specified in Section 01 6116 - Volatile Organic Compound (VOC) Content Restrictions.
- C. CDPH: Products to comply with CAL (CDPH SM).
- D. Life Cycle: Products in this section to have LCA as specified in Section 016000.
- E. Recycled Content: Products in this Section to meet minimum recycled content thresholds specified in Section 016000.

2.02 PERFORMANCE REQUIREMENTS

- A. Surface-Burning Characteristics: Flame spread/ smoke developed index 25/50 Maximum when tested in accordance to ASTM E84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
- B. Refer to Architectural drawings for minimum STC values to be achieved at interior assemblies.

2.03 REGULATORY REQUIREMENTS

- A. California:
 - 1. Light- and Heavy-Density Mineral Wool Board Insulation: Global Warming Potential (GWP) less than or equal to maximum allowable value. See Section 014113.11 - Regulatory Requirements - Global Warming Potential (GWP), for additional information.

2.04 ACOUSTIC BATT INSULATION

- A. Mineral Wool Unfaced Acoustic Batts: ASTM C665, Type I (batts without membrane facing) produced by combining thermosetting resins free of added urea, phenol, and urea-extended phenol formaldehyde, and with mineral fibers manufactured from rock wool.
 - 1. Products:
 - a. Rockwool; AFB Sound Attenuation Batts.

- b. Thermafiber (Owens Corning); Thermafiber SAFB (Sound Attenuation Fire Blanket).
 - c. Substitutions: See Section 01 2500 - Substitution Procedures.
 - 2. Physical Properties:
 - a. Thickness:
 - 1) Partitions: As required to fill cavity.
 - 2) Above suspended ceilings: full height
 - 3. Location:
 - a. Concealed applications.
 - b. Where required to meet requirements of fire-rated partitions.
 - c. Where shown on the drawings.
- B. Glass-Fiber Unfaced Acoustic Batts: ASTM C665, Type I (batts without membrane facing) produced by combining thermosetting resins free of added urea, phenol, and urea-extended phenol formaldehyde, and with mineral fibers manufactured from glass.
 - 1. Products:
 - a. CertainTeed; NoiseReducer.
 - b. Johns Manville; Unfaced Fiberglass.
 - c. Owens Corning; Ecotouch Sound Attenuation Batts (SAB).
 - d. Substitutions: See Section 01 2500 - Substitution Procedures.
 - 2. Physical Properties:
 - a. Thickness:
 - 1) Partitions: As required to fill cavity.
 - 2) Above suspended ceilings: full height
 - 3. Location:
 - a. Concealed applications.
 - b. Where shown on the drawings.

2.05 SPRAYED ACOUSTIC INSULATION FOR MISCELLANEOUS VOIDS

- A. Sprayed Polyurethane Foam Acoustic Insulation: Low-density, low-pressure, 2-component open-cell.
 - 1. Products:
 - a. ICP Building Solutions; HandiFoam Low Density.
 - b. RHH Foam Systems; Versi-Foam System 31.
 - c. Substitutions: See Section 01 2500 - Substitution Procedures.
 - 2. Location:
 - a. Concealed applications.

2.06 ACOUSTIC ACCESSORIES

- A. Acoustic Joint Sealants: See Section 092116 - Gypsum Board Assemblies.
- B. Impaling Pin Adhesives: Type recommended by manufacturer to suit substrate conditions indicated.
- C. Acoustic Putty Pads:
 - 1. Products:
 - a. Pabco; QuietPutty.
 - b. Substitutions: See Section 01 2500 - Substitution Procedures.
 - 2. Physical Properties:
 - a. Size: 7-1/4 inch x 7-1/4 inch.
 - b. Tensile Strength (ASTM D412): 135 psi.
 - c. Weight: 7 ounces.
 - 3. Location:

- a. Outlet boxes and similar penetrations in STC-rated gypsum panels.
- b. Where shown on the drawings.

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.

3.02 INSTALLATION, GENERAL

- A. Comply with manufacturer's written installation instructions.
- B. Install insulation that is undamaged, dry, and unsoiled and that has not been left exposed to ice, rain, or snow at any time.
- C. Extend insulation to envelop entire area to be insulated. Cut and fit tightly around obstructions and fill voids with insulation. Remove projections that interfere with placement.
- D. Provide sizes to fit applications indicated and selected from manufacturer's standard thicknesses, widths, and lengths. Apply single layer of insulation units to produce thickness indicated unless multiple layers are otherwise shown or required to make up total thickness.

3.03 BATT INSULATION INSTALLATION

- A. Use insulation widths and lengths that fill the cavities formed by framing members. If more than one length is required to fill the cavities, provide lengths that will produce a snug fit between ends.
- B. Place insulation in cavities formed by framing members to produce a friction fit between edges of insulation and adjoining framing members.
- C. Fit insulation tightly in cavities and tightly to exterior side of mechanical and electrical services within the plane of the insulation.
- D. Maintain 3 inch clearance of insulation around recessed lighting fixtures not rated for or protected from contact with insulation.

3.04 SPRAY-APPLIED INSULATION INSTALLATION

- A. Install according to manufacturer's written installation instructions and approved shop drawings.
- B. Spray insulation to envelop entire area to be insulated and fill voids.
- C. Apply in multiple passes to not exceed maximum thicknesses recommended by manufacturer. Do not spray into rising foam.

3.05 PROTECTION

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

END OF SECTION

SECTION 099113
EXTERIOR PAINTING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Exterior painting.

1.02 RELATED REQUIREMENTS

- A. Section 099123 - Interior Painting.

1.03 DEFINITIONS

- A. Comply with ASTM D16 for interpretation of terms used in this section.

1.04 REFERENCE STANDARDS

- A. ASTM D16 - Standard Terminology for Paint, Related Coatings, Materials, and Applications; 2024.
- B. ASTM D4442 - Standard Test Methods for Direct Moisture Content Measurement of Wood and Wood-Based Materials; 2020.
- C. CAL (CDPH SM) - Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers Version 1.2; 2017.
- D. MPI (APSM) - Master Painters Institute Architectural Painting Specification Manual; Current Edition.
- E. SSPC-SP 1 - Solvent Cleaning; 2015, with Editorial Revision (2016).
- F. SSPC-SP 6/NACE No.3 - Commercial Blast Cleaning; 2006.
- G. SSPC-SP 13/NACE No.6 - Surface Preparation of Concrete; 2018.

1.05 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: For each item to be installed. Provide complete list of products to be used, with the following information for each:
 - 1. Manufacturer's name, product name and/or catalog number, and general product category (e.g. "alkyd enamel").
 - 2. MPI product number (e.g. MPI #47).
 - 3. Cross-reference to specified paint system(s) product is to be used in; include description of each system.
 - 4. Manufacturer's installation instructions.
- C. Sustainable Product Data: See Section 01 6000 - Product Requirements and Section 01 6116 - Volatile Organic Compound (VOC) Content Restrictions.
 - 1. VOC content restrictions data.
 - 2. CAL (CDPH SM) compliance data.
- D. Samples: Submit three paper "draw down" samples, 8-1/2 by 11 inches in size, illustrating range of colors available for each finishing product specified.

1. Where sheen is specified, submit samples in only that sheen.
 2. Where sheen is not specified, discuss sheen options with Architect before preparing samples, to eliminate sheens not required.
- 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 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 the manufacturer's label.

1.06 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the products specified, with minimum five years documented experience.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. See Section 01 6000 - Product Requirements.
- B. Deliver products to site in sealed and labeled containers; inspect to verify acceptability.
- C. Container Label: Include manufacturer's name, type of paint, brand name, lot number, brand code, coverage, surface preparation, drying time, cleanup requirements, color designation, and instructions for mixing and reducing.
- D. Paint Materials: Store at minimum ambient temperature of 45 degrees F and a maximum of 90 degrees F, in ventilated area, and as required by manufacturer's instructions.
- E. See Section 01 7419 - Construction Waste Management and Disposal, for packaging waste requirements.

1.08 FIELD CONDITIONS

- A. Do not apply materials when surface and ambient temperatures are outside the paint product manufacturer's temperature ranges.
- B. Follow manufacturer's recommended procedures for producing best results, including testing of substrates, moisture in substrates, and humidity and temperature limitations.
- C. Do not apply exterior paint and finishes during rain or snow, or when relative humidity is outside the humidity ranges required by the paint product manufacturer.
- D. Provide lighting level of 80 ft candles measured mid-height at substrate surface.

PART 2 PRODUCTS

2.01 SUSTAINABLE PRODUCT REQUIREMENTS

- A. See Section 01 6000 - Product Requirements.
- B. VOC Content Restrictions: Products in this section to not exceed VOC content limits specified in Section 01 6116 - Volatile Organic Compound (VOC) Content Restrictions.
- C. CDPH: Products to comply with CAL (CDPH SM) .

2.02 MANUFACTURERS

- A. Provide paints and finishes used in any individual system from the same manufacturer; no exceptions.
- B. Paints:

1. Benjamin Moore.
2. Dunn-Edwards.
3. PPG.
4. Sherwin-Williams.
5. Tnemec.
6. Substitutions: See Section 01 2500 - Substitution Procedures.

2.03 PAINTS AND FINISHES - GENERAL

- A. Paint Colors:
 1. Products: See Finish Schedule on the Architectural drawings.
 2. P-1: (Manufacturer; Product, Color)
- B. Paints and Finishes: Ready-mixed, unless required to be a field-catalyzed paint.
 1. Provide paints and finishes of a soft paste consistency, capable of being readily and uniformly dispersed to a homogeneous coating, with good flow and brushing properties, and capable of drying or curing free of streaks or sags.
 2. Provide materials that are compatible with one another and the substrates indicated under conditions of service and application, as demonstrated by manufacturer based on testing and field experience.
 3. Supply each paint material in quantity required to complete entire project's work from a single production run.
 4. Do not reduce, thin, or dilute paint or finishes or add materials unless such procedure is described explicitly in manufacturer's product instructions.
- C. Sheens: Provide the sheens specified; where sheen is not specified, sheen will be selected later by Architect from the manufacturer's full line.

2.04 PAINT SYSTEMS - EXTERIOR

- A. Paint WE-OP-3A - Wood, Opaque, Alkyd, 3 Coat:
 1. One coat of alkyd primer sealer.
 2. Gloss: Two coats of alkyd enamel.
 3. Semi-gloss: Two coats of alkyd enamel.
- B. Paint CE-OP-3A - Concrete/Masonry, Opaque, Alkyd, 3 Coat:
 1. One coat of block filler.
 2. Semi-gloss: Two coats of alkyd enamel.
 3. Flat: Two coats of alkyd enamel.
- C. Paint GE-OP-3L - Exterior Plaster, Opaque, Latex, 3 Coat:
 1. One coat of latex primer sealer.
 2. Flat: Two coats of latex.
- D. Paint ME-OP-3A - Ferrous Metals, Unprimed, Alkyd, 3 Coat:
 1. One coat of alkyd primer.
 2. Gloss: Two coats of alkyd enamel.
 3. Semi-gloss: Two coats of alkyd enamel.
- E. Paint ME-OP-2A - Ferrous Metals, Primed, Alkyd, 2 Coat:
 1. Touch-up with rust-inhibitive primer recommended by top coat manufacturer.
 2. Gloss: Two coats of alkyd enamel.
 3. Semi-gloss: Two coats of alkyd enamel.
- F. Paint MgE-OP-3A - Galvanized Metals, Alkyd, 3 Coat:
 1. One coat galvanize primer.
 2. Gloss: Two coats of alkyd enamel.

3. Semi-gloss: Two coats of alkyd enamel.
- G. Paint MaE-OP-3A - Aluminum, Unprimed, Alkyd, 3 Coat:
 1. One coat etching primer.
 2. Gloss: Two coats of alkyd enamel.
 3. Semi-gloss: Two coats of alkyd enamel.

2.05 PRIMERS

- A. Provide primer as recommended by manufacturer for substrate and conditions.

2.06 ACCESSORY MATERIALS

- A. Accessory Materials: Provide primers, sealers, cleaning agents, cleaning cloths, sanding materials, and clean-up materials as required for final completion of painted surfaces.
- B. Patching Material: Latex filler.
- C. Fastener Head Cover Material: Latex filler.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Do not begin application of paints and finishes until substrates have been properly prepared.
- B. Verify that surfaces are ready to receive work as instructed by the product manufacturer.
- C. Examine surfaces scheduled to be finished prior to commencement of work. Report any condition that may potentially affect proper application.
- D. Test shop-applied primer for compatibility with subsequent cover materials.
- E. Measure moisture content of surfaces using an electronic moisture meter. Do not apply finishes unless moisture content of surfaces are below the following maximums:
 1. Exterior Plaster and Stucco: 12 percent.
 2. Fiber Cement Siding: 12 percent.
 3. Masonry, Concrete, and Concrete Masonry Units: 12 percent.
 4. Exterior Wood: 15 percent, measured in accordance with ASTM D4442.
 5. Concrete Floors and Traffic Surfaces: 8 percent.

3.02 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. Remove or mask surface appurtenances, including electrical plates, hardware, light fixture trim, escutcheons, and fittings, prior to preparing surfaces for finishing.
- D. Seal surfaces that might cause bleed through or staining of topcoat.
- E. Remove mildew from impervious surfaces by scrubbing with solution of tetra-sodium phosphate and bleach. Rinse with clean water and allow surface to dry.
- F. Concrete:
 1. Remove release agents, curing compounds, efflorescence, and chalk. Do not coat surfaces if moisture content or alkalinity of surfaces to be coated exceeds that permitted in manufacturer's written instructions.

2. Prepare surface as recommended by top coat manufacturer and in accordance with SSPC-SP 13/NACE No.6.
- G. Masonry:
1. Remove efflorescence and chalk. Do not coat surfaces if moisture content or alkalinity of surfaces or if alkalinity of mortar joints exceed that permitted in manufacturer's written instructions. Allow to dry.
 2. Prepare surface as recommended by top coat manufacturer.
- H. Fiber Cement Siding: Remove dirt, dust and other foreign matter with a stiff fiber brush. Do not coat surfaces if moisture content or alkalinity of surfaces to be coated exceeds that permitted in manufacturer's written instructions.
- I. Exterior Plaster: Fill hairline cracks, small holes, and imperfections with exterior patching plaster. Make smooth and flush with adjacent surfaces. Wash and neutralize high alkali surfaces.
- J. Concrete Floors and Traffic Surfaces: Remove contamination, acid etch, and rinse floors with clear water. Verify required acid-alkali balance is achieved. Allow to dry.
- K. Aluminum: Remove surface contamination and oils and wash with solvent according to SSPC-SP 1.
- L. Copper: Remove contamination by steam, high pressure water, or solvent washing.
- M. Galvanized Surfaces:
1. Remove surface contamination and oils and wash with solvent according to SSPC-SP 1.
- N. Ferrous Metal:
1. Solvent clean according to SSPC-SP 1.
 2. Remove rust, loose mill scale, and other foreign substances using methods recommended in writing by paint manufacturer and blast cleaning in accordance with SSPC-SP 6/NACE No.3. Protect from corrosion until coated.
- O. Exterior Wood Surfaces to Receive Opaque Finish: Remove dust, grit, and foreign matter. Seal knots, pitch streaks, and sappy sections. Fill nail holes with tinted exterior calking compound after prime coat has been applied. Back prime concealed surfaces before installation.
- P. Glue-Laminated Beams: Prior to finishing, wash surfaces with solvent, remove grease and dirt.
- Q. Metal Doors to be Painted: Prime metal door top and bottom edge surfaces.

3.03 APPLICATION

- A. Exterior Wood to Receive Opaque Finish: If final painting must be delayed more than 2 weeks after installation of woodwork, apply primer within 2 weeks and final coating within 4 weeks.
- B. Apply products in accordance with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual".
- C. Do not apply finishes to surfaces that are not dry. Allow applied coats to dry before next coat is applied.
- D. Apply each coat to uniform appearance.
- E. Vacuum clean surfaces of loose particles. Use tack cloth to remove dust and particles just prior to applying next coat.
- F. Reinstall electrical cover plates, hardware, light fixture trim, escutcheons, and fittings removed prior to finishing.

3.04 CLEANING

- A. Collect waste material that could constitute a fire hazard, place in closed metal containers, and remove daily from site.

3.05 PROTECTION

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

END OF SECTION

SECTION 099123
INTERIOR PAINTING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Interior painting.

1.02 RELATED REQUIREMENTS

- A. Section 099113 - Exterior Painting.

1.03 DEFINITIONS

- A. Comply with ASTM D16 for interpretation of terms used in this section.

1.04 REFERENCE STANDARDS

- A. ASTM D16 - Standard Terminology for Paint, Related Coatings, Materials, and Applications; 2024.
- B. ASTM D4442 - Standard Test Methods for Direct Moisture Content Measurement of Wood and Wood-Based Materials; 2020.
- C. CAL (CDPH SM) - Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers Version 1.2; 2017.
- D. MPI (APSM) - Master Painters Institute Architectural Painting Specification Manual; Current Edition.
- E. SSPC-SP 1 - Solvent Cleaning; 2015, with Editorial Revision (2016).
- F. SSPC-SP 6/NACE No.3 - Commercial Blast Cleaning; 2006.
- G. SSPC-SP 13/NACE No.6 - Surface Preparation of Concrete; 2018.

1.05 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. Manufacturer's name, product name and/or catalog number, and general product category (e.g., "alkyd enamel").
 - 2. MPI product number (e.g., MPI #47).
 - 3. Cross-reference to specified paint system products to be used in project; include description of each system.
 - 4. Manufacturer's installation instructions.
- C. Sustainable Product Data: See Section 01 6000 - Product Requirements and Section 01 6116 - Volatile Organic Compound (VOC) Content Restrictions.
 - 1. VOC content restrictions data.
 - 2. CAL (CDPH SM) compliance data.
- D. Samples: Submit three paper "draw down" samples, 8-1/2 by 11 inches in size, illustrating range of colors available for each finishing product specified.

1. Where sheen is specified, submit samples in only that sheen.
 2. Where sheen is not specified, discuss sheen options with Architect before preparing samples, to eliminate sheens not required.
- E. Manufacturer's Instructions: Indicate special surface preparation procedures.
- F. Maintenance Data: Submit data including finish schedule showing where each product/color/finish was used, product technical data sheets, material safety data sheets (MSDS), care and cleaning instructions, touch-up procedures, repair of painted and finished surfaces, and color samples of each color and finish used.
- 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 Paint and Finish Materials: 1 gal of each color; from the same product run, store where directed.
 3. Label each container with color in addition to the manufacturer's label.

1.06 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the products specified, with minimum five years documented experience.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. See Section 01 6000 - Product Requirements.
- B. Deliver products to site in sealed and labeled containers; inspect to verify acceptability.
- C. Container Label: Include manufacturer's name, type of paint, brand name, lot number, brand code, coverage, surface preparation, drying time, cleanup requirements, color designation, and instructions for mixing and reducing.
- D. Paint Materials: Store at minimum ambient temperature of 45 degrees F and a maximum of 90 degrees F, in ventilated area, and as required by manufacturer's instructions.
- E. See Section 01 7419 - Construction Waste Management and Disposal, for packaging waste requirements.

1.08 FIELD CONDITIONS

- A. Do not apply materials when surface and ambient temperatures are outside the temperature ranges required by the paint product manufacturer.
- B. Follow manufacturer's recommended procedures for producing best results, including testing of substrates, moisture in substrates, and humidity and temperature limitations.
- C. Minimum Application Temperatures for Paints: 50 degrees F for interiors unless required otherwise by manufacturer's instructions.
- D. Provide lighting level of 80 fc measured mid-height at substrate surface.

PART 2 PRODUCTS

2.01 SUSTAINABLE PRODUCT REQUIREMENTS

- A. See Section 01 6000 - Product Requirements.
- B. VOC Content Restrictions: Products in this section to not exceed VOC content limits specified in Section 01 6116 - Volatile Organic Compound (VOC) Content Restrictions.
- C. CDPH: Products to comply with CAL (CDPH SM) .

2.02 MANUFACTURERS

- A. Provide paints and finishes used in any individual system from the same manufacturer; no exceptions.
- B. Paints:
 - 1. Benjamin Moore.
 - 2. Dunn-Edwards.
 - 3. PPG.
 - 4. Sherwin-Williams.
 - 5. Substitutions: See Section 01 2500 - Substitution Procedures.

2.03 PAINTS AND FINISHES - GENERAL

- A. Paint Colors:
 - 1. Products: See Finish Schedule on the Architectural drawings.
 - 2. P-1: (Manufacturer; Product, Color)
- B. Paints and Finishes: Ready-mixed, unless intended to be a field-catalyzed paint.
 - 1. Provide paints and finishes of a soft paste consistency, capable of being readily and uniformly dispersed to a homogeneous coating, with good flow and brushing properties, and capable of drying or curing free of streaks or sags.
 - 2. Provide materials that are compatible with one another and the substrates indicated under conditions of service and application, as demonstrated by manufacturer based on testing and field experience.
 - 3. Supply each paint material in quantity required to complete entire project's work from a single production run.
 - 4. Do not reduce, thin, or dilute paint or finishes or add materials unless such procedure is specifically described in manufacturer's product instructions.
- C. Sheens: Provide the sheens specified; where sheen is not specified, sheen will be selected later by Architect from the manufacturer's full line.

2.04 PAINT SYSTEMS - INTERIOR

- A. Paint WI-OP-3L - Wood, Opaque, Latex, 3 Coat:
 - 1. One coat of latex primer sealer.
 - 2. Gloss: Two coats of latex enamel.
 - 3. Semi-gloss: Two coats of latex enamel.
 - 4. Eggshell: Two coats of latex enamel.
 - 5. Flat: Two coats of latex enamel.
- B. Paint CI-OP-3A - Concrete/Masonry, Opaque, Alkyd, 3 Coat:
 - 1. One coat of block filler.
 - 2. Semi-gloss: Two coats of alkyd enamel.
 - 3. Flat: Two coats of alkyd enamel.
- C. Paint MI-OP-3A - Ferrous Metals, Unprimed, Alkyd, 3 Coat:
 - 1. One coat of alkyd primer.
 - 2. Gloss: Two coats of alkyd enamel.
 - 3. Semi-gloss: Two coats of alkyd enamel.
- D. Paint MI-OP-2A - Ferrous Metals, Primed, Alkyd, 2 Coat:
 - 1. Touch-up with alkyd primer.
 - 2. Gloss: Two coats of alkyd enamel.
 - 3. Semi-gloss: Two coats of alkyd enamel.
- E. Paint Mgl-OP-3A - Galvanized Metals, Alkyd, 3 Coat:

1. One coat galvanize primer.
 2. Gloss: Two coats of alkyd enamel.
 3. Semi-gloss: Two coats of alkyd enamel.
- F. Paint Mal-OP-3A - Aluminum, Unprimed, Alkyd, 3 Coat:
1. One coat etching primer.
 2. Gloss: Two coats of alkyd enamel.
 3. Semi-gloss: Two coats of alkyd enamel.
- G. Paint CI-OP-3Af - Concrete/Masonry, Alkyd Floor Enamel, 3 Coat:
1. One coat of alkali-resistant primer.
 2. Gloss: Two coats of alkyd floor enamel.
- H. Paint GI-OP-3L - Gypsum Board/Plaster, Latex, 3 Coat:
1. One coat of alkyd primer sealer.
 2. Gloss: Two coats of latex enamel.
 3. Semi-gloss: Two coats of latex enamel.
 4. Eggshell: Two coats of latex enamel.
 5. Flat: Two coats of latex enamel.

2.05 PRIMERS

- A. Provide primer as recommended by manufacturer for substrate and conditions.

2.06 ACCESSORY MATERIALS

- A. Accessory Materials: Provide primers, sealers, cleaning agents, cleaning cloths, sanding materials, and clean-up materials as required for final completion of painted surfaces.
- B. Patching Material: Latex filler.
- C. Fastener Head Cover Material: Latex filler.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Do not begin application of paints and finishes until substrates have been adequately prepared.
- B. Verify that surfaces are ready to receive work as instructed by the product manufacturer.
- C. Examine surfaces scheduled to be finished prior to commencement of work. Report any condition that may potentially affect proper application.
- D. Test shop-applied primer for compatibility with subsequent cover materials.
- E. Measure moisture content of surfaces using an electronic moisture meter. Do not apply finishes unless moisture content of surfaces is below the following maximums:
1. Gypsum Wallboard: 12 percent.
 2. Plaster and Stucco: 12 percent.
 3. Masonry, Concrete, and Concrete Masonry Units: 12 percent.
 4. Interior Wood: 15 percent, measured in accordance with ASTM D4442.
 5. Concrete Floors and Traffic Surfaces: 8 percent.

3.02 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. Remove or mask surface appurtenances, including electrical plates, hardware, light fixture trim, escutcheons, and fittings, prior to preparing surfaces or finishing.
- D. Seal surfaces that might cause bleed through or staining of topcoat.
- E. Remove mildew from impervious surfaces by scrubbing with solution of tetra-sodium phosphate and bleach. Rinse with clean water and allow surface to dry.
- F. Concrete:
 - 1. Remove release agents, curing compounds, efflorescence, and chalk. Do not coat surfaces if moisture content or alkalinity of surfaces to be coated exceeds that permitted in manufacturer's written instructions.
 - 2. Prepare surface as recommended by top coat manufacturer and in accordance with SSPC-SP 13/NACE No.6.
- G. Masonry:
 - 1. Remove efflorescence and chalk. Do not coat surfaces if moisture content, alkalinity of surfaces, or if alkalinity of mortar joints exceed that permitted in manufacturer's written instructions. Allow to dry.
 - 2. Prepare surface as recommended by top coat manufacturer.
- H. Concrete Floors and Traffic Surfaces: Remove contamination, acid etch and rinse floors with clear water. Verify required acid-alkali balance is achieved. Allow to dry.
- I. Gypsum Board: Fill minor defects with filler compound. Spot prime defects after repair.
- J. Plaster: Fill hairline cracks, small holes, and imperfections with latex patching plaster. Make smooth and flush with adjacent surfaces. Wash and neutralize high-alkali surfaces.
- K. Aluminum: Remove surface contamination and oils and wash with solvent according to SSPC-SP 1.
- L. Copper: Remove contamination by steam, high-pressure water, or solvent washing.
- M. Galvanized Surfaces:
 - 1. Remove surface contamination and oils and wash with solvent according to SSPC-SP 1.
- N. Ferrous Metal:
 - 1. Solvent clean according to SSPC-SP 1.
 - 2. Remove rust, loose mill scale, and other foreign substances using methods recommended in writing by paint manufacturer and blast cleaning in accordance with SSPC-SP 6/NACE No.3. Protect from corrosion until coated.
- O. Wood Surfaces to Receive Opaque Finish: Wipe off dust and grit prior to priming. Seal knots, pitch streaks, and sappy sections with sealer. Fill nail holes and cracks after primer has dried; sand between coats. Back prime concealed surfaces before installation.
- P. Glue-Laminated Beams: Prior to finishing, wash surfaces with solvent, remove grease and dirt.
- Q. Wood Doors to be Field-Finished: Seal wood door top and bottom edge surfaces with clear sealer.
- R. Metal Doors to be Painted: Prime metal door top and bottom edge surfaces.

3.03 APPLICATION

- A. Apply products in accordance with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual".
- B. Do not apply finishes to surfaces that are not dry. Allow applied coats to dry before next coat is applied.
- C. Apply each coat to uniform appearance in thicknesses specified by manufacturer.

- D. Sand wood and metal surfaces lightly between coats to achieve required finish.
- E. Vacuum clean surfaces of loose particles. Use tack cloth to remove dust and particles just prior to applying next coat.
- F. Reinstall electrical cover plates, hardware, light fixture trim, escutcheons, and fittings removed prior to finishing.

3.04 CLEANING

- A. Collect waste material that could constitute a fire hazard, place in closed metal containers, and remove daily from site.

3.05 PROTECTION

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

END OF SECTION

SECTION 099600
HIGH-PERFORMANCE COATINGS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. High performance coatings.

1.02 REFERENCE STANDARDS

- A. 40 CFR 59, Subpart D - National Volatile Organic Compound Emission Standards for Architectural Coatings; U.S. Environmental Protection Agency; Current Edition.
- B. ASTM D4258 - Standard Practice for Surface Cleaning Concrete for Coating; 2023.
- C. CAL (CDPH SM) - Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers Version 1.2; 2017.
- D. MPI (APL) - Master Painters Institute Approved Products List; Master Painters and Decorators Association; Current Edition.
- E. MPI (APSM) - Master Painters Institute Architectural Painting Specification Manual; Current Edition.
- F. SCAQMD 1113 - Architectural Coatings; 1977, with Amendment (2016).
- G. SSPC V1 (PM1) - Good Painting Practice: Painting Manual Volume 1; 2024.
- H. SSPC V2 (PM2) - Systems and Specifications: Steel Structures Painting Manual Volume 2; 2021.
- I. SSPC-PA 1 - Shop, Field, and Maintenance Coating of Metals; 2024.
- J. SSPC-SP 1 - Solvent Cleaning; 2015, with Editorial Revision (2016).
- K. SSPC-SP 2 - Hand Tool Cleaning; 2024.
- L. SSPC-SP 3 - Power Tool Cleaning; 2024.
- M. SSPC-SP 6/NACE No.3 - Commercial Blast Cleaning; 2006.
- N. SSPC-SP 11 - Power-Tool Cleaning to Bare Metal; 2020.
- O. SSPC-SP 13/NACE No.6 - Surface Preparation of Concrete; 2018.

1.03 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide complete list of all products to be used, with the following information for each:
 - 1. Manufacturer's name, product name and/or catalog number, and general product category (e.g. "alkyd enamel").
 - 2. MPI product number (e.g. MPI #47).
 - 3. Cross-reference to specified coating system(s) product is to be used in; include description of each system.
 - 4. Manufacturer's installation instructions.
- C. Sustainable Product Data: See Section 01 6000 - Product Requirements and Section 01 6116 - Volatile Organic Compound (VOC) Content Restrictions.
 - 1. VOC content restrictions data.

- 2. CAL (CDPH SM) compliance data.
- D. Manufacturer's Certificate: Certify that high-performance coatings comply with VOC limits specified.
- E. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- F. Manufacturer's Installation Instructions: Indicate special procedures and perimeter conditions requiring special attention.
- G. Maintenance Data: Include cleaning procedures and repair and patching techniques.
- H. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. Extra Coating Materials: 1 gallon of each type and color.
 - 2. Label each container with manufacturer's name, product number, color number, and room names and numbers where used.

1.04 QUALITY ASSURANCE

- A. Maintain one copy of each referenced document that applies to application on site.
- B. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum ten years documented experience.
- C. Applicator Qualifications: Company specializing in performing the work of this section with minimum five years documented experience.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. See Section 01 6000 - Product Requirements.
- B. Deliver products to site in sealed and labeled containers; inspect to verify acceptability.
- C. Container Label: Include manufacturer's name, type of coating, brand name, lot number, brand code, coverage, surface preparation, drying time, cleanup requirements, color designation, and instructions for mixing and reducing.
- D. Coating Materials: Store at minimum ambient temperature of 45 degrees F and a maximum of 90 degrees F, in ventilated area, and as required by manufacturer's instructions.
- E. See Section 01 7419 - Construction Waste Management and Disposal, for packaging waste requirements.

1.06 FIELD CONDITIONS

- A. Follow manufacturer's recommended procedures for producing best results, including testing of substrates, moisture in substrates, and humidity and temperature limitations.
- B. Do not apply exterior coatings during rain or snow, or when relative humidity is outside the humidity ranges required by the coating product manufacturer.
- C. Do not install materials when temperature is below 55 degrees F or above 90 degrees F.
- D. Maintain this temperature range, 24 hours before, during, and 72 hours after installation of coating.
- E. Restrict traffic from area where coating is being applied or is curing.

1.07 WARRANTY

- A. See Section 017800 - Closeout Submittals for additional warranty requirements.
- B. Correct defective Work within a one (1) year period after Date of Substantial Completion.
- C. Warranty: Include coverage for bond to substrate.

PART 2 PRODUCTS

2.01 SUSTAINABLE PRODUCT REQUIREMENTS

- A. See Section 01 6000 - Product Requirements.
- B. VOC Content Restrictions: Products in this section to not exceed VOC content limits specified in Section 01 6116 - Volatile Organic Compound (VOC) Content Restrictions.
- C. CDPH: Products to comply with CAL (CDPH SM) .

2.02 MANUFACTURERS

- A. High-Performance Coatings:
 - 1. Dow.
 - 2. Dunn Edwards.
 - 3. ICI.
 - 4. Kelly-Moore.
 - 5. PPG.
 - 6. Precision Coatings.
 - 7. Rust-Oleum
 - 8. Sika.
 - 9. Sherwin-Williams.
 - 10. Tex-Cote (Tnemec).
 - 11. Tnemec.
 - 12. Substitutions: See Section 01 2500 - Substitution Procedures.

2.03 HIGH-PERFORMANCE COATINGS

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

2.04 TOP COAT MATERIALS

- A. Coatings - General: Provide complete multi-coat systems formulated and recommended by manufacturer for the applications indicated, in the thicknesses indicated; number of coats specified does not include primer or filler coat.
 - 1. Colors: As shown on the Architectural drawings, or as otherwise selected from manufacturer's full range.
- B. Elastomeric Coating:
 - 1. Number of Coats: Two.
 - 2. Top Coat(s): Exterior Pigmented Elastomeric, Water Based; MPI #113. For exterior block and cement plaster.
 - a. Sheen: Flat.
 - b. Products:
 - 1) Dow; DOWSIL ALLGUARD Silicone Elastomeric Coating: www.dow.com/#sle.
 - 2) Pittsburgh Paints; Perma-Crete Pitt-Flex Elastomeric Coating, 4-110XI Series, Flat: www.pittsburghpaintsco.com/#sle. (MPI #113)
 - 3) Sika; Thorolastic-750.
 - 4) Tnemec Company, Inc; Series 156 Enviro-Crete: www.tnemec.com/#sle.
 - 5) Substitutions: See Section 01 2500 - Substitution Procedures.
- C. Epoxy Coating:
 - 1. Number of coats: Two.

2. Top Coat(s): High Performance Institutional, Interior, Two-Component, Water Based Epoxy or Polyurethane Coating; MPI #252, #254, #255, #256.
 - a. Sheen: Satin.
 - b. Products:
 - 1) PPG Protective and Marine Coatings; Aquapon WB EP Two-Component Waterborne Epoxy, 98E-1/98E-100 Series, Semi-Gloss: www.ppgpmc.com/#sle.
 - 2) Rust-Oleum Corporation; Water-Based Epoxy Maintenance Coating - S60: www.rustoleum.com/#sle.
 - 3) Sherwin-Williams; Pro Industrial Water Based Catalyzed Epoxy: www.protective.sherwin-williams.com/#sle. (MPI #254)
 - 4) Vista Paint; Ure-Tech Int/Ext 2 Comp. Polyurethane.
 - 5) Substitutions: See Section 01 2500 - Substitution Procedures.
- D. Urethane Coating:
 1. Number of Coats: Two.
 2. Product Characteristics:
 - a. Dry film thickness, per coat: 2-3 mils, minimum.
 3. Top Coat(s): Polyurethane, Solvent-Based, Two-Component; MPI #72, #174. For interior and exterior block, concrete, plaster, wood, and metal substrates.
 - a. Sheen: Semi-Gloss.
 - b. Products:
 - 1) Sherwin-Williams; Acrolon 218 HS: www.protective.sherwin-williams.com/#sle. (MPI #72, #174)
 - 2) Stonhard; Stonglaze VSE: www.stonhard.com/#sle.
 - 3) Tnemec Company, Inc; Series 1095 Endura-Shield: www.tnemec.com/#sle.
 - 4) Substitutions: See Section 01 2500 - Substitution Procedures.
 4. Top Coat(s): Polyurethane, Water Based, Two-Component.
 - a. Sheen: Satin.
 - b. Products:
 - 1) PPG Protective and Marine Coatings; Amerishield VOC Polyester Acrylic Polyurethane, AMV-3 Series, Gloss: www.ppgpmc.com/#sle. (MPI #83)
 - 2) Sherwin-Williams Pro Industrial Waterbased Alkyd Urethane, Low Sheen: www.protective.sherwin-williams.com/#sle. (MPI #157)
 - 3) Tnemec Company, Inc; Series 297 Enviro-Glaze: www.tnemec.com/#sle.
 - 4) Substitutions: See Section 01 2500 - Substitution Procedures.
- E. Graffiti-Resistant Coating for Concrete:
 1. Number of Coats: As recommended by manufacturer.
 2. Top Coat: Polysiloxane hybrid coating.
 - a. Color: Clear.
 - b. Sheen: Satin.
 - c. Products:
 - 1) RainguardPro; Micro-Seal with Graffiti Control Water Repellent / Anti-Graffiti: www.rainguardpro.com/#sle.
 - 2) Sherwin-Williams; Anti-Graffiti Coating.
 - 3) Tex-Cote (Tnemec); Graffiti Gard IV Clear.
 - 4) Substitutions: See Section 01 2500 - Substitution Procedures.
- F. Fluoropolymer Coating for Exterior Metals:
 1. Number of Coats: Two.
 2. Top Coat(s): Air Dry Fluoropolymer, One or Two Component.
 - a. Sheen: Gloss.

- b. Finish: Metallic.
- c. Products:
 - 1) APV Engineered Coatings; NeverFade Original Restoration Topcoat: www.apvcoatings.com/#sle.
 - 2) Arkema, Inc; Kynar Aquatec: www.arkema.com/#sle.
 - 3) PPG Paints; Corafon ADS: www.ppgpaints.com/#sle.
 - 4) Tex-Cote LLC; Reflect-TEC Heat Reflective Roof & Wall Coating: www.texcote.com/#sle.
 - 5) Tnemec Company, Inc; Series 1071V Fluoronar: www.tnemec.com/#sle.
 - 6) Substitutions: See Section 01 2500 - Substitution Procedures.
- G. Primers: As recommended by coating manufacturer for specific substrate, unless otherwise specified.
- H. Shellac: Pure, white type.

2.05 ACCESSORY MATERIALS

- A. Accessory Materials: Provide primers, sealers, cleaning agents, cleaning cloths, sanding materials, and clean-up materials as required for final completion of coated surfaces.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Do not begin application of coatings until substrates have been properly prepared.
- C. Verify that substrate surfaces are ready to receive work as instructed by the coating manufacturer. Obtain and follow manufacturer's instructions for examination and testing of substrates.
- D. Examine surfaces scheduled to be finished prior to commencement of work. Report any condition that may potentially affect proper application.
- E. Measure moisture content of surfaces using an electronic moisture meter. Do not apply finishes unless moisture content of surfaces are below the following maximums:
 - 1. Cementitious Substrates: Do not begin application until substrate has cured 28 days minimum and measured moisture content is not greater than 12 percent.
 - 2. Plaster and Stucco: 12 percent.
 - 3. Masonry, Concrete, and Concrete Unit Masonry: 12 percent.
 - 4. Concrete Floors and Traffic Surfaces: 8 percent.
 - 5. Wood: Do not begin application if substrate has moisture content over 12 percent.
- F. Proceed with coating application only after unacceptable conditions have been corrected.
 - 1. Commencing coating application constitutes Contractor's acceptance of substrates and conditions.

3.02 PREPARATION

- A. Protect adjacent surfaces and materials not receiving coating from spatter and overspray; mask if necessary to provide adequate protection. Repair damage.
- B. Clean surfaces of loose foreign matter.
- C. Remove substances that would bleed through finished coatings. If unremovable, seal surface with shellac.

- D. Remove finish hardware, fixture covers, and accessories and store.
- E. Concrete:
 - 1. Remove release agents, curing compounds, efflorescence, and chalk. Do not coat surfaces if moisture content or alkalinity of surfaces to be coated exceeds that permitted in manufacturer's written instructions.
 - 2. Prepare surface as recommended by coating manufacturer and in accordance with SSPC-SP 13/NACE No.6.
- F. Masonry:
 - 1. Remove efflorescence and chalk. Do not coat surfaces if moisture content or alkalinity of surfaces or if alkalinity of mortar joints exceed that permitted in manufacturer's written instructions. Allow to dry.
 - 2. Prepare surface as recommended by coating manufacturer.
- G. Galvanized Surfaces:
 - 1. Remove surface contamination and oils and wash with solvent according to SSPC-SP 1.
- H. Ferrous Metal:
 - 1. Solvent clean according to SSPC-SP 1.
 - 2. Remove rust, loose mill scale, and other foreign substances using methods recommended in writing by paint manufacturer and blast cleaning in accordance with SSPC-SP 6/NACE No.3, and protect from corrosion until coated.

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. Concrete: Prior to priming, patch with masonry filler to produce smooth surface.

3.04 COATING APPLICATION

- A. Apply coatings in accordance with manufacturer's written instructions, to thicknesses specified and recommendations in MPI - Architectural Painting and Specification Manual.
- B. Apply in uniform thickness coats, without runs, drips, pinholes, brush marks, or variations in color, texture, or finish. Finish edges, crevices, corners, and other changes in dimension with full coating thickness.

3.05 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.

3.06 PROTECTION

- A. Protect finished work from damage.

END OF SECTION

**SECTION 101100
VISUAL DISPLAY UNITS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Chalkboards.
- B. Porcelain enamel steel markerboards.
- C. Glass markerboards.
- D. Electronic markerboards.
- E. Tackboards.
- F. Bulletin board cabinets.
- G. Lecture cabinets.
- H. Horizontal sliding visual display units.
- I. Vertical sliding visual display units.
- J. Glass markerboard sliding wall system.
- K. Porcelain markerboard sliding wall system.
- L. Glass markerboard wall.
- M. Porcelain markerboard wall.
- N. Tackable wall panels.

1.02 REFERENCE STANDARDS

- A. 16 CFR 1201 - Safety Standard for Architectural Glazing Materials; Current Edition.
- B. ANSI A208.1 - American National Standard for Particleboard; 2022.
- C. ANSI Z97.1 - American National Standard for Safety Glazing Materials Used in Buildings - Safety Performance Specifications and Methods of Test; 2015 (Reaffirmed 2020).
- D. ASTM A424/A424M - Standard Specification for Steel, Sheet, for Porcelain Enameling; 2018.
- E. ASTM C1048 - Standard Specification for Heat-Strengthened and Fully Tempered Flat Glass; 2025.
- F. ASTM C1172 - Standard Specification for Laminated Architectural Flat Glass; 2024.
- G. CAL (CDPH SM) - Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers Version 1.2; 2017.

1.03 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's data on chalkboard, porcelain enamel steel markerboard, glass markerboard, tackboard, tackboard surface covering, trim, and accessories.
- C. Sustainable Product Data: See Section 01 6000 - Product Requirements and Section 01 6116 - Volatile Organic Compound (VOC) Content Restrictions.
 - 1. VOC content restrictions data.
 - 2. CAL (CDPH SM) compliance data.

3. Life cycle data.
4. Sustainable wood data.
5. Recycled content data.
- D. Shop Drawings: Indicate wall elevations, dimensions, joint locations , special anchor details.
- E. Samples: Two, 12" x 12" in size illustrating materials and finish, color and texture of porcelain enamel steel markerboard, trim, tackstrip, and _____.
- F. Manufacturer's printed installation instructions.

1.04 WARRANTY

- A. See Section 017800 - Closeout Submittals, for additional warranty requirements.
- B. Provide five year warranty for chalkboard and markerboard to include warranty against discoloration due to cleaning, crazing or cracking, and staining.

PART 2 PRODUCTS

2.01 VISUAL DISPLAY UNITS

- A. Chalkboards: Slate, 1/4 to 3/8 inch thick, machine ground .
- B. Chalkboards: Porcelain enamel on steel, laminated to core.
 1. Manufacturers:
 - a. Claridge.
 - b. Nelson Adams NACO.
 - c. Substitutions: See Section 01 2500 - Substitution Procedures.
 2. Color: Green.
 3. Steel Face Sheet Thickness: 24 gauge, 0.0239 inch.
 4. Hardboard Face Sheet Thickness: 1/4 inch.
 5. Core: Particleboard, manufacturer's standard thickness, laminated to face sheet.
 6. Backing: Aluminum foil, laminated to core.
 7. Size: As indicated on drawings.
 8. Frame: Extruded aluminum , with concealed fasteners.
 9. Frame Finish: Anodized, natural.
- C. Porcelain Enamel Steel Markerboards:
 1. Manufacturers:
 - a. AJW Architectural Products.
 - b. ASI Visual Display Products.
 - c. Claridge.
 - d. Nelson Adams NACO.
 - e. Substitutions: See Section 01 2500 - Substitution Procedures.
 2. Color: White.
 3. Steel Face Sheet Thickness: 24 gauge, 0.0239 inch .
 4. Core: Particleboard, manufacturer's standard thickness, laminated to face sheet.
 5. Backing: Aluminum foil, laminated to core.
 6. Size: As indicated on drawings.
 7. Frame: Extruded aluminum , with concealed fasteners.
 8. Frame Finish: Anodized, natural.
- D. Magnetic Glass Markerboards:
 1. Manufacturers:
 - a. Claridge.

- b. General Glass International (GGI).
 - c. Ghent (GMI).
 - d. MooreCo.
- 2. Glass: Laminated, low iron, 1/4 inch thick, with bevel edges and radiused corners, laminated to steel backing sheet for use with magnets. Coated or treated for use as dry erase board or projection surface.
- 3. Glass Finish: White back-coating.
- 4. Size: As indicated on drawings.
- 5. Frame: No frame, with concealed fasteners.
- 6. Mounting: Concealed Z clips.
- 7. Accessories: Provide magnetic marker tray and magnetic marker holder.
- E. Electronic Markerboards: Interactive video whiteboard with central processing unit (CPU), voice recognition technology, Wi-Fi, ethernet, and bluetooth.
 - 1. Screen Color: Black.
 - 2. Screen Resolution: 1920 by 1080.
 - 3. Frame: Extruded aluminum.
- F. Tackboards: Fine-grained, homogeneous natural cork.
 - 1. Cork Thickness: 1/8 inch.
- G. Bulletin Board Cabinets: Factory-fabricated wood-framed unit with tackable panel on back inside surface and glazed doors at front.
 - 1. Wood Frames: Factory-assembled red oak, with factory-applied clear varnish finish.
- H. Lecture Cabinet: Cabinet with hinged doors and fixed rear panel.
- I. Horizontal Sliding Visual Display Unit: Cabinet with horizontal sliding panels and fixed rear panel.
- J. Vertical Sliding Visual Display Unit: Cabinet with vertical sliding panels and fixed rear panel.
 - 1. Cabinet:
- K. Glass Markerboard Sliding Wall System:
 - 1. Sliding Magnetic Glass Markerboard Panels:
- L. Porcelain Enamel Steel Markerboard Sliding Wall System:
 - 1. Sliding Markerboard Panels: Porcelain enamel on steel, laminated to core.
- M. Magnetic Glass Markerboard Wall: Room-size presentation surface made of multiple floor-to-ceiling glass panels.
 - 1. Glass: Back-coated glass, laminated, low iron, 1/4 inch thick, with bevel edges and radiused corners, laminated to steel backing sheet for use with magnets. Coated or treated for use as dry-erase board or projection surface.
 - 2. Steel Backing Sheet Thickness: 24 gauge, 0.0239 inch .
 - 3. Mounting: Concealed Z clips.
- N. Porcelain Enamel Steel Markerboard Wall: Room-size presentation surface made of multiple floor-to-ceiling porcelain enamel steel markerboard panels.
- O. Tackable Wall Panels: Fabric laminated to fiberboard; Factory-fabricated.
 - 1. Fabric: Vinyl-coated fabric.

2.02 MATERIALS

- A. Porcelain Enameled Steel Sheet: ASTM A424/A424M, Type I, Commercial Steel, with fired-on vitreous finish.
- B. Float Glass: Provide float-glass-based glazing unless otherwise indicated.
 - 1. Kind FT - Fully Tempered Type: Comply with ASTM C1048.

- C. Laminated Glass: Float glass laminated in accordance with ASTM C1172.
 - 1. Laminated Safety Glass: Comply with ANSI Z97.1 - Class B or 16 CFR 1201 - Category I impact test requirements.
- D. Particleboard: ANSI A208.1; wood chips, set with waterproof resin binder, sanded faces.
- E. Foil Backing: Aluminum foil sheet, 0.005 inch thick.

2.03 ACCESSORIES

- A. Map Rail: Extruded aluminum, manufacturer's standard profile, with cork insert and runners for accessories; 1 inch wide overall , full width of frame.
- B. Marker Tray: Aluminum, manufacturer's standard profile, one piece full length of markerboard, molded ends, concealed fasteners, same finish as frame.
- C. Mounting Brackets: Concealed.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that internal wall blocking is ready to receive work and positioning dimensions are as indicated on shop drawings.
- C. Verify flat wall surface for frameless adhesive-applied boards.

3.02 PREPARATION

- A. Acclimatize tackable wall panels by removing from packaging in installation area not less than 24 hours before application.
- B. Remove switchplates, wall plates, and surface-mounted fixtures where tackable wall paneling is applied. Reinstall items on completion of installation.
- C. 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. Install boards in accordance with manufacturer's instructions.
- B. Secure units level and plumb.
- C. Butt Joints: Install with tight hairline joints.
- D. Install tackable wall panels in accordance with manufacturer's recommendations on specified substrates with concealed attachments.
 - 1. Fabricate re-wrapped edges where partial panels about each other, or adjacent surfaces or trim.
 - 2. Re-wrap top, bottom or side edges for cutting panels around door or window openings, abutting trim, protruding objects, and at other openings, including x-cut at receptacles, light switches, and other openings.
 - a. Wrap minimum 2 inches around back of panel.
 - b. Carefully cut fiber board, leaving vinyl wallcovering intact. Wrap wallcovering tightly around edge of board and adhere continuously around back of panel with manufacturer's recommended vinyl wallcovering adhesive.

3.04 CLEANING

- A. Clean board surfaces in accordance with manufacturer's instructions.

END OF SECTION

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**SECTION 101124
TACKABLE WALL SYSTEMS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Factory built, fabric-covered tackable wall system.
- B. Accessories as required for complete installation.
- C. Maintenance.

1.02 RELATED REQUIREMENTS

- A. Section 016116 - Volatile Organic Compound (VOC) Content Restrictions.
- B. Section 097200 - Wall Coverings: Fabric wall coverings for adhesive application to solid wall surfaces.

1.03 REFERENCE STANDARDS

- A. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2024.
- B. ASTM E2573 - Standard Practice for Specimen Preparation and Mounting of Site-Fabricated Stretch Systems to Assess Surface Burning Characteristics; 2019.

1.04 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. Installation methods.
 - 4. Specimen warranty.
- C. Shop Drawings: Elevations indicating proposed locations of fabric seams and details indicating typical transitions to other finish surfaces.
- D. Selection Samples: Fabric swatches representing manufacturer's full range of available colors, textures, and patterns.
- E. Verification Samples:
 - 1. For each fabric specified, minimum size 8 inches square, representing actual product in color, texture, and pattern.
 - 2. Actual samples of all track profiles to be employed, including transitions between dissimilar profiles.
 - 3. Tackable core backing material, minimum 12 inches square.
 - 4. Accessory package.
- F. Test Reports: Certified test data from an independent test agency verifying that wall systems meet specified requirements for fire performance.
- G. Warranty: Submit manufacturer's warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Provide all components of tackable wall systems by a single manufacturer, including recommended primers, adhesives, and sealants.
- B. Installer Qualifications: Firm specializing in site-fabricated wall systems, with not less than 5 years of documented experience in installing wall systems of the type specified, and approved by the manufacturer.
- C. Mock-Up: Provide a mock-up for evaluation of application workmanship.
 - 1. Finish areas designated by Architect.
 - 2. Do not proceed with remaining work until workmanship and overall appearance are approved by Architect.
 - 3. Refinish mock-up area as required to produce acceptable workmanship.
 - 4. Approved mock-up may remain as part of the completed Work.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Protect fabric, core, and track from excessive moisture in shipment, storage, and handling. Do not deliver materials to project until wet work such as concrete and plaster has been completed.
- B. Store products in manufacturer's unopened packaging until ready for installation.
- C. Store and dispose of solvent-based materials, and materials used with solvent-based materials, in accordance with requirements of local authorities having jurisdiction.

1.07 FIELD CONDITIONS

- A. Do not begin installation until interior conditions have reached temperature and humidity that will be maintained during occupancy. Do not install products under environmental conditions outside manufacturer's absolute limits.

1.08 WARRANTY

- A. See Section 017800 - Closeout Submittals, for additional warranty requirements.
- B. Correct defective Work within a 5-year period after Date of Substantial Completion.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Tackable Wall Systems:
 - 1. Lavmin.
 - 2. Substitutions: See Section 016000 - Product Requirements.

2.02 TACKABLE WALL SYSTEM

- A. Tackable Wall System: Site-installed stretched fabric over tackable core and continuous perimeter and intermediate mounting extrusions applied directly to wall surface; designed to permit removal and replacement of fabric in individual panels without affecting adjacent panels.
 - 1. Surface Burning Characteristics: Flame Spread Index of 25, maximum; Smoke Developed Index of 450, maximum; when whole system is tested in accordance with ASTM E84 using mounting specified in ASTM E2573.
 - 2. Prefabricated framed panels are not acceptable.
 - 3. Fabric must be installed over tackable substrate without adhesives, tapes, or fasteners.

4. Seams in fabric are not permitted unless specifically detailed; adjust the layout of frames to suit fabric width; obtain approval of Architect.
- B. Verify that all adhesives and sealants employed in installation of tackable wall systems are low-emission types, with low VOC ratings.

2.03 MATERIALS

- A. Frame: Extruded polymer track system with serrated jaws of sufficient strength to hold fabric in place after repeated applications.
 1. Track Size: 3/8 inch protrusion from wall with minimum 1 inch base leg.
 2. Track Shape: Square at perimeter; square at intermediate abutting joints.
 3. Wall Thickness of Track: Minimum 0.062 inch.
 4. Color: As selected from manufacturer's standards.
- B. Core: Same thickness as track.
- C. Fasteners: As recommended by manufacturer of tackable wall system for project conditions.
- D. Adhesives: Low VOC or water-based, approved by wall system manufacturer, and complying with requirements of Section 016116.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Do not begin installation until substrates have been properly prepared.
- B. Verify that all casework, markerboards, door and window jambs, finished ceiling, and other finished items abutting tackable wall systems have been installed.
- C. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

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.
- C. Remove wall plates and other obstacles, and prepare substrates to receive core material in accordance with manufacturer's instructions.

3.03 INSTALLATION

- A. Install tackable wall systems at locations indicated, complying with manufacturer's instructions.
- B. Track: Install perimeter and intermediate track using fasteners appropriate to substrate, securing firmly to prevent track separation from substrate.
 1. Follow contours of wall and scribe to adjoining work at borders, penetrations, and imperfections.
 2. Install track around openings and penetrations.
 3. At outside corners, miter track to allow installation of core and fabric around corner without intermediate track members.
 4. Allow for spacing to accommodate insertion of installation tool.

- C. Core Material: Cut core material to fit snugly within frame perimeter. Apply manufacturer's recommended, non-toxic, low-vapor, clay-base adhesive, and press core material into place, maintaining constant plane. Staple core material to prevent air gaps and to maintain secure contact for full adhesion.
 - 1. At fixtures mounted within area of tackable wall system, install MDF for backing and to maintain fixture surface flush with tackable panels.
- D. Fabric: Stretch fabric over core material, locking fabric edges into track's serrated jaws using manufacturer's recommended tool. Keep fabric weave plumb, level, and true, in proper relation to building lines, without ripples, waviness, hourglass, or other deleterious effects.
 - 1. Seams are not permitted.
 - 2. In installing fabric, do not employ adhesives or mechanical fasteners of any type, assuring that the fabric is free-floating and in firm contact with core material.
 - 3. Tension fabric sufficiently to prevent sagging under anticipated changes in temperature and humidity.
 - 4. At outside corners, wrap fabric in one piece, without joints or seams.

3.04 CLEANING

- A. Clean exposed surfaces of tackable wall system, complying with manufacturer's instructions for cleaning and repair of minor finish damage. Remove and replace work that cannot be successfully cleaned and repaired to permanently eliminate evidence of damage.

3.05 PROTECTION

- A. Protect installed products until completion of project, using methods that will ensure that the finished work will be without damage or deterioration at Date of Substantial Completion.

3.06 MAINTENANCE

- A. Replace damaged, soiled, or vandalized tackable wall panels for up to 3 years from Date of Substantial Completion.
- B. Replacement of up to 10 percent of the originally installed panels shall be at no additional cost to Owner.
- C. Replacement of defective panels covered under warranty provisions is not included in this maintenance service.

END OF SECTION

SECTION 101400 SIGNAGE

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Room and door signs.
- B. Interior directional and informational signs.
- C. Emergency evacuation maps.
- D. Building identification signs.
- E. Plaque.

1.02 RELATED REQUIREMENTS

1.03 REFERENCE STANDARDS

- A. 36 CFR 1191 - Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities; Architectural Barriers Act (ABA) Accessibility Guidelines; current edition.
- B. ADA Standards - 2010 ADA Standards for Accessible Design; 2010.
- C. ICC A117.1 - Accessible and Usable Buildings and Facilities; 2017.
- D. CBC Section 11B-703 - Signs; California Building Code.
- E. CBC Section 1011.3 - Tactile Exit Signs; California Building Code.

1.04 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Manufacturer's printed product literature for each type of sign, indicating sign styles, font, foreground and background colors, locations, overall dimensions of each sign.
- C. Signage Schedule: Provide information sufficient to completely define each sign for fabrication, including room number, room name, other text to be applied, sign and letter sizes, fonts, and colors.
 - 1. When room numbers to appear on signs differ from those on drawings, include the drawing room number on schedule.
 - 2. When content of signs is indicated to be determined later, request such information from Owner through Architect at least 2 months prior to start of fabrication; upon request, submit preliminary schedule.
 - 3. Submit for approval by Owner through Architect prior to fabrication.
- D. Samples: Submit two samples of each type of sign, of size similar to that required for project, illustrating sign style, font, and method of attachment.
- E. Selection Samples: Where colors are not specified, submit two sets of color selection charts or chips.
- F. Verification Samples: Submit samples showing colors specified.
- G. Manufacturer's Installation Instructions: Include installation templates and attachment devices.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years of documented experience.
- B. Signage and graphics: CBC Section 11B-703
 - 1. Depth: It shall be 1/32 inch minimum above their background and shall be sans serif uppercase and be duplicated in Braille.
 - 2. Height: It shall be 5/8 inch minimum and 2 inches maximum based on the height of the uppercase letter "I". CBC Section 11B-703.2.5
 - 3. Finish and Contrast: Characters and their background shall have a non-glare finish. Character shall contrast with their background with either light characters on a dark background, or dark characters on a light background. CBC Section 11B-703.5.1
 - 4. Proportions: It shall be selected from fonts where the height of the uppercase letter "O" is 60% minimum and 110% maximum of the height of the uppercase letter "I". Stroke thickness of the uppercase letter "I" shall be 15% maximum of the height of the character. CBC Section 11B-703.4 and 11B-703.6
 - 5. Character Spacing: Spacing between individual tactile characters shall comply with CBC Section 11B-703.2.7 and 11B-703.2.8
 - 6. Braille: It shall be contracted (Grade 2) and shall comply with CBC Sections 11B-703.3 and 11B-703.4. Braille dots shall have a domed and rounded shape and shall comply with CBC Table and Figure 11B-703.3.1.
 - 7. Mounting Height: A tactile sign shall be located 48 inches minimum to the baseline of the lowest Braille cells and 60 inches maximum to the baseline of the highest line of raised characters above the finish floor or ground surface.
 - 8. Mounting Location: a tactile sign shall be located on the approach side, as one enters or exits rooms or space, and be reached within 0 inches of the required clear floor space per CBC Section and Figure 11B-703.4.2 as follows:
 - a. A clear floor space of 18 x 18 inches minimum, centered on the tactile characters, shall be provided beyond the arc of any door swings between the closed position and 45 degree open position.
 - b. On the wall at the latch side of a single door.
 - c. On the inactive leaf of a double door with one active leaf.
 - d. On the wall at the right side of a double door with two active leaves.
 - e. On the nearest adjacent wall where there is no wall space at the latch side of a single door or no space at the right side of a double door with two active leaves.
 - 9. Visual characters shall comply with CBC Section 11B-703.5 and shall be 40 inches minimum above finish floor or ground.
 - 10. Pictograms shall comply with CBC Section 11B-703.6.
 - 11. Symbol of accessibility shall comply with CBC Section 11B-703.7.
- C. Inspection: Tactile signs shall be field inspected for compliance after installation (11B-703.1.1.2)

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Package signs as required to prevent damage before installation.
- B. Package room and door signs in sequential order of installation, labeled by floor or building.
- C. Store tape adhesive at normal room temperature.

1.07 FIELD CONDITIONS

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

- B. Maintain this minimum temperature during and after installation of signs.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Flat Signs:
 - 1. Best Sign Systems, Inc: www.bestsigns.com.
 - 2. Cosco Industries (ADA signs): www.coscoarchitecturalsigns.com/#sle.
 - 3. Inpro: www.inprocorp.com.
 - 4. Mohawk Sign Systems, Inc: www.mohawksign.com.
 - 5. Seton Identification Products: www.seton.com/aec.
 - 6. ASI.
 - 7. Substitutions: See Section 016000 - Product Requirements.
- B. Dimensional Letter Signs:
 - 1. Cosco Industries; Cast Aluminum: www.coscoarchitecturalsigns.com/#sle.
 - 2. Inpro: www.inprocorp.com.
 - 3. Substitutions: See Section 016000 - Product Requirements.

2.02 SIGNAGE APPLICATIONS

- A. Accessibility Compliance: Signs are required to comply with ADA Standards and ICC A117.1, unless otherwise indicated; in the event of conflicting requirements, comply with the most comprehensive and specific requirements.
- B. Room and Door Signs: Provide a sign for every doorway, whether it has a door or not, not including corridors, lobbies, and similar open areas.
 - 1. Sign Type: Flat signs with engraved panel media as specified.
 - 2. Provide "tactile" signage, with letters raised minimum 1/32 inch and Grade II braille.
- C. Interior Directional and Informational Signs:
 - 1. Sign Type: Same as room and door signs.
 - 2. Sizes: As indicated on drawings.
- D. Building Identification Signs:
 - 1. Use individual metal letters.
 - 2. Mount on outside wall in location shown on drawings or as indicated by the owner
- E. Other Dimensional Letter Signs: Wall-mounted.
 - 1. Exterior: Allow for total of 50 letters, 6 inches high, metal.
 - 2. Interior: Allow for total of 50 letters, 6 inches high, metal.

2.03 SIGN TYPES

- A. Flat Signs: Signage media without frame.
 - 1. Edges: Square.
 - 2. Corners: Square.
 - 3. Wall Mounting of One-Sided Signs: Tape adhesive.
- B. Color and Font: Unless otherwise indicated:
 - 1. Character Font: Per Plans.
 - 2. Character Case: Upper case only.
 - 3. Background Color: As scheduled.
 - 4. Character Color: Per plan color.

2.04 NON-TACTILE SIGNAGE MEDIA

- A. Silk Screened Plastic Panels: Letters and graphics silk screened onto reverse side of plastic surface:
 - 1. Sign Color: Color as selected.
 - 2. Total Thickness: 1/4 inch.

2.05 PLAQUES

- A. Metal Plaques:
 - 1. Metal: Aluminum casting.
 - 2. Metal Thickness: 1/8 inch, minimum.
 - 3. Material: Aluminum.
 - 4. Sheet
 - 5. Mounting: Concealed studs for substrates encountered.

2.06 DIMENSIONAL LETTERS

- A. Metal Letters:
 - 1. Metal: Aluminum casting.
 - 2. Finish: Brushed, satin.

2.07 ACCESSORIES

- A. Concealed Screws: Stainless steel, galvanized steel, chrome plated, or other non-corroding metal.
- B. Exposed Screws: Stainless steel, tamper-resistant.
- C. Tape Adhesive: Double sided tape, permanent adhesive.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that substrate surfaces are ready to receive work.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install neatly, with horizontal edges level.
- C. Install all exterior signs using concealed or exposed tamper-resistant fasteners as indicated on the drawings; adhesive application is not acceptable for exterior locations.
- D. Locate signs where indicated:
 - 1. Room and Door Signs: Locate on wall at latch side of door with centerline of sign at 60 inches above finished floor.
 - 2. If no location is indicated obtain Owner's instructions.

END OF SECTION

SECTION 102600
WALL AND DOOR PROTECTION

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Wall and door protection.

1.02 RELATED REQUIREMENTS

- A. Section 055213 - Pipe and Tube Railings: Metal railings not intended to protect walls..

1.03 REFERENCE STANDARDS

- A. ABA Standards - ABA Accessibility Standards; 2004, with Amendments (2015).
- B. ADA Standards - 2010 ADA Standards for Accessible Design; 2010.
- C. ASTM A240/A240M - Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications; 2024b.
- D. ASTM D256 - Standard Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics; 2023, with Editorial Revision.
- E. ASTM D543 - Standard Practices for Evaluating the Resistance of Plastics to Chemical Reagents; 2021.
- F. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2024.
- G. ASTM F476 - Standard Test Methods for Security of Swinging Door Assemblies; 2023.
- H. ASTM G21 - Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi; 2015, with Editorial Revision (2021).
- I. CAL (CDPH SM) - Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers Version 1.2; 2017.
- J. ICC A117.1 - Accessible and Usable Buildings and Facilities; 2017.
- K. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Current Edition, Including All Revisions.

1.04 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. Sustainable Product Data: See Section 01 6000 - Product Requirements and Section 01 6116 - Volatile Organic Compound (VOC) Content Restrictions.
 - 1. VOC content restrictions data.
 - 2. CAL (CDPH SM) compliance data.
 - 3. Life cycle data.
 - 4. Sustainable wood data.
 - 5. Recycled content data.

- D. Shop Drawings: Include plans, elevation, sections, and attachment details. Show design and spacing of supports for protective corridor handrails, required to withstand structural loads.
- E. Manufacturer's Installation Instructions: Indicate special procedures, perimeter conditions requiring special attention.
- F. Warranty Documentation: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.
- G. Maintenance Data: Manufacturer's instructions for care and cleaning of each type of product. Include information about both recommended and potentially detrimental cleaning materials and methods.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. See Section 01 6000 - Product Requirements.
- B. Deliver wall and door protection items in original, undamaged protective packaging. Label items to designate installation locations.
- C. Protect materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources. Store in a dry location.
- D. See Section 01 7419 - Construction Waste Management and Disposal, for packaging waste requirements.

1.06 WARRANTY

- A. See Section 017800 - Closeout Submittals for additional warranty requirements.
- B. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of impact-resistant wall protection units that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures.
 - b. Deterioration of plastic and other materials beyond normal use.
 - 2. Warranty Period: 5 years from date of Substantial Completion.

PART 2 PRODUCTS

2.01 SUSTAINABLE PRODUCT REQUIREMENTS

- A. See Section 01 6000 - Product Requirements.
- B. VOC Content Restrictions: Products in this section to not exceed VOC content limits specified in Section 01 6116 - Volatile Organic Compound (VOC) Content Restrictions.
- C. CDPH: Products to comply with CAL (CDPH SM) .
- D. Life Cycle: Products in this section to have LCA as specified in Section 016000.
- E. Sustainable Wood: Products in this Section to meet sustainable wood requirements specified in Section 016000.
- F. Recycled Content: Products in this Section to meet minimum recycled content thresholds specified in Section 016000.

2.02 MANUFACTURERS

- A. Manufacturers:
 - 1. Construction Specialties, Inc.

2. Inpro.
3. Koroseal Interior Products.
4. MDC Interior Solutions.
5. Panolam.
6. Pawling.
7. Substitutions: See Section 01 2500 - Substitution Procedures.

2.03 PERFORMANCE REQUIREMENTS

- A. Impact Strength: Unless otherwise noted, provide protection products and assemblies that have been successfully tested for compliance with applicable provisions of ASTM D256 and/or ASTM F476.
- B. Chemical and Stain Resistance: Unless otherwise noted, provide protection products and assemblies with chemical and stain resistance complying with applicable provisions of ASTM D543.
- C. Fungal Resistance: Unless otherwise noted, provide protection products and assemblies which pass ASTM G21 testing.
- D. Structural Performance: Provide handrails capable of withstanding the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:
 1. Uniform load of 50 lbf/ft. applied in any direction.
 2. Concentrated load of 200 lbf. applied in any direction.
 3. Uniform and concentrated loads need not be assumed to act concurrently.
- E. Surface-Burning Characteristics: As determined by testing identical products per ASTM E84 or UL 723.
- F. Accessibility: Comply with applicable provisions in the ADA Standards, ABA Standards, and ICC A117.1.

2.04 RAILS

- A. Bumper Rails: Factory- or shop-fabricated, with preformed end caps and internal and external corners:
 1. Basis of Design Product:
 - a. .
 - b. Substitutions: See Section 01 2500 - Substitution Procedures.
 2. Material: Polyethylene terephthalate (PET or PETG); PVC-free, color as selected from manufacturer's standard colors.
 3. Surface Burning Characteristics: Provide assemblies with flame spread index of 25 or less and smoke developed index of 450 or less, when tested in accordance with ASTM E84.
 4. Mounting: Surface.
- B. Metal Crash Rails: Factory- or shop-fabricated, with preformed end wall returns, and internal and external corners:
 1. Basis of Design Product:
 - a. .
 - b. Substitutions: See Section 01 2500 - Substitution Procedures.
 2. Material: Metal; 6061-T6511 Aluminum.
 3. Mounting: Surface.
 4. Rail Type: Continuous metal bar.
 5. Finishes:
 - a. Aluminum, MIL-A-8625, Type II, Clear.

- C. Protective Corridor Handrails: Factory- or shop-fabricated, with preformed end caps and internal and external corners:
 - 1. Basis of Design Product:
 - a. .
 - b. Substitutions: See Section 01 2500 - Substitution Procedures.
 - 2. Material: Polyethylene terephthalate (PET or PETG); PVC-free, color as selected from manufacturer's standard colors.
 - 3. Mounting: Surface.
 - 4. Return rail to wall.

2.05 CORNER GUARD

- A. Corner Guards - Flush Mounted:
 - 1. Basis of Design Product:
 - a. .
 - b. Substitutions: See Section 01 2500 - Substitution Procedures.
 - 2. Width of Wings: 2 inches.
 - 3. Corner: Square.
 - 4. Color: As selected from manufacturer's standard colors.
 - 5. Length: One piece.
- B. Corner Guards - Flush Mounted: Rigid vinyl drywall corner bead with semi-rigid vinyl corner guard.
 - 1. Basis of Design Product:
 - a. .
 - b. Substitutions: See Section 01 2500 - Substitution Procedures.
 - 2. Corner: 90 degrees.
 - 3. Color: As selected from manufacturer's standard colors.
- C. Corner Guards - Surface Mounted:
 - 1. Basis of Design Product:
 - a. .
 - b. Substitutions: See Section 01 2500 - Substitution Procedures.
 - 2. Material: Polyethylene terephthalate (PET or PETG); PVC-free with full height extruded aluminum retainer.
 - 3. Material: Type 304 stainless steel, No. 4 finish.
 - 4. Width of Wings: 2 inches.
 - 5. Corner: Square.
 - 6. Color: As selected from manufacturer's standard colors.
 - 7. Length: One piece.

2.06 PROTECTIVE WALL COVERING

- A. Protective Wall Panels:
 - 1. Basis of Design Product:
 - a. .
 - b. Substitutions: See Section 01 2500 - Substitution Procedures.
 - 2. Material: Fiber Reinforced Laminate (FRL): Thermofused melamine overlay, decorative paper and fire-rated phenolic paper with fiber reinforcing inner layers.
 - 3. Thickness: 0.075 inch.
 - 4. Panel Size: 3 feet by 8 feet.
 - 5. Color and Pattern: As selected from manufacturer's standard finishes.
 - 6. Texture: As selected from manufacturer's standard textures.

7. Mounting: Adhesive.
- B. Stainless Steel Wall Panels: Surface-mounted, ASTM A240/A240M stainless steel protection system fabricated from sheet metal that includes panels, outside corners, and inside corners.
 1. Manufacturers:
 - a. InPro Corporation.
 - b. ProTek Systems.
 - c. Substitutions: See Section 01 2500 - Substitution Procedures.
 2. Material: Stainless steel, Type 304.
 - a. Thickness:
 - 1) Wall Panels: Minimum 0.0478 inch.
 - 2) Corners: Minimum 0.0598 inch.
 - b. Finish: Directional satin, No. 4.
 - c. Seams: Recessed, overlapped joints.
 3. Height: As indicated on drawings.

2.07 ACCESSORIES

- A. Adhesives and Primers: As recommended by manufacturer.
- B. Mounting Brackets and Attachment Hardware: Appropriate to component and substrate.

2.08 FABRICATION

- A. Fabricate components with tight joints, corners and seams.
- B. Pre-drill holes for attachment.
- C. Form end trim closure by capping and finishing smooth.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that rough openings, concealed blocking, and anchors are correctly sized and located.
- B. Verify that field measurements are as indicated on drawings.
- C. Verify that substrate surfaces for adhered items are clean and smooth.
 1. Test painted or wall covering surfaces for adhesion in inconspicuous area, as recommended by manufacturer. Follow adhesive manufacturer's recommendations for remedial measures at locations and/or application conditions where adhesion test's results are unsatisfactory.
- D. Start of installation constitutes acceptance of project conditions.

3.02 INSTALLATION

- A. Install components in accordance with manufacturer's instructions and approved shop drawings, level and plumb, secured rigidly in position to supporting construction.
- B. Refer to the Architectural drawings for mounting heights.
- C. Terminate rails 1 inch short of door openings and intersecting walls.

3.03 CLEANING

- A. See Section 017419 - Construction Waste Management and Disposal, for additional requirements.

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

END OF SECTION

SECTION 102800
TOILET, BATH, AND LAUNDRY ACCESSORIES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Commercial toilet accessories.
- B. Under-lavatory pipe supply covers.
- C. Electric hand/hair dryers.
- D. Diaper changing stations.
- E. Utility room accessories.

1.02 REFERENCE STANDARDS

- A. ADA Standards - 2010 ADA Standards for Accessible Design; 2010.
- B. ASME A112.18.9 - Protectors/Insulators for Exposed Waste and Supplies on Accessible Fixtures; 2011 (Reaffirmed 2022).
- C. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2024.
- D. ASTM A269/A269M - Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service; 2022.
- E. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2023.
- F. ASTM A666/A666M - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar; 2024.
- G. ASTM B86 - Standard Specification for Zinc and Zinc-Aluminum (ZA) Alloy Foundry and Die Castings; 2023.
- H. ASTM C1036 - Standard Specification for Flat Glass; 2025.
- I. ASTM C1048 - Standard Specification for Heat-Strengthened and Fully Tempered Flat Glass; 2025.
- J. ASTM C1822 - Standard Specification for Insulating Covers on Accessible Lavatory Piping; 2021.
- K. ASTM D4802 - Standard Specification for Poly(Methyl Methacrylate) Acrylic Plastic Sheet; 2016.
- L. ASTM D5047 - Standard Specification for Polyethylene Terephthalate Film and Sheeting; 2017.
- M. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2024.
- N. ASTM F2285 - Standard Consumer Safety Performance Specification for Diaper Changing Tables for Commercial Use; 2022.
- O. ASTM G21 - Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi; 2015, with Editorial Revision (2021).
- P. ICC A117.1 - Accessible and Usable Buildings and Facilities; 2017.
- Q. CBC 1118B - Space Allowance and Reach Ranges; California Building Code.

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: For each item to be installed. Submit data on accessories describing size, finish, details of function, and attachment methods.
- C. Manufacturer's Installation Instructions: Indicate special procedures and conditions requiring special attention.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. See Section 01 6000 - Product Requirements.
- B. Deliver materials to Project site in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, approval or listing agency markings, and directions for storing.
- C. Protect materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources. Store in a dry location.
- D. Comply with manufacturer's written instructions for handling, storing, and protecting during installation.
- E. See Section 01 7419 - Construction Waste Management and Disposal, for packaging waste requirements.

1.06 WARRANTY

- A. See Section 01 6000 - Product Requirements and Section 01 7800 - Closeout Submittals for additional warranty requirements.
- B. Provide manufacturer's standard warranty for each product.

PART 2 PRODUCTS

2.01 REGULATORY REQUIREMENTS

- A. Sanitary Facility Elements: CBC Section 11B-602 through 11B-612
 - 1. Elements of sanitary facilities shall be mounted at locations in compliance with CBC Sections 11B-602 through 11B-612.
 - 2. Grab bars on toilet facilities and bathing facilities shall comply with CBC Section 11B-609. Grab bars and any wall or other surfaces adjacent to grab bars shall be free of sharp or abrasive elements and shall have rounded edges. The space around the grab bars shall be as follows:
 - a. 1-1/2 inches between the grab bar and the wall.
 - b. 1-1/2 inches minimum between the grab bar and projecting objects below and at the ends.
 - c. 12 inches minimum between the grab bar and projecting objects above.
 - 3. Toilet paper dispensers shall be continuous flow type.

2.02 MANUFACTURERS

- A. Commercial Toilet, Shower, and Bath Accessories:

1. AJW.
 2. American Specialties, Inc. (ASI).
 3. Bobrick.
 4. Bradley.
 5. Georgia-Pacific Professional.
 6. Seachrome.
 7. Substitutions: See Section 01 2500 - Substitution Procedures.
- B. Under-Lavatory Pipe Supply Covers:
1. Plumberex Specialty Products, Inc.
 2. Truebro (IPS Corporation).
 3. Substitutions: See Section 01 2500 - Substitution Procedures.
- C. Electric Hand Dryers:
1. American Specialties, Inc. (ASI).
 2. Dyson.
 3. Excel Dryer.
 4. Mitsubishi Electric.
 5. World Dryer.
 6. Substitutions: See Section 01 2500 - Substitution Procedures.
- D. Diaper Changing Stations:
1. American Specialties, Inc. (ASI).
 2. Bradley.
 3. Diaper Deck & Company.
 4. Foundations Worldwide.
 5. Koala Kare Products (Bobrick).
 6. Safe-Strap.
 7. Substitutions: See Section 01 2500 - Substitution Procedures.
- E. Provide products of each category type by single manufacturer.

2.03 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.
1. Grind welded joints smooth.
 2. Fabricate units made of metal sheet of seamless sheets with flat surfaces.
- B. Keys: Provide 2 keys for each accessory to Owner; master key lockable accessories.
- C. Stainless Steel Sheet: ASTM A666/A666M, Type 304.
- D. Stainless Steel Tubing: ASTM A269/A269M, Grade TP304 or TP316.
- E. Galvanized Sheet Steel: Hot-dipped galvanized steel sheet, ASTM A653/A653M, with G90/Z275 coating.
- F. Zinc Alloy: Die cast, ASTM B86.
- G. Acrylic Plastic Sheet: ASTM D4802.
- H. PETG Plastic Sheet: ASTM D5047.
- I. Mirror Glass: Tempered safety glass, ASTM C1048; and ASTM C1036 Type I, Class 1, Quality Q2, with silvering as required.
- J. Adhesive: Two component epoxy type, waterproof.
- K. Fasteners, Screws, and Bolts: Hot dip galvanized; tamper-proof; security type.

- L. Expansion Shields: Fiber, lead, or rubber as recommended by accessory manufacturer for component and substrate.

2.04 FINISHES

- A. Stainless Steel: Satin finish, unless otherwise noted.
- B. Galvanizing for Items Other than Sheet: Comply with ASTM A123/A123M; galvanize ferrous metal and fastening devices.
- C. Back paint components where contact is made with building finishes to prevent electrolysis.

2.05 COMMERCIAL TOILET ACCESSORIES

- A. Products: See Restroom Accessories Schedule on the Architectural drawings.
- B. Mirrors: Stainless steel framed, 1/4 inch thick tempered safety glass; ASTM C1048.
- C. Grab Bars: Stainless steel, smooth surface.
- D. Combination Sanitary Napkin/Tampon Dispenser with Disposal: Stainless steel, surface-mounted.
- E. Sanitary Napkin Disposal Unit: Stainless steel, surface-mounted, self-closing door, locking bottom panel with full-length stainless steel piano-type hinge, removable receptacle.

2.06 UNDER-LAVATORY PIPE AND SUPPLY COVERS

- A. Under-Lavatory Pipe and Supply Covers:
 - 1. Insulate exposed drainage piping, including hot, cold, and tempered water supplies under lavatories or sinks to comply with ADA Standards.
 - 2. Exterior Surfaces: Smooth non-absorbent, non-abrasive surfaces.
 - 3. Construction: 1/8 inch flexible PVC.
 - a. Surface Burning Characteristics: Flame spread index of 25 or less and smoke developed index of 450 or less, when tested in accordance with ASTM E84.
 - b. Comply with ASTM C1822, type indicated.
 - c. Comply with ASME A112.18.9.
 - d. Comply with ICC A117.1.
 - e. Microbial and Fungal Resistance: Comply with ASTM G21.
 - 4. Color: White.
 - 5. Fasteners: Reusable, snap-locking fasteners with no sharp or abrasive external surfaces.

2.07 ELECTRIC HAND DRYERS

- A. Electric Hand Dryers: Traditional fan-in-case type, with downward fixed nozzle.
 - 1. Operation: Automatic, sensor-operated on and off.
 - 2. Mounting: Wall-mounted - surface.
 - 3. Cover: Plastic.
 - a. Tamper-resistant screw attachment of cover to mounting plate.
- B. Electric Dryers: Traditional fan-in-case type, with downward nozzle.
 - 1. Electric Hair Dryer Products:
 - a. Dyson, Inc.; Airblade: www.dyson.com.

2.08 DIAPER CHANGING STATIONS

- A. Diaper Changing Station: Wall-mounted folding diaper changing station for use in commercial toilet facilities, meeting or exceeding ASTM F2285.
 - 1. Material: Polyethylene.

2. Mounting: Surface.

2.09 UTILITY ROOM ACCESSORIES

- A. Mop and Broom Holder: 0.05 inch thick stainless steel, Type 304, hat-shaped channel.
- B. Combination Utility Shelf/Mop and Broom Holder: 0.05 inch thick stainless steel, Type 304, with 1/2 inch returned edges, 0.06 inch steel wall brackets.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Verify exact location of accessories for installation.
- C. For electrically-operated accessories, verify that electrical power connections are ready and in the correct locations.

3.02 PREPARATION

- A. Deliver inserts and rough-in frames to site for timely installation.
- B. Provide templates and rough-in measurements as required.

3.03 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. Mounting Heights: As shown on the Architectural drawings.

3.04 PROTECTION

- A. Protect installed accessories from damage due to subsequent construction operations.

END OF SECTION

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SECTION 104400
FIRE PROTECTION SPECIALTIES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Fire extinguishers.
- B. Fire extinguisher cabinets.
- C. Emergency key cabinets.

1.02 DEFINITIONS

- A. Classifications of fires for portable fire extinguishers in NFPA 10.
 - 1. Class A: Fires involving ordinary combustibles like wood, paper, cloth, and some plastics.
 - 2. Class B: Fires involving flammable liquids, combustible liquids, petroleum greases, tars, oils, oil-based paints, solvents, lacquers, alcohols, and flammable gases.
 - 3. Class C: Fires that involve energized electrical equipment. Requires a non-conductive extinguishing agent to prevent electrical shock.
 - 4. Class D: Fires in combustible metals such as magnesium, titanium, zirconium, sodium, lithium, and potassium.
 - 5. Class K: Fires in cooking appliances that involve combustible cooking media, such as vegetable or animal oils and fats.

1.03 REFERENCE STANDARDS

- A. ABA Standards - ABA Accessibility Standards; 2004, with Amendments (2015).
- B. ADA Standards - 2010 ADA Standards for Accessible Design; 2010.
- C. ASTM E814 - Standard Test Method for Fire Tests of Penetration Firestop Systems; 2023a.
- D. FM (AG) - FM Approval Guide; Current Edition.
- E. ICC A117.1 - Accessible and Usable Buildings and Facilities; 2017.
- F. NFPA 10 - Standard for Portable Fire Extinguishers; 2022.
- G. UL (DIR) - Online Certifications Directory; Current Edition.
- H. UL 437 - Standard for Key Locks; Current Edition, Including All Revisions.
- I. UL 1037 - Antitheft Alarms and Devices; Current Edition, Including All Revisions.
- J. UL 1610 - Central-Station Burglar-Alarm Units; Current Edition, Including All Revisions.

1.04 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: For each item to be installed.
- 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.

1.05 COORDINATION

- A. Fire Protection Cabinets:
 - 1. Coordinate type and capacity of fire extinguishers with fire protection cabinets to ensure fit and function.
 - 2. Coordinate size of fire protection cabinets to ensure that type and capacity of fire extinguishers indicated are accommodated.
 - 3. Coordinate sizes and locations of fire protection cabinets with wall depths.
 - 4. Verify with Architect that handle / pull locations meet accessibility criteria.
- B. Emergency Key Cabinets:
 - 1. If not indicated on Architectural drawings, verify with Architect if emergency key cabinets will be surface- or recessed-mounted, prior to installation of unit.
 - a. If installing into cast-in-place concrete, confirm physical and electrical requirements prior to concrete pour.
 - 2. Coordinate electrical requirements for connection of emergency key cabinet to building's alarm system.
 - 3. At stud construction, verify adequate blocking for manufacturer's through-wall fasteners. Provide blocking as recommended by emergency key cabinet manufacturer.
 - 4. Coordinate with local fire department for cabinet keying requirements.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. See Section 01 6000 - Product Requirements.
- B. Protect materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources. Store in a dry location.
- C. Comply with manufacturer's written instructions for handling, storing, and protecting during installation.
- D. See Section 01 7419 - Construction Waste Management and Disposal, for packaging waste requirements.

1.07 FIELD CONDITIONS

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

1.08 WARRANTY

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

PART 2 PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Fire Extinguishers:
 - 1. NFPA Compliance: Fabricate and label fire extinguishers to comply with NFPA 10.
 - 2. Listed and labeled for type, rating, and classification by an independent testing agency acceptable to authorities having jurisdiction.

- B. Fire Extinguisher Cabinets:
 - 1. Fire-Rated Fire-Protection Cabinets: Listed and labeled to comply with requirements in ASTM E814 for fire-resistance rating of walls where they are installed.
- C. Emergency Key Cabinets:
 - 1. Meet requirements of UL 1037, UL 1610, and UL 437.

2.02 REGULATORY REQUIREMENTS

- A. Accessibility: Comply with applicable provisions in the ADA Standards, ABA Standards, and ICC A117.1.
- B. California:
 - 1. Fire extinguisher cabinets must comply with CBC Sections 11B-307, 11B-308, 11B-309 and 11B-403.

2.03 MANUFACTURERS

- A. Fire Extinguishers:
 - 1. Ansul.
 - 2. J.L. Industries (Activar).
 - 3. Kidde.
 - 4. Larsen's Manufacturing.
 - 5. Nystrom.
 - 6. Potter-Roemer.
 - 7. Substitutions: See Section 01 2500 - Substitution Procedures.
- B. Fire Extinguisher Cabinets:
 - 1. Kidde.
 - 2. J.L. Industries (Activar).
 - 3. Larsen's Manufacturing.
 - 4. Nystrom.
 - 5. Potter-Roemer.
 - 6. Substitutions: See Section 01 2500 - Substitution Procedures.
- C. Emergency Key Cabinets:
 - 1. Knox.
 - 2. Substitutions: See Section 01 2500 - Substitution Procedures.
- D. Source Limitations: Furnish products produced by single manufacturer and obtained from single supplier.

2.04 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.
 - 2. Refer to Definitions article above for classifications of fires.
- B. Type Fire Extinguishers: tank, with pressure gauge.
 - 1. Products:
 - a. J.L. Industries (Activar); Cosmic Series.
 - b. Substitutions: See Section 01 2500 - Substitution Procedures.
 - 2. Class: A:B:C type. Provide 4A:40B:C at Science Classrooms
 - 3. Size: 5 pound.
 - 4. Location:

- a. Typical unless noted otherwise.
- C. Wet Chemical Type Fire Extinguishers: Stainless steel tank, with pressure gauge.
 - 1. Products:
 - a. J.L. Industries (Activar); Saturn Series.
 - b. Substitutions: See Section 01 2500 - Substitution Procedures.
 - 2. Class: K type.
 - 3. Size: 1.6 gallons.
 - 4. Size and classification as scheduled.
 - 5. Finish: Polished stainless steel.
 - 6. Temperature range: 40 degrees F to 120 degrees F.
 - 7. Location:
 - a. Kitchens.
- D. Stored-Pressure Water-Mist Fire Extinguishers: Stainless steel tank, with pressure gauge, non-magnetic.
 - 1. Products:
 - a. J.L. Industries (Activar); Nebula Series.
 - b. Substitutions: See Section 01 2500 - Substitution Procedures.
 - 2. Class: A:C type.
 - 3. Size: 2.5 gallon nominal capacity.
 - 4. Finish: Enamel, color as selected by Architect from manufacturer's standard range.
 - 5. Location:
 - a. MRI areas.

2.05 FIRE EXTINGUISHER CABINETS

- A. Fire Extinguisher Cabinets: Provide manufacturer's standard box (tub), with trim, frame, door, and hardware to suit cabinet type, trim style, and door style indicated.
 - 1. Refer to Architectural drawings for locations of fire-rated extinguisher cabinets.
 - 2. Fire-Rated Extinguisher Cabinets: Listed and labeled in accordance with ASTM E814. Construct cabinets with double walls fabricated from 0.0428-inch-thick, cold-rolled steel sheet lined with minimum 5/8-inch-thick fire-barrier material. Refer to Architectural drawings for locations of rated fire extinguisher cabinets.
- B. Fire Extinguisher Cabinet:
 - 1. Basis of Design Product:
 - a. .
 - b. Substitutions: See Section 01 2500 - Substitution Procedures.
 - 2. Cabinet Fire Rating: As shown on the Architectural drawings.
 - 3. Cabinet Material: Steel sheet.
 - 4. Mounting: Semi-recessed.
 - 5. Door Style: Vertical duo panel with frame.
 - a. Door Glazing: Clear tempered float glass.
 - 6. Door Hardware: Manufacturer's standard door-operating hardware of proper type for cabinet type, trim style, and door material and style indicated.
 - a. Handle / Pull: Provide recessed door pull and friction latch.
 - 7. Identification: Lettering complying with authorities having jurisdiction for letter style, size, color, spacing, and location. Text to be located as directed by Architect.
 - 8. Finish: Baked enamel.
 - a. Color: As selected by Architect from manufacturer's full range.
- C. Cabinet Mounting Hardware: Appropriate to cabinet, with pre-drilled holes for placement of anchors.

- D. Finish of Cabinet Interior: White colored enamel.

2.06 ACCESSORIES

- A. Extinguisher Brackets: Formed steel, chrome-plated.

2.07 EMERGENCY KEY CABINETS

- A. Emergency Key Cabinets: Designed for storage of keys to be used by emergency personnel, with tamper switches to connect to intrusion detection system.
- B. Basis of Design Product:
 - 1. Knox; Knoxbox 3200.
 - 2. Substitutions: See Section 01 2500 - Substitution Procedures.
- C. Finish: Manufacturer's standard powder-coat.
 - 1. Color: As selected by Architect from manufacturer's full range.

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 and approved shop drawings.
- B. Secure rigidly in place.
- C. Place extinguishers in cabinets.
- D. Fire-Rated Cabinets:
 - 1. Install cabinet with not more than 1/16-inch tolerance between pipe OD and knockout OD. Center pipe within knockout.
 - 2. Seal through penetrations with firestopping sealant as recommended by cabinet manufacturer or as otherwise specified in Section 078400 - Firestopping.

3.03 MAINTENANCE

- A. See Section 017000 - Execution and Closeout Requirements, for additional requirements relating to maintenance service.

END OF SECTION

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**SECTION 115313
LABORATORY FUME HOODS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Standard laboratory fume hoods.
- B. Fume hood base cabinets and stands.
- C. Work surfaces.
- D. Laboratory cup sinks in fume hoods.
- E. Service fittings and outlets.
- F. Airflow indicators and alarms.

1.02 REFERENCE STANDARDS

- A. ASHRAE Std 110 - Methods of Testing Performance of Laboratory Fume Hoods; 2016, with Errata.
- B. ASTM A240/A240M - Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications; 2024b.
- C. ASTM A666/A666M - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar; 2024.
- D. 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; 2024.
- E. SEFA 1 - Laboratory Fume Hoods; 2010.
- F. UL 1805 - Standard for Safety Laboratory Fume Hoods and Cabinets; Current Edition, Including All Revisions.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination: Coordinate installation of fume hoods with laboratory casework and other laboratory equipment.
- B. Sequencing: Ensure that utility connections are achieved in an orderly and expeditious manner.

1.04 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide fume hood exterior and interior dimensions and construction, utility and service requirements and locations.
- C. Shop Drawings: Indicate locations, large scale plans, elevations, cross sections, rough-in and anchor placement dimensions and tolerances, clearances required, locations and types of service fittings.
- D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements. Provide documentation of successful Factory Acceptance Testing.
- E. Operation Data: Include description of equipment operation and required adjusting and testing.

- F. Warranty Documentation: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.
- G. Project Record Documents: Record actual locations of concealed utility connections.

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. Installer Qualifications: Company specializing in performing work of the type specified and with minimum three years of documented experience.
- C. Preconstruction Testing: Factory-test each type of hood as per referenced standard.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Protect finished surfaces during handling and installation with protective covering of polyethylene film or another suitable material.

1.07 FIELD CONDITIONS

- A. Ambient Conditions: Maintain temperature and relative humidity at occupancy levels during and after installation of fume hoods.

1.08 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 one year manufacturer warranty for manufacturer's standard items (listed by part number in manufacturer's official publication).

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Metal Laboratory Fume Hoods:
 - 1. Mott Manufacturing Ltd: www.mott.ca/#sle.
- B. Provide laboratory fume hoods from same manufacturer as laboratory casework.

2.02 PERFORMANCE REQUIREMENTS

- A. Fume hoods complying with the following when tested in accordance with ASHRAE Std 110:
 - 1. As-Manufactured (AM) Rating: AM 0.01 (0.01 ppm).
 - 2. As-Installed (AI) Rating: AI 0.10 (0.10 ppm).
 - 3. Average Face Velocity: 100 FPM (0.51 m/s) plus or minus 10 percent with sashes fully open.
 - 4. Face-Velocity Variation: Not more than 10 percent of average face velocity across the face opening with sash(es) fully open.
 - 5. Release Rate: 4.0 L/min.
 - 6. Static-Pressure Loss: Not more than 1/2-inch w.g. (124 Pa) at 100 FPM (0.51 m/s) face velocity with sash fully open when measured at four locations 90 degrees apart around the exhaust duct and at least three duct diameters downstream from duct collar.

2.03 FUME HOODS

- A. General Requirements:
 - 1. Comply with SEFA 1.
 - a. Provide fume hoods UL listed and labeled for compliance with UL 1805.
- B. Fume Hood:
 - 1. Ventilation: Variable Air Volume (VAV).
 - 2. Configuration: Standing-height; bench mounted.
 - 3. Nominal Interior Height: 48 inches.
 - 4. Sash Type: Vertical rising.
 - a. Leak-free enclosure box, manufacturer's standard construction, for vertical rising sash.
 - b. Glazing: Laminated safety glass.
 - c. Sash Guides: Corrosion-resistant polyvinyl chloride (PVC) track.
 - d. Vertical Sash mechanism: Designed to prevent sash drop in case of mechanism failure.
 - 1) Cable: Minimum 3/32 inch (2 mm) thick stainless steel of construction standard with the manufacturer.
 - e. Vertical Sash Pull: Type 316 stainless steel, with No.4 finish.
 - 5. Top Front Panel: Standard integral grille stamped into panel of same materials as fume hood exterior.
 - 6. Exterior: Sheet steel.
 - 7. Interior Lining: Polypropylene.
 - 8. Service Fittings and Fixtures:
 - a. Cup Sink : Drop-in Epoxy, complete with removable stainer and waste fitting, side-mounted at floor-mounted fume hood.
 - 1) Shape: Round.
 - 2) Size: 5 inch (127mm) diameter.
 - b. Natural Gas Fitting Assembly
 - 9. Access Panels: Provide removable panels on both sides hood exterior and interior lining panels.
 - 10. Work Surface:
 - a. Work Top for Fume Hoods Other Than Floor-mounted Type: Epoxy resin.
 - 1) Edge: Raised rim with rounded edges and corners.
- C. Fume Hood Base Cabinets:
 - 1. Exterior construction: Wood Cabinets.
 - a. Standard storage cabinets.
 - 2. Material: Sheet steel.
 - 3. Color/Finish: As indicated on drawings.
- D. Light Fixtures: UL labeled, vaporproof, one-tube, T-5 fluorescent light fixtures. Number and length of fixtures as necessary for fume hood width. Mounted above sealed safety glass panel. White baked-enamel finish on fixture interior.

2.04 FABRICATION

- A. General: Assemble fume hoods in factory to greatest extent possible. Disassemble fume hoods only as necessary for shipping and handling limitations, or as necessary to permit movement through a 35 inches by 79 inches clear door opening.

- B. Steel Exterior: Fabricated from steel sheet, 0.048 inch thick, with component parts screwed together to allow removal of end panels, front fascia, and airfoil and to allow access to plumbing lines and service fittings. Chemical-resistant finish applied to interior and exterior surfaces of component parts before assembly.
- C. Ends: Fabricated with double-wall end panels. Close area between double walls at front of fume hood and as needed to house sash counterbalance weights, utility lines, and remote-control valves.
- D. Lining Assembly: Unless otherwise indicated, assembled with stainless-steel fasteners or epoxy adhesive, concealed where possible. Joints sealed by filling with chemical-resistant sealant during assembly.
 - 1. Punched fume hood lining side panels for service fittings and remote controls.
Removable plug buttons for holes not used for indicated fittings.
- E. Rear Baffle: Same material as fume hood lining, unless otherwise indicated, at rear of hood with openings at top and bottom, with corrosion-resistant fasteners. Fabricated for removal to facilitate cleaning behind baffle.
- F. Exhaust Plenum: Full width of fume hood, sized and configured to provide uniform airflow, of same material as hood lining, and with duct stub for exhaust connection.
 - 1. Duct-Stub Material: Epoxy-coated steel, unless otherwise indicated.
- G. Airfoil: At bottom of fume hood face opening, with 1 inch gap between bottom of airfoil and work top. Sash to close on top of airfoil. Designed to direct airflow across work.
 - 1. Fabricated from 14 gauge, 0.0781 inch stainless steel with No.4 finish.
- H. Ceiling Extensions: Filler panels matching fume hood exterior to enclose space above fume hoods at front and sides of fume hoods, and extending from tops of fume hoods to approximately 4 inches (102 mm) above ceiling. Flange, notch, and reinforce ceiling extensions as required for rigidity. Fabricate to form well-fitting closures, free from oil-canning.
- I. Comply with requirements of other sections for factory installation of water and laboratory gas service fittings, piping, electrical devices, and wiring. Securely anchor fittings, piping, and conduit to fume hoods, unless otherwise indicated.

2.05 MATERIALS

- A. Steel Sheet: Cold-rolled, commercial steel (CS) sheet, complying with ASTM A1008/A1008M; matte finish; suitable for exposed applications.
- B. Stainless-Steel Sheet: ASTM A240/A240M or ASTM A666/A666M, Type 304, stretcher-leveled standard of flatness.
- 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. Fasteners: Stainless-steel, where exposed to fumes.

2.06 ACCESSORIES

- A. Airflow Monitors/Indicators and Alarms: Provide each fume hood with a airflow monitor/indicator complete with an audible and visual alarm that activates when airflow sensor reading is outside of preset range.
 - 1. Source: Fume hood manufacturer.
 - 2. Airflow Monitor/Indicator Functionality:
 - 3. Airflow Alarm functionality: Audible (85 dB @ 4 inch distance), and visual alarm that activates when airflow sensor reading is outside of preset range.
 - a. Reset and test mode.

- b. Programmable Switch: Designed to silence audible alarm and automatically reset when airflow returns to within preset range. Warning light to stay on when alarm is silenced.
- c. Capability for integration with BAS (Building Automation System) via BACnet.

2.07 SOURCE QUALITY CONTROL

- A. See Section 014000 - Quality Requirements, for additional requirements.
- B. Factory testing of each type of fume hood.
- C. Non-Complying Work: See Section 014000.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Locate concealed framing, blocking, and reinforcements that support fume hoods by field measurements before being enclosed, and indicate measurements on Shop Drawings.
- B. Examine areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of fume hoods.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. General: Install fume hoods according to manufacturer's written instructions. Install level, plumb, and true; shim as required, using concealed shims, and securely anchor to building and adjacent laboratory casework. Securely attach access panels but provide for easy removal and secure reattachment. Where fume hoods abut other finished work, apply filler strips and scribe for accurate fit, with fasteners concealed where practical.
- B. Large Components: Ensure that large components can be moved into final position without damage to other construction.
- C. Comply with indicated requirements for installing water and laboratory gas service fittings, and electrical and telecommunications devices.

3.03 FIELD QUALITY CONTROL

- A. Field test fume hoods as specified below.
 - 1. General: Test fume hoods as installed to assess airflow velocity. Perform tests with static mode (set sash position) conditions. Conduct testing as outlined below for 100% of the hoods provided in the Project.
 - 2. Preparation:
 - a. Inspect each fume hood to confirm its installation complies with drawings and specifications.
 - b. Inspect laboratory space to verify that construction complies with drawings and specified requirements.
 - c. Do not proceed with fume hood testing until an acceptable TAB report has been received.
 - d. Verify that proper temperature and pressurization of the lab space can be maintained, with door(s) to the space in closed and open positions.
 - e. Adjust non-complying physical and control systems until conditions favorable to testing fume hoods are present.
 - 3. Operating Conditions Tests:

- a. Conduct face velocity tests to confirm that target velocities are being achieved within acceptable tolerances.
 - b. Conduct airflow indicator/monitor tests to confirm acceptable variation from corresponding measured value. Calibrate and adjust device to function within specified accuracy parameters.
 - c. Conduct exhaust flow and static pressure tests of the HVAC system and its controls to confirm flow volume and static pressures are within acceptable tolerances.
 - d. Conduct tests of alarm device by shutting off the fume hood exhaust and verify that the individual fume hood alarm activates and operates in specified manner.
 - e. Conduct tests of individual controls provided at the fume hood (such as unoccupied cycle override, alarm override, etc.) to verify they operate in specified manner.
4. Containment Performance Tests:
- a. Conduct airflow visualization tests (local smoke challenges) to provide a visual indication of fume hood's capture performance.
 - 1) Coordinate disabling of local fire alarm system when performing this test.
 - 2) Compensate for smoke discharge velocity and exposure outside of the fume hood.
 - 3) If required to be performed, do not proceed with the large volume challenge test if the hood has failed the local challenge test.

3.04 ADJUSTING

- A. Adjust moving parts for smooth, near silent, accurate sash operation with one hand only. Adjust sashes for uniform contact of rubber bumpers. Verify that counterbalances operate without interference.

3.05 CLEANING

- A. Clean finished surfaces, including both sides of glass; touch up as required; and remove or refinish damaged or soiled areas to match original factory finish, as approved by Architect.

3.06 DEMONSTRATION

- A. Demonstrate proper operation of fume hoods and their accessories to Owner's designated representative.

END OF SECTION

SECTION 123553.19
WOOD LABORATORY CASEWORK

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Custom wood cabinets and cabinet hardware.
- B. Tables.
- C. Acid storage cabinets.
- D. Solvent storage cabinets.
- E. Countertops.
- F. Laboratory sinks.
- G. Pegboards.
- H. Laboratory emergency equipment plumbing fixtures.
- I. Service fittings and outlets.

1.02 DEFINITIONS

- A. Exposed: Portions of casework visible when drawers and cabinet doors are closed, including end panels, bottoms of cases more than 42 inches above finished floor, tops of cases less than 72 inches above finished floor and all members visible in open cases or behind glass doors.
- B. Semi-Exposed: Portions of casework and surfaces behind solid doors, tops of cases more than 72 inches above finished floor and bottoms of cabinets more than 30 inches but less than 42 inches above finished floor.
- C. Concealed: Sleepers, web frames, dust panels and other surfaces not generally visible after installation and cabinets less than 30 inches above finished floor.

1.03 REFERENCE STANDARDS

- A. ANSI Z358.1 - American National Standard for Emergency Eyewash and Shower Equipment; 2014.
- B. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2024.
- C. ASTM E119 - Standard Test Methods for Fire Tests of Building Construction and Materials; 2024.
- D. AWI (QCP) - Quality Certification Program; Current Edition.
- E. HPVA HP-1 - American National Standard for Hardwood and Decorative Plywood; 2024.
- F. ICC (IFC) - International Fire Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- G. NFPA 1 - Fire Code; 2024, with Errata.
- H. NFPA 30 - Flammable and Combustible Liquids Code; 2024, with Amendment.
- I. SEFA 1 - Laboratory Fume Hoods; 2010.
- J. SEFA 2 - Installations; 2010.
- K. SEFA 3 - Laboratory Work Surfaces; 2020.

- L. SEFA 7 - Laboratory Fixtures; 2021.
- M. SEFA 8W - Laboratory Grade Wood Casework; 2020.
- N. SEFA 11 - Liquid Chemical Storage Cabinets; 2019.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination: Coordinate installation of casework with related items.
- B. Service Fixtures: Coordinate location and characteristics of service connections.

1.05 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Component dimensions, configurations, construction details, joint details, attachments; manufacturer's catalog literature on hardware, accessories, and service fittings, if any.
- C. Shop Drawings: Indicate casework types, sizes, and locations, using large scale plans, elevations, and cross sections. Include rough-in and anchors and reinforcements placement dimensions and tolerances, clearances required, and utility locations, if any. Include coordinated information for laboratory equipment specified in another section and/or furnished by Owner.
- D. Samples For Color Selection: Wood samples, fully finished, for color and species selection. Minimum Sample Size: 2 inches by 3 inches.
- E. Certificate: Submit labels and certificates required by quality assurance and quality control programs.
- F. Test Reports: From independent laboratory indicating compliance with referenced chemical-resistance standards for cabinet finish and liner materials.
- G. Installer's Qualification Statement.
- H. Maintenance Data: Manufacturer's recommendations for care and cleaning.
- I. Finish touch-up kit for each type and color of materials provided.

1.06 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years of documented experience.
- B. Installer Qualifications: Company specializing in performing work of the type specified in this section, with not less than three years of documented experience and approved by manufacturer.
- C. Quality Certification:
 - 1. Comply with AWI (QCP) woodwork association quality certification service/program in accordance with requirements for work specified in this section: www.awiqcp.org/#sle.
 - 2. Provide labels or certificates indicating that the installed work complies with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS) requirements for grade or grades specified.
 - 3. Provide designated labels on shop drawings as required by certification program.
 - 4. Provide designated labels on installed products as required by certification program.
 - 5. Submit certifications upon completion of installation that verifies this work is in compliance with specified requirements.
- D. Operable parts for all accessible casework shall comply with CBC Section 11B-309.
 - 1. Provide U-shaped pulls or touch latches at all accessible casework.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Protect items provided by this section, including finished surfaces and hardware items during handling and installation. For metal surfaces, use polyethylene film or other protective material standard with the manufacturer.
- B. Acceptance at Site:
 - 1. Do not deliver or install casework until the conditions specified under Part 3, Examination Article of this section have been met. Products delivered to sites that are not enclosed and/or improperly conditioned will not be accepted if warping or damage due to unsatisfactory conditions occurs.
- C. Storage:
 - 1. Store casework in the area of installation. If necessary, prior to installation, temporarily store in another area, meeting the environmental requirements specified under Part 3, "Site Verification of Conditions" paragraph of this section.

1.08 WARRANTY

- A. Correct defective work within a five year period after Date of Substantial Completion, at no additional cost to Owner. Defects include, but are not limited to:
 - 1. Ruptured, cracked, or stained finish coating.
 - 2. Discoloration, or lack of finish integrity.
 - 3. Cracking or peeling of finish.
 - 4. Failure of hardware.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Wood Laboratory Casework:
 - 1. Hamilton Scientific LLC: www.hamiltonscientific.com.
 - 2. Kewaunee Scientific Corp: www.kewaunee.com/#sle.
 - 3. Mott Manufacturing: www.mott.ca/#sle.
- B. Countertops:
 - 1. Durcon (Epoxy resin, Solid phenolic): www.durcon.com/#sle.
- C. Sinks and Cup Sinks:
 - 1. Durcon (Epoxy resin, Polyolefin): www.durcon.com/#sle.
- D. Water and Gas Service Fittings:
 - 1. Broen-Lab A/S: www.broen-lab.com/#sle.
 - 2. Chicago Faucets, a Geberit company: www.chicagofaucets.com/#sle.
 - 3. WaterSaver Faucet Co: www.wsflab.com/#sle.
- E. Obtain casework from single source and manufacturer, unless otherwise indicated.

2.02 WOOD LABORATORY CASEWORK

- A. Wood Laboratory Casework: Solid wood and wood panel construction; each unit self-contained and not dependent on adjacent units or building structure for rigidity; in sizes necessary to avoid field cutting except for scribes and filler panels. Include adjustable levelers for base cabinets.
 - 1. Style: Flush overlay. Ease doors and drawer fronts slightly at edges.
 - 2. Cabinet Nominal Dimensions: Unless otherwise indicated, provide cabinets of widths and heights indicated on drawings, and with following front-to-back dimensions:

- a. Base Cabinets: 22 inches.
 - b. Tall Cabinets: 22 inches.
 - c. Upper Cabinets: 16 inches.
 3. Construction: Joints doweled, glued and screwed, except drawers may be lock-shoulder jointed; with interior of units smooth and flush; cabinet bottom flush with top of face frame; without gaps or inaccessible spaces or areas where dirt or moisture could accumulate.
 4. Structural Performance: In addition to the requirements of SEFA 3, SEFA 7, and SEFA 8W, components safely support the following minimum loads:
 5. Fittings and Fixture Locations: Cut and drill counter tops, backs, and other components for service outlets and fixtures.
 6. Fixed panels at backs of open spaces between base cabinets and at ends of utility spaces not otherwise enclosed.
 - a. Cutouts for power receptacles where indicated on drawings.
 7. Scribes and Fillers: Panels of matching construction and finish, for locations where cabinets do not fit tight to adjacent construction.
 8. Factory-finish all exposed and semi-exposed surfaces with the same finish.
 - a. Finish Performance: Provide finish on all surfaces having chemical resistance of Level 0 (no change) or Level 1 (slight change of gloss or slight discoloration) according to SEFA 8W and no visible effect when surface is exposed to:
 - 1) Hot water at temperature between 190 degrees F and 205 degrees F trickled down the test surface at 45 degree angle for 5 minutes.
 - 2) Constant moisture in the form of 2 by 3 by 1 inch thick cellulose sponge kept continually saturated with water and in contact with test surface for 100 hours.
 - b. Preparation: Wood sanded smooth, free from dust and mill marks.
 - c. Coating: Clear, superior-quality, chemical-resistant acyclic urethane; applied in accordance with manufacturer instructions, force-dried, sanded and wiped clean.
 - d. Coats: Multiple coats as required to achieve minimum 1.5 mil dry film thickness.
 - e. Appearance: Clear satin gloss; not cloudy or muddy.
- B. Acid Storage Cabinets:
1. Completely lined with corrosion-resistant liner material; stainless steel fasteners for all connections and hardware inside cabinets.
 2. Shelves: Removable, same material as cabinet, covered with corrosion-resistant liner.
 3. Bottom Pan: Liquid-tight liner covering entire bottom of acid-storage cabinet.
 4. Vents: Comply with SEFA 1.
 - a. Locate acid-storage cabinet vents in accordance with manufacturer's instructions.
- C. Solvent (Flammable and Combustible Liquids) Storage Cabinets: Construction identical to other cabinets, with following exceptions:
1. Construct to NFPA 30 and applicable OSHA requirements.
 2. Comply with SEFA 11.
 3. Fire Resistance: Maximum internal temperature of 325 degrees F at the center, and 1 inch from top of the cabinet when cabinet is subjected to a ten minute fire test that simulates fire exposure of a standard time-temperature curve specified in ASTM E119.
 4. Shelves: Full depth, adjustable.
 5. Bottom Pan: 2 inches deep, liquid-tight pan covering entire bottom of cabinet.
 6. Cabinet Hardware: UL-listed.
 - a. Hinges: Full-length stainless steel continuous (piano) hinges.
 - b. Self-closing Doors: Comply with requirements of NFPA 1 and ICC (IFC). Minimum 90 degree opening. Three-point latch arrangement, door(s) shutting and latching automatically when hold-open device's fusible link melts at 165 degrees F under fire conditions outside the cabinet. At pair of doors, synchronize latching so that both doors always fully close.

- c. Door Handles: Manufacturer's standard, with slip-resistant grip.
 - 1) Provide manufacturer's standard cylinder lock and key set.
- 7. Vents: Provide venting capable of achieving ten air changes per hour.
 - a. Tie into building hazardous exhaust system.
 - b. Vent Connections: 1-1/2 inch minimum diameter, corrosion-resistant piping having flame spread index of 25 or less when tested in accordance with ASTM E84.
 - c. Vent each cabinet separately with sufficient mixing distance for incompatible chemicals.
 - d. Provide minimum of two vents with fire arrestor for each cabinet.
- 8. Signage: Provide manufacturer's standard signage reading "FLAMMABLE - KEEP FIRE AWAY" or similar message in bright red color.
- D. Tables: With standard aprons manufactured of not less than 3/4 by 3 1/2 inch solid lumber, machined to receive corner blocks, and bolted to 2 1/8 by 2 1/8 inch solid hardwood legs. 3/8 inch leveling devices, and slip-on type black PVC shoes.
 - 1. Mobile tables constructed the same as standard laboratory tables, except with table legs designed to receive swivel casters.
 - a. Caster wheels of non-marring type urethane tires in gray or black color.
- E. Wall Shelving: At locations indicated.
 - 1. Adjustable Shelf Supports: Standard back-mounted system using single-slotted surface mounted stainless steel shelf standards, in lengths indicated, with coordinated cantilevered shelf brackets, no.4 finish, designed for nominal 1 inch spacing adjustments.

2.03 CABINET HARDWARE

- A. Manufacturer's standard styles, and as indicated below.
- B. Conform to BHMA A156.9 requirements.
- C. Finish of exposed stainless steel components: No.4 finish.
- D. Locks: Provide locks on casework drawers and doors where indicated. Lock with 5 pin cylinder and 2 keys per lock.
 - 1. Hinged Doors: Cam type lock, 625 finish.
 - 2. Framed Sliding Doors: Plunger-type sliding showcase lock, 626 finish.
 - 3. Keying: Key locks alike within a space; key each room separately.
 - 4. Master Key System: All locks operable by master key.
- E. Shelves in Cabinets:
 - 1. Shelf Standards and Rests: Vertical standards with rubber button fitted rests, satin chromium plated over nickel on base material.
- F. Swinging Doors:
 - 1. Hinges: Offset pin.
 - a. European-Style Hinges: For overlay doors, concealed. Steel, nickel-plated, 110 degree opening angle.
 - 2. Catches: Magnetic.
 - 3. Pulls: Chrome wire pulls, 4 inches wide.
 - 4. Sliding Doors:
 - a. Pulls: Steel, recessed circular design.
 - 1) Steel Finish: 625, bright chromium plated.
 - b. Track Assembly: Nylon track with solid bearing followers.
 - 5. Drawers:
 - a. Pulls: Chrome wire pulls, 4 inches wide.
 - b. Slides: Steel, full extension arms, ball bearings; self-closing; capacity as recommended by manufacturer for drawer height and width.

2.04 COUNTERTOPS

- A. Countertops: As specified in Section 123600.

2.05 PEGBOARDS

- A. Epoxy pegboards with pre-drilled or punched holes in a staggered pattern, designed to accept removable white polypropylene pegs. With each pegboard include a stainless steel drip-trough with drain outlet and matching diameter 36 inches long PVC drain hose.
 - 1. Size: 30 inches wide by 30 inches high.

2.06 LABORATORY EMERGENCY EQUIPMENT PLUMBING FIXTURES

- A. General: Provide emergency equipment products complying with requirements of ANSI Z358.1.
- B. Eyewash/Safety Shower Combination Units: Recessed into wall construction.
 - 1. Cover/Eyewash Drain Pan: Combination fixture, with projecting activation handle requiring grasping and pulling down into operating position for activation.
 - 2. Shower Head: 10 inch diameter stainless steel, with 20 gallons per minute flow control.
 - a. Mounting: Below finished ceiling. Include vertical supply pipe and ceiling escutcheon.
 - b. Offset Dimension from Wall to Centerline of Head: 36 inches, barrier-free.
 - 3. Activation Handle: Recessed into cabinet, projecting 1-7/8 inches maximum beyond face of wall, and requiring pushing down for activation.
 - a. Grip: Manufacturer's standard vinyl grip.

2.07 SERVICE FITTINGS

- A. General: Comply with requirements of SEFA 7.
- B. Gas Service Fittings and Fixtures:
 - 1. Laboratory Gas Fitting :
 - a. Valve: Forged or cast brass body, 90 degree inlet - outlet configuration, with polished chrome with clear epoxy coating finish.
 - b. Control: Ball valve.
 - c. Mounting: Panel (vertical surface).
 - d. Supply Gas: Natural Gas.
 - e. Inlet: 3/8 inch NPS NPT.
 - f. Outlet: Manufacturer's standard, with removable seven-serration hose end.
 - 1) Number: One.
 - g. Handle: Manufacturer's standard four-arm Handle with color-coded index disc.
- C. Electrical Fittings and Fixtures:
 - 1. Electrical Fittings, General: Types indicated, for mounting on laboratory casework, including, as appropriate, grounding screws, and mounting accessories and fasteners.
 - 2. Electrical Power Fitting :
 - a. General: 3-wire polarized receptacles, aluminum with metallic finish pedestal and line-type boxes; plated steel recessed boxes, meeting requirements of NFPA 70.
 - b. Mounting: Pedestal, surface-mounted.
 - c. Receptacles: Duplex, 5-20R, GFCI.
 - d. Twist-Lock Receptacles: Single, L6-20R, GFCI.
 - e. Orientation: Single face.
 - f. Service: Normal power.
 - g. See electrical drawings for circuiting.

2.08 MATERIALS

- A. Wood-Based Materials:
 - 1. Solid Wood: Air-dried to 4.5 percent moisture content, then tempered to 6 percent moisture content before use.
 - 2. Composite Wood Panels: Containing no urea-formaldehyde resin binders.
- B. Exposed Solid Wood: Clear, dry, sound, plain sawn, selected for compatible grain and color, no defects.
- C. Exposed Hardwood Plywood: Veneer core; HPVA HP-1 Grade AA, Type I; same species as exposed solid wood, clear, compatible grain and color, no defects. Band exposed edges with solid wood of same species as veneer.
- D. Semi-Exposed Solid Wood: Dry, sound, plain sawn, no appearance defects, any species similar in color and grain to exposed portions.
- E. Semi-Exposed Hardwood Plywood: Veneer core; HPVA HP-1 Grade C, Type I; plain sliced, any species similar in color and grain to exposed portions.
- F. Concealed Solid Wood or Plywood: Any species and without defects affecting strength or utility.
- G. Solid Epoxy Resin: Modified epoxy resin and non-asbestos inert fillers cast into sheets.
- H. Glass: Fully tempered float; ASTM C1036, Type 1, Quality Q3; ASTM C1048, tempered using horizontal tempering and complying with ANSI Z97.1; 4 mm thick minimum; exposed edges ground, and cut or drilled to receive hardware; clear.
- I. Solvent-Resistant Liner Material: High-density, asbestos-free, non-combustible, calcium-silicate-based panel consisting of autoclaved Portland cement, mineral fillers and synthetic fibers.
- J. Sealant for Use in Casework Construction: Manufacturer's recommended type.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Site Verification of Environmental Conditions:
 - 1. Do not deliver casework until the following conditions have been met:
 - a. Building has been enclosed (windows and doors sealed and weather-tight).
 - b. An operational HVAC system that maintains temperature and humidity at occupancy levels has been put in place.
 - c. Ceiling, overhead ductwork, piping, and lighting have been installed.
 - d. Installation areas do not require further "wet work" construction.
- B. Verify adequacy of support framing and anchors.
- C. Verify that service connections are correctly located and of proper characteristics.

3.02 INSTALLATION

- A. Perform installation in accordance with manufacturer's instructions and with SEFA 2.
- B. Large Components: Ensure that large components can be moved into final position without damage to other construction.
- C. Use anchoring devices to suit conditions and substrate materials encountered. Use concealed fasteners to the greatest degree possible. Use exposed fasteners only where allowed by approved shop drawings, or where concealed fasteners are impracticable.
- D. Set casework items plumb and square, securely anchored to building structure.

1. Base Cabinets: Examine floor levelness and flatness of installation space. Do not proceed with installation if encountered floor conditions required more than 3/4 inch leveling adjustment. When installation conditions are acceptable, for each space, establish the high point of the floor. Set and make level and plumb first cabinet in relation to this high point.
2. Wall Cabinets: Examine wall surfaces in installation space. Do not proceed with installation if the following conditions are encountered:
 - a. Maximum variation from plane of masonry wall exceeds 1/4 inch in 10 ft and 1/2 inch in 20 ft or more, and/or maximum variation from plumb exceeds 1/4 inch per story.
 - b. Maximum Variation of finished gypsum board surface from true flatness exceeds 1/8 inch in 10 feet in any direction.
- E. Align cabinets to adjoining components, install filler and/or scribe panels where necessary to close gaps.
- F. Fasten together cabinets in continuous runs, with joints flush, uniform and tight. Misalignment of adjacent units not to exceed 1/16 inch. In addition, do not exceed the following tolerances:
 1. Variation of Tops of Base Cabinets from Level: 1/16 inch in 10 feet.
 2. Variation of Faces of Cabinets from a True Plane: 1/8 inch in 10 feet.
 3. Variation of Adjacent Surfaces from a True Plane (Lippage): 1/32 inch.
 4. Variation in Alignment of Adjacent Door and Drawer Edges: 1/16 inch.
- G. Secure upper and floor cabinets to concealed reinforcement at gypsum board assemblies.
- H. Separate dissimilar metals to prevent galvanic action.
- I. Base Cabinets: Fasten cabinets to service space framing and/or wall substrates, with fasteners spaced not more than 16 inches on center. Bolt adjacent cabinets together with joints flush, tight, and uniform.
- J. Install hardware uniformly and precisely. Set hinges snug and flat in mortises.
- K. Vented Cabinets: Install in strict compliance with manufacturer's written installation instructions.
 1. Install vent kits and connect to fume hood exhaust system.
 2. Use only rigid materials for venting. No flexible materials permitted.
- L. Countertops: Install countertops in one true plane, with ends abutting at hairline joints, and no raised edges.
- M. Replace units that are damaged, including those that have damaged finishes.

3.03 ADJUSTING

- A. Adjust operating parts, including doors, drawers, hardware, and fixtures to function smoothly.

3.04 CLEANING

- A. Clean casework and other installed surfaces thoroughly.

3.05 PROTECTION

- A. Do not permit finished casework to be exposed to continued construction activity.
- B. Protect casework and countertops from ongoing construction activities. Prevent installers from standing on or storing tools and materials on casework or countertops.

- C. Repair damage that occurs prior to Date of Substantial Completion, including finishes, using methods prescribed by manufacturer; replace units that cannot be repaired to like-new condition.

END OF SECTION

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SECTION 123600 COUNTERTOPS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Countertops for architectural cabinet work.
- B. Wall-hung counters and vanity tops.
- C. Sinks molded into countertops.
- D. Epoxy resin sinks.

1.02 REFERENCE STANDARDS

- A. ASTM D635 - Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position; 2022.
- B. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2024.
- C. AWI (QCP) - Quality Certification Program; Current Edition.
- D. ISFA 2-01 - Classification and Standards for Solid Surfacing Material; 2013.
- E. NEMA LD 3 - High-Pressure Decorative Laminates; 2005.
- F. PS 1 - Structural Plywood; 2023.
- G. SEFA 2 - Installations; 2010.
- H. SEFA 3 - Laboratory Work Surfaces; 2020.

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.
- F. Certificate: Submit labels and certificates required by quality assurance and quality control programs.
- G. Maintenance Data: Manufacturer's instructions and recommendations for maintenance and repair of countertop surfaces.

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.

B. Quality Certification:

1. Comply with AWI (QCP) woodwork association quality certification service/program in accordance with requirements for work specified in this section: www.awiqcp.org/#sle.
2. Provide labels or certificates indicating that the installed work complies with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS) requirements for grade or grades specified.
3. Provide designated labels on shop drawings as required by certification program.
4. Provide designated labels on installed products as required by certification program.
5. Submit certifications upon completion of installation that verifies this work is in compliance with specified requirements.

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. Quality Standard: Custom Grade, in accordance with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS), unless noted otherwise.
- B. Quality Standard: SEFA 3 for laboratory worksurfaces.
- C. Plastic Laminate Countertops: High-pressure decorative laminate (HPDL) sheet bonded to substrate.
 1. Laminate Sheet: NEMA LD 3, Grade HGS, 0.048 inch nominal thickness.
 - a. Manufacturers:
 - 1) Panolam Industries International, Inc; Pionite Standard HPL: www.panolam.com/#sle.
 - 2) Wilsonart: www.wilsonart.com/#sle.
 - b. Surface Burning Characteristics: Flame spread index of 25, maximum; smoke developed index of 450, maximum; when tested in accordance with ASTM E84.
 - c. Wear Resistance: In addition to specified grade, comply with NEMA LD 3 High Wear Grade requirements for wear resistance.
 - d. Finish: Matte or suede, gloss rating of 5 to 20.
 - e. Surface Color and Pattern: As indicated on drawings.
 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 AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS), Section 11 - Countertops, Custom Grade.
 5. Fabricate in accordance with manufacturer's standard requirements.

- D. Epoxy Resin Countertops: Filled epoxy resin molded into homogenous, non-porous sheets; no surface coating and color and pattern consistent throughout thickness; with integral or adhesively seamed components.
1. Manufacturers:
 - a. Durcon, Inc: www.durcon.com/#sle.
 - b. Prime Industries, Inc: www.piilab.com/#sle.
 2. Flat Surface Thickness: 1 inch, nominal.
 3. Chemical-Resistance: Provide products that resist the following chemicals with not more than Moderate Effect when tested in accordance with NEMA LD 3:
 4. Flammability: Self-extinguishing, when tested in accordance with ASTM D635.
 5. Surface Finish: Smooth, non-glare.
 6. Color: Black.
 7. Exposed Edge Shape: 1/8 inch bevel chamfer.
 8. Drip Edge: Drip groove 1/8 inch wide and deep, located 1/2 inch back from edge on underside of all exposed edges.
 9. Back and End Splashes: Same material, same thickness; separate for field attachment.
 10. Sinks: Same material, same color; integrally molded with counter; bottom sloped to outlet; molded outlets; drain outlet located in back corner.
 - a. Sides and Ends: 1/2 inch minimum thickness.
 - b. Bottoms: 5/8 inch minimum thickness.
 - c. Interior Corners: 1 inch minimum radius.
 - d. Clamping collars for 1-1/2 or 2 inch diameter waste pipe, for sealed but not permanent connection.
 - e. Steel channel supports front to back on each side, fastened to underside of top to support twice full sink weight.
 11. Fabricate in accordance with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS), Section 11 - Countertops, Premium Grade.
 12. Fabricate in accordance with manufacturer's standard requirements.
- E. Solid Surfacing Countertops: Solid surfacing sheet or plastic resin casting .
1. Flat Sheet Thickness: , minimum.
 2. Solid Surfacing Sheet and Plastic Resin Castings: Complying with ISFA 2-01 and NEMA LD 3; acrylic or polyester resin, mineral filler, and pigments; homogenous, non-porous and capable of being worked and repaired using standard woodworking tools; no surface coating; color and pattern consistent throughout thickness.
 - a. Manufacturers:
 - 1) Arsitech.
 - b. Finish on Exposed Surfaces: Matte, gloss rating of 5 to 20.
 - c. Color and Pattern: As indicated on drawings.
 3. Other Components Thickness: 1/2 inch, minimum.
 4. Exposed Edge Treatment: Built up to minimum 1-1/4 inch thick; square edge; use marine edge at sinks.
 5. Back and End Splashes: Same sheet material, square top; minimum 4 inches high.
 6. Fabricate in accordance with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS), Section 11 - Countertops, Premium Grade.
 7. Fabricate in accordance with manufacturer's standard requirements.
- F. Natural Quartz and Resin Composite Countertops: Sheet or slab of natural quartz and plastic resin .
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 woodworking tools; no surface coating; color and pattern consistent throughout thickness.
 - a. Manufacturers:
 - 1) Caesarstone.
 - b. Finish on Exposed Surfaces: Polished.
 - c. Color and Pattern: As indicated on drawings.
3. Other Components Thickness: 3/4 inch, minimum.
4. Exposed Edge Treatment: Built up to minimum 1-1/4 inch thick; square edge; use marine edge at sinks.
5. Back and End Splashes: Same sheet material, square top; minimum 4 inches high.
6. Fabricate in accordance with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS), Section 11 - Countertops, Premium Grade.
7. Fabricate in accordance with manufacturer's standard requirements.

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.
 - a. Rout a 1/8 inch drip groove at underside of exposed overlapping edges, set back 1/2 inch from face of edge.
 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.
- C. Solid Surfacing: Fabricate up to long in one piece; join pieces with adhesive sealant in accordance with manufacturer's recommendations and instructions.

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. Install laboratory worksurface countertops in compliance with requirements of SEFA 2.
- B. Securely attach countertops to cabinets using concealed fasteners. Make flat surfaces level; shim where required.
- C. Attach plastic laminate countertops using screws with minimum penetration into substrate board of 5/8 inch.
- D. Attach epoxy resin countertops using compatible adhesive.
- E. 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

- A. Clean countertops surfaces thoroughly.

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

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SECTION 21 13 13
WET-PIPE SPRINKLER SYSTEMS

PART 1 GENERAL

1.01 GENERAL DESCRIPTION

- A. Furnish all materials and labor for the design, installation, and testing of an automatic wet-pipe sprinkler system throughout the renovated Sonora High School Science Lab.
- B. Authority Having Jurisdiction (AHJ)
 - 1. The Division of the State Architect (DSA).
 - 2. City of La Habra.
- C. The contract drawings and this specification are intended to convey the scope of work required and all of which the Contractor is responsible to furnish, install, adjust, and make operable. Where conflicts occur between this specification and the contract drawings, clarification shall be requested. In general, should a conflict occur, this specification will overrule the contract drawings.
- D. All work shall be performed in accordance with these specifications, applicable codes and standards, the design drawings, and good engineering and installation practice. Provide all devices and equipment required by these specifications. Equipment or devices shall not be deleted without written approval of the Owner.
- E. The work performed pursuant to these specifications is to be complete in every respect, resulting in the System installed in accordance with the applicable codes, standards, manufacturers' recommendations, and Underwriters Laboratories Inc. (UL) and/or Factory Mutual (FM) Global approval.

1.02 SUMMARY

- A. Section includes:
 - 1. Pipes, fittings, and specialties.
 - 2. Hangers, seismic bracing, and restraint.
 - 3. Valves.
 - 4. Specialty valves.
 - 5. Sprinklers.
 - 6. Alarm devices.
 - 7. Pressure gauges.
 - 8. Air vent.

1.03 WORK INCLUDED

- A. The scope of work for Sonora High School Lab Modernization project is to modify the existing automatic wet-pipe sprinkler system by demolishing all existing armovers and sprinklers, and providing new branch lines, flexible sprinkler drops, and sprinklers. All existing fire protection underground site utilities, aboveground site utilities, sprinkler riser, sprinkler mains, and sprinkler branch lines shall remain.

- B. The automatic wet-pipe sprinkler system shall provide sprinkler coverage throughout the renovated Sonora High School Science Lab. The system is to be designed and installed in accordance with California Building Code (CBC) and NFPA 13.
- C. Furnish and install all components necessary to result in fully operational and code compliant systems as detailed in this section.
- D. Where impairments to the existing fire sprinkler system are necessary to complete the scope of work, impairment procedures shall be coordinated with the AHJ and Owner in accordance with NFPA 25.
- E. Provide personnel to inspect and verify piping locations as indicated on the contract drawings. The Contractor is responsible for any pipe routing changes, including offsets, required to install the new system.
- F. Submittals: Prepare and submit shop drawings, product data sheets, hydraulic calculations, record drawings, and other submittals required herein.
- G. Tests: Complete all tests required by applicable codes, NFPA standards, Owner requirements, and AHJ requirements.
- H. Approvals and Fees: Contractor shall obtain all approvals from the AHJ and Owner for the work in this section. Contractor shall be responsible for filing all documents, paying all fees, and securing all permits, inspections, and approvals necessary for completing the scope of work in this section.

1.04 RELATED DOCUMENTS AND WORK SPECIFIED ELSEWHERE

- A. Drains: Floor drains and other facilities for receiving discharge from sprinkler system drains.
- B. Alarms: Wiring and connection to sprinkler system alarm and supervisory devices shall be provided by the Fire Alarm Contractor as detailed in the Fire Alarm System Specifications.

1.05 DEFINITIONS

- A. Standard-Pressure Sprinkler Piping: Fire suppression system piping designed to operate at working pressure of 175-psig maximum.
- B. Underground Service-Entrance Piping: Underground service piping below the building.
- C. Wet-Pipe Sprinkler System: Automatic sprinklers are attached to piping containing water. The piping is connected to the water supply. Water discharges immediately from sprinklers when they are opened. Sprinklers open when heat destroys the frangible device or melts the fusible link.
- D. CBC: California Building Code
- E. CFC: California Fire Code
- F. NFPA: National Fire Protection Association

1.06 QUALITY ASSURANCE

- A. Installer Qualifications:
 - 1. Hold all licenses and obtain all permits necessary to perform work of this type in the State of California. Copies of Contractor's licenses shall be provided with bid submittal.
 - 2. Be regularly engaged, for the past five years in the design, installation, testing and servicing of automatic sprinkler systems for buildings of this type.
 - 3. Installer's responsibilities, including designing, fabricating, and installing sprinkler systems.
 - 4. Installer shall be licensed as a C-16 Fire Protection Contractor.

- B. Welding Qualifications: Qualify procedures and operators according to American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code.
- C. Applicable Codes, Standards, and References: All work and materials shall conform to all Federal, State, and local codes and regulations governing this installation, including all parts of Title 24 of the statewide California codes. All work shall conform to the requirements of the applicable editions and portions of the following codes, standards, and references.
 - 1. NFPA 13, "Standard for the Installation of Fire Sprinkler Systems" – 2022 edition
 - 2. NFPA 24, "Standard for the Installation of Private Fire Service Mains and Their Appurtenances – 2022 edition
 - 3. NFPA 25, "Standard for the Inspection, Testing and Maintenance of Water-Based Fire Protection Systems – 2013 edition
 - 4. NFPA 72, "National Fire Alarm and Signaling Code – 2022 edition
 - 5. Title 24, Part 2, California Building Code (CBC), 2022 edition
 - 6. Title 24, Part 3, California Electrical Code (CEC), 2022 edition
 - 7. Title 24, Part 5, California Plumbing Code (CPC), 2022 edition
 - 8. Title 24, Part 9, California Fire Code (CFC), 2022 edition
- D. Code Conflicts: Should conflicts exist between the referenced NFPA Standards, Federal, State, or local codes and this specification, Contractor shall bring the conflict to the attention of Owner for resolution. The Contractor shall not attempt to resolve code conflicts with the AHJ, independent of the Owner. In general, in the event of a conflict, the most stringent of the requirements will apply.

1.07 DESIGN REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in the CEC, by a qualified testing agency, and marked for intended location and application.
- B. Sprinkler system design shall be approved by the AHJ.
- C. Water Supply: Pipe sizing shall be determined by hydraulic calculations in accordance with NFPA 13 requirements. Hydraulic calculations shall be based upon flow test information obtained from the local jurisdiction or based on a hydrant flow test performed by the contractor.
 - 1. Available hydrant flow request records provided by Spectrum Fire Protection indicate the following water supply information:
 - a. Date: May 21, 2025
 - b. Performed by: Spectrum Fire Protection
 - c. Location of Flow Hydrant: 401 South Palm Street
 - d. Static Pressure at Residual Hydrant: 70 psi
 - e. Measured Flow at Flow Hydrant: 1,002 gpm
 - f. Residual Pressure at Residual Hydrant: 50 psi
- D. Margin of Safety for Available Water Flow and Pressure: 10 percent, including losses through water-service piping, valves, and backflow preventers. Hydraulic designs shall incorporate a safety factor of 10 percent of the available water supply pressure at the system demand flow rate.
- E. Sprinkler Occupancy Hazard Classifications
 - 1. Conference Room, Circulation: Light Hazard
 - 2. Biology Storage, Custodial, Electrical Closet: Ordinary Hazard, Group 1
 - 3. Biology Classrooms, Chemistry Classrooms, Chemical Storage: Ordinary Hazard, Group 2
- F. Sprinkler System Design Criteria – Minimum Density
 - 1. Light-Hazard Occupancy: 0.10 gpm over 1,500-sq. ft. area.
 - 2. Ordinary-Hazard, Group 1 Occupancy: 0.15 gpm over 1,500-sq. ft. area.

3. Ordinary-Hazard, Group 2 Occupancy: 0.20 gpm over 1,500-sq. ft. area.
 4. The hydraulic most remote area shall be increased by 30 percent if it is under a sloped ceiling with a pitch exceeding 1 in 6 per NFPA 13, 11.2.3.2.4.
 5. The hydraulic most remote area is permitted to be decreased where quick-response sprinklers are used in light hazard areas in accordance with the methods of NFPA 13, Section 11.2.3.2.3.1.
- G. Maximum Protection Area per Sprinkler
1. Maximum protection area based on UL listing and/or NFPA 13.
 2. Light Hazard Areas: 225 sq. ft.
 3. Ordinary Hazard Areas: 130 sq. ft.
 4. Maximum protection areas per extended coverage sprinkler shall comply with NFPA 13 and manufacturer's listed spacing.
 5. Other Areas: According to NFPA 13 recommendations and/or UL listing unless otherwise indicated.
- H. Total Combined Hose-Stream Demand – According to NFPA 13, unless otherwise indicated:
1. Light-Hazard Occupancies: 100 GPM for 30 minutes.
 2. Ordinary-Hazard Occupancies: 250 GPM for 60 minutes.
- I. Seismic Performance: Sprinkler piping shall withstand the effects of earthquake motions determined according to NFPA 13 and ASCE/SEI 7.
- J. Sprinkler System Zoning
1. The maximum floor area on any one floor to be protected by sprinklers supplied by any one sprinkler system riser or combined system riser shall be as follows:
 - a. Light Hazard: 52,000 sf
 - b. Ordinary Hazard: 52,000 sf
 - c. Other Areas: Per NFPA 13 unless otherwise indicated.

1.08 ACTION SUBMITTALS

- A. Product Data: For each type of product, including type of pipe, hangers and bracing, valves, pipe fittings/joining methods, sprinklers, waterflow devices, supervisory devices, alarm bell, escutcheons, signage, fire department connection (FDC), and other equipment as applicable.
1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
 2. Specific components on catalog cut sheets must be highlighted or otherwise identified. All equipment drawing alarm or supervisory current shall have documentation of the current draw clearly marked and highlighted in the submittal information.
 3. Technical information showing physical dimensions, weight, finish and mounting requirements.
 4. All manufacturer's data sheets shall clearly show all UL listing and/or FM approvals for each product submitted.
 5. Data sheets shall include, but not be limited to, the following components:
 - a. Sprinklers and accessories
 - b. Pipes, couplings, and fittings
 - c. Check valves
 - d. Gauges
 - e. Alarm flow switches
 - f. Hangers, seismic bracing, restraint, and supports
 - g. Control valves including post indicator valves, gate valves, butterfly valves, and globe valves
 - h. Valve supervisory switches
 - i. Air vents

- j. Identification signs
 - k. CSFM listing numbers (where available)
- B. Shop Drawings
- 1. Provide working plans prepared in accordance with NFPA 13. Shop drawings shall show all the information required by NFPA 13 and the AHJ for working plans.
 - 2. Calculations: Provide hydraulic calculations and seismic bracing calculations in accordance with NFPA 13.
 - 3. Contractor will be authorized to start portions of the project when the shop drawings for the work are received, reviewed, and approved by the Owner and/or AHJ. Installation or fabrication prior to these approvals shall be at the Contractor's risk.
 - 4. Shop drawings shall include a drawing legend sheet identifying:
 - a. All symbols used on the drawings, by type of device or equipment, manufacturer, and manufacturer's part number. This information shall correspond to the manufacturer's catalog data sheets and installation manuals.
 - b. All conventions, abbreviations, and specialized terminology used on the drawings, as necessary to understand and interpret the information contained therein.
 - c. A complete drawing list identifying all drawings in the shop drawing package by title and drawing number.
 - 5. Shop drawings shall include, but not be limited to, the following information:
 - a. Hydraulic calculations.
 - b. Complete piping plan for new work and sufficient existing information to substantiate hydraulic calculations.
 - c. Reflected ceiling plan with all areas of work clearly identified.
 - d. Location and size of all new hangers and earthquake bracing.
 - e. Project location.
 - f. Point of compass.
 - g. Ceiling construction.
 - h. Full length cross section.
 - i. Location of fire rated construction, wall partitions, and other obstructions.
 - j. Location of seismic joints in project areas.
 - k. Occupancy hazard classification of each area or room.
 - l. Location and size of blank spaces and closets.
 - m. Identify small enclosures not intended to be provided with sprinkler protection.
 - n. Water supply information – calculate water available from point of connection with water main, upstream of any cross-connection device.
 - o. Other sources of water supply.
 - p. Make, type, number, and nominal orifice size of sprinklers.
 - q. Temperature rating and location of high temperature sprinklers.
 - r. Total area protected by each system on each floor. Number of new sprinklers on each riser per floor.
 - s. Nominal pipe size and cutting lengths or center-to-center dimensions of pipe.
 - t. Location and size of riser nipples.
 - u. Type of fittings, joints, sleeves, and location of all welds and bends.
 - v. Location of all control valves, check valves, drain pipes, test pipes, and their terminals.
 - w. Underground pipe size, length, location, weight, material, point of connection to city main, type of valves and meters, and the depth that the top of the pipe is laid below grade.
 - x. Provisions for flushing – size all drains and test valves to handle maximum water volume.
 - y. Complete hydraulic name-plate data.

- z. Name and address of Contractor, California State Contractor's license stamp, and identity of the designer.
 - aa. Mounting height of fire department connections.
 - bb. UL listed through-penetration firestop system for penetrations of rated assemblies.
 - cc. Edition year of NFPA 13 to which the sprinkler system is designed.
- C. Hydraulic Calculations
 - 1. Hydraulic calculations shall be provided in a separate document from the product data submittal and sprinkler drawings.
 - 2. All hydraulically designed sprinkler systems shall be provided with a minimum of a ten percent safety margin on the pressure side of the design graph.
 - 3. All sprinkler systems shall be designed to provide the appropriate density based upon a hazard occupancy classification specified by NFPA 13. In those cases where NFPA 13 does not specifically identify the hazard occupancy classification, the AHJ shall determine the hazard classification.
- D. Seismic Bracing Calculations shall be provided in accordance with NFPA 13. Identify the zone of influence associated with the calculations on the shop drawings.

1.09 INFORMATIONALSUBMITTALS

- A. Coordination Drawings: Sprinkler systems, or BIM model, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved.
- B. Qualification Data: For qualified Installer.
- C. Welding certificates.
- D. Field Test Reports: 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."
- E. Field quality-control reports.

1.10 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For fire suppression systems and specialties to include in emergency, operation, and maintenance manuals.
 - 1. Manufacturer's catalog data sheets and installation manuals.
 - 2. Copy of NFPA 25 inspection, testing, and maintenance procedures, with applicable amendments.
 - 3. Copy of all test certificates and approvals.
 - 4. A list of recommended spare parts and summary of spare parts provided.
 - 5. A service directory, including a list of Contractor's contact names and telephone numbers for service on the system, including emergency service as required elsewhere in these specifications.
- B. Upon completion of this work, and as a part of this contract, Contractor shall provide Owner with:
 - 1. Complete information and "as-built" record drawings describing and depicting the entire system as installed, including all information necessary for maintaining, troubleshooting, and/or expanding the system at a future date.
 - 2. Complete documentation of system testing and AHJ acceptance.
 - 3. Certification that the Contractor's work has been inspected and tested, is installed entirely in accordance with the applicable codes, standards, manufacturers' recommendations and UL listings and/or FM approvals, and is in proper working order. Contractor shall use "Contractor's Material and Test Certificate(s)" as required by NFPA codes.

1.11 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 sprinkler 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 the project.
- B. Spare parts and special tools shall be provided to Owner prior to final acceptance and shall be provided for each system riser location.

1.12 WARRANTY AND EMERGENCY SERVICE

- A. Contractor shall warranty all materials and workmanship for a period of one (1) year beginning with the date of final acceptance of the Contractor's completed installation by the Owner. Contractor shall be responsible during the design, installation, testing and warranty periods for any damage caused by the Contractor (or its subcontractors) or by defects in the Contractor's (or its subcontractors') work, materials, or equipment.
- B. Emergency Service: During the installation and warranty period, the Contractor shall provide emergency repair service for the sprinkler system within four (4) hours of a request by Owner for such service. This service shall be provided on a 24-hour per day, seven days per week basis.

1.13 FIELD CONDITIONS

- A. Interruption of Existing Sprinkler Service: Do not interrupt sprinkler service to facilities occupied by the Owner or others unless permitted under the following conditions and then only after arranging to provide temporary sprinkler service according to requirements indicated:
 - 1. Notify the Owner and/or AHJ no fewer than five (5) days in advance of proposed interruption of sprinkler service.
 - 2. Do not proceed with interruption of sprinkler service without written permission from the Owner and/or AHJ.

PART 2 PRODUCTS

2.01 GENERAL

- A. Equipment: All devices, systems, equipment, and materials furnished and installed shall be new and shall be submitted for approval by the Owner. All sprinklers, pipe, fittings, hangers, valves, and other materials and other equipment shall be UL Listed and/or FM approved for their intended use. All equipment shall be acceptable to the AHJ and listed with the California State Fire Marshal when listings of acceptable equipment are available.
- B. Where the Contractor substitutes products and materials from those identified in the contract documents or specifications, the Contractor shall be responsible for additional work and all fees associated with these changes, with no additional cost to the Owner. No substitution of products and materials (piping, sprinklers, hangers, fittings, etc.) shall be made from those identified in the AHJ approved permit drawings unless expressed written approval is obtained from the Owner and AHJ.

2.02 STEEL PIPE AND FITTINGS

- A. Standard-piping system component working pressure: Listed for minimum 175 psig.

- B. Threaded-End, Schedule 40, Black-Steel Pipe: ASTM A 53/A 53M, ASTM A 135, or ASTM A 795. Pipe ends may be factory or field formed threaded ends.
 - 1. Cast-Iron Threaded Fittings: ASME B16.4, Class 125, standard pattern.
 - 2. Steel Couplings: ASTM A 865/A 865M, threaded.
 - 3. Steel Threaded Pipe Nipples – ASTM A 53/A 53M, Schedule 40 steel pipe, hot-dip galvanized where indicated. Include ends matching joining method.
- C. Grooved-End, Schedule 40, Black-Steel Pipe: ASTM A53/A 53M, ASTM A 135, or ASTM A 795. Pipe ends may be factory or field formed, square-cut- or rolled- grooved ends.
 - 1. Grooved-End Fittings: UL-listed, ASTM A 536, ductile-iron casting with OD matching steel-pipe OD.
 - 2. Grooved-End-Pipe Couplings: UL 213 and AWWA C606, rigid pattern, unless otherwise indicated; gasketed fitting matching steel-pipe OD. Include ductile-iron housing with keys matching steel-pipe and fitting grooves, rubber gasket listed for use with housing, and steel bolts and nuts.
- D. Schedule 40, Stainless Steel Pipe: Standard Weight stainless steel conforming to ASTM A312/A312M, Grade TP304L. Fittings may include SS screwed fittings, grooved fittings, or welded.
 - 1. Seamless socket weld type or flanged type fitting shall conform to ASTM A403/A403M, Grade WP 304L, and shall be compatible with the pipe.
 - 2. Grooved type fittings and couplings shall be Type 316 Stainless Steel conforming to ASTM A351/A351M.
- E. Schedule 10, Black-Steel Pipe: ASTM A135/A135M or ASTM A795/A795M, Schedule 10 in NPS 5 (DN 125) and smaller; and NFPA 13-specified wall thickness in NPS 6 to NPS 10 (DN 150 to DN 250). Pipe ends may be factory or field formed, rolled- grooved ends.
- F. Schedule 40 piping must be used for piping less than 2 1/2-inches in diameter. Schedule 10 piping is permitted for piping of 2 1/2-inches in diameter and larger.
- G. Uncoated-Steel Couplings: ASTM A865/A865M, threaded.
- H. Uncoated, Cast-Iron Threaded Fittings: ASME B16.4, Class 125, standard pattern.
- I. Malleable Iron Threaded Fittings: ASME B16.3, Classes 150 and 300.
- J. Malleable- or Ductile-Iron Unions: UL 860.
- K. Cast-Iron Flanges: ASME 16.1, Class 125.
- L. Steel Flanges and Flanged Fittings: ASME B16.5, Class 150.
 - 1. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 inch thick, ASME B16.21, nonmetallic and asbestos free, or EPDM rubber gasket.
 - a. Class 125 and Class 250, Cast-Iron, Flat-Face Flanges: Full-face gaskets.
 - b. Class 150 and Class 300, Ductile-Iron or -Steel, Raised-Face Flanges: Ring-type gaskets.
 - 2. Metal, Pipe-Flange Bolts and Nuts: Carbon steel unless otherwise indicated.
- M. Grooved-Joint, Steel-Pipe Appurtenances
 - 1. Pressure Rating: 175-psig minimum.
 - 2. Uncoated Grooved-End Fitting for Steel Piping: ASTM A47/A47M, malleable-iron casting or ASTM A536, ductile-iron casting, with dimensions matching steel pipe.
 - 3. Grooved-End-Pipe Couplings for Steel Piping: AWWA C606 and UL 213 rigid pattern, unless otherwise indicated, for steel-pipe dimensions. Include ferrous housing sections, EPDM-rubber gasket, and bolts and nuts.
- N. Steel pipe shall be joined by means of flanges screwed to the pipe, threaded fittings, or grooved couplings only. Mechanical fastened tees shall not be used in new systems unless approved by the building owner and the AHJ.

- O. Pressure seal type fittings or methods of joining pipe as well as plain-end fittings are not acceptable. Reductions in pipe sizes shall be made with one-piece reducing fittings. Bushings are not acceptable.

2.03 PIPING SCHEDULE

- A. Sprinkler specialty fittings may be used, downstream of control valves, instead of specified fittings.
- B. Galvanized pipe shall be used for drain pipe.
- C. Piping between Fire Department Connections and Check Valves: Galvanized, standard-weight steel pipe with:
 - 1. Threaded ends, cast-iron threaded fittings, and threaded joints.
 - 2. Grooved ends, grooved-end fittings, grooved-end-pipe couplings, and grooved joints.
- D. Standard-pressure, fire suppression system, NPS 2 and smaller shall be one of the following:
 - 1. Schedule 40 black-steel pipe with threaded ends; uncoated, cast-iron threaded fittings; and threaded joints.
 - 2. Schedule 40 black-steel pipe with cut- or roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end pipe couplings for steel piping; and grooved joints.
 - 3. Schedule 40 black-steel pipe with plain ends; steel welding fittings; and welded joints.
- E. Standard-pressure, fire suppression system, NPS 2-1/2 and larger, shall be one of the following:
 - 1. Schedule 40 or greater black-steel pipe with threaded ends; uncoated, cast-iron threaded fittings; and threaded joints.
 - 2. Schedule 10 or greater black-steel pipe with cut- or rolled-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
 - 3. Schedule 40 black steel-pipe with cut- or roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
 - 4. Schedule 10 or greater black-steel pipe with plain ends; steel welding fittings; and welded joints.

2.04 VALVES

- A. All valves must be UL listed, FM approved, and/or California State Fire Marshal approved for their intended use. Valves shall be manufactured by companies with a full line of fire protection system components.
- B. Pressure Rating: All valves shall meet or exceed the maximum working pressures available within the system.
- C. Body Material: Bronze, cast, or ductile iron.
- D. Size: Same as connected piping.
- E. End Connections: Flanged or grooved.
- F. Ball Valves
 - 1. NPS 1-1/2 and Smaller: Bronze body with threaded ends.
 - 2. NPS 2 and NPS 2-1/2: Bronze body with threaded ends or ductile-iron body with grooved ends.
 - 3. NPS 3: Ductile-iron body with grooved ends.
- G. Butterfly Valves
 - 1. NPS 2 and Smaller: Bronze body with threaded ends.
 - 2. NPS 2-1/2 and Larger: Bronze, cast-iron, or ductile-iron body; wafer type or with flanged or grooved ends.

- H. Check Valves
 - 1. NPS 2 and Larger: Swing type, cast-iron body with flanged or grooved ends.
- I. OS&Y Type Gate Valves
 - 1. NPS 2 and Smaller: Bronze body with threaded ends.
 - 2. NPS 2-1/2 and Larger: Cast-iron body with flanged ends.
- J. Indicating Valves
 - 1. Includes integral indicating device and ends matching connecting piping.
 - 2. Indicator: Electrical, 115-V ac, prewired, 2-circuit, supervisory switch.
 - 3. NPS 2 and Smaller: Ball or butterfly valve with bronze body and threaded ends.
 - 4. NPS 2-1/2 and Larger: Butterfly valve with cast- or ductile-iron body; wafer type or with flanged or grooved ends.
- K. Automatic (Ball Drip) Drain Valves
 - 1. Standard: UL 1726.
 - 2. Pressure Rating: 175-psig minimum.
 - 3. Type: automatic draining, ball check.
 - 4. Size: NPS 3/4 (DN 20).
 - 5. End Connections: Threaded.
- L. Other Valves
 - 1. Ball Valves NPS 2 and Smaller: MSS SP-110, 2-piece copper-alloy body with chrome-plated brass ball, 600- psig minimum CWP rating, blowout-proof stem, and threaded ends.
 - 2. Check Valves NPS 2 and Smaller: MSS SP-80, Type 4, Class 125 minimum, swing type with bronze body, nonmetallic disc, and threaded ends.
 - 3. Gate Valves NPS 2 and Smaller: MSS SP-80, Type 2, Class 125 minimum, with bronze body, solid wedge and threaded ends.
 - 4. Globe Valves NPS 2 and Smaller: MSS SP-80, Type 2, Class 125 minimum, with bronze body, nonmetallic disc, and threaded ends.

2.05 AIR VENT

- A. Manual Air Vent/Valve
 - 1. Description: Ball valve that requires human intervention to vent air.
 - 2. Body: Forged brass.
 - 3. Ends: Threaded.
 - 4. Minimize Size: 1/2 inch.
 - 5. Minimum Water Working Pressure Rating: 175 psig.
- B. Automatic Air Vent
 - 1. Description: Automatic air vent that automatically vents trapped air without human intervention.
 - 2. Standard: UL listed or FM Global approval for use in wet-pipe fire sprinkler systems.
 - 3. Vents oxygen continuously from system.
 - 4. Float valve to prevent water discharge.
 - 5. Minimum Water Working Pressure Rating: 175 psig.
- C. Automatic Air Vent Assembly
 - 1. Description: Automatic dual air vent assembly that automatically vents trapped air without human intervention, including Y-strainer and ball valve in a pre-piped assembly.
 - 2. Standard: UL listed or FM Global approved for use in wet-pipe fire sprinkler system.
 - 3. Vents oxygen continuously from system.
 - 4. Float valve to prevent water discharge.
 - 5. Minimum Water Working Pressure Rating: 175 psig.

2.06 SPRINKLER PIPING SPECIALTIES

- A. Sprinkler specialty fittings shall be UL listed or FM approved, with 175-psig minimum working-pressure rating, and made of materials compatible with piping. Sprinkler specialty fittings shall have minimum 250-psig minimum working-pressure rating if fittings are components of high-pressure piping system.
- B. Flow Detection and Test Assemblies
 - 1. Pressure Rating: 175-psig minimum.
 - 2. Body Material: Cast- or ductile-iron housing with orifice, sight glass, and integral test valve.
 - 3. Size: Same as connected piping.
 - 4. Inlet and Outlet: Threaded or grooved.
- C. Sprinkler Inspector's Test Fittings
 - 1. Pressure Rating: 175-psig minimum.
 - 2. Body Material: Cast- or ductile-iron housing with sight glass.
 - 3. Size: Same as connected piping.
 - 4. Inlet and Outlet: Threaded.
- D. Adjustable Drop Nipples
 - 1. Standard: UL 1474.
 - 2. Pressure Rating: 250-psig minimum.
 - 3. Body Material: Steel pipe with EPDM-rubber O-ring seals.
 - 4. Size: Same as connected piping.
 - 5. Length: Adjustable.
 - 6. Inlet and Outlet: Threaded.
- E. Flexible Sprinkler Hose Fittings
 - 1. Standard: UL 1474.
 - 2. Type: Flexible hose for connection to sprinkler, and with bracket for connection to ceiling grid. Materials shall be suitable for system fluid.
 - 3. Pressure Rating: 175-psig minimum.
 - 4. Size: Same as connected piping, for sprinkler.
 - 5. NPS 2 and Smaller: Threaded.
 - 6. NPS 2-1/2 and Larger: Flanged.
 - 7. Option for NPS 2-1/2 and Larger: Grooved for use with grooved-end-pipe couplings.
 - 8. Bronze-Hose, Flexible Connectors: Corrugated, bronze, inner tubing covered with bronze wire braid. Include copper-tube ends or bronze flanged ends, braze welded to hose.
 - 9. Stainless-Steel-Hose/Steel Pipe, Flexible Connectors: Corrugated, stainless-steel, inner tubing covered with stainless-steel wire braid. Include steel nipples or flanges, welded to hose.
 - 10. Stainless-Steel-Hose/Stainless-Steel Pipe, Flexible Connectors: Corrugated, stainless-steel, inner tubing covered with stainless-steel wire braid. Include stainless-steel nipples or flanges, welded to hose.

2.07 FLEXIBLE CONNECTORS

- A. Flexible connectors shall have materials suitable for system fluid. Include 175-psig minimum working-pressure rating and ends according to the following:
 - 1. NPS 2 and Smaller: Threaded.
 - 2. NPS 2-1/2 and Larger: Flanged.
 - 3. Option for NPS 2-1/2 and Larger: Grooved for use with grooved-end-pipe couplings.
 - 4. Standard: UL 1474.

5. Type: Flexible hose for connection to sprinkler, and with bracket for connection to ceiling grid.
6. Pressure Rating: 175-psig minimum.
7. Size: Same as connected piping, for sprinkler.
- B. Bronze-Hose, Flexible Connectors: Corrugated, bronze, inner tubing covered with bronze wire braid. Include copper-tube ends or bronze flanged ends, braze welded to hose.
- C. Stainless-Steel-Hose/Steel Pipe, Flexible Connectors: Corrugated, stainless-steel, inner tubing covered with stainless-steel wire braid. Include steel nipples or flanges, welded to hose.
- D. Stainless-Steel-Hose/Stainless-Steel Pipe, Flexible Connectors: Corrugated, stainless-steel, inner tubing covered with stainless-steel wire braid. Include stainless-steel nipples or flanges, welded to hose.

2.08 ELECTRICAL WORK

- A. Furnish all labor, equipment, and services necessary for the design and the installation of the electrical wiring of connections as required to complete a fully operational system. Contractor will be responsible for the mounting of all water flow and tamper switches for the fire protection system in this specification. Wiring of such devices is outside the scope of this specification. Wiring of such devices is included in the Fire Alarm System Specifications, and is the responsibility of the fire alarm contractor.

2.09 SPRINKLERS

- A. Sprinklers shall be UL listed and/or FM approved, with 175-psig minimum pressure rating.
- B. Pressure Rating for Automatic Sprinklers: 175-psig minimum.
- C. Automatic Sprinklers with Heat-Responsive Element
 1. Nonresidential Applications: UL 199
- D. Sprinkler Orifice: Nominal 1/2-inch orifice with Discharge Coefficient K of 5.6 unless otherwise indicated or required by application in accordance with NFPA 13. Sprinkler orifice shall conform to NFPA 13 for the application the sprinkler is used for.
- E. Sprinkler types, features, and options, subject to Architect's and Owner's approval, as follows:
 1. Concealed ceiling sprinklers, including cover plate
 2. Recessed or Semi-Recessed ceiling sprinklers, including escutcheon
 3. Pendent sprinklers
 4. Quick-response sprinklers
 5. Sidewall sprinklers
 6. Upright sprinklers
- F. Temperature Rating
 1. Install sprinklers of the proper temperature rating as required by NFPA 13.
 2. Within the Electrical Rooms, install intermediate temperature sprinklers.
- G. Sprinkler Finishes: Chrome plated, bronze and/or painted.
- H. Corrosion Resistance: Sprinklers located on exterior piping systems, in areas exposed to the exterior, or in areas exposed to corrosive atmospheres shall be UL listed and/or FM approved corrosion resistant sprinklers.
 1. Wax coated
 2. Polyester Finish
 3. ENT/Electroless Nickel PFTE
 4. Stainless Steel

5. Corrosion resistant coatings shall be part of the sprinkler listing.
- I. Sprinkler Escutcheons: Materials, types, and finishes for the following sprinkler mounting applications.
 1. Escutcheons for concealed and recessed-type sprinklers are specified with sprinklers.
 2. Recessed Mounting: Chrome-plated steel, two-piece, recessed.
 3. Sidewall Mounting: Chrome-plated steel, two-piece, recessed.
- J. Sprinkler Guards
 1. Standard: UL 199.
 2. Type: Wire cage with fastening device for attaching to sprinkler.

2.10 SPRINKLER SCHEDULE

- A. Use sprinkler types in subparagraphs below for the following applications:
 1. Rooms without Ceilings: Upright sprinklers.
 2. Rooms with Suspended Ceilings: Concealed, recessed, or semi-recessed pendent sprinklers.
 3. Spaces Subject to Freezing: Pendent, dry sprinklers; Upright, pendent, dry sprinklers; and sidewall, dry sprinklers as indicated.
 4. Wall Mounting: Sidewall sprinklers.
 5. Special Applications: Attic sprinklers, Combustible concealed space sprinklers.
 6. IT/Electrical Rooms: Sidewall sprinklers or extended coverage sidewall sprinklers preferred to minimize system piping within room, where allowed by room arrangement. Sprinklers to be listed to protect Ordinary Hazard occupancy classification.
 7. Corrosion Resistance: Sprinklers located on exterior piping systems or in areas exposed to corrosive atmospheres shall be UL listed and/or FM approved corrosion resistant coated or stainless steel.
- B. Provide sprinkler types in subparagraphs below with finishes indicated.
 1. Concealed Sprinklers: Rough brass, with factory-painted white cover plate.
 2. Flush Sprinklers: Bright chrome, with painted white escutcheon.
 3. Recessed Sprinklers: Bright chrome, with bright chrome escutcheon.
 4. Upright, Pendent, and Sidewall Sprinklers: Chrome-plated in finished spaces exposed to view; rough bronze in unfinished spaces not exposed to view; wax coated where exposed to acids, chemicals, or other corrosive fumes.
- C. Provide quick-response sprinklers throughout, unless noted otherwise, and in accordance with NFPA 13 and CBC requirements.

2.11 ALARM DEVICES

- A. Alarm-device types shall match piping and equipment connections.
- B. Electrically Operated Notification Appliances
 1. Electric Bell
 - a. Standard: UL 464.
 - b. Type: Vibrating, metal alarm bell.
 - c. Size: 6-inch minimum diameter.
 - d. Voltage: 120 V ac, 60 Hz, 1 phase or 24 V dc.
 - e. Finish: Red-enamel or polyester powder-coat factory finish, suitable for outdoor use with approved and listed weatherproof backbox.
 2. Strobe/Horn
 - a. Standard: UL 464.

- b. Tone: Selectable, steady, Temporal-3 (T-3) in accordance with ISO 8201 and ANSI/ASA S3.41, 2400 Hz, electromechanical, broadband.
 - c. Voltage: 120 V ac, 60 Hz.
 - d. Effective Intensity: 110 cd.
 - e. Finish: Red, suitable for outdoor use with approved and listed weatherproof backbox. White letters on housing identifying device as for "Fire".
 - f. Sign, Integrated: Mount between backbox and strobe/horn with text visible on both sides, above and below strobe/horn. Housing to be shaped to cover surface-mounted weatherproof backbox. Sign is to consist of white lettering on red plastic identifying it as a "Sprinkler Fire Alarm" and instructing viewers to call 911, police, or fire department.
- C. Waterflow Switches: Vane-type and/or pressure-type water flow indicators shall be provided to indicate waterflow in each sprinkler system zone and shall be UL listed and/or FM approved. All water flow switches shall be equipped with an adjustable retard setting that can be varied from 0 to at least 60 (minimum) seconds.
- D. Water-Flow Indicators
 - 1. Standard: UL 346.
 - 2. Water-Flow Detector: Electrically supervised.
 - 3. Components: Two single-pole, double-throw circuit switches for isolated alarm and auxiliary contacts, 7 A, 125-V ac and 0.25 A, 24-V dc; complete with factory-set, field-adjustable retard element to prevent false signals and tamperproof cover that sends signal if removed.
 - 4. Type: Paddle operated.
 - 5. Pressure Rating: 250 psig.
 - 6. Design Installation: Horizontal or vertical.
- E. Waterflow Pressure Switches
 - 1. Standard: UL 346.
 - 2. Type: Electrically supervised water-flow switch with retard feature.
 - 3. Components: Single-pole, double-throw switch with normally closed contacts.
 - 4. Design Operation: Rising pressure signals water flow.
- F. Valve Supervisory Switches
 - 1. Standard: UL 346.
 - 2. Type: Electrically supervised.
 - 3. Components: Single-pole, double-throw switch with normally closed contacts.
 - 4. Design: Signals that controlled valve is in other than fully open position.
 - 5. 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.
- G. Loop Type Valve Supervisory Switches: Contractor shall not use wire loop type switches.

2.12 SLEEVES AND ESCUTCHEONS

- A. Sleeves
 - 1. Sleeves through structural concrete members and sleeves for walls below grade and floors on grade shall be standard weight galvanized Schedule 40 steel pipe.
 - 2. Sleeves through other than structural components of the building shall be 20 gage galvanized sheet metal with lock seam joints.
 - 3. Sleeves set in walls and slabs with waterproof membrane may be either cast iron or steel and shall be provided with a flashing clamp device and corrosion resistance clamping bolts.

4. Sleeves in floors on grade or exterior wall below grade shall be packed with oakum between pipe and sleeve, flush with top of sleeve for floors and with outer surface for walls.
 5. Sleeves at seismic or expansion joints shall not be packed unless located in a fire wall where piping is routed through fire walls which are seismic or expansion joints. Approved swing joints shall be used, and the sleeves appropriately packed as specified above.
- B. Pipe escutcheon plates to be installed where exposed piping passes through walls, ceilings, and floors of building shall be minimum 20 gage steel, chrome.

2.13 HANGERS AND BRACING

- A. Pipe hangers and supports shall be UL listed and/or FM approved and shall be the adjustable type. Installation shall be according to the manufacturer's listing and NFPA 13.
- B. Seismic hangers, bracing, and restraint shall be UL listed and/or FM approved for fire protection use and shall be installed in accordance with their listings and manufacturers' recommendations. Type, quantity, and spacing shall be in accordance with the requirements for the specific seismic zone requirements and those of NFPA 13.
- C. Piping material and hanger material shall not be of dissimilar materials.
- D. Hanger rods of less than 3/8-inch diameter are not permitted.
- E. All beam clamps shall be fitted with steel retainer straps.
- F. Corrosion protection: All hangers and supports, where exposed to the weather or installed in a corrosive atmosphere, shall be protected against corrosion. Corrosion-resistant materials or protective corrosion-resistant coatings shall be used.

2.14 IDENTIFICATION SIGNS

- A. Identification signs shall be rigid, metal plaques with embossed enamel background and lettering. Signs shall be secured by chain or durable wire to each sprinkler zone control valve, main and auxiliary drain, and inspector's test valve. System hydraulic calculation placards affixed using adhesives, and/or using permanent marker for information, are NOT acceptable.

2.15 MISCELLANEOUS PRODUCTS

- A. Pressure Gages
 1. Standard: UL 393.
 2. Dial Size: 3-1/2- to 4-1/2-inch diameter.
 3. Pressure Gage Range: 0- to 250-psig minimum.
 - a. Label: Include "WATER" or "AIR/WATER" label on dial face.
 - b. Air System Piping Gage: Include retard feature and "AIR" or "AIR/WATER" label on dial face.

PART 3 EXECUTION

3.01 PREPARATION

- A. Obtain water supply information from the Owner and/or local jurisdiction.
- B. Verify all conditions of the water supply and fire service piping that supplies the fire suppression system.

3.02 EXAMINATION

- A. Examine incoming fire service and point of connection.

3.03 JOB CONDITIONS

- A. Damage: Protect all unfinished work to prevent damage and furnish protection of all surrounding areas where necessary.
- B. Leak Damage: The Contractor shall be responsible during the installation and testing periods of the sprinkler system for any damage to the work of others, to the building or its contents caused by leaks in any equipment, by unplugged or disconnected pipes or fittings, or by overflow, and shall pay for the necessary replacements or repairs to work of others damaged by such leakage.

3.04 SERVICE-ENTRANCE PIPING

- A. Connect sprinkler piping to water-service piping for service entrance to building.
- B. Install shutoff valve, pressure gauge, drain, and other accessories indicated at connection to water-service piping.
- C. Connect fire sprinkler system piping to water-service piping for service entrance to building.

3.05 GENERAL INSTALLATION

- A. Aesthetics shall be a primary consideration when installing sprinklers and sprinkler piping in all areas. Any facet of sprinkler installation that deviates from the approved shop drawings and does not meet with Owner's approval shall be revised by Contractor to Owner's satisfaction at no additional cost.
- B. All holes made by the Contractor in any wall, ceiling, or floor shall be patched by the Contractor, restoring the wall, ceiling, floor or member to its original condition, fire resistance, and integrity.
- C. Location of all equipment, controls, piping, valves and drains shall be subject to Owner's approval.
- D. Deviations from approved working plans require written approval from authorities having jurisdiction. File written approval with the Architect before deviating from approved working plans.
- E. Protection: Contractor shall provide the Owner approved, adequate permanent protection for any installed piping, valves, devices, or accessories which, in Owner's opinion, are subject to physical damage or may be hazardous.

3.06 PIPING INSTALLATION

- A. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated on approved working plans.
 - 1. Deviations from approved working plans for piping require written approval from authorities having jurisdiction. File written approval with the Architect before deviating from approved working plans.
 - 2. Coordinate layout and installation of sprinklers with other construction that penetrates ceilings, including light fixtures, HVAC equipment, and partition assemblies.
- B. Piping Standard: Comply with NFPA 13 requirements for installation of sprinkler piping.
- C. Corrosion protection: All piping and hangers, where exposed to the weather or installed in a corrosive atmosphere, shall be protected against corrosion. Corrosion-resistant types of pipe, fittings, and hangers or protective corrosion-resistant coatings shall be used.

- D. Install seismic restraints on piping. Comply with NFPA 13 requirements for seismic-restraint device materials and installation.
- E. Use listed fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.
- F. Install "Inspector's Test Connections" in sprinkler system piping, complete with shutoff valve, and sized and located according to NFPA 13.
- G. Install sprinkler piping with drains for complete system drainage. Coordinate locations of sprinkler piping with drains.
- H. Install sprinkler control valves, test assemblies, and drain risers adjacent to standpipes when sprinkler piping is connected to standpipes.
- I. Install automatic (ball drip) drain valve at each check valve for fire-department connection, to drain piping between fire-department connection and check valve. Install drain piping to and spill over floor drain or to outside building.
- J. Install alarm devices in piping systems.
- K. Install hangers and supports for sprinkler system piping according to NFPA 13. Comply with requirements for hanger materials in NFPA 13.
- L. Install pressure gauges where required by applicable NFPA standards. Install pressure gauges on riser or feed main and at each sprinkler test connection in accordance with the applicable NFPA standard. Include pressure gauges with connection not less than NPS 1/4 (DN 8) and with soft-metal seated globe valve, arranged for draining pipe between gauge and valve. Install gauges to permit removal, and install where they are not subject to freezing.
- M. Fill wet-pipe sprinkler system piping with water.
- N. Install sleeves for piping penetrations of walls, ceilings, and floors. Install sleeve seals for piping penetrations of concrete walls and slabs. Install escutcheons for piping penetrations of walls, ceilings, and floors.
 - 1. Sleeve shall extend three inches past floors and shall be flush with walls, ceilings, and partitions.
 - 2. In concrete construction, sleeves shall be set in forms prior to pour.
 - 3. Fire-rated walls and floors: Caulk space between pipe and sleeve with flexible, approved fire-resistive packing compound to achieve rating at least equal to that of the wall or floor penetrated and in accordance with UL firestopping system.
 - 4. Sleeves in floors on grade or exterior wall below grade shall be packed with oakum between pipe and sleeve, flush with top of sleeve for floors and with outer surface for walls.
 - 5. Sleeves at seismic or expansion joints shall not be packed unless located in a fire wall where piping is routed through fire walls which are seismic or expansion joints. Approved swing joints shall be used, and the sleeves appropriately packed as specified above.
 - 6. Sleeve Clearance: Clearance between sleeves and pipes shall be 1-inch for pipes through 3 1/2-inch, 2-inch for pipe sizes 4-inches and greater, and three inches for seismic joints.
 - 7. Shop weld pipe joints where welded piping is indicated.
- O. Shop weld pipe joints where welded piping is indicated.
- P. All branch line piping shall be minimum 1-inch nominal size. Branch line piping in gridded systems shall be minimum 1 1/4-inch nominal size. Threaded outlets on branch lines supplying sprinklers shall match the sprinkler heads, but shall be 1-inch NPT if supplying a sprig or drop.
- Q. Pipe Routing: Sprinkler piping shall not be run through electrical rooms, IT or telecom rooms, or elevator equipment spaces unless piping is serving those spaces. Pipe routing shall be coordinated to avoid installation of sprinkler piping directly above electrical equipment. If pipe routing over equipment is unavoidable, the Contractor shall provide drain pans under piping to prevent leaking pipe drips from damaging equipment while maintaining sprinkler coverage.

- R. All sprinkler piping installed in public areas or non-public areas with suspended ceilings shall be concealed in the walls, ceilings, or soffits. Pipe in unfinished areas may be exposed.
- S. Minimum Height: All exposed piping and devices shall be installed as high as possible, but no less than seven (7) feet clear above the finished floor in traffic or working areas, so as not to obstruct any portion of a window, doorway, stairway, or passageway. Pipe and fittings shall not interfere with the operation or accessibility of any mechanical, plumbing, or electrical equipment.
- T. Fire-stopping: Pipe that passes through fire-rated resistive barriers (including shaft walls) shall be protected by a UL listed through-penetration fire-stop system in accordance with the California Building Code to maintain the integrity and rating of the fire resistive barrier. The materials used to seal penetrations shall be compatible with the piping material.

3.07 JOINT CONSTRUCTION

- A. Pressure ratings: Pressure ratings of all fittings shall meet or exceed maximum working pressures available within the system.
- B. Install couplings, flanges, flanged fittings, unions, nipples, and transition and special fittings that have finish and pressure ratings same as or higher than system's pressure rating for aboveground applications unless otherwise indicated.
- C. Install unions adjacent to each valve in pipes NPS 2 (DN 50) and smaller.
- D. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 (DN 65) and larger end connections.
- E. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- F. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
- G. Flanged Joints: Select appropriate gasket material in size, type, and thickness suitable for water service. Join flanges with gasket and bolts according to ASME B31.9.
- H. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
- I. Welded Joints: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to "Quality Assurance" Article.
 - 1. Shop weld pipe joints where welding piping is indicated. Do not use welded joints for galvanized-steel pipe.
- J. Steel-Piping, Cut-Grooved Joints: Cut square-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe joints.
- K. Steel-Piping, Roll-Grooved Joints: Roll rounded-edge groove in end of pipe according to AWWA C606. Assemble couplings with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe grooved joints.
- L. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

3.08 VALVE AND SPECIALTIES INSTALLATION

- A. Install listed fire-protection valves, trim and drain valves, specialty valves and trim, controls, and specialties according to NFPA 13 and the AHJ.
- B. Install listed fire-protection shutoff valves supervised open, located to control sources of water supply except from fire-department connections. Install permanent identification signs indicating the portion of system controlled by each valve.
- C. Install listed fire-protection isolation control valves at each standpipe riser. Valves shall be supervised in the open position.
- D. Install check valve in each water-supply connection. Install backflow preventers instead of check valves in potable-water-supply sources.
- E. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
- F. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
- G. Examine threads on valve and mating pipe for form and cleanliness.
- H. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.
- I. Do not attempt to repair defective valves; replace with new valves.
- J. Specialty Valves
 - 1. Install valves in vertical position for proper direction of flow, in main supply to system.
 - 2. Install alarm valves with bypass check valve and retarding chamber drain-line connection.
- K. Air Vent
 - 1. Provide at least one air vent at high point in each wet-pipe sprinkler system in accordance with NFPA 13 requirements. Connect vent into top of fire sprinkler piping.
 - 2. Provide dielectric union for dissimilar metals, ball valve, and strainer upstream of automatic air vent.
 - 3. Pipe from outlet of air vent to drain.
- L. Relief Valves: For all wet pipe systems, provide a relief valve not less than 1/2-inch size and set to operate at 175 psi or 10 psi in excess of the maximum system pressure, whichever is greater. Location of relief valves to be in accordance with NFPA 13.
- M. Access: Control valves shall be located in accessible spaces. Contractor shall furnish and install access panels (minimum size 12-inches by 12-inches) for all control valves concealed in walls. Valves controlling water supply to the sprinkler systems shall be less than seven (7) feet above the finished floor. When specifically approved by the Owner, the control valves may be located at a higher elevation, but they must be provided with operating chains. Control valves more than 7-feet above the finished floor shall be provided with a means of opening and closing the valve from floor level per the California Building Code Chapter 35's amendment to NFPA 13. Owner will select the finish of the access panels. Access panels installed in fire resistive construction shall be of the types required for maintaining proper protection of assembly.
- N. Valves and assemblies that are exposed to potential damage by vehicles or other traffic are to be protected by providing a cage or other approved barrier when located inside the building.
- O. Supervision: All system control valves shall be capable of being locked in the open position. Valve supervisory switches shall be provided on all valves controlling water supply to the fire sprinkler system, including valves located at backflow preventers. All supervisory switches shall be electrically supervised by the building fire alarm system.

3.09 SPRINKLER INSTALLATION

- A. Sprinklers under ducts (or other): Provide sprinklers under ducts, stairs, and other obstructions as required by NFPA 13.
- B. Uniformity: All sprinklers within a space shall be from the same manufacturer and shall have the same type and style of heat response element, including temperature rating and response characteristics.
- C. Install sprinklers of the proper temperature rating as required by NFPA 13 and the Owner's requirements.
- D. All sprinklers shall be installed in center of tile in areas with 2-feet x 2-feet suspended ceiling tiles, plus or minus 1-inch. Sprinklers shall be installed in quarter or center of tile in areas with 2-feet x 4-feet suspended ceiling tiles, plus or minus 1-inch. Coordinate location of all sprinklers in finished areas with the Architect and/or Owner. Sprinklers should be aligned in all directions when multiple sprinklers are in the same area and are in the same line of sight.
- E. Do not install pendent or sidewall, wet-type sprinklers in areas subject to freezing. Use dry-type sprinklers with water supply from heated space.
- F. Install sprinklers into flexible, sprinkler hose fittings, and install hose into bracket on ceiling grid.
- G. All sprinklers and equipment shall be installed in accordance with manufacturers' instructions. All special tools recommended by the manufacturer shall be used, including sprinkler wrenches.
- H. Sprinklers in concealed combustible spaces: Provide sprinkler protection in concealed spaces of combustible construction as required by NFPA 13.
- I. Sprinklers shall be installed with the deflector to ceiling distances in accordance with their UL listings and/or FM approval and the requirements of NFPA 13. Provide sprig-ups when necessary to comply with deflector distance requirements of NFPA 13.
- J. Sprinkler guards shall be installed on any sprinklers within 7-feet of finished floor or when sprinklers may be subject to mechanical damage. Install guards for sprinklers located within IT and Electrical Rooms. Sprinkler guards shall be UL listed. Fusible link style sprinklers shall be acceptable in areas subject to damage. Sprinkler finish in such areas shall be brass, unless otherwise directed by the Owner in the submittal process.

3.10 FIRE DEPARTMENT CONNECTION

- A. Install fire-department connection (FDC) downstream of backflow preventer. FDC may be either yard mounted or located on the backflow prevention assembly. Install yard-type fire-department connections in concrete slab support.
- B. Locate FDC on address side of the building, fully visible from the street or nearest point of fire department vehicle access.
- C. Maintain 36-inch clear space around the FDC, provided to a height of 78-inches.
- D. Fences, bushes, trees, walls, and other fixed or movable obstructions shall not impair access to the FDC.
- E. Install automatic (ball drip) drain valve at each check valve for fire-department connection, to drain piping between fire-department connection and check valve. Install drain piping to a spill-over floor drain or to outside of the building.

3.11 BACKFLOW PREVENTER INSTALLATION

- A. Install backflow preventers of type, size, and capacity indicated. Include valves and test cocks. Install according to requirements of the Public Health Department and AHJ.
- B. Do not install backflow preventers that have relief drain in vault or in other spaces subject to flooding.
- C. Do not install bypass piping around backflow preventers.

- D. Support NPS 2-1/2 (DN 65) and larger backflow preventers and piping on concrete piers.

3.12 SYSTEM TEST AND DRAIN CONNECTIONS

- A. Contractor shall provide all test valves and drain connections as required by NFPA 13.
- B. Install sprinkler piping with drains in accordance with NFPA 13 for complete system drainage.
- C. Install "Inspector's Test Connections" in sprinkler system piping, complete with shutoff valve, and sized and located according to NFPA 13.
- D. All test connections and drain riser connections shall be hard piped to discharge wastewater to building's sanitary sewer system. The sewer system shall accommodate the full flow for the main drain. Coordinate routing of the drain pipe and points of discharge with the AHJ and Owner requirements.
- E. Pipe all inspector's test connections discharging to atmosphere to location where water drained will not damage stock, equipment, vehicles, planted areas, etc. or injure personnel.
- F. Provide splash blocks where inspector's test discharge could damage surroundings.
- G. Provide 1-inch sight glass if inspector's test discharge cannot be steadily observed while operating valve.
- H. All pipe and fittings downstream of inspector's test valve shall be galvanized.

3.13 HANGERS, SUPPORT, AND BRACING

- A. Install hangers and supports for sprinkler system piping according to NFPA 13. Comply with requirements for hanger materials in NFPA 13.
- B. Install seismic restraints on piping. Comply with NFPA 13 requirements for seismic-restraint device materials and installation.
- C. All flexible couplings, hangers, sway bracing, and branch line restraint shall be designed and installed as required by NFPA 13 and in accordance with their listings and/or approvals. Flexibility, internal pressure, and differential movement between the piping and building, earth, or other supporting structure shall be allowed for so that no allowable stress is exceeded in any member.
- D. A seismic separation assembly shall be installed where sprinkler piping crosses a building's seismic separation joints.
- E. Non-sprinkler materials are prohibited from being suspended from or attached to sprinkler piping or components.

3.14 ELECTRICAL WORK

- A. Furnish all labor, equipment, and services necessary for the design and installation of the electrical wiring of connections as required to complete a fully operational system. Contractor will be responsible for the mounting of all water flow and tamper switches for the fire protection system in this specification. Wiring of such devices is outside the scope of this specification. Wiring of such devices is included in the Fire Alarm System Specifications, and is the responsibility of the fire alarm contractor.
- B. Service. Confirm power connections with the electrical contractor.
- C. Testing. Provide the required assistance to the fire alarm contractor to test, adjust, and place the fire protection system into initial operation.

3.15 IDENTIFICATION

- A. Signs: All water supply control valves and drain valves shall be marked with metal signs and shall be secured with metal chains or other means approved by the Owner and AHJ to show their function and sprinkler system zone that they serve. Attachment of signs to the valves with adhesives is not permitted. Access and signage shall be obvious, and visibility of signage shall not be blocked by equipment.
- B. Hydraulic calculation signs shall include all information indicated in NFPA 13 and its appendices.
- C. Identify system components, wiring, cabling, and terminals.

3.16 FLUSHING AND SANITIZATION

- A. All equipment and materials prior to installation shall be clean inside and outside. All waste material such as chips, filings, welding stubs, dirt, rags, debris, and any other foreign material shall be removed from the components before assembly.
- B. All steel pipe coupons or punched holes for welded outlets shall be attached to the pipe near the pipe hole. Protective plastic caps shall be located over openings and pipe ends during installation to prevent foreign material from entering the pipe at any time.
- C. Testing: All piping is to be flushed and hydraulically tested prior to acceptance by the Owner. Flushing and testing must be performed in accordance with NFPA standards.
- D. Contractor shall provide all equipment necessary for testing and flushing, and any special equipment required for the installation of any portion of the sprinkler system. Contractor shall remove all such equipment at the end of the job.

3.17 FIELD QUALITY CONTROL

- A. Coordinate the installation schedule for this portion of the work with the overall construction schedule for the project to ensure orderly progress of the work without delay.
- B. Coordinate the interface of the fire suppression systems with the work of all other trades as well as new construction to ensure proper and adequate provision for the installation and connection of this system.
- C. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
 - 1. Leak Test: After installation, charge systems and test for leaks. Repair leaks and retest until no leaks exist.
 - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 - 3. Flush, test, and inspect sprinkler systems according to NFPA 13, "Systems Acceptance" chapter.
 - 4. Energize circuits to electrical equipment and devices.
 - 5. Coordinate with fire-alarm tests. Operate as required.
- D. Sprinkler system will be considered defective if it does not pass tests and inspections.
- E. Perform field test and inspections, and prepare test reports.

3.18 FINAL INSPECTIONS AND TESTING

- A. Contractor shall make arrangements with the Owner for the Owner's final inspection and witnessing of the final acceptance tests. This test shall be separate from testing by the local authorities.
- B. All tests and inspections required by the referenced codes and standards, AHJ, and Owner shall be conducted by the Contractor per the following scope of work:

1. When the AHJ is required to witness tests, the Contractor shall be responsible for making all necessary arrangements with the code authorities and coordinating testing with the Owner.
 2. Contractor shall be responsible for completing all test documents with necessary approval stamps and signatures of the AHJ. Contractor shall submit three (3) copies of each of these documents to the Owner for their records.
- C. Acceptance Testing: Upon completion of each system, perform and document on an NFPA, or similar, approved format acceptance test form as described herein. All acceptance tests shall be performed in the presence of the Owner.
1. Hydrostatic tests in accordance with NFPA 13. Test to consist of holding test pressure at the high end for a period of two hours. Test pressure is 200 psi or 50 psi over normal operating pressure, whichever is greater.
 2. Flushing of piping in accordance with NFPA 24 and NFPA 13.
 3. Test of sprinkler supervisory system. The fire alarm contractor shall be present at the testing of all sprinkler alarm and supervisory devices. The Contractor shall coordinate the final testing of all such devices with the fire alarm contractor.
- D. Final approval and acceptance of the work will be given by the Owner when:
1. The completed sprinkler system has been inspected, tested, and approved by the Owner and AHJ.
 2. Required submittals, system operation and maintenance manuals, record drawings, spare parts, special tools, and training have been provided to, reviewed, and accepted by the Owner.
 3. Written certification is submitted that states that all equipment has been inspected and tested by a manufacturer's certified representative.
 4. Written certification is submitted that states that all equipment is installed in accordance with the manufacturer's recommendations and UL and/or FM approvals.
- E. Additional Tests: Any additional tests required by the referenced codes, standards, guidelines/criteria, or the Owner shall be performed. This documentation shall include:
1. The date and time of each test.
 2. A reference set of contractor record drawings, numerically identifying the individual components and circuits tested, test locations, and indicating the measured sound level.
 3. A description of each test performed.
 4. A checklist of each device tested, indicating the results of each test.
 5. The names and signatures of the individuals conducting and witnessing each test.

3.19 CLEANING AND PROTECTION

- A. Clean dirt and debris from sprinklers.
- B. Only sprinklers with their original factory finish are acceptable. Remove and replace any sprinklers that are painted or have any other finish than their original factory finish.
- C. Maintain the premises free from accumulation of waste materials or rubbish caused by this work.
- D. Sprinklers shall be covered with paper or plastic bags when installed prior to painting of the building interior. The paper or plastic bag coverings shall only be removed once building painting has been completed.

3.20 DEMONSTRATION

- A. Engage a factory-authorized service representative to train or train the Owner's maintenance personnel to adjust, operate, and maintain the system.

END OF SECTION

**SECTION 220500
COMMON WORK RESULTS FOR PLUMBING**

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 apply to this Section.

1.02 SUMMARY

- A. This Section includes the following:
 - 1. Piping materials and installation instructions common to most piping systems.
 - 2. Transition fittings.
 - 3. Dielectric fittings.
 - 4. Mechanical sleeve seals.
 - 5. Sleeves.
 - 6. Escutcheons.

1.03 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in chases.
- E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

1.04 SUBMITTALS

- A. Product Data: Submit brochures for the following materials to the Architect in accordance with the provisions of Division 1 of these specifications.
 - 1. Transition fittings.
 - 2. Dielectric fittings.
 - 3. Mechanical sleeve seals.
 - 4. Escutcheons.

1.05 QUALITY ASSURANCE

- A. Codes and Standards:
 - 1. All governing Codes, Ordinances and Agencies, in accordance with the provisions of Division 1 of these specifications.
- B. Warranty: In accordance with the provisions of Division 1 of these specifications.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

1.07 DISCREPANCIES

- A. The Contractor shall check all Drawings furnished immediately upon their receipt and shall promptly notify the School District's Representative of any discrepancies.
- B. Where requirements between Drawings and Specifications conflict, the more restrictive provisions shall apply.
- C. If any part of the Specifications or Drawings appears unclear or contradictory, apply to School District's Representative for interpretation and decision as early as possible, including during bidding period. Do not proceed with such work without School District's Representatives decision. Beginning work of any Section constitutes acceptance of conditions.

1.08 COORDINATION

- A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for plumbing installations.
- B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.
- C. Coordinate requirements for access panels and doors for plumbing items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in PLUMBING SPECIALTIES Section 221119.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

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

2.02 PIPE, TUBE, AND FITTINGS

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

2.03 JOINING MATERIALS

- A. Refer to individual Division 22 piping Sections for special joining materials not listed below.
- B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
 - 1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
 - a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
 - b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

- 2. AWWA C110, rubber, flat face, 1/8 inch thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.
- C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
- D. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
- E. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated.

2.04 TRANSITION FITTINGS

- A. AWWA Transition Couplings: Same size as, and with pressure rating at least equal to and with ends compatible with, piping to be joined.
 - 1. Manufacturers:
 - a. Cascade Waterworks Mfg. Co.
 - b. Dresser Industries, Inc.; DMD Div.
 - c. JCM Industries.
 - 2. Underground Piping NPS 1-1/2 and Smaller: Manufactured fitting or coupling.
 - 3. Underground Piping NPS 2 and Larger: AWWA C219, metal sleeve-type coupling.
 - 4. Aboveground Pressure Piping: Pipe fitting.
- B. Plastic-to-Metal Transition Fittings: PVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.
 - 1. Manufacturers:
 - a. Eslon Thermoplastics, or equal.
- C. Plastic-to-Metal Transition Adaptors: One-piece fitting with manufacturer's SDR 11 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.
 - 1. Manufacturers:
 - a. Thompson Plastics, Inc., or equal.
- D. Plastic-to-Metal Transition Unions: MSS SP-107, PVC four-part union. Include brass end, solvent-cement-joint end, rubber O-ring, and union nut.
 - 1. Manufacturers:
 - a. NIBCO INC., or equal.

2.05 DIELECTRIC FITTINGS

- A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.
- B. Insulating Material: Suitable for system fluid, pressure, and temperature.
- C. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig minimum working pressure at 180 deg F.
 - 1. Manufacturers:
 - a. Epco Sales, Inc.
 - b. Watts Industries, Inc.; Water Products Div.
 - c. Zurn Industries, Inc.; Wilkins Div.
- D. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.
 - 1. Manufacturers:
 - a. Epco Sales, Inc.
 - b. Watts Industries, Inc.; Water Products Div.
- E. Dielectric-Flange Kits: Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.

1. Manufacturers:
 - a. Advance Products & Systems, Inc.
 - b. Calpico, Inc.
 - c. Pipeline Seal and Insulator, Inc.
 2. Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig minimum working pressure where required to suit system pressures.
- F. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.
1. Manufacturers:
 - a. Calpico, Inc.
 - b. Lochinvar Corp.
- G. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 deg F.
1. Manufacturers:
 - a. Precision Plumbing Products, Inc.
 - b. Sioux Chief Manufacturing Co., Inc.
 - c. Victaulic Co. of America.

2.06 MECHANICAL SLEEVE SEALS

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

2.07 SLEEVES

- A. Galvanized-Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.
- B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.
- C. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
- D. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
1. Underdeck Clamp: Clamping ring with set screws.
- E. Molded PVC: Permanent, with nailing flange for attaching to wooden forms.
- F. PVC Pipe: ASTM D 1785, Schedule 40.
- G. Molded PE: Reusable, PE, tapered-cup shaped, and smooth-outer surface with nailing flange for attaching to wooden forms.

2.08 ESCUTCHEONS

- A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening. Polished chrome-plated with set screw.

PART 3 - EXECUTION

3.01 PIPING SYSTEMS - COMMON REQUIREMENTS

- A. Install piping according to the following requirements and Division 22 Sections specifying piping systems.
- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as closely as practical to routing indicated on plans.
- C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- F. Install piping to permit valve servicing.
- G. Install piping at indicated slopes.
- H. Install piping free of sags and bends.
- I. Install fittings for changes in direction and branch connections.
- J. Install piping to allow application of insulation.
- K. Select system components with pressure rating equal to or greater than system operating pressure.
- L. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:
 - 1. New Piping:
 - a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
 - b. Chrome-Plated Piping: One-piece, cast-brass type with polished chrome-plated finish.
 - c. Insulated Piping: One-piece, stamped-steel type with spring clips.
 - d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
 - e. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass type with polished chrome-plated finish.
 - f. Bare Piping in Equipment Rooms: One-piece, cast-brass type.
 - g. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.
- M. Sleeves are not required for core-drilled holes.
- N. Permanent sleeves are not required for holes formed by removable PE sleeves.
- O. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs.
- P. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.
 - 1. Cut sleeves to length for mounting flush with both surfaces.
 - a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
 - 2. Install sleeves in new walls and slabs as new walls and slabs are constructed.
 - 3. Install sleeves that are large enough to provide 1/2 inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
 - a. Steel Pipe Sleeves: For pipes smaller than NPS 6.

- b. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level. Refer to Section "Sheet Metal Flashing and Trim" for flashing.
 - 1) Seal space outside of sleeve fittings with grout.
- 4. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint.
- Q. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
 - 1. Install steel pipe for sleeves smaller than 6 inches in diameter.
 - 2. Install cast-iron "wall pipes" for sleeves 6 inches and larger in diameter.
 - 3. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- R. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with approved firestop materials, equal to Hilti.
- S. Verify final equipment locations for roughing-in.
- T. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.02 PIPING JOINT CONSTRUCTION

- A. Join pipe and fittings according to the following requirements and Division 22 Sections specifying piping systems.
- B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.
- E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.
- F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.
- H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.03 PIPING CONNECTIONS

- A. Make connections according to the following, unless otherwise indicated:
 - 1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.

2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.
3. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.
4. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

3.04 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

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

3.05 PAINTING

- A. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.06 ERECTION OF METAL SUPPORTS AND ANCHORAGES

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

3.07 ERECTION OF WOOD SUPPORTS AND ANCHORAGES

- A. Cut, fit, and place wood grounds, nailers, blocking, and anchorages to support, and anchor plumbing materials and equipment.
- B. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.
- C. Attach to substrates as required to support applied loads.

END OF SECTION

**SECTION 220519
METERS AND GAGES FOR PLUMBING PIPING**

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. METERS AND GAGES FOR PLUMBING PIPING consists of furnishing transportation, labor, materials, and equipment to furnish and install the following meters and gages for mechanical systems:
 - 1. Thermometers
 - 2. Gages
 - 3. Test plugs

1.02 RELATED WORK

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 of these specifications.
- B. DOMESTIC WATER PIPING - Section 221116
- C. COMMON WORK RESULTS FOR PLUMBING - Section 220500

1.03 REFERENCES

- A. American Society of Mechanical Engineers (ASME)

1.04 QUALITY ASSURANCE

- A. Codes and Standards:
 - 1. All governing Code, Ordinance and Agencies, in accordance with the provisions of Division 1 of these specifications.

1.05 SUBMITTALS

- A. Product Data: For each type of product indicated; include performance curves.
- B. Product Certificates: For each type of thermometer, gauge, flowmeter and thermal-energy meter, signed by product manufacturer.
- C. Operation and Maintenance Data: For flowmeters and thermal-energy meters to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.01 METAL-CASE, LIQUID-IN-GLASS THERMOMETERS

- A. Manufacturers:
 - 1. Palmer - Wahl Instruments Inc.

2. Weiss Instruments, Inc.
3. Terice, H.O. Co.
- B. Case: Die-cast aluminum or brass, 7 inches long.
- C. Tube: Red or blue reading, mercury or organic-liquid filled, with magnifying lens.
- D. Tube Background: Satin-faced, nonreflective aluminum with permanently etched scale markings.
- E. Window: Glass.
- F. Connector: Adjustable type, 180 degrees in vertical plane, 360 degrees in horizontal plane, with locking device.
- G. Stem: Copper-plated steel, aluminum, or brass for thermowell installation and of length to suit installation.
- H. Accuracy: Plus or minus 1 percent of range or plus or minus 1 scale division to maximum of 1.5 percent of range.

2.02 PRESSURE GAGES

- A. Manufacturers:
 1. Palmer – Wahl Instruments Inc.
 2. Terice, H. O. Co.
 3. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.
- B. Direct-Mounting, Dial-Type Pressure Gages: Indicating-dial type complying with ASME B40.100.
 1. Case: Liquid-filled type, drawn steel or cast aluminum, 6-inch diameter.
 2. Pressure-Element Assembly: Bourdon tube, unless otherwise indicated.
 3. Pressure Connection: Brass, NPS 1/4, bottom-outlet type unless back-outlet type is indicated.
 4. Movement: Mechanical, with link to pressure element and connection to pointer.
 5. Dial: Satin-faced, nonreflective aluminum with permanently etched scale markings.
 6. Pointer: Red or other dark-color metal.
 7. Window: Glass.
 8. Ring: Metal.
 9. Accuracy: Grade B, plus or minus 2 percent of middle half scale.
 10. Vacuum-Pressure Range: 30-inch Hg of vacuum to 15 psig of pressure.
 11. Range for Fluids under Pressure: Two times operating pressure.
- C. Pressure-Gage Fittings:
 1. Valves: NPS 1/4 brass or stainless-steel needle type.
 2. Syphons: NPS 1/4 coil of brass tubing with threaded ends.
 3. Snubbers: ASME B40.5, NPS 1/4 brass bushing with corrosion-resistant, porous-metal disc of material suitable for system fluid and working pressure.

2.03 TEST PLUGS

- A. Manufacturers:
 1. Flow Design, Inc.
 2. MG Piping Products Co.
 3. Watts Industries, Inc.; Water Products Div.
- B. Description: Corrosion-resistant brass or stainless-steel body with core inserts and gasketed and threaded cap, with extended stem for units to be installed in insulated piping.
- C. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F.
- D. Core Inserts: One or two self-sealing rubber valves.

1. Insert material for air, water, oil, or gas service at 20 to 200 degrees F shall be CR.
2. Insert material for air or water service at minus 30 to plus 275 degrees F shall be EPDM.

PART 3 - EXECUTION

3.01 THERMOMETER APPLICATIONS

- A. Install liquid-in-glass thermometers in the following locations:
 1. Outlet of each domestic water heater.
 2. Each domestic hot water return pipe.
- B. Provide the following temperature ranges for thermometers:
 1. Domestic Hot Water: 30 to 180 degrees F, with 2-degree scale divisions.

3.02 GAGE APPLICATIONS

- A. Install dry-case-type pressure gages for discharge of each pressure-reducing valve.

3.03 INSTALLATIONS

- A. Install direct-mounting thermometers and adjust vertical and tilted positions.
- B. Install direct-mounting pressure gages in piping tees with pressure gage located on pipe at most readable position.
- C. Install test plugs in tees in piping.

3.04 CONNECTIONS

- A. Install meters and gages adjacent to machines and equipment to allow service and maintenance for meters, gages, machines, and equipment.

3.05 ADJUSTING

- A. Adjust faces of thermometers and gages to proper angle for best visibility.

END OF SECTION

**SECTION 220523
GENERAL DUTY VALVES FOR PLUMBING PIPING**

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. GENERAL-DUTY VALVES FOR PLUMBING PIPING consists of furnishing transportation, labor, materials, and equipment to furnish and install the following general-duty valves:
 - 1. Ball valves.
 - 2. Check valves.
 - 3. Gate valves.

1.02 RELATED WORK

- A. Drawings and general provision of the Contract, including General and Supplementary Conditions and Division 01 of these specifications.
- B. COMMON WORK RESULTS FOR PLUMBING - Section 220500
- C. IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT - Section 220553
- D. DOMESTIC AND RECYCLED WATER PIPING - Section 221116

1.03 REFERENCES

- A. American Society of Mechanical Engineers (ASME)
- B. American Water Works Association (AWWA)

1.04 SUBMITTALS

- A. Product Data: For each type of valve indicated. Include body, seating, and trim materials; valve design; pressure and temperature classifications; end connections; arrangement; dimensions; and required clearances. Include list indicating valve and its application. Include rated capacities; shipping, installed, and operating weights; furnished specialties; and accessories.

1.05 QUALITY ASSURANCE

- A. Codes and Standards:
 - 1. All governing Codes, Ordinance and Agencies, in accordance with the provisions of Division 01 of these specifications.
- B. ASME Compliance:
 - 1. ASME B16.10 and ASME B16.34 for ferrous valved dimensions and design criteria.
 - 2. ASME B31.9 for building service piping valves.
- C. NSF Compliance: NSF 61-G for valve materials for potable-water service.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Prepare valves for shipping as follows:
 - 1. Protect internal parts against rust and corrosion.
 - 2. Protect threads, flange faces, grooves, and weld ends.

3. Set gate valves closed to prevent rattling.
 4. Set ball and plug valves open to minimize exposure of functional surfaces.
 5. Block check valves in either closed or open position.
- B. Use the following precautions during storage:
1. Maintain valve end protection.
 2. Store valves indoors and maintain at higher than ambient dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

PART 2 - PRODUCTS

2.01 VALVES, GENERAL

- A. Refer to Valve Applications Article in this Section for applications of valves.
- B. Bronze valves shall be made with dezincification-resistant materials.
1. Valves for potable water must comply with California Lead Free Law.
 2. Lead free refers to the wetted surface of pipe, fittings and fixtures in potable water systems that have a weighted average lead content $\leq 0.25\%$. Source: California Health Safety Code (116875).
 3. All valves must be 3rd party certified.
- C. Bronze Valves: NPS 2 and smaller with threaded ends, unless otherwise indicated.
- D. Ferrous Valves: NPS 2-1/2" and larger with flanged ends, unless otherwise indicated.
- E. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
- F. Valve Sizes: Same as upstream pipe, unless otherwise indicated.
- G. Valve Actuator Types:
1. Handwheel: For valves other than quarter-turn types.
 2. Handlever: For quarter-turn valves NPS 6 and smaller, except plug valves.
 3. Locking Handlever: All valves used in recycled water piping shall be provided with locking hand levers.
- H. Valves in Insulated Piping: With 2-inch stem extensions and the following features:
1. Gate Valves: With non-rising stem.
 2. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeves that allows operation of valve without breaking the vapor seal or disturbing insulation and memory stops that are fully adjustable after insulation is applied.
- I. Valve-End Connections:
1. Flanged: With flanges according to ASME B16.1 for iron valves, ASME B16.5 for steel valves.
 2. Solder Joint: With sockets according to ASME B16.18.
 3. Threaded: With threads according to ASME B1.20.1.
- J. Valve Bypass and Drain Connections: MSS SP-45.

2.02 BRONZE BALL VALVES

- A. 2 1/2 in. and smaller: Two-Piece, Bronze Ball Valves, Dezincification resistant lead free bronze body with full-port, stainless steel ball and trim; TFE seats; and 600-psig minimum cold working pressure rating and blowout-proof stem, MSS SP-110, NSF-61-G. Provide with locking lever handle feature where used in recycled water piping.
1. Manufacturers:
 - a. Conbraco Industries, Inc.; Apollo Division: Model 77CLF-100 Series

- b. NIBCO INC., Model T-685-80-66-LF
 - B. 3 in. and larger: Two-Piece, Bronze Ball Valves: Dezincification resistant lead free bronze body with standard-port, chromium-plated ball and trim; RPTFE seats; and 600-psig minimum cold working pressure rating and blowout-proof stem. Provide with locking lever handle feature where used in recycled water piping.
 - 1. Manufacturers:
 - a. Conbraco Industries, Inc.; Apollo Division: Model 70LF-100 Series
- 2.03 BRONZE CHECK VALVES
- A. 3 in. and smaller: Y-pattern, Class 125, Bronze, and Horizontal Swing Check Valves: Dezincification resistant lead free bronze body with renewable nonmetallic disc and bronze seat, MSS SP-80.
 - 1. Manufacturers:
 - a. Conbraco Industries, Inc.; Apollo Division: Model 61Y-LF Series
 - b. NIBCO INC., Model T-413-Y-LF
- 2.04 BRONZE GATE VALVES
- A. 3 in and smaller: Bronze Alloy construction, screw-in bonnet, Non-rising stem, Lead-Free bronze body with bronze solid wedge, dezincification Resistant, MSS SP-80.
 - 1. Manufacturers:
 - a. NIBCO INC., Model S or T-113-LF
 - b. Conbraco Industries, Inc.; Apollo Division: Model 30-LF Series.
- 2.05 DUCTILE-IRON GATE VALVES
- A. 4" and larger: Class 125, Bolted Bonnet, non-rising stem, resilient-wedge, flanged ends, 250 psi, epoxy coated inside and outside, ductile iron body, Lead-Free.
 - 1. Manufacturers:
 - a. NIBCO INC., Model F-619-RW
- 2.06 SPRING-LOADED CHECK VALVES
- A. In-Line Check Valve: 2 in. and smaller; Lead-Free Bronze body, threaded, stainless steel spring, 400 psi CWP.
 - 1. Manufacturers:
 - a. NIBCO, INC., Model T-413-Y-LF.
 - b. Conbraco Industries, Inc., Apollo Division: Model CVB-61-100-LF Series.
 - B. Dual Check Valve: 2 in. and smaller; Lead-Free composite body, corrosion resistant internal parts, and two (2) independently operated in-line spring-loaded modular checks.
 - 1. Manufacturers:
 - a. Wilkins Model 705-XL.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine piping system for compliance with requirements for installation tolerances and other conditions affecting performance.
 - 1. Proceed with installation only after unsatisfactory conditions have been corrected.

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

3.02 VALVE APPLICATIONS

- A. Refer to piping Sections for specific valve applications. If valve applications are not indicated, use the following:
 - 1. Shutoff Service: Ball, or gate valves.
 - 2. Throttling Service: Ball valves.
- B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP class or CWP ratings may be substituted.
- C. Domestic Water Piping: Use the following types of valves:
 - 1. Ball Valves: NPS 2 ½ in. and Smaller; Bronze Lead-Free Ball Valves, Two-piece, Full-Port, 600-psig CWP rating with stainless steel ball. NPS 3 in and larger; Bronze Lead-Free Ball Valves, Two-piece, standard-port, 600 psi CWP rating with chromium-plated ball.
 - 2. Swing Check Valves, NPS 3 and Smaller: Lead-Free, "Y"-Pattern, Class 125, bronze.
 - 3. Swing Check Valves, NPS 4 and Larger: Type II, Class 125, ductile iron.
 - 4. Spring-Loaded Check Valves, NPS 2 and Smaller: Class 125, Bronze, stainless steel spring.
 - 5. Gate Valves, NPS 3 in. and smaller: Lead-Free, Bronze, non-rising stem, Lead-Free, Class 125. NPS 4 in. and larger; Ductile iron body, Lead-Free, epoxy coated, flanged ends.
- D. Recycled Water Piping: Valves shall be the same as for domestic water piping except as follows:
 - 1. Recycled Water Control Valves: Lever handle valves equipped with a locking feature and painted purple to match the mylar wrapping tape.

3.03 VALVE INSTALLATION

- A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- C. Locate valves for easy access and provide separate support where necessary.
- D. Install valves in horizontal piping with stem at or above center of pipe.
- E. Install valves in position to allow full stem movement.
- F. Install check valves for proper direction of flow and as follows:
 - 1. Swing Check Valves: In horizontal position with hinge pin level.
 - 2. Lift Check Valves: With stem upright and plumb.

3.04 JOINT CONSTRUCTION

- A. Refer to Division 22 Section "Common Work Results for Plumbing" for basic piping joint construction.

- B. Soldered Joints: Use ASTM B 813, water-flushable, lead-free flux; ASTM B32, lead-free-alloy solder; and ASTM B 828 procedure, unless otherwise indicated.

3.05 ADJUSTING

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

END OF SECTION

**SECTION 220529
HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT**

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. Hangers and supports for plumbing piping and equipment consists of furnishing transportation, labor, materials and equipment to furnish and install the following:
 - 1. Steel pipe hangers and supports.
 - 2. Trapeze pipe hangers.
 - 3. Metal framing systems.
 - 4. Thermal-hanger shield inserts.
 - 5. Fastener systems.
 - 6. Pipe stands.
 - 7. Pipe positioning systems.
 - 8. Equipment supports.

1.02 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. Related Sections include the following:
 - 1. Section "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
 - 2. Division 22 Section "Noise, Vibration and Seismic Controls for Plumbing Piping and Equipment" for vibration isolation devices.

1.03 DEFINITIONS

- A. MSS: Manufacturers Standardization Society for The Valve and Fittings Industry Inc.
- B. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

1.04 PERFORMANCE REQUIREMENTS

- A. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
- B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
- C. Design seismic-restraint hangers and supports for piping and equipment and obtain approval from authorities having jurisdiction.

1.05 SUBMITTALS

- A. Product Data: For the following:
 - 1. Steel pipe hangers and supports.
 - 2. Thermal-hanger shield inserts.
 - 3. Powder-actuated fastener systems.

- 4. Pipe positioning systems.
- B. Welding certificates.

1.06 QUALITY ASSURANCE

- A. Welding: Welding shall be performed only by qualified welders, and shall comply with ASME Boiler Construction Code, ANSI Code and State of California requirements.
- B. Codes and Standards:
 - 1. All governing codes, ordinances and agencies, in accordance with the provisions of Division 1 of these specifications.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

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

2.02 STEEL PIPE HANGERS AND SUPPORTS

- A. Description: MSS SP-58, Types 1 through 58, factory-fabricated components. Refer to Part 3 "Hanger and Support Applications" Article for where to use specific hanger and support types.
- B. Manufacturers:
 - 1. B-Line Systems, Inc.; a division of Cooper Industries.
 - 2. ERICO/Michigan Hanger Co.
 - 3. Hilti Inc.
 - 4. Tolco Inc.
- C. Galvanized, Metallic Coatings: Pregalvanized or hot dipped.
- D. Nonmetallic Coatings: Plastic coating, jacket, or liner.
- E. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion for support of bearing surface of piping.

2.03 TRAPEZE PIPE HANGERS

- A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural-steel shapes with MSS SP-58 hanger rods, nuts, saddles, and U-bolts.

2.04 METAL FRAMING SYSTEMS

- A. Description: MFMA-3, shop- or field-fabricated pipe-support assembly made of steel channels and other components.
- B. Manufacturers:
 - 1. B-Line Systems, Inc.; a division of Cooper Industries.
 - 2. ERICO/Michigan Hanger Co.; ERISTRUT Div.
 - 3. Hilti Inc.
 - 4. Tolco Inc.
 - 5. Unistrut Corp.; Tyco International, Ltd.

- C. Coatings: Manufacturer's standard finish unless bare metal surfaces are indicated.
- D. Nonmetallic Coatings: Plastic coating, jacket, or liner.

2.05 THERMAL-HANGER SHIELD INSERTS

- A. Description: 100-psig- minimum, compressive-strength insulation insert encased in sheet metal shield.
- B. Manufacturers:
 - 1. ERICO/Michigan Hanger Co.
 - 2. Pipe Shields, Inc.
- C. Insulation-Insert Material for Cold Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate or ASTM C 552, Type II cellular glass with vapor barrier.
- D. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate or ASTM C 552, Type II cellular glass.
- E. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
- F. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
- G. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.06 FASTENER SYSTEMS

- A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened Portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
 - 1. Manufacturers:
 - a. Hilti, Inc.
 - b. ITW Ramset/Red Head.
 - c. Powers Fasteners.
- B. Mechanical-Expansion Anchors: Insert-wedge-type stainless steel, for use in hardened Portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
 - 1. Manufacturers:
 - a. B-Line Systems, Inc.; a division of Cooper Industries.
 - b. Hilti, Inc.
 - c. ITW Ramset/Red Head.
 - d. Powers Fasteners.

2.07 PIPE STAND FABRICATION

- A. Pipe Stands, General: 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.
 - 1. Manufacturers:
 - a. ERICO/Michigan Hanger Co.
 - b. MIRO Industries.
- C. Curb-Mounting-Type Pipe Stands: Shop- or field-fabricated pipe support made from structural-steel shape, continuous-thread rods, and rollers for mounting on permanent stationary roof curb.

2.08 PIPE POSITIONING SYSTEMS

- A. Description: IAPMO PS 42, system of metal brackets, clips, and straps for positioning piping in pipe spaces for plumbing fixtures for commercial applications.
- B. Manufacturers:
 - 1. C & S Mfg. Corp.
 - 2. HOLDRITE Corp.; Hubbard Enterprises.
 - 3. Samco Stamping, Inc.

2.09 EQUIPMENT SUPPORTS

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

2.10 MISCELLANEOUS MATERIALS

- A. Structural Steel: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

PART 3 - EXECUTION

3.01 HANGER AND SUPPORT APPLICATIONS

- A. Specific hanger and support requirements are specified in Sections specifying piping systems and equipment.
- B. Comply with MSS SP-69 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 finish.
- D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- E. Use padded hangers for piping that is subject to scratching.
- F. 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. 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.
 - 3. 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.
 - 4. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated stationary pipes, NPS 3/4 to NPS 8.
 - 5. Split Pipe-Ring with or without Turnbuckle-Adjustment Hangers (MSS Type 11): For suspension of noninsulated stationary pipes, NPS 3/8 to NPS 8.
 - 6. Extension Hinged or 2-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated stationary pipes, NPS 3/8 to NPS 3.
 - 7. U-Bolts (MSS Type 24): For support of heavy pipes, NPS 1/2 to NPS 30.
 - 8. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
 - 9. 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.

10. 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 and with U-bolt to retain pipe.
 11. 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.
 12. Single Pipe Rolls (MSS Type 41): For suspension of pipes, NPS 1 to NPS 30, from 2 rods if longitudinal movement caused by expansion and contraction might occur.
 13. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes, NPS 2-1/2 to NPS 20, from single rod if horizontal movement caused by expansion and contraction might occur.
 14. Complete Pipe Rolls (MSS Type 44): For support of pipes, NPS 2 to NPS 42, if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
 15. 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 might occur and vertical adjustment is not necessary.
 16. 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 might be required in addition to expansion and contraction.
- G. 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 20.
- H. 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 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.
- I. 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. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
 8. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
 9. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
 10. Malleable Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
 11. 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.
 - 12. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
 - 13. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
 - 14. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.
- J. 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.
- K. 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 absorb 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 absorb 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 absorb 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.
- L. Comply with MSS SP-69 for trapeze pipe hanger selections and applications that are not specified in piping system Sections.
- M. Comply with MFMA-102 for metal framing system selections and applications that are not specified in piping system Sections.
- N. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.
- O. Use pipe positioning systems in pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures.

3.02 HANGER AND SUPPORT INSTALLATION

- A. Steel Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.

- B. Trapeze Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. 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 above for individual pipe hangers.
 - 2. Field fabricate from ASTM A 36/A 36M, steel shapes selected for loads being supported. Weld steel according to AWS D1.1.
- C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled metal framing systems.
- D. Fiberglass Strut System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled fiberglass struts.
- E. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.
- F. 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.
- G. Pipe Stand Installation:
 - 1. Pipe Stand Types except Curb-Mounting Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
 - 2. Curb-Mounting-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. Refer to Section "Roof Accessories" for curbs.
- H. Pipe Positioning System Installation: Install support devices to make rigid supply and waste piping connections to each plumbing fixture. Refer to Division 22 Section "Plumbing Fixtures" for plumbing fixtures.
- I. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.
- J. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- K. 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.
- L. Install lateral bracing with pipe hangers and supports to prevent swaying.
- M. 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.
- N. Load Distribution: Install hangers and supports so piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- O. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.9 (for building services piping) are not exceeded.
- P. Insulated Piping: Comply with the following:
 - 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 according to ASME B31.9 for building services piping.
- 2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
- 3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
- 4. Shield Dimensions for Pipe: Not less than the following:
 - a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
 - b. NPS 4: 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 inserts.
- 6. Insert Material: Length at least as long as protective shield.
- 7. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.03 EQUIPMENT SUPPORTS

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

3.04 METAL FABRICATIONS

- A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.
- B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1 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 contours of welded surfaces match adjacent contours.

3.05 ADJUSTING

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

3.06 PAINTING

- A. Touch Up: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 - 1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.
- B. Touch Up: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in 09
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION

SECTION 220553
IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. Identification for plumbing piping and equipment consists of furnishing transportation, labor, materials, and equipment to furnish and install the following:
 - 1. Pipe labels.
 - 2. Valve tags.
 - 3. Water heater Labels

1.02 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. COMMON WORK RESULTS FOR PLUMBING - Section 220500

1.03 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.

1.04 COORDINATION

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

1.05 QUALITY ASSURANCE

- A. Codes and Standards:
 - 1. All governing codes, ordinances and agencies, in accordance with the provisions of Division 1 of these specifications

PART 2 - PRODUCTS

2.01 PIPE LABELS

- A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.
- B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.
- C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

- D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.
1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
 2. Lettering Size: At least 1-1/4 inches high for pipe sizes 2-1/2 to 6 inches, 3/4 inch high for pipe sizes 1-1/2 to 2 inches and 1/2 high for pipe sizes 1/2 to 1-1/4 inches.
 3. Color Field Length: At least 12 inches for pipe sizes 2-1/2 to 6 inches and 8 inches for pipe sizes 1/2 to 2 inches.
 4. Non-potable water systems shall have the words "CAUTION: NON-POTABLE WATER, DO NOT DRINK" in upper case lettering.

2.02 VALVE TAGS

- A. Valve Tags: Provide a valve tag consisting of a 2 in. dia., 20 ga. brass disk for each valve with 1/2 in. letters identifying service designation. Fasten tags in place with continuous chain around valve stem.

PART 3 - EXECUTION

3.01 PREPARATION

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

3.02 PIPE LABEL INSTALLATION

- A. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, and exterior exposed locations as follows:
1. Near each valve and control device.
 2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
 3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
 4. At access doors, manholes, and similar access points that permit view of concealed piping.
 5. Near major equipment items and other points of origination and termination.
 6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
 7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.
- B. Pipe Label Color Schedule:
1. Domestic Water Piping:
 - a. Background Color: Green.
 - b. Letter Color: White.
 2. Industrial Cold Water Piping:
 - a. Background Color: Yellow
 - b. Letter Color: Black
 3. Sanitary Waste and Storm Drainage Piping:
 - a. Background Color: Green.
 - b. Letter Color: White.

3.03 VALVE-TAG INSTALLATION

- A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; shutoff valves; faucets; convenience and lawn-watering hose connections; and similar roughing-in connections of end-use fixtures and units.

END OF SECTION

SECTION 220719
PLUMBING PIPING INSULATION

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. PLUMBING PIPING INSULATION consists of furnishing transportation, labor, materials, and equipment to furnish and install piping insulation including preformed, rigid and flexible pipe insulation; field-applied jackets; accessories and attachments; and sealing compounds.

1.02 RELATED WORK

- A. COMMON WORK RESULTS FOR PLUMBING - Section 220500
- B. HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT - Section 220529

1.03 REFERENCES

- A. American Society for Testing and Materials (ASTM International)

1.04 SUBMITTALS

- A. Product Data: Identify thermal conductivity, thickness, and jackets (both factory and field applied, if any), for each type of product indicated.

1.05 QUALITY ASSURANCE

- A. Insulation Installed Indoors: Flame-spread rating of 25 or less, and smoke-developed rating of 50 or less.
- B. Insulation Installed Outdoors: Flame-spread rating of 75 or less, and smoke-developed rating of 150 or less.
- C. Codes and Standards:
 - 1. All governing Codes, Ordinances and agencies, in accordance with the provisions of Division 1 of these specifications.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Packaging: Ship insulation materials in containers marked by manufacturer with appropriate ASTM specification designation, type and grade, and maximum use temperature.

1.07 COORDINATION

- A. Coordinate size and location of supports, hangers, and insulation shields specified in HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT Section.
- B. Coordinate clearance requirements with piping Installer for insulation application.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Glass Fiber Insulation:
 - 1. Johns-Manville
 - 2. Pittsburgh-Corning Corporation
- B. Closed-Cell Phenolic-Foam Insulation:
 - 1. Kooltherm Insulation Products, Ltd.

2.02 INSULATION MATERIALS

- A. Glass Fiber Insulation: Inorganic, foamed or cellulated glass, annealed, rigid, hermetically sealed cells, incombustible.
 - 1. Preformed Pipe Insulation, without Jacket: Comply with ASTM C552, Type II, Class 1.
 - 2. Preformed Pipe Insulation, with Jacket: Comply with ASTM C552, Type II, Class 2.
 - 3. Closed-Cell Phenolic-Foam Insulation: Preformed pipe insulation of rigid, expanded, closed-cell structure. Comply with ASTM C1126, Type III, Grade 1.
- B. Prefabricated Thermal Insulating Fitting Covers: Comply with ASTM C450 for dimensions used in preforming insulation to cover valves, elbows, tees, and flanges.

2.03 FIELD-APPLIED JACKETS

- A. General: ASTM C921, Type 1, unless otherwise indicated.
- B. Foil and Paper Jacket: Laminated, glass-fiber-reinforced, flame-retardant kraft paper and aluminum foil.
- C. PVC Jacket: High-impact, ultraviolet-resistant PVC; 20 mils thick; roll stock ready for shop or field cutting and forming.
 - 1. Adhesive: As recommended by insulation material manufacturer.
 - 2. PVC Jacket Color: Color-code piping jackets based on materials contained within the piping system.
 - 3. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories for the disabled.
 - 4. Adhesive: As recommended by insulation material manufacturer.
- D. Standard PVC Fitting Covers: Factory-fabricated fitting covers manufactured from 20-mil- thick, high-impact, ultraviolet-resistant PVC.
 - 1. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories for the disabled.
 - 2. Adhesive: As recommended by insulation material manufacturer.
- E. Aluminum Jacket: Factory cut and rolled to indicate sizes. Comply with ASTM B209, 3003 alloy, H-14 temper.
 - 1. Finish and Thickness: Smooth finish, 0.010 inch thick.
 - 2. Moisture Barrier: 1-mil- thick, heat-bonded polyethylene and kraft paper.
 - 3. Elbows: Preformed, 45- and 90-degree, short- and long-radius elbows; same material, finish, and thickness as jacket.

2.04 ACCESSORIES AND ATTACHMENTS

- A. Glass Cloth and Tape: Comply with MIL-C-20079H, Type I for cloth and Type II for tape. Woven glass-fiber fabrics, plain weave, presized a minimum of 8 ounces per square yard.
 - 1. Tape Width: 4 inches.
- B. Bands: 3/4 inch wide, in one of the following materials compatible with jacket:
 - 1. Stainless Steel: ASTM A666, Type 304; 0.020 inch thick.
 - 2. Galvanized Steel: 0.005 inch thick.
 - 3. Aluminum: 0.007 inch thick.
 - 4. Brass: 0.010 inch thick.
 - 5. Nickel-Copper Alloy: 0.005 inch thick.
- C. Wire: 0.080-inch, nickel-copper alloy; 0.062-inch, soft-annealed, stainless steel; or 0.062-inch, soft-annealed, galvanized steel.

2.05 VAPOR RETARDERS

- A. Mastics: Materials recommended by insulation material manufacturer that are compatible with insulation materials, jackets, and substrates.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Surface Preparation: Clean and dry pipe and fitting surfaces. Remove materials that will adversely affect insulation application.

3.03 GENERAL APPLICATION REQUIREMENTS

- A. Apply insulation materials, accessories, and finishes according to the manufacturer's written instructions; with smooth, straight, and even surfaces; free of voids throughout the length of piping, including fittings, valves, and specialties.
- B. Refer to schedules at the end of this Section for materials, forms, jackets, and thicknesses required for each piping system.
- C. Use accessories compatible with insulation materials and suitable for the service. Use accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Apply insulation with longitudinal seams at top and bottom of horizontal pipe runs.
- E. Apply multiple layers of insulation with longitudinal and end seams staggered.
- F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- G. Seal joints and seams with vapor-retarder mastic on insulation indicated to receive a vapor retarder.
- H. Keep insulation materials dry during application and finishing.

- I. Apply insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by the insulation material manufacturer.
- J. Apply insulation with the least number of joints practical.
- K. Apply insulation over fittings, valves, and specialties, with continuous thermal and vapor-retarder integrity, unless otherwise indicated. Refer to special instructions for applying insulation over fittings, valves, and specialties.
- L. Hangers and Anchors: Where vapor retarder is indicated, seal penetrations in insulation at hangers, supports, anchors, and other projections with vapor-retarder mastic.
 - 1. Apply insulation continuously through hangers and around anchor attachments.
 - 2. For insulation application where vapor retarders are indicated, extend insulation on anchor legs at least 12 inches from point of attachment to pipe and taper insulation ends. Seal tapered ends with a compound recommended by the insulation material manufacturer to maintain vapor retarder.
 - 3. Install insert materials and apply insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by the insulation material manufacturer.
 - 4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect the jacket from tear or puncture by the hanger, support, and shield.
- M. Insulation Terminations: For insulation application where vapor retarders are indicated, taper insulation ends. Seal tapered ends with a compound recommended by the insulation material manufacturer to maintain vapor retarder.
- N. Apply adhesives and mastics at the manufacturer's recommended coverage rate.
- O. Apply insulation with integral jackets as follows:
 - 1. Pull jacket tight and smooth.
 - 2. Circumferential Joints: Cover with 3-inch wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip and spaced 4 inches on center.
 - 3. Longitudinal Seams: Overlap jacket seams at least 1-1/2 inches. Apply insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 4 inches on center.
 - a. Exception: Do not staple longitudinal laps on insulation having a vapor retarder.
 - 4. Vapor-Retarder Mastics: Where vapor retarders are indicated, apply mastic on seams and joints and at ends adjacent to flanges, unions, valves, and fittings.
 - 5. At penetrations in jackets for thermometers and pressure gages, fill and seal voids with vapor-retarder mastic.
- P. Roof Penetrations: Apply insulation for interior applications to a point even with top of roof flashing.
 - 1. Seal penetrations with vapor-retarder mastic.
 - 2. Apply insulation for exterior applications tightly joined to interior insulation ends.
 - 3. Extend metal jacket of exterior insulation outside roof flashing at least 2 inches below top of roof flashing.
 - 4. Seal metal jacket to roof flashing with vapor-retarder mastic.
- Q. Exterior Wall Penetrations: For penetrations of below-grade exterior walls, terminate insulation flush with mechanical sleeve seal. Seal terminations with vapor-retarder mastic.
- R. Interior Wall and Partition Penetrations: Apply insulation continuously through walls and floors.
- S. Fire-Rated Wall and Partition Penetrations: Apply insulation continuously through penetrations of fire-rated walls and partitions.
 - 1. Firestopping and fire-resistive joint sealers are specified in FIRESTOPPING Section.
- T. Floor Penetrations: Apply insulation continuously through floor assembly.

1. For insulation with vapor retarders, seal insulation with vapor-retarder mastic where floor supports penetrate vapor retarder.

3.04 GLASS FIBER INSULATION APPLICATION

- A. Apply insulation to straight pipes and tubes as follows:
 1. Secure each layer of insulation to pipe with wire, tape, or bands without deforming insulation materials.
 2. Where vapor retarders are indicated, seal longitudinal seams and end joints with vapor-retarder mastic.
 3. For insulation with factory-applied jackets, secure laps with outward clinched staples at 6 inches on center.
 4. For insulation with factory-applied jackets with vapor retarders, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by the insulation material manufacturer and seal with vapor-retarder mastic.
- B. Apply insulation to flanges as follows:
 1. Apply preformed pipe insulation to outer diameter of pipe flange.
 2. Make width of insulation segment the same as overall width of the flange and bolts, plus twice the thickness of the pipe insulation.
 3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of cellular-glass block insulation of the same thickness as pipe insulation.
 4. Apply canvas jacket material with manufacturer's recommended adhesive, overlapping seams at least 1 inch, and seal joints with vapor-retarder mastic.
- C. Apply insulation to fittings and elbows as follows:
 1. Apply premolded insulation sections of the same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
 2. When premolded sections of insulation are not available, apply mitered sections of cellular-glass insulation. Secure insulation materials with wire, tape, or bands.
 3. Cover fittings with heavy PVC fitting covers. Overlap PVC covers on pipe insulation jackets at least 1 inch at each end. Secure fitting covers with manufacturer's attachments and accessories. Seal seams with tape and vapor-retarder mastic.
- D. Apply insulation to valves and specialties as follows:
 1. Apply premolded segments of cellular-glass insulation or glass-fiber blanket insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation. For check valves, arrange insulation for access to strainer basket without disturbing insulation.
 2. Apply insulation to flanges as specified for flange insulation application.
 3. Use preformed standard PVC fitting covers for valve sizes where available. Secure fitting covers with manufacturer's attachments and accessories. Seal seams with tape and vapor-retarder mastic.
 4. Use preformed heavy PVC fitting covers for valve sizes where available. Secure fitting covers with manufacturer's attachments and accessories. Seal seams with tape and vapor-retarder mastic.
 5. For larger sizes where PVC fitting covers are not available, seal insulation with canvas jacket and sealing compound recommended by the insulation material manufacturer.

3.05 CLOSED-CELL PHENOLIC-FOAM INSULATION APPLICATION

- A. Apply insulation to straight pipes and tubes as follows:
 1. Secure each layer of insulation to pipe with wire, tape, or bands without deforming insulation materials.

2. Where vapor retarders are indicated, seal longitudinal seams and end joints with vapor-retarder mastic.
 3. For insulation with factory-applied jackets, secure laps with outward clinched staples at 6 inches on center.
 4. For insulation with factory-applied jackets with vapor retarders, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by the insulation material manufacturer and seal with vapor-retarder mastic.
- B. Apply insulation to flanges as follows:
1. Apply preformed pipe insulation to outer diameter of pipe flange.
 2. Make width of insulation segment the same as overall width of the flange and bolts, plus twice the thickness of the pipe insulation.
 3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of block insulation of the same material and thickness as pipe insulation.
 4. Apply canvas jacket material with manufacturer's recommended adhesive, overlapping seams at least 1 inch, and seal joints with vapor-retarder mastic.
- C. Apply insulation to fittings and elbows as follows:
1. Apply premolded insulation sections of the same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
 2. When premolded sections of insulation are not available, apply mitered sections of phenolic-foam insulation. Secure insulation materials with wire, tape, or bands.
 3. Cover fittings with heavy PVC fitting covers. Overlap PVC covers on pipe insulation jackets at least 1 inch at each end. Secure fitting covers with manufacturer's attachments and accessories. Seal seams with tape and vapor-retarder mastic.
- D. Apply insulation to valves and specialties as follows:
1. Apply premolded insulation sections of the same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
 2. When premolded sections of insulation are not available, apply mitered segments of phenolic-foam insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation. For check valves, arrange insulation for access to strainer basket without disturbing insulation.
 3. Apply insulation to flanges as specified for flange insulation application.
 4. Use preformed heavy PVC fitting covers for valve sizes where available. Secure fitting covers with manufacturer's attachments and accessories. Seal seams with tape and vapor-retarder mastic.
 5. For larger sizes where PVC fitting covers are not available, seal insulation with canvas jacket and sealing compound recommended by the insulation material manufacturer.

3.06 FIELD-APPLIED JACKET APPLICATION

- A. Apply glass-cloth jacket, where indicated, directly over bare insulation or insulation with factory-applied jackets.
1. Apply jacket smooth and tight to surface with 2-inch overlap at seams and joints.
 2. Embed glass cloth between two 0.062-inch- thick coats of jacket manufacturer's recommended adhesive.
 3. Completely encapsulate insulation with jacket, leaving no exposed raw insulation.
- B. Foil and Paper Jackets: Apply foil and paper jackets where indicated.
1. Draw jacket material smooth and tight.
 2. Apply lap or joint strips with the same material as jacket.
 3. Secure jacket to insulation with manufacturer's recommended adhesive.
 4. Apply jackets with 1-1/2-inch laps at longitudinal seams and 3-inch- wide joint strips at end joints.

5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-retarder mastic.
- C. Apply PVC jacket where indicated, with 1-inch overlap at longitudinal seams and end joints. Seal with manufacturers recommended adhesive.
- D. Apply metal jacket where indicated, with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches on center and at end joints.

3.07 PIPING SYSTEM APPLICATIONS

- A. Insulation materials and thicknesses are specified in schedules at the end of this Section.
- B. Items Not Insulated: Unless otherwise indicated, do not apply insulation to the following systems, materials, and equipment:
 1. Flexible connectors.
 2. Vibration-control devices.
 3. Fire-suppression piping.
 4. Drainage piping located in crawl spaces, unless otherwise indicated.
 5. Below-grade piping, unless otherwise indicated.
 6. Chrome-plated pipes and fittings, unless potential for personnel injury.
 7. Air chambers, unions, strainers, check valves, plug valves, and flow regulators.

3.08 INSULATION APPLICATION SCHEDULE, GENERAL

- A. Refer to insulation application schedules for required insulation materials, vapor retarders, and field-applied jackets.
- B. Application schedules identify piping system and indicate pipe size ranges and material, thickness, and jacket requirements.

3.09 INTERIOR INSULATION APPLICATION SCHEDULE

- A. Service: Domestic hot, tempered and recirculated hot water.
 1. Operating Temperature: 60 to 165 degrees F.
 2. Insulation Material: Cellular glass fiber, with jacket.
 3. Insulation Thickness: Apply the following insulation thicknesses:
 - a. Copper Pipe, 1/2 in to 1 inch: 1 inch thick.
 - b. Copper Pipe, 1-1/4 inch and larger: 1-1/2 inches thick.
 4. Field-Applied Jacket: Foil and paper at mechanical rooms where piping is exposed.
 5. Vapor Retarder Required: Yes.
 6. Finish: None.
- B. Service: Condensate drain.
 1. Operating Temperature: 35 to 60 degrees F.
 2. Insulation Material: Closed-cell phenolic foam.
 3. Insulation Thickness: Apply the following insulation thicknesses:
 - a. Copper Pipe, 1/2 inch to 1 inch: 1/2 inch thick.
 - b. Copper Pipe, 1-1/4 inches and larger: 1/2 inch thick.
- C. Finish: None.

END OF SECTION

SECTION 221110
FACILITY NATURAL-GAS PIPING

PART 1 GENERAL

1.01 WORK INCLUDED

- A. FACILITY NATURAL-GAS PIPING consists of furnishing transportation, labor, materials and equipment to furnish and install the following:
1. Pipes, tubes, and fittings.
 2. Piping specialties.
 3. Piping and tubing joining materials.
 4. Valves.
 5. Pressure regulators.
 6. Mechanical sleeve seals.

1.02 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.03 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspace, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

1.04 PERFORMANCE REQUIREMENTS

- A. Minimum Operating-Pressure Ratings:
1. Piping and Valves: 100 psig minimum unless otherwise indicated.
 2. Service Regulators: 100 psig minimum unless otherwise indicated.
- B. Natural-Gas System Pressure within Buildings: Two pressure ranges. Primary pressure is more than 2 psig but not more than 5 psig, and is reduced to secondary pressure of 0.5 psig or less.
- C. Delegated Design: Design restraints and anchors for natural-gas piping and equipment, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

1.05 SUBMITTALS

- A. Product Data: For each type of the following:
1. Piping specialties.
 2. Corrugated, stainless-steel tubing with associated components.
 3. Valves. Include pressure rating, capacity, settings, and electrical connection data of selected models.
 4. Pressure regulators. Indicate pressure ratings and capacities.
 5. Dielectric fittings.
 6. Mechanical sleeve seals.

7. Escutcheons.

- B. Delegated-Design Submittal: For natural-gas piping and equipment 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 seismic restraints.
 - 2. Design Calculations: Calculate requirements for selecting seismic restraints.
- C. Qualification Data: For qualified professional engineer.
- D. Welding certificates.
- E. Field quality-control reports.
- F. Operation and Maintenance Data: For pressure regulators to include in emergency, operation, and maintenance manuals.

1.06 QUALITY ASSURANCE

- A. Steel Support Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.
- C. Codes and Standards:
 - 1. All governing codes, ordinances and agencies, in accordance with the provisions of Division 1 of these specifications.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Handling Flammable Liquids: Remove and dispose of liquids from existing natural-gas piping according to requirements of authorities having jurisdiction.
- B. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.
- C. Store and handle pipes and tubes having factory-applied protective coatings to avoid damaging coating, and protect from direct sunlight.
- D. Protect stored PE pipes and valves from direct sunlight.

1.08 COORDINATION

- A. Coordinate sizes and locations of concrete bases with actual equipment provided.
- B. Coordinate requirements for access panels and doors for valves installed concealed behind finished surfaces. Comply with requirements in Section "Access Doors and Frames."

PART 2 PRODUCTS

2.01 PIPES, TUBES, AND FITTINGS

- A. Steel Pipe: ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.
 - 1. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern.
 - 2. Wrought-Steel Welding Fittings: ASTM A 234/A 234M for butt welding and socket welding.
 - 3. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends.
 - 4. Forged-Steel Flanges and Flanged Fittings: ASME B16.5, minimum Class 150, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
 - a. Material Group: 1.1.
 - b. End Connections: Threaded or butt welding to match pipe.

- c. Lapped Face: Not permitted underground.
 - d. Gasket Materials: ASME B16.20, metallic, flat, asbestos free, aluminum o-rings, and spiral-wound metal gaskets.
 - e. Bolts and Nuts: ASME B18.2.1, carbon steel aboveground and stainless steel underground.
- 5. Protective Coating for Underground Piping: Factory-applied, three-layer coating of epoxy, adhesive, and PE.
 - a. Joint Cover Kits: Epoxy paint, adhesive, and heat-shrink PE sleeves.
- 6. Mechanical Couplings:
 - a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) Dresser Piping Specialties; Division of Dresser, Inc.
 - 2) Smith-Blair, Inc.
 - b. Steel flanges and tube with epoxy finish.
 - c. Buna-nitrile seals.
 - d. Steel bolts, washers, and nuts.
 - e. Coupling shall be capable of joining PE pipe to PE pipe, steel pipe to PE pipe, or steel pipe to steel pipe.
 - f. Steel body couplings installed underground on plastic pipe shall be factory equipped with anode.
- B. PE Pipe: ASTM D 2513, SDR 11.
 - 1. PE Fittings: ASTM D 2683, socket-fusion type or ASTM D 3261, butt-fusion type with dimensions matching PE pipe.
 - 2. PE Transition Fittings: Factory-fabricated fittings with PE pipe complying with ASTM D 2513, SDR 11; and steel pipe complying with ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.
 - 3. Anodeless Service-Line Risers: Factory fabricated and leak tested.
 - a. Underground Portion: PE pipe complying with ASTM D 2513, SDR 11 inlet.
 - b. Aboveground Portion: PE transition fitting.
 - c. Outlet shall be threaded or flanged or suitable for welded connection.
 - d. Tracer wire connection.
 - e. Ultraviolet shield.
 - f. Stake supports with factory finish to match steel pipe casing or carrier pipe.
 - 4. Transition Service-Line Risers: Factory fabricated and leak tested.
 - a. Underground Portion: PE pipe complying with ASTM D 2513, SDR 11 inlet connected to steel pipe complying with ASTM A 53/A 53M, Schedule 40, Type E or S, Grade B, with corrosion-protective coating for aboveground outlet.
 - b. Outlet shall be threaded or flanged or suitable for welded connection.
 - c. Bridging sleeve over mechanical coupling.
 - d. Factory-connected anode.
 - e. Tracer wire connection.
 - f. Ultraviolet shield.
 - g. Stake supports with factory finish to match steel pipe casing or carrier pipe.
 - 5. Plastic Mechanical Couplings, NPS 1-1/2 and Smaller: Capable of joining PE pipe to PE pipe.
 - a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) Lyall, R. W. & Company, Inc.
 - 2) Mueller Co.; Gas Products Div.
 - 3) Perfection Corporation; a subsidiary of American Meter Company.
 - b. PE body with molded-in, stainless-steel support ring.
 - c. Buna-nitrile seals.

- d. Acetal collets.
- e. Electro-zinc-plated steel stiffener.
- 6. Plastic Mechanical Couplings, NPS 2 and Larger: Capable of joining PE pipe to PE pipe, steel pipe to PE pipe, or steel pipe to steel pipe.
 - a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) Lyall, R. W. & Company, Inc.
 - 2) Mueller Co.; Gas Products Div.
 - 3) Perfection Corporation; a subsidiary of American Meter Company.
 - b. Fiber-reinforced plastic body.
 - c. PE body tube.
 - d. Buna-nitrile seals.
 - e. Acetal collets.
 - f. Stainless-steel bolts, nuts, and washers.
- 7. Steel Mechanical Couplings: Capable of joining plain-end PE pipe to PE pipe, steel pipe to PE pipe, or steel pipe to steel pipe.
 - a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) Dresser Piping Specialties; Division of Dresser, Inc.
 - 2) Smith-Blair, Inc.
 - b. Steel flanges and tube with epoxy finish.
 - c. Buna-nitrile seals.
 - d. Steel bolts, washers, and nuts.
 - e. Factory-installed anode for steel-body couplings installed underground.

2.2 PIPING SPECIALTIES

- A. Appliance Flexible Connectors:
 - 1. Indoor, Fixed-Appliance Flexible Connectors: Comply with ANSI Z21.24.
 - 2. Indoor, Movable-Appliance Flexible Connectors: Comply with ANSI Z21.69.
 - 3. Outdoor, Appliance Flexible Connectors: Comply with ANSI Z21.75.
 - 4. Corrugated stainless-steel tubing with polymer coating.
 - 5. Operating-Pressure Rating: 0.5 psig.
 - 6. End Fittings: Zinc-coated steel.
 - 7. Threaded Ends: Comply with ASME B1.20.1.
 - 8. Maximum Length: 36 inches.
- B. Quick-Disconnect Devices: Comply with ANSI Z21.41.
 - 1. Copper-alloy convenience outlet and matching plug connector.
 - 2. Nitrile seals.
 - 3. Hand operated with automatic shutoff when disconnected.
 - 4. For indoor or outdoor applications.
 - 5. Adjustable, retractable restraining cable.
- C. Y-Pattern Strainers:
 - 1. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.
 - 2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
 - 3. Strainer Screen: 60-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
 - 4. CWP Rating: 125 psig.

2.03 JOINING MATERIALS

- A. Joint Compound and Tape: Suitable for natural gas.
- B. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
- C. Brazing Filler Metals: Alloy with melting point greater than 1000 deg F complying with AWS A5.8/A5.8M. Brazing alloys containing more than 0.05 percent phosphorus are prohibited.

2.04 MANUAL GAS SHUTOFF VALVES

- A. General Requirements for Metallic Valves, NPS 2 and Smaller: Comply with ASME B16.33.
 - 1. CWP Rating: 125 psig.
 - 2. Threaded Ends: Comply with ASME B1.20.1.
 - 3. Dryseal Threads on Flare Ends: Comply with ASME B1.20.3.
 - 4. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction for valves 1 inch and smaller.
 - 5. Service Mark: Valves 1-1/4 inches to NPS 2 shall have initials "WOG" permanently marked on valve body.
- B. General Requirements for Metallic Valves, NPS 2-1/2 and Larger: Comply with ASME B16.38.
 - 1. CWP Rating: 125 psig.
 - 2. Flanged Ends: Comply with ASME B16.5 for steel flanges.
 - 3. Service Mark: Initials "WOG" shall be permanently marked on valve body.
- C. Bronze Plug Valves: MSS SP-78.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Mueller Co.; Gas Products Div.
 - b. McDonald, A. Y. Mfg. Co.
 - c. Southern Manufacturing Corp.
 - 2. Body: Bronze, complying with ASTM B 584.
 - 3. Plug: Bronze.
 - 4. Ends: Threaded, socket, or flanged.
 - 5. Operator: Square head or lug type with tamperproof feature where indicated.
 - 6. Pressure Class: 125 psig.
 - 7. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
 - 8. Service: Suitable for natural-gas service with "WOG" indicated on valve body.
- D. Cast-Iron, Nonlubricated Plug Valves: MSS SP-78.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. McDonald, A. Y. Mfg. Co.
 - b. Mueller Co.; Gas Products Div.
 - c. Southern Manufacturing Corp.
 - 2. Body: Cast iron, complying with ASTM A 126, Class B.
 - 3. Plug: Bronze or nickel-plated cast iron.
 - 4. Seat: Coated with thermoplastic.
 - 5. Stem Seal: Compatible with natural gas.
 - 6. Ends: Threaded or flanged.
 - 7. Operator: Square head or lug type with tamperproof feature where indicated.
 - 8. Pressure Class: 125 psig.
 - 9. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.

10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.
- E. Cast-Iron, Lubricated Plug Valves: MSS SP-78.
 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Southern Manufacturing Corp.
 - b. McDonald, A. Y. Mfg. Co.
 - c. Milliken Valve Company.
 - d. Mueller Co.; Gas Products Div.
 2. Body: Cast iron, complying with ASTM A 126, Class B.
 3. Plug: Bronze or nickel-plated cast iron.
 4. Seat: Coated with thermoplastic.
 5. Stem Seal: Compatible with natural gas.
 6. Ends: Threaded or flanged.
 7. Operator: Square head or lug type with tamperproof feature where indicated.
 8. Pressure Class: 125 psig.
 9. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
 10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.
- F. PE Ball Valves: Comply with ASME B16.40.
 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Kerotest Manufacturing Corp.
 - b. Lyall, R. W. & Company, Inc.
 - c. Perfection Corporation; a subsidiary of American Meter Company.
 2. Body: PE.
 3. Ball: PE.
 4. Stem: Acetal.
 5. Seats and Seals: Nitrile.
 6. Ends: Plain or fusible to match piping.
 7. CWP Rating: 80 psig.
 8. Operating Temperature: Minus 20 to plus 140 deg F.
 9. Operator: Nut or flat head for key operation.
 10. Include plastic valve extension.
 11. Include tamperproof locking feature for valves where indicated on Drawings.
- G. Valve Boxes:
 1. Cast-iron, two-section box.
 2. Top section with cover with "GAS" lettering.
 3. Bottom section with base to fit over valve and barrel a minimum of 5 inches in diameter.
 4. Adjustable cast-iron extensions of length required for depth of bury.
 5. Include tee-handle, steel operating wrench with socket end fitting valve nut or flat head, and with stem of length required to operate valve.

2.05 EARTHQUAKE VALVES

- A. Earthquake Valves: Comply with ASCE 25.
 1. Seismic Gas Shutoff Valve: The sensing means of the valve or system shall actuate the shutoff means of the valve or system within 5 seconds when subjected to a horizontal, sinusoidal oscillation having a peak acceleration of 0.3g and a period of 0.4 seconds. The valve shall be capable of being reset externally without valve removal. The earthquake valve shall meet or exceed California Standard No. 12-23-1, ANSI Z21.71 1981 and shall carry a lifetime warranty. Equivalent to Koso, Quakemaster or Safe-T-Quake.

2.06 PRESSURE REGULATORS

- A. Gas Pressure Regulating Valves: Service regulator internal relief valve type diaphragm assembly and vent valve. Provide a strainer ahead of all regulators. Characteristics as indicated on drawings.

2.07 DIELECTRIC FITTINGS

- A. Dielectric Unions:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Hart Industries International, Inc.
 - b. McDonald, A. Y. Mfg. Co.
 - c. Watts Regulator Co.; Division of Watts Water Technologies, Inc.
 - d. Wilkins; Zurn Plumbing Products Group.
 - 2. Minimum Operating-Pressure Rating: 150 psig.
 - 3. Combination fitting of copper alloy and ferrous materials.
 - 4. Insulating materials suitable for natural gas.
 - 5. Combination fitting of copper alloy and ferrous materials with threaded, brazed-joint, plain, or welded end connections that match piping system materials.
- B. Dielectric Flanges:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Watts Regulator Co.; Division of Watts Water Technologies, Inc.
 - b. Wilkins; Zurn Plumbing Products Group.
 - 2. Minimum Operating-Pressure Rating: 150 psig.
 - 3. Combination fitting of copper alloy and ferrous materials.
 - 4. Insulating materials suitable for natural gas.
 - 5. Combination fitting of copper alloy and ferrous materials with threaded, brazed-joint, plain, or welded end connections that match piping system materials.
- C. Dielectric-Flange Kits:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Advance Products & Systems, Inc.
 - b. Calpico Inc.
 - c. Pipeline Seal and Insulator, Inc.
 - 2. Minimum Operating-Pressure Rating: 150 psig.
 - 3. Companion-flange assembly for field assembly.
 - 4. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or PE bolt sleeves, phenolic washers, and steel backing washers.
 - 5. Insulating materials suitable for natural gas.
 - 6. Combination fitting of copper alloy and ferrous materials with threaded, brazed-joint, plain, or welded end connections that match piping system materials.

2.08 SLEEVES

- A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.
- B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

2.09 MECHANICAL SLEEVE SEALS

- A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Thunderline "Link Seal"
 - b. Calpico Inc.
 - c. Metraflex Company (The).
 - d. Pipeline Seal and Insulator, Inc.
 - 2. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe and sleeve.
 - 3. Pressure Plates: Stainless steel.
 - 4. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one nut and bolt for each sealing element.

2.10 ESCUTCHEONS

- A. General Requirements for Escutcheons: Manufactured wall and ceiling escutcheons and floor plates, with ID to fit around pipe or tube, and OD that completely covers opening.
- B. One-Piece, Deep-Pattern Escutcheons: Deep-drawn, box-shaped brass with polished chrome-plated finish.
- C. One-Piece, Cast-Brass Escutcheons: With set screw.
 - 1. Finish: Polished chrome-plated.
- D. Split-Casting, Cast-Brass Escutcheons: With concealed hinge and set screw.
 - 1. Finish: Polished chrome-plated.
- E. One-Piece, Floor-Plate Escutcheons: Cast-iron floor plate.
- F. Split-Casting, Floor-Plate Escutcheons: Cast brass with concealed hinge and set screw.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine roughing-in for natural-gas piping system to verify actual locations of piping connections before equipment installation.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Close equipment shutoff valves before turning off natural gas to premises or piping section.
- B. Inspect natural-gas piping according to NFPA 54 to determine that natural-gas utilization devices are turned off in piping section affected.
- C. Comply with NFPA 54 requirements for prevention of accidental ignition.

3.03 OUTDOOR PIPING INSTALLATION

- A. Comply with NFPA 54 for installation and purging of natural-gas piping.
- B. Install underground, natural-gas piping buried at least 18 inches below finished grade. Comply with requirements in Section "Earthwork" for excavating, trenching, and backfilling.
- C. Install underground, PE, natural-gas piping according to ASTM D 2774.
- D. Steel Piping with Protective Coating:

1. Apply joint cover kits to pipe after joining to cover, seal, and protect joints.
 2. Repair damage to PE coating on pipe as recommended in writing by protective coating manufacturer.
 3. Replace pipe having damaged PE coating with new pipe.
- E. Copper Tubing with Protective Coating:
1. Apply joint cover kits over tubing to cover, seal, and protect joints.
 2. Repair damage to PE coating on pipe as recommended in writing by protective coating manufacturer.
- F. Install fittings for changes in direction and branch connections.
- G. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
1. Install steel pipe for sleeves smaller than 6 inches in diameter.
 2. Install cast-iron "wall pipes" for sleeves 6 inches and larger in diameter.
- H. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- I. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- J. Install pressure gage upstream and downstream from each service regulator. Pressure gages are specified in Division 22 Section "Meters and Gages for Plumbing Piping."

3.04 INDOOR PIPING INSTALLATION

- A. Comply with NFPA 54 for installation and purging of natural-gas piping.
- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- C. Arrange for pipe spaces, chases, slots, sleeves, and openings in building structure during progress of construction, to allow for mechanical installations.
- D. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- E. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- F. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- G. Locate valves for easy access.
- H. Install natural-gas piping at uniform grade down toward drip and sediment traps.
- I. Install piping free of sags and bends.
- J. Install fittings for changes in direction and branch connections.
- K. Install escutcheons at penetrations of interior walls, ceilings, and floors.
1. New Piping:
 - a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
 - b. Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.

- c. Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type.
 - d. Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
 - e. Piping at Ceiling Penetrations in Finished Spaces: One-piece, stamped-steel type and set screw.
 - f. Piping in Unfinished Service Spaces: One-piece, cast-brass type with polished chrome-plated finish.
 - g. Piping in Equipment Rooms: One-piece, cast-brass type.
 - h. Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.
- L. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements in Section "Through-Penetration Firestop Systems."
- M. Verify final equipment locations for roughing-in.
- N. Comply with requirements in Sections specifying gas-fired appliances and equipment for roughing-in requirements.
- O. Drips and Sediment Traps: Install drips at points where condensate may collect, including service-meter outlets. Locate where accessible to permit cleaning and emptying. Do not install where condensate is subject to freezing.
- 1. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use nipple a minimum length of 3 pipe diameters, but not less than 3 inches long and same size as connected pipe. Install with space below bottom of drip to remove plug or cap.
- P. Extend relief vent connections for service regulators, line regulators, and overpressure protection devices to outdoors and terminate with weatherproof vent cap.
- Q. Conceal pipe installations in walls, pipe spaces, utility spaces, above ceilings, below grade or floors, and in floor channels unless indicated to be exposed to view.
- R. Concealed Location Installations:
- 1. Above Accessible Ceilings: Natural-gas piping, fittings, valves, and regulators may be installed in accessible spaces without containment conduit.
 - 2. In Floor Channels: Install natural-gas piping in floor channels. Channels must have cover and be open to space above cover for ventilation.
 - 3. In Walls or Partitions: Protect tubing installed inside partitions or hollow walls from physical damage using steel striker barriers at rigid supports.
 - a. Exception: Tubing passing through partitions or walls does not require striker barriers.
 - 4. Prohibited Locations:
 - a. Do not install natural-gas piping in or through circulating air ducts, clothes or trash chutes, chimneys or gas vents (flues), ventilating ducts, or dumbwaiter or elevator shafts.
 - b. Do not install natural-gas piping in solid walls or partitions.
- S. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.
- T. Connect branch piping from top or side of horizontal piping.
- U. Install unions in pipes NPS 2 and smaller, adjacent to each valve, at final connection to each piece of equipment. Unions are not required at flanged connections.
- V. Do not use natural-gas piping as grounding electrode.
- W. Install strainer on inlet of each line-pressure regulator and automatic or electrically operated valve.
- X. Install pressure gage upstream and downstream from each line regulator. Pressure gages are specified in Division 22 Section "Meters and Gages for Plumbing Piping."

3.05 WRAPPING FOR BURIED STEEL AND COPPER PIPING

- A. All buried steel pipe shall be factory coated with Plexco 20 mil high density polyethylene coating (yellow color). Finished coating shall have continuous imprinting of coating type and applicator and pipe type and manufacturer. All fittings and field joints of buried steel piping shall be cleaned, primed then fully protected by wrapping with two separate wrappings (each half lapped) of 0.010x2 in. wide pressure sensitive polyvinyl tape. All fitting and joint wrapping shall overlap pipe wrapping a minimum of 2 in.
- B. Affidavit: Deliver coated pipe to jobsite accompanied by applicator's affidavit certifying that wrapped pipe has been given high voltage holiday detector test and that pipe was free of holidays when pipe was shipped from applicator's yard. Submit one copy of every affidavit to Architect prior to installation.
- C. Field Joints: Test field applications for holidays by a high voltage holiday test method in Architect's presence.
- D. Damage: Handle wrapped piping with extreme care to avoid damage. Repair and retest marred or damaged pipe wrapping.
- E. Install cathodic protection for steel or ferrous piping per Corrosion Engineer's recommendations and/or applicator contractor familiar with cathodic protection having a minimum of 5 years experience in the fabrication and installation of cathodic protection.
- F. Backfill steel and copper piping with clean sand a minimum of 4 inches all around pipe and fittings.

3.06 VALVE INSTALLATION

- A. Install manual gas shutoff valve for each gas appliance ahead of corrugated stainless-steel tubing, aluminum, or copper connector.
- B. Install underground valves with valve boxes.
- C. Install regulators and overpressure protection devices with maintenance access space adequate for servicing and testing.
- D. Install earthquake valves aboveground outside buildings according to listing.
- E. Install anode for metallic valves in underground PE piping.

3.07 PIPING JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- C. Threaded Joints:
 - 1. Thread pipe with tapered pipe threads complying with ASME B1.20.1.
 - 2. Cut threads full and clean using sharp dies.
 - 3. Ream threaded pipe ends to remove burrs and restore full inside diameter of pipe.
 - 4. Apply appropriate tape or thread compound to external pipe threads unless dryseal threading is specified.
 - 5. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- D. Welded Joints:
 - 1. Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators.
 - 2. Bevel plain ends of steel pipe.
 - 3. Patch factory-applied protective coating as recommended by manufacturer at field welds and where damage to coating occurs during construction.

- E. Braze Joints: Construct joints according to AWS's "Braze Handbook," "Pipe and Tube" Chapter.
- F. Flanged Joints: Install gasket material, size, type, and thickness appropriate for natural-gas service. Install gasket concentrically positioned.
- G. Flared Joints: Cut tubing with roll cutting tool. Flare tube end with tool to result in flare dimensions complying with SAE J513. Tighten finger tight, then use wrench. Do not overtighten.
- H. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657.
 - 1. Plain-End Pipe and Fittings: Use butt fusion.
 - 2. Plain-End Pipe and Socket Fittings: Use socket fusion.

3.08 HANGER AND SUPPORT INSTALLATION

- A. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."
- B. Comply with requirements for pipe hangers and supports specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."

3.09 CONNECTIONS

- A. Connect to utility's gas main according to utility's procedures and requirements.
- B. Install natural-gas piping electrically continuous, and bonded to gas appliance equipment grounding conductor of the circuit powering the appliance according to NFPA 70.
- C. Install piping adjacent to appliances to allow service and maintenance of appliances.
- D. Connect piping to appliances using manual gas shutoff valves and unions. Install valve within 36 inches of each gas-fired appliance and equipment. Install union between valve and appliances or equipment.
- E. Sediment Traps: Install tee fitting with capped nipple in bottom to form drip, as close as practical to inlet of each appliance.

3.10 LABELING AND IDENTIFYING

- A. Comply with requirements in Division 22 for piping and valve identification.

3.11 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
 - 1. Test, inspect, and purge natural gas according to NFPA 54 and authorities having jurisdiction.
- C. Natural-gas piping will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

3.12 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain earthquake valves.

3.13 PIPING SCHEDULE

A. Gas Piping:

1. 3-1/2 in. and smaller above ground: Schedule 40 black steel pipe, ASTM A-135, A-795, with Class 150 WOG black banded malleable iron screwed fittings. Paint all exposed piping in accordance with Division 1.
2. 4 in. and larger above ground: Schedule 40 black steel pipe, ASTM A-135, A-795, with schedule 40 butt welded fittings. Paint all exposed piping in accordance with Division 01.
3. Below ground: Driscoplex PE2406 polyethylene piping systems with electric fusion socket fusion joints. Provide #12 electric tracer copper wire, spiral wrapped around pipe. Backfill with clean sand 4" around pipe. Installation shall be in accordance with manufacturer's direction and authorities having jurisdiction.
4. Underground steel piping inside to 5 feet outside of building shall be steel pipe and fittings as specified for above ground. Piping shall be wrapped and cathodically protected per Corrosion Engineer's directions.

END OF SECTION

**SECTION 221116
DOMESTIC WATER PIPING**

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. DOMESTIC WATER PIPING consists of furnishing transportation, labor, materials, and equipment to furnish and install domestic water piping inside the building to 5 feet outside the building.

1.02 RELATED SECTIONS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, and Division 1, apply to this Section.
- B. COMMON WORK RESULTS FOR PLUMBING - Section 220500
- C. METERS AND GAGES FOR PLUMBING PIPING - Section 220519
- D. PLUMBING SPECIALTIES - Section 221119

1.03 REFERENCES

- A. American Society of Mechanical Engineers (ASME)

1.04 SUBMITTALS

- A. Product Data: For pipe, tube, fittings, couplings and sterilization report.

1.05 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9," for potable domestic water piping and components.
- C. Codes and Standards:
 - 1. All governing codes, ordinances and agencies, in accordance with the provisions of Division 1 of these specifications
- D. Comply with the California Department of Health Services, Coachella Valley Water District requirements.

PART 2 - PRODUCTS

2.01 PIPING MATERIALS

- A. Materials when not otherwise definitely specified shall conform to the applicable standards.

2.02 DOMESTIC HOT and COLD WATER PIPE AND FITTINGS

- A. Above Ground: ASTM B 88, ANSI B16.22, Type L, hard drawn copper tube and wrought copper fittings with soldered joints.

- B. Below Ground: ASTM B88, ANSI B16.22, Type K hard drawn copper tube and wrought copper fittings with soldered joints.

2.03 MATERIALS FOR JOINTS, FITTINGS AND VALVES

- A. Solder and Flux:
 - 1. Equivalent to Harris "Bridget" lead-free solder alloy, ASTM B813 liquid and paste flux. 95-5 solders are not approved. Below ground piping shall have brazed joints with silver solder.

2.04 VALVES

- A. Bronze and cast-iron, general-duty valves are specified in GENERAL-DUTY VALVES Section.
- B. Balancing and drain valves are specified in PLUMBING SPECIALTIES Section

PART 3 - EXECUTION

3.01 EXCAVATION

- A. Excavating, trenching, and backfilling are specified in EARTHWORK and TRENCHING AND BACKFILLING Sections.

3.02 PIPE AND FITTING APPLICATIONS

- A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below, unless otherwise indicated.
- B. Flanges may be used on aboveground piping, unless otherwise indicated.
- C. Fitting Option: Extruded-tee connections and brazed joints may be used on aboveground copper tubing 2 in. and larger.
- D. Water-Service Piping on Service Side of Water Meter: Refer to WATER DISTRIBUTION Section.
- E. Under-Building-Slab, (allowed only at areas as indicated on Drawings), Domestic and Recycled Water, Trap primer, NPS 1 and Smaller: Hard copper tube, Type K.

3.03 VALVE APPLICATIONS

- A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements shall apply:
 - 1. Shutoff Duty: Use bronze ball or gate valves for piping NPS 2 and smaller. Use cast-iron butterfly or gate valves with flanged ends for piping NPS 2-1/2 and larger.
 - 2. Throttling Duty: Use bronze ball or globe valves for piping NPS 2 and smaller. Use cast-iron butterfly valves with flanged ends for piping NPS 2-1/2 and larger.
 - 3. Drain Duty: Hose-end drain valves.
- B. Install shutoff valve close to water main on each branch and riser serving plumbing fixtures or equipment, on each water supply to equipment, and on each water supply to plumbing fixtures that do not have supply stops. Use ball or gate valves for piping NPS 2 and smaller. Use butterfly or gate valves for piping NPS 2-1/2 and larger.

3.04 PIPING INSTALLATION

- A. Basic piping installation requirements are specified in COMMON WORK RESULTS FOR PLUMBING Section.
- B. Install under-building-slab copper tubing in conformance with to CDA's Copper Tube Handbook.
- C. Install cast-iron sleeve with water stop and mechanical sleeve seal at each service pipe penetration through foundation wall. Select number of interlocking rubber links required to make installation watertight. Sleeves and mechanical sleeve seals are specified in COMMON WORK RESULTS FOR PLUMBING Section.
- D. Install wall penetration system at each service pipe penetration through foundation wall. Make installation watertight. Wall penetration systems are specified in COMMON WORK RESULTS FOR PLUMBING Section.
- E. Install shutoff valve, inside the building at domestic water service entrance.
- F. Install domestic water piping level without pitch.
- G. Wrap underground copper pipe with a minimum of 8 mils of dielectric (nonconductive), continuous "holiday" free (no "open" joints or seams; no holes or tears) polyethylene sleeve. All seams and other openings must be sealed with polyethylene tape. Do not tape wrap buried copper piping. Backfill copper piping with clean sand a minimum of 4 inches all around pipe and fittings.

3.05 JOINT CONSTRUCTION

- A. Basic piping joint construction requirements are specified in COMMON WORK RESULTS FOR PLUMBING Section.
- B. Soldered Joints: Use ASTM B813, water-flushable, lead-free flux; ASTM B32, lead-free-alloy solder; and ASTM B828 procedure, unless otherwise indicated.
- C. Extruded-Tee Connections: Form tee in copper tube according to ASTM F2014. Use tool designed for copper tube; drill pilot hole, form collar for outlet, dimple tube to form seating stop, and braze branch tube into collar.
- D. Brazed Joints: Construct joints according to AWS "Brazing Handbook" Pipe and Tube chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.

3.06 HANGER AND SUPPORT INSTALLATION

- A. Seismic-restraint Devices: NOISE, VIBRATION AND SEISMIC CONTROLS OF PLUMBING PIPING AND EQUIPMENT Section.
- B. Pipe Hanger and Support Devices are specified in HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT Section. Install the following:
 - 1. Vertical Piping: MSS Type 8 or Type 42, clamps.
 - 2. Individual, Straight, Horizontal Piping Runs:
 - a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
 - b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
 - c. Longer Than 100 Feet: MSS Type 49, spring cushion rolls, if indicated.
 - 3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
 - 4. Base of Vertical Piping: MSS Type 52, spring hangers.
- C. Install supports in conformance with HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT Section.
- D. Support vertical piping and tubing at base and at each floor.
- E. Rod diameter may be reduced 1 size for double-rod hangers, to a minimum of 3/8 inch.

- F. Install hangers for copper tubing in compliance with the CPC.
- G. Install supports for vertical copper tubing in compliance with the CPC.

3.07 CONNECTIONS

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

3.08 FIELD QUALITY CONTROL

- A. Inspect domestic water piping as follows:
 - 1. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
 - 2. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:
 - a. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
 - b. Final Inspection: Arrange final inspection for authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
 - 3. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.
 - 4. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
- B. Test domestic and recycled water piping as follows:
 - 1. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
 - 2. Test for leaks and defects in piping. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
 - 3. Leave domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
 - 4. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
 - 5. Repair leaks and defects with new materials and retest piping or portion thereof until satisfactory results are obtained.
 - 6. Prepare reports for tests and required corrective action.
- C. domestic water systems shall undergo a complete thorough cross-connection test witnessed by local Water District and the Health Department prior to being placed into service.

3.09 ADJUSTING

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

3.10 CLEANING

- A. Clean and disinfect potable and non-potable domestic water piping as follows:
 - 1. Purge new piping and parts of existing domestic water piping that have been altered, extended, or repaired before using.
 - 2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction or, if methods are not prescribed, procedures described in either AWWA C651 or AWWA C652 or as described below:
 - a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
 - b. Fill and isolate system according to either of the following:
 - 1) Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours.
 - 2) Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for three hours.
 - c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
 - d. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.
- B. Prepare and submit reports of purging and disinfecting activities.
- C. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

END OF SECTION

**SECTION 221119
PLUMBING SPECIALTIES**

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. PLUMBING SPECIALTIES consists of furnishing transportation, labor, materials, and equipment to furnish and install the following plumbing specialties:
 - 1. Key-operation hydrants.
 - 2. Trap seal primer valves.
 - 3. Miscellaneous piping specialties.
 - 4. Access Panels.
 - 5. Flashing materials.
 - 6. Cleanouts.
 - 7. Drains.

1.02 RELATED WORK

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1, apply to this Section.
- B. METERS AND GAGES FOR PLUMBING SYSTEMS - Section 220519
- C. COMMON WORK RESULTS FOR PLUMBING

1.03 REFERENCES

- A. American Water Works Association (AWWA)
- B. American Society of Testing and Materials (ASTM)
- C. American Society of Sanitation Engineers (ASSE)
- D. American Society of Mechanical Engineering (ASME)

1.04 PERFORMANCE REQUIREMENTS

- A. Provide components and installation capable of producing piping systems with following minimum working-pressure ratings, unless otherwise indicated:
 - 1. Domestic Water Piping: 125 psig.
 - 2. Sanitary Waste and Vent Piping: 10-foot head of water.
 - 3. Storm Drainage Piping: 10-foot head of water.

1.05 QUALITY ASSURANCE

- A. Codes and Standards:
 - 1. All governing Codes, Ordinances and Agencies, in accordance with the provisions of Division 1 of these specifications.

1.06 SUBMITTALS

- A. Product Data:
 - 1. Water hammer arresters, air vents, and trap seal primer valves and systems.

2. Hose bibbs.
 3. Cleanouts, floor drains, open receptors and roof drains.
 4. Vent caps, vent terminals, and roof flashing assemblies.
 5. Sleeve penetration systems.
- B. Operation and Maintenance Data:
1. Trap seal primer valves and systems.
 2. Hose bibbs.

PART 2 - PRODUCTS

2.01 BACKFLOW PREVENTERS

- A. Hose-Connection Vacuum Breakers: ASSE 1011, nickel plated, with nonremovable and manual drain features, and ASME B1.20.7, garden-hose threads on outlet. Units attached to rough-bronze-finish hose connections may be rough bronze. Wilkins Model BFZP-8.

2.02 TRAP SEAL PRIMER VALVES

- A. TP-1: Piston Operated Trap Seal Primer Valves: ASSE 1018, pressure drop activated, with distribution unit as required.
1. Manufacturers:
 2. Precision Plumbing Products Model P-1 or P-2, or equal.
 3. Provide for drains and floor sinks where trap primer is not provided from a water closet and as indicated and specified, each including trap primer valve, standpipe, and distribution unit(s) required for the specified distribution. Provide each concealed assembly with access panel, 8 in. by 8 inch size when distribution units are not required and 12 inches by 12 inches size when one or two distribution units are required. Provide trap primer piping same as specified for domestic water, including pipe wrapping.

2.03 MISCELLANEOUS PLUMBING SPECIALTIES

- A. Hose Bibbs:
1. HB-1: Equivalent to Woodford B74, recessed wall hydrant with locking door, vacuum breaker and loose tee key.
 2. HB-2: Equivalent to Woodford 24P – 3/4, polished chrome-plated wall faucet with vacuum breaker and loose tee key.
- B. Access Panels:
1. Access Panels in Plaster Walls and Ceilings: Karp #DSC214PL, Elmdor PW, 24x24 in. with metal access door and frame, prime coated steel and painted to match adjacent surfaces. For fire rated areas use Karp #KRP-150 FR 1-1/2 hour "B" Label access panels, U.L. listed.
 2. Access Panels in Acoustic Tile Ceilings: Karp #DSC-210, Elmdor AT, 24x24 in. with metal access door and frame, 24x24 in. minimum size, prime coated steel, recessed to accept standard tile in full opening door.
 3. Access Panels in Ceramic Tile Walls: Karp #DSC214M, Smith 4730, chrome-plated cover and frame of suitable size for purpose intended, but not less than 8x8 in. size. For fire rated areas use Karp #FRP-150 FR 1-1/2 hour "B" Label access panels, U.L. listed.
- C. Roof Flashing Assemblies: Manufactured assembly made of 4 pounds per square foot, 0.0625-inch- thick, one piece lead flashing collar and skirt extending at least 6 inches from pipe with galvanized steel boot reinforcement, and counterflashing fitting.

1. Sanitary Vent Flashing: Semco 1100-3 or 1100-5, one-piece lead flashing and counter flashing sleeve.
2. Other Pipe Thru Flashing: Semco 1100-2 or 1100-4, one-piece, 4 lb. lead flashing and counter flashing sleeve.
3. Low-Silhouette Vent Cap: With vandal-proof vent cap.

2.04 SLEEVE PENETRATION SYSTEMS

- A. Fire-rated wall and floor penetrations shall be made with U. L. listed fire safing installed in conformance with manufacturers directions.
 1. Manufacturers:
 2. Hilti.
 - a. Pro-set.
 - b. Nelson.
- B. Description: UL 1479, through-penetration firestop assembly through fire rated walls and floors.
- C. Provide at concrete or masonry exterior bearing walls: Wall sleeves shall be flush with finished surface. Sleeves shall be sized to allow 1/2 in. clearance around pipe or insulation. Insulation and covering shall be continuous through sleeves.
 1. Manufacturers:
 2. Adjust-to-Crete
 - a. Paramount.
 - b. Sperzel Cretesleeve.
- D. At exterior walls below grade provide a modular mechanical seal consisting of inter-locking EPDM rubber links shaped to continuously fill the annular space between the pipe and the wall opening with a molded high density polyethylene sleeve water-stop ring, end caps and reinforcing ribs. ASTM B117, ISO 9002. Mechanical seals shall be "Thunderline" Link Seal.

2.05 CLEANOUTS

- A. For cast-iron soil pipe, iron body with extra heavy bronze plugs screwed into caulking ferrules; for steel pipe, extra heavy bronze plugs; and for vitrified clay pipe, vitrified clay plugs. Where cleanouts occur in finished interior walls, provide access panels, plates, and frames for flush mounting. Exposed parts of floor cleanouts shall have adjustable top. All cleanouts and cleanout plugs shall be accessible. Cleanout shall be the following:
 1. In finished floors: Cast-iron with polished nickel bronze round top, non-skid diamond tread set flush with the floor. Provide with carpet marker when located in future carpeted areas and flashing flange when used with waterproofing membrane.
 2. Smith - 4023
 - a. Wade - W-6000
 - b. Zurn - ZN-1420-2
 3. In mechanical equipment areas: Cast-iron with heavy cast-iron round top, non-skid diamond tread set flush with the floor. Provide flashing flange when used with waterproofing membrane.
 4. Smith - 4223
 - a. Wade - W-6000
 - b. Zurn - Z-1400
 5. In walls: Cleanout tee with squared polished nickel bronze access plate with vandal proof screws and frames. Opening 8 inches by 8 inches minimum.
 6. Smith - 4558-U
 - a. Wade - W-8460-S
 - b. Zurn - ZN-1447

7. In exterior grades: Cast-iron body, vandal proof cover, non-skid diamond tread, set flush with grade or finished surface. In non-surfaced area, they shall be cast in a concrete block 14 inches by 14 by 6 inches deep.
8. Smith – 4248
 - a. Wade - 6010-Z-75

2.06 ROOF DRAINS

A. Roof Drain (RD-1):

1. Cast-iron drain, 3 inch wide flange, adjustable extension sleeve, flashing collar, gravel stop cast-iron dome strainer, sump receiver and underdeck clamp.
 - a. Smith – 1010-YCU

B. Overflow Roof Drain (OD-1):

1. Cast-iron drain, 3 inch wide flange, extension sleeve, flashing collar, 2 inch high water dam, cast-iron dome strainer, sumo receiver and underdeck clamp.
 - a. Smith – 1080-YCU

C. Roof Receptor (RR-1):

1. 12 in. diameter cast-iron drain, 2 inch high solid water dam, 4 inch wide flange, cast-iron bottom dome strainer, sump receiver and underdeck clamp.
 - a. Smith – 3980-Y.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Refer to COMMON WORK RESULTS FOR PLUMBING Section 220500 for piping joining materials, joint construction, and basic installation requirements.
- B. Install backflow preventers in each water supply to mechanical equipment and systems and to other equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction.
 1. Locate backflow preventers as indicated on plans.
 2. Install drain for backflow preventers with fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe to receptor. Locate air-gap device attached to or under backflow preventer. Simple air breaks are not acceptable for this application.
 3. Do not install bypass piping around backflow preventers.
- C. Install pressure regulators with inlet and outlet shutoff valves and balance valve bypass. Install pressure gages on inlet and outlet.
- D. Install strainers on supply side of each pressure regulator, and solenoid valve.
- E. Install trap seal primer valves with outlet piping pitched down toward drain trap a minimum of 1 percent and connect to floor-drain body, trap, or inlet fitting. Adjust valve for proper flow.
- F. Install expansion joints on vertical risers, stacks, and conductors if indicated.

- G. Install cleanout deck plates with top flush with finished floor for floor cleanouts on piping below floors.
- H. Install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall, for cleanouts located in concealed piping.
- I. Install flashing flange and clamping device with each stack and cleanout passing through floors with waterproof membrane.
- J. Install vent flashing sleeves on stacks passing through roof. Secure over stack flashing according to manufacturer's written instructions.
- K. Install drains at low points of surface areas to be drained as indicated on the architectural drawings. Set grates of drains flush with finished floor, unless otherwise indicated.
- L. Install roof drains at low points of roof areas as indicated on the architectural Drawings.
- M. Fasten wall-hanging plumbing specialties securely to supports attached to building substrate if supports are specified and to building wall construction if no support is indicated.
- N. Fasten recessed-type plumbing specialties to reinforcement built into walls.
- O. Install blocking reinforcement for wall-mounting and recessed-type plumbing specialties.
- P. Install individual shutoff valve in each water supply to plumbing specialties. Use ball, gate, or globe valve if specific valve is not indicated. Install shutoff valves in accessible locations. See GENERAL-DUTY VALVES Section 220523 for general-duty ball, butterfly, check, gate, and globe valves.
- Q. Install escutcheons at wall, floor, and ceiling penetrations in exposed finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding pipe fittings.

3.02 CONNECTIONS

- A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to equipment to allow service and maintenance.
- C. Connect plumbing specialties to piping specified in other Division 22 Sections.
- D. Connect plumbing specialties and devices that require power conforming to Division 22 Sections.

3.03 PROTECTION

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

3.04 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Department maintenance personnel to adjust, operate, and maintain plumbing specialties.

END OF SECTION

**SECTION 22 13 16 –
SANITARY WASTE AND VENT PIPING**

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. SANITARY WASTE AND VENT PIPING consists of furnishing transportation, labor, materials, and equipment to furnish and install the following for soil, waste, and vent piping inside the building:
 - 1. Pipe and fittings.
 - 2. Special pipe fittings.
 - 3. Encasement for underground metal piping.

1.02 RELATED WORK

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1, apply to this Section.
- B. COMMON WORK RESULTS FOR PLUMBING - Section 220500

1.03 REFERENCES

- A. American Society for Testing and Materials (ASTM International)
- B. American Water Works Association (AWWA)
- C. Cast Iron Soil Pipe Institute (CISPI)
- D. Sheet Metal and Air Condition Contractor's National Association (SMACNA)

1.04 PERFORMANCE REQUIREMENTS

- A. Components and installation shall be capable of withstanding the following minimum working pressure, unless otherwise indicated:
 - 1. Soil, Waste, and Vent Piping: 10-foot head of water.
- B. Seismic Performance: Soil, waste, and vent piping and support and installation shall be in conformance with the SMACNA Guidelines.

1.05 SUBMITTALS

- A. Product Data: For pipe, tube, fittings, and couplings.

1.06 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B. Codes and Standards:
 - 1. All governing Codes, Ordinances and Agencies in accordance with the provisions of Division 1 of these specifications.

PART 2 - PRODUCTS

2.01 HUBLESS CAST-IRON SOIL PIPE AND FITTINGS

- A. Pipe and Fittings:
 - 1. Soil, waste, vent and storm drain piping to 5 feet outside building: Cast-iron soil pipe and fittings conforming to the requirements of CISPI Standard 301, ASTM A888 or ASTM A74 for all pipe and fittings. Pipe and fittings shall be marked with the collective trademark of the Cast Iron Soil Pipe Institute or receive prior approval of the Engineer. Wrap all underground piping per paragraph 3.3 G, 1 herein.
 - a. Manufacturers:
 - 1) Tyler Pipe
 - 2) A.B. & I.
 - 3) Charlotte Pipe and Foundry
- B. Shielded Couplings: ASTM C1277 assembly of metal shield or housing, corrosion-resistant fasteners, and rubber sleeve with integral, center pipe stop.
 - 1. Above Ground: Type 300 Series stainless steel, "No-Hub" standard duty, shielded couplings as approved by the Cast Iron Soil Pipe Institute, CISPI-310-85 with stainless steel corrugated shield, stainless steel bands and tightening devices and ASTM C564 rubber sleeve. Equivalent to Tyler.
 - 2. Below Ground: Type 304 stainless steel, "No-Hub" by the Cast Iron Soil Pipe Institute, CISPI-310-85 with stainless steel shield, stainless steel band and tightening devices and ASTM C564 rubber sleeve. Equivalent to Husky HD-2000.
 - a. Manufacturers:
 - 1) Clamp-All Corporation
 - 2) Husky Technologies.
 - 3) Tyler Pipe; Soil Pipe Division

PART 3 - EXECUTION

3.01 EXCAVATION

- A. Refer to EARTHWORK and TRENCHING AND BACKFILLING Sections for excavating, trenching, and backfilling.

3.02 PIPING APPLICATIONS

- A. Soil and waste piping shall be hubless cast-iron soil pipe and fittings; standard-duty shielded, stainless-steel couplings; and hubless-coupling joints.
- B. Vent piping shall be hubless cast-iron soil pipe and fittings; standard, shielded, stainless-steel couplings; and hubless-coupling joints.

3.03 PIPING INSTALLATION

- A. Sanitary sewer piping outside the building is specified in civil drawings.
- B. Basic piping installation requirements are specified in COMMON WORK RESULTS FOR PLUMBING Section 220500.
- C. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers.

- D. Install cast-iron sleeve with water stop and mechanical sleeve seal at each service pipe penetration through foundation wall. Select number of interlocking rubber links required to make installation watertight. Sleeves and mechanical sleeve seals are specified in PLUMBING SPECIALTIES Section 221119.
- E. Install wall-penetration fitting at each service pipe penetration through foundation wall. Make installation watertight.
- F. Install cast-iron soil piping in conformance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."
 - 1. Where soil is corrosive install 8 mil. Polyethylene encasement on underground piping in conformance with ASTM A674 or AWWA C105/ANSI A21.5. Backfill with clean sand a minimum of 4 inches all around pipe and fittings.
- G. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Use long-turn, double Y-branch and 1/8-bend fittings if 2 fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.
- H. Install soil and waste drainage piping at 2 percent minimum slope, unless otherwise indicated on Drawings:
- I. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

3.04 JOINT CONSTRUCTION

- A. Basic piping joint construction requirements are specified in COMMON WORK RESULTS FOR PLUMBING Section 220500.
- B. Join hubless cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-coupling joints.

3.05 HANGER AND SUPPORT INSTALLATION

- A. **Pipe hangers and supports are specified in HANGERS AND SUPPORTS FOR PLUMBING PIPING & EQUIPMENT Section 220529. Install the following:**
 - 1. Vertical Piping: MSS Type 8 or Type 42, clamps.
 - 2. Install individual, straight, horizontal piping runs in conformance with to the following:
 - a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
 - b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
 - c. Longer Than 100 Feet, if Indicated: MSS Type 49, spring cushion rolls.
 - 3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
 - 4. Base of Vertical Piping: MSS Type 52, spring hangers.
- B. Install supports according to Hangers and Supports Section.
- C. Support vertical piping and tubing at base and at each floor.
- D. Horizontal cast-iron no-hub piping: Provide hangers or supports at each side of a no-hub fitting.

Sanitary Waste and Vent Piping

- E. Install hangers for cast-iron soil piping with maximum horizontal spacing and minimum rod diameters in accordance with the requirements of the California Plumbing Code.

3.06 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.
- C. Connect drainage and vent piping to the following:
 - 1. Plumbing Fixtures: Connect drainage piping in sizes indicated, but not smaller than required by the CPC.
 - 2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by the CPC.
 - 3. Plumbing Specialties: Connect drainage and vent piping in sizes indicated, but not smaller than required by the CPC.

3.07 FIELD QUALITY CONTROL

- A. During installation, notify authorities having jurisdiction before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
 - 1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
 - 2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
- B. Re-inspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.
- C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
- D. Test sanitary drainage and vent piping according to procedures of the authorities having jurisdiction or, in absence of published procedures, in accordance with the requirements of the California Plumbing Code.

3.08 CLEANING

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

END OF SECTION

SECTION 221413
STORM DRAINAGE PIPING

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. STORM DRAINAGE PIPING consists of furnishing transportation, labor, materials, and equipment to furnish and install the following storm drainage piping inside the building:
 - 1. Pipe, tube, and fittings.
 - 2. Special pipe fittings.

1.02 RELATED WORK

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 apply to this Section.
- B. COMMON WORK RESULTS FOR PLUMBING - Section 220500

1.03 REFERENCES

- A. American Society for Testing and Materials (ASTM International)
- B. Cast Iron Soil Pipe Institute (CISPI)
- C. Sheet Metal and Air Conditioning Contractors National Association (SMACNA)
- D. American Water Works Association (AWWA)

1.04 PERFORMANCE REQUIREMENTS

- A. Components and installation shall be capable of withstanding the following minimum working-pressure, unless otherwise indicated:
 - 1. Storm Drainage Piping: 10-foot head of water.
- B. Seismic Performance: Piping and support and installation shall be in conformance with the SMACNA Guidelines.

1.05 SUBMITTALS

- A. Product Data: For pipe, tube, fittings, and couplings.

1.06 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B. Codes and Standards:
 - 1. All governing Codes, Ordinances and Agencies, in accordance with the provisions of Division 1 of these specifications.

PART 2 - PRODUCTS

2.01 HUBLESS CAST-IRON SOIL PIPE AND FITTINGS

- A. Pipe and Fittings:
 - 1. Soil, waste, vent and storm drain piping to 5 feet outside building: Cast-iron soil pipe and fittings conforming to the requirements of CISPI Standard 301, ASTM A888 or ASTM A74 for all pipe and fittings. Pipe and fittings shall be marked with the collective trademark of the Cast Iron Soil Pipe Institute or receive prior approval of the engineer. Wrap all underground piping as specified in this Section.
 - a. Manufacturers:
 - 1) Tyler Pipe
 - 2) A.B. & I.
 - 3) Charlotte Pipe and Foundry.
- B. Shielded Couplings: ASTM C1277 assembly of metal shield or housing, corrosion-resistant fasteners, and rubber sleeve with integral, center pipe stop.
 - 1. Above Ground: Type 300 Series stainless steel, "No-Hub" standard duty, shielded couplings as approved by the Cast Iron Soil Pipe Institute, CISPI-310-85 with stainless steel corrugated shield, stainless steel bands and tightening devices and ASTM C564 rubber sleeve. Equivalent to Tyler.
 - 2. Below Ground: Type 304 stainless steel, "No-Hub" by the Cast Iron Soil Pipe Institute, CISPI-310-85 with stainless steel shield, stainless steel band and tightening devices and ASTM C564 rubber sleeve. Equivalent to Husky HD-2000.
 - a. Manufacturers:
 - 1) Clamp-All Corporation
 - 2) Husky Technologies
 - 3) Tyler Pipe; Soil Pipe Division

PART 3 - EXECUTION

3.01 EXCAVATION

- A. Refer to EARTHWORK and TRENCHING AND BACKFILLING Sections for excavating, trenching, and backfilling.

3.02 PIPING APPLICATIONS

- A. Storm drainage piping inside building shall be hubless cast-iron soil pipe and fittings; standard-duty shielded, stainless-steel couplings; and hubless-coupling joints.

3.03 PIPING INSTALLATION

- A. Storm drainage piping outside the building downstream of point of connection (POC) are specified in civil drawings.
- B. Basic piping installation requirements are specified in COMMON WORK RESULTS FOR PLUMBING Section 220500.
- C. Install seismic restraints on piping. Seismic-restraint devices are specified in NOISE, VIBRATION AND SEISMIC CONTROLS OF PLUMBING PIPING AND EQUIPMENT Section 220548.
- D. Install cleanouts at grade and extend to where building storm drains connect to building storm sewers. Cleanouts are specified in PLUMBING SPECIALTIES Section 221119.
- E. Install cast-iron sleeve with water stop and mechanical sleeve seal at each service pipe penetration through foundation wall. Select number of interlocking rubber links required to make installation watertight. Sleeves and mechanical sleeve seals are specified in PLUMBING SPECIALTIES Section 221119.

- F. Install wall-penetration fitting system at each service pipe penetration through foundation wall. Make installation watertight.
- G. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."
 - 1. Where soil is corrosive install 8 mil. polyethylene encasement on underground piping in conformance with ASTM A674 or AWWA C105/ANSI A21.5. Backfill with clean sand a minimum of 4 inches all around pipe and fittings.
- H. Make changes in direction for storm piping using appropriate branches, bends, and long-sweep bends. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.
- I. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

3.04 JOINT CONSTRUCTION

- A. Basic piping joint construction requirements are specified in COMMON WORK RESULTS FOR PLUMBING Section 220500.
- B. Hubless Cast-Iron Soil Piping Coupled Joints: Join according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-coupling joints.

3.05 HANGER AND SUPPORT INSTALLATION

- A. Seismic-restraint devices are specified in NOISE, VIBRATION AND SEISMIC CONTROLS Section 220548.
- B. Pipe hangers and supports are specified in HANGERS AND SUPPORTS Section 220529. Install the following:
 - 1. Vertical Piping: MSS Type 8 or Type 42, clamps.
 - 2. Individual, Straight, Horizontal Piping Runs: According to the following:
 - a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
 - b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
 - c. Longer Than 100 Feet, if indicated: MSS Type 49, spring cushion rolls.
 - 3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
 - 4. Base of Vertical Piping: MSS Type 52, spring hangers.
- C. Install supports in conformance with HANGERS AND SUPPORTS Section 220529.
- D. Support vertical piping and tubing at base and at each floor.
- E. Horizontal cast-iron no-hub piping: Provide hangers or supports at each side of a no-hub fitting.
- F. Install hangers for cast-iron soil piping with maximum horizontal spacing and minimum rod diameter in accordance with the requirements of the California Plumbing Code.
- G. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.06 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect interior storm drainage piping to exterior storm drainage piping. Use transition fitting to join dissimilar piping materials.
- C. Connect storm drainage piping to roof drains and storm drainage specialties.

3.07 FIELD QUALITY CONTROL

- A. During installation, notify authorities having jurisdiction before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
 - 1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in.
 - 2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
- B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.
- C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
- D. Test storm drainage piping according to the procedures of authorities having jurisdiction or, in absence of published procedures, in accordance with the requirements of the California Plumbing Code.

3.08 CLEANING

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

END OF SECTION

**SECTION 223300 –
ELECTRIC WATER HEATERS**

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. This Section includes the following electric water heaters:
 - 1. Commercial, storage electric water heaters.
 - 2. Compression tanks.
 - 3. Water heater accessories.

1.03 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Commercial domestic-water heaters shall withstand the effects of earthquake motions determined according to SMACNA Guidelines.
 - 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".

1.04 SUBMITTALS

- A. Product Data: For each type and size of water heater indicated. Include rated capacities, operating characteristics, furnished specialties, and accessories.
- B. Operation and Maintenance Data: For electric water heaters to include in emergency, operation, and maintenance manuals.
- C. Warranty: Special warranty specified in this Section.

1.05 QUALITY ASSURANCE

- A. Source Limitations: Obtain same type of electric water heaters through one source from a single manufacturer.
- B. Product Options: Drawings indicate size, profiles, and dimensional requirements of electric water heaters and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- D. ASME Compliance: Where indicated, fabricate and label commercial water heater storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 01.
- E. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9," for all components that will be in contact with potable water.

- F. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1.

1.06 COORDINATION

- A. Coordinate size and location of concrete bases with Architectural and Structural Drawings.

1.07 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of electric 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 Period(s): From date of Substantial Completion:
 - a. Commercial Electric Water Heaters:
 - 1) Storage Tank: Three years.
 - 2) Controls and Other Components: Three years.
 - b. Compression Tanks: One year.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

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

2.02 COMMERCIAL ELECTRIC WATER HEATERS

- A. Commercial, Storage Electric Water Heaters: Comply with UL 1453 requirements for storage-tank-type water heaters.
1. Manufacturers:
 - a. Bradford White Corporation.
 - b. Lochinvar Corporation.
 - c. A.O. Smith.
 - d. EEMAX
 2. Storage-Tank Construction: Non-ASME-code, steel vertical arrangement, glass lined.
 - a. Tappings: Factory fabricated of materials compatible with tank and piping connections. Attach tappings to tank before testing.
 - 1) NPS 2 and Smaller: Threaded ends according to ASME B1.20.1.
 - 2) NPS 2-1/2 and Larger: Flanged ends according to ASME B16.5 for steel and stainless-steel flanges, and according to ASME B16.24 for copper and copper-alloy flanges.
 - b. Pressure Rating: 150 psig.
 3. Factory-Installed Storage-Tank Appurtenances:
 - a. Anode Rod: Extruded high density.
 - b. Drain Valve: Corrosion-resistant metal complying with ASSE 1005.
 - c. Insulation: Comply with ASHRAE/IESNA 90.1.
 - d. Jacket: Steel with enameled finish.
 - e. Heating Elements: Medium watt density with zinc-plated copper sheath.
 - f. Temperature Control: Adjustable thermostat.

- g. Safety Controls: High-temperature-limit and low-water cutoff devices or systems.
- h. Relief Valves: ASME rated and stamped and complying with ASME PTC 25.3, for combination temperature and pressure relief valves. Include one or more relief valves with total relieving capacity at least as great as heat input, and include pressure setting less than water heater working-pressure rating. Select one relief valve with sensing element that extends into storage tank.
- 4. Special Requirements: NSF 5 construction.
- 5. Capacity and Characteristics:
 - a. As indicated on Plumbing Drawing

2.03 INSTANTANEOUS ELECTRIC WATER HEATERS

- A. A. Instantaneous Electric Water Heaters: Comply with UL 499 for tankless electric (water heater) heating appliance.
 - 1. Available Manufacturers:
 - a. Chronomite Laboratories, Inc.
 - b. EEMAX, Inc.
 - c. Stiebel Eltron
 - 2. Construction: Copper piping or tubing complying with NSF 61 barrier materials for potable water, without storage capacity.
 - a. Pressure Rating: 150 psig (1035 kPa).
 - b. Heating Element: Resistance heating system.
 - c. Temperature Control: [Thermostat]
 - d. Safety Control: High-temperature-limit cutoff device or system.
 - e. Jacket: Aluminum or steel with enameled finish or plastic.
 - 3. Support: Bracket for wall mounting.

1.02 COMPRESSION TANKS

- A. Description: Steel pressure-rated tank constructed with welded joints and factory-installed butyl-rubber diaphragm. Include air precharge to minimum system-operating pressure at tank.
 - 1. Manufacturers:
 - a. AMTROL Inc.
 - b. Watts Regulator Co.
 - c. Wessels Co.
 - 2. Construction:
 - a. Tappings: Factory-fabricated steel, welded to tank before testing and labeling. Include ASME B1.20.1, pipe thread.
 - b. Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
 - c. Air-Charging Valve: Factory installed.
 - 3. Capacity and Characteristics:
 - a. Working-Pressure Rating: 150 psig.
 - b. Capacity Acceptable: 2 gal. minimum.
 - c. Air Precharge Pressure: 55 psig.

1.03 WATER HEATER ACCESSORIES

- A. Combination Temperature and Pressure Relief Valves: ASME rated and stamped and complying with ASME PTC 25.3. Include relieving capacity at least as great as heat input, and include pressure setting less than water heater working-pressure rating. Select relief valves with sensing element that extends into storage tank.
- B. Pressure Relief Valves: ASME rated and stamped and complying with ASME PTC 25.3. Include pressure setting less than water heater working-pressure rating.

- C. Water Heater Stands: Water heater manufacturer's factory-fabricated steel stand for floor mounting and capable of supporting water heater and water. Include dimension that will support bottom of water heater a minimum of 18 inches above the floor.
- D. Water Heater Restraint System: Heavy duty water heater seismic restraint system for wall mounting. Install per Manufacturer's direction and detail on plan.
- E. Drain Pans: Corrosion-resistant metal with raised edge. Include dimensions not less than base of water heater and include drain outlet not less than NPS 3/4.

1.04 SOURCE QUALITY CONTROL

- A. Test and inspect water heater storage tanks, specified to be ASME-code construction, according to ASME Boiler and Pressure Vessel Code.
- B. Hydrostatically test water heater storage tanks before shipment to minimum of one and one-half times pressure rating.
- C. Prepare test reports.

PART 2 - EXECUTION

2.01 WATER HEATER INSTALLATION

- A. Install commercial water heaters on concrete bases.
 - 1. Exception: Omit concrete bases for commercial water heaters if installation on stand, bracket, suspended platform, or direct on floor is indicated.
 - 2. Concrete base construction requirements are specified in Division 22 Section "Common Work Results for Plumbing."
- B. Install water heaters level and plumb, according to layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.
- C. Install seismic restraints for commercial water heaters. Anchor to substrate.
- D. Install combination temperature and pressure relief valves in top portion of storage tanks. Use relief valves with sensing elements that extend into tanks. Extend commercial-water-heater relief-valve outlet, with drain piping same as domestic water piping in continuous downward pitch, and discharge by positive air gap above floor sink.
- E. Install water-heater drain piping as indirect waste to spill by positive air gap over floor sinks. Install hose-end drain valves at low points in water piping for water heaters that do not have tank drains. Refer to Division 22 Section "Plumbing Specialties" for hose-end drain valves.
- F. Install thermometer on outlet piping of water heaters. Refer to Division 22 Section "Meters and Gages for Plumbing Piping" for thermometers.
- G. Fill water heaters with water.
- H. Charge compression tanks with air.

2.02 CONNECTIONS

- A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to water heaters to allow service and maintenance. Arrange piping for easy removal of water heaters.
- C. Ground equipment and connect wiring according to Division 26 Section "General Electrical Specification."

2.03 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.
- B. Perform the following field tests and inspections and prepare test reports:
 - 1. Leak Test: After installation, test for leaks. Repair leaks and retest until no leaks exist.
 - 2. Operational Test: After electrical circuitry has been energized, confirm proper operation.
 - 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Remove and replace water heaters that do not pass tests and inspections and retest as specified above.

2.04 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain commercial and instantaneous electric water heaters. Refer to Division 01 Section "Closeout Procedures, Demonstration and Training."

END OF SECTION

SECTION 22 41 00
PLUMBING FIXTURES

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. Plumbing fixtures consists of furnishing transportation, labor, materials, and equipment to furnish and install the following plumbing fixtures and related components:
 - 1. Faucets
 - 2. Flushometers
 - 3. Protective shielding guards
 - 4. Service sinks
- B. Accessible Fixtures:
 - 1. Accessible plumbing fixtures shall comply with all of the requirements of CBC Section 1115B.
 - 2. Heights and location of all fixtures shall comply with 2022 CBC and DSA Check List Figure 15-A.
 - 3. Fixture controls shall comply with CBC Sections 1115B.4.3, Item 1 for lavatories; Section 1115B.4.1, Item 5 toilets; and Section 1115B.4.2, Item 2 for urinals.
 - 4. Each accessible sink shall be a maximum of 6-1/2" deep. Sinks shall be mounted with the counter or rim no higher than 34" above the finish floor. CBC Section 1117B.9, Item 2

1.02 RELATED DOCUMENTS

- A. COMMON WORK RESULTS FOR PLUMBINGSection 220500
- B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 specification sections, apply to this section.

1.03 DEFINITIONS

- A. Accessible Fixture: Plumbing fixture that can be approached, entered, and used by people with disabilities.
- B. Fitting: Device that controls the flow of water into or out of the plumbing fixture. Fittings specified in this Section include supplies and stops, faucets and spouts, shower heads and tub spouts, drains and tailpieces, and traps and waste pipes. Piping and general-duty valves are included where indicated.
- C. FRP: Fiberglass-reinforced plastic.
- D. Solid Surface: Nonporous, homogeneous, cast-polymer-plastic material with heat-, impact-, scratch-, and stain-resistance qualities.

1.04 SUBMITTALS

- A. Manufacturer's Literature: Submit brochures on all materials and equipment to the Engineer.
- B. Other Submittals:
 - 1. Shop Drawings.

2. Sterilization Test Report.
3. Test Data.
4. Operations and Maintenance Manuals.
5. Record Drawings.

1.05 QUALITY ASSURANCE

- A. Source Limitations: Obtain plumbing fixtures, faucets, and other components of each category through one source from a single manufacturer.
 1. Exception: If fixtures, faucets, or other components are not available from a single manufacturer, obtain similar products from other manufacturers specified for that category.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Flush Valves: As specified; refer to plumbing fixture schedule.
- B. Plumbing Fixtures: As specified; refer to plumbing fixture schedule.
- C. Faucets: As specified; refer to plumbing fixture schedule.

2.02 PLUMBING FIXTURES AND TRIMS

- A. Flush Valve: Sloan Royal 111-1.28 flush valve 1.28 GPF.
 1. Do not interfere flush valve with handle bar, see Architectural drawings.
 2. Flush valve handle shall be on the wide side of stall.
 3. Faucet: Chicago 3400-TABCP with 0.5 GPM flow, manual metering faucet with E39VPJKABCP flow restrictor. Grid drain with chrome-plated tailpiece. Grid drain with chrome-plated tailpiece. Angle Stops and Supplies: Equivalent to McGuire LFH "lead-free" Series with solid flexible tube rises. Trap: Chrome-plated 17 gauge tubular brass "P" trap.
- B. Service Sink (SS-1): Floor-mounted.
 1. Cast-iron acid-resisting enameled 28x28 in. with rim guard.
 2. American Standard 7741.000 "Florwell"
 3. Faucet: Chrome-plated, wall-mounted fitting with hose end, vacuum breaker, wall brace, bucket hook, integral stops, 2.5 GPM flow. Chicago Faucet 897-CP.
- C. Sink (S-1): Single-compartment, A.D.A. Stainless steel, 22 x 19 x 6-1/2 in. deep, three hole punched, 18 gauge, self-rimming, undercoated for sound deadening, center rear drain.
 1. Elkay LRAD-2219
 2. Chicago Faucet 201-AGN8AE35VPABCP
 3. Angle Stops and Supplies: Equivalent to McGuire LFH Series with solid flexible tube rises, lead-free.
 4. Trap: 17 gauge chrome-plated tubular brass "P" trap.
- D. Lab Sink (LS-1): Student, non-ADA with DT-1; refer to plumbing fixture schedule.
- E. Lab Sink (LS-2): Student, ADA with DT-1; refer to plumbing fixture schedule.
- F. Lab Sink (LS-3): Teacher, ADA with DT-1; refer to plumbing fixture schedule.

- G. Lab Sink (LS-4): Prep area; refer to plumbing fixture schedule.
- H. Dilution Trap (DT-1): Refer to plumbing fixture schedule.
- I. Emergency Eyewash / Shower (EWS-1): Refer to plumbing fixture schedule.

PART 3 - EXECUTION

3.01 EXAMINATION

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

3.02 INSTALLATION

- A. Assemble plumbing fixtures, trim, fittings, and other components according to manufacturers' written instructions.
- B. Install off-floor supports, affixed to building substrate, for wall-mounting fixtures.
 - 1. Use carrier supports with waste fitting and seal for back-outlet fixtures.
 - 2. Use carrier supports without waste fitting for fixtures with tubular waste piping.
- C. Install back-outlet, wall-mounting fixtures onto waste fitting seals and attach to supports.
- D. Install floor-mounting fixtures on closet flanges or other attachments to piping or building substrate.
- E. Install wall-mounting fixtures with tubular waste piping attached to supports.
- F. Install counter-mounting fixtures in and attached to casework.
- G. Install fixtures level and plumb according to roughing-in drawings.
- H. Install water-supply piping with stop on each supply to each fixture to be connected to water distribution piping. Attach supplies to supports or substrate within pipe spaces behind fixtures. Install stops in locations where they can be easily reached for operation.
- I. Install trap and tubular waste piping on drain outlet of each fixture to be directly connected to sanitary drainage system.
- J. Install tubular waste piping on drain outlet of each fixture to be indirectly connected to drainage system.
- K. Install flushometer valves for accessible water closets and urinals with handle mounted on wide side of compartment. Install other actuators in locations that are easy for people with disabilities to reach.
- L. Install toilet seats on water closets.

- M. Install faucet-spout fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.
- N. Install water-supply flow-control fittings with specified flow rates in fixture supplies at stop valves.
- O. Install faucet flow-control fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.
- P. Install traps on fixture outlets.
 - 1. Exception: Omit trap on fixtures with integral traps.
- Q. Install disposer in outlet of each sink indicated to have disposer. Install switch where indicated or in wall adjacent to sink if location is not indicated.
- R. Install escutcheons at piping wall ceiling penetrations in exposed, finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding fittings.
- S. Seal joints between fixtures and walls, floors, and countertops using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color.

3.03 CONNECTIONS

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

3.04 FIELD QUALITY CONTROL

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

3.05 ADJUSTING

- A. Operate and adjust faucets and controls. Replace damaged and malfunctioning fixtures, fittings, and controls.
- B. Operate and adjust disposers. Replace damaged and malfunctioning units.
- C. Adjust water pressure at faucets and flushometer valves to produce proper flow and stream.

- D. Replace washers and seals of leaking and dripping faucets and stops.
- E. Install fresh batteries in sensor-operated mechanisms.

3.06 CLEANING

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

3.07 PROTECTION

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

END OF DOCUMENT

SECTION 230000
GENERAL MECHANICAL REQUIREMENTS

PART 1 GENERAL

1.01 SCOPE

- A. Basic mechanical requirements specifically applicable to Division 23.
- B. Work includes but is not necessarily limited to the following:
 - 1. Labor, materials, services, equipment, and appliances required for completion of tasks as indicated on drawing or in specification or as inherently necessary to prepare spaces and systems for new installations as follows:
 - 2. Heating, ventilating and air conditioning systems and equipment
 - 3. Testing, adjusting and balancing

1.02 DRAWINGS AND SPECIFICATIONS

- A. Drawings accompanying these Specifications show intent of Work to be done. Specifications shall identify quality and grade of installation and where equipment and hardware is not particularly specified, Contractor shall provide submittals for all products and install them per manufacturers' recommendations, and in a first class manner.
- B. Examine Drawings and Specifications for elements in connection with this Work; determine existing and new general construction conditions and be familiar with all limitations caused by such conditions.
- C. Plans are intended to show general arrangement and extent of Work contemplated. Exact location and arrangement of parts shall be determined after the Owner has reviewed equipment, as Work progresses, to conform in best possible manner with surroundings, and as directed by the Owner's Representative.
- D. Contract Documents are in part diagrammatic and intended to show the scope and general arrangement of the Work under this Contract. The Contractor shall follow these drawings in laying out the equipment, piping and ductwork. Drawings are not intended to be scaled for roughing in measurements or to serve as shop drawings. Where job conditions require minor changes or adjustments in the indicated locations or arrangement of the Work, such changes shall be made without change in the Contract amount.
- E. Follow dimensions without regard to scale. Where no figures or notations are given, the Plans shall be followed.

1.03 UTILITIES

- A. Location and sizes of electrical, mechanical and plumbing service facilities are shown in accordance with data secured from existing record drawings and site observations. Data shown are offered as an estimating guide without guarantee of accuracy. Check and verify all data given and verify exact location of all utility services pertaining to Work prior to excavation or performing Work.

1.04 APPLICABLE REFERENCE STANDARDS, CODES AND REGULATIONS

- A. Meet requirements of all state codes having jurisdiction.
- B. State of California Code of Regulations:
 - 1. Title 8, Industrial Relations
 - 2. Title 19, State Fire Marshal Regulations
 - 3. 2022 California Building Code (CBC), Title 24, Part 2

4. 2022 California Electrical Code, Title 24, Part 3
 5. 2022 California Mechanical Code, Title 24, Part 4
 6. 2022 California Plumbing Code, Title 24, Part 5
 7. 2022 California Energy Code, Title 24, Part 6
 8. 2022 California Fire Code, Title 24, Part 9
 9. 2022 California Standards Code, Title 24, Part 12
- C. Additional Referenced Standards:
1. AABC Associated Air Balance Council
 2. AMCA Air Moving and Conditioning Association
 3. ARI Air-Conditioning and Refrigeration Institute
 4. ASHRAE American Society of Heating, Refrigeration and Air Conditioning Engineers
 5. ASME American Society of Mechanical Engineers
 6. ASTM American Society for Testing and Materials
 7. NEMA National Electrical Manufacturer's Association
 8. NFPA National Fire Protection Association Standards
 9. PDI Plumbing and Drainage Institute
 10. UL Underwriters Laboratories
- D. Codes and ordinances having jurisdiction over Work are minimum requirements; but, if Contract Documents indicate requirements, which are in excess of those minimum requirements, then requirements of the Contract Documents shall be followed. Should there be any conflicts between Contract Documents or codes or any ordinances having jurisdiction, report these to the Owner's Representative.
- E. Obtain permits and request inspections from authority having jurisdiction.

1.05 PROJECT AND SITE CONDITIONS

- A. The arrangement of and connection to equipment shown on the Drawings is based upon information available and is not intended to show exact dimensions peculiar to a specific manufacturer. The Drawings are, in part, diagrammatic and some features of the illustrated equipment installations may require revision to meet actual equipment installation requirements. Structural supports, housekeeping pads, piping connections and adjacent equipment may have to be altered to accommodate the equipment provided. No additional payment will be made for such revisions or alterations.
- B. Examine all Drawings and Specifications to be fully cognizant of all work required under this Division.
1. Examine site related work and surfaces before starting work of any Section.
 2. Install Work in locations shown on approved Drawings, unless prevented by Project conditions.
 3. Prepare shop drawings showing proposed rearrangement of Work to meet Project conditions, including changes to Work specified in other Sections. Obtain permission from the Owner's Representative before proceeding.

1.06 COOPERATION WITH WORK UNDER OTHER DIVISIONS

- A. Cooperate with other trades to facilitate general progress of Work. Allow all other trades every reasonable opportunity for installation of their work.
- B. Work under this Division shall follow general building construction closely. Set pipe sleeves and inserts and verify that openings for chases and pipes are provided.
- C. Work with other trades in determining exact location of outlets, pipes, and pieces of equipment to avoid interference with lines required to maintain proper installation of Work.

- D. Make such progress in the Work to not delay work of other trades.
- E. Mechanical Work shall have precedence over the other in the following sequence:
 - 1. Soil and waste piping
 - 2. Ductwork
 - 3. Domestic water piping
 - 4. Fire sprinkler piping

1.07 DISCREPANCIES

- A. The Contractor shall check all Drawings furnished him immediately upon their receipt and shall promptly notify the Owner's Representative of any discrepancies. Figures marked on Drawings shall in general be followed in preference to scale measurements. Piping and instrumentation diagrams shall in general govern floor plans and sections. Large-scale drawings shall in general govern small-scale drawings.
- B. Where requirements between Drawings and Specifications conflict, the more restrictive provisions shall apply.
- C. If any part of the Specifications or Drawings appears unclear or contradictory, apply to Owner's Representative for interpretation and decision as early as possible, including during bidding period. Do not proceed with such work without Owner Representatives decision. Beginning work of any Section constitutes acceptance of conditions.

1.08 CHANGES

- A. The Contractor shall be responsible to make and obtain approval from the Owner's Representative for all necessary adjustments in piping and equipment layouts as required to accommodate the relocations of equipment and/or devices, which are affected by any approved authorized changes or Product substitutions per Specification 01 25 00. All changes shall be clearly indicated in the "Record" drawings.

1.09 SUBMITTALS

- A. The manufacturer, contractor or supplier shall include a written statement that the submitted equipment, hardware or accessory complies with the requirement of that particular specification section.
- B. The manufacturer shall resubmit the specification section showing compliance with each respective paragraphs and specified items and features in that particular specification section.
- C. All exceptions shall be clearly identified by referencing respective paragraph and other requirements along with proposed alternative.
- D. Note that prior to acceptance of submittals for review, a submittal schedule shall be submitted to the Owner's Representative.
- E. Submit all Division 23 shop drawings and product data grouped and referenced by the specification technical section number in one complete submittal package.
- F. Shop Drawings:
 - 1. Include installation details of equipment indicating proposed location, layout and arrangement, accessories, piping, and other items that must be shown to assure a coordinated installation.
 - 2. Indicate adequate clearance for operation, maintenance, and replacement of operating equipment devices.
 - 3. If equipment is rejected, revise drawings to show acceptable equipment and resubmit.
 - 4. Whenever more than one (1) manufacturer's product is specified, the first named product is the basis of design used in the Drawings and the use of alternate-named manufacturer's products or substitutes may require modifications to the design.

5. The Contractor shall be responsible for all equipment ordered and/or installed prior to receipt of shop drawings returned from the Owner's Representative bearing the Owner's Representative stamp of "Reviewed". All corrections or modifications to the equipment as noted on the shop drawings shall be performed and equipment removed from the job site at the request of the Owner's Representative without additional compensation.
6. Manufacturer's Data: For each manufactured item, provide current manufacturer's descriptive literature of cataloged products, certified equipment drawings, diagrams, performance and characteristic curves if applicable, and catalog cuts.
7. Standard Compliance: When materials or equipment provided by the Contractor must conform to the standards of organizations such as American National Standards Institute (ANSI) or American Water Works Association (AWWA), submit proof of such conformance to the Owner Representative for approval. If an organization uses a label or listing to indicate compliance with a particular standard, the label or listing will be acceptable evidence, unless otherwise specified. In lieu of the label or listing, submit a certificate from an independent testing organization, which is competent to perform acceptance testing and is approved by the Owner Representative. The certificate shall state that the item has been tested in accordance with the specified organization's test methods and that the item conforms to the specified organization's standard.
8. Certified Test Reports: Before delivery of materials and equipment, certified copies of all test reports specified in individual sections shall be submitted for approval.
9. Certificates of Compliance or Conformance: Submit manufacturer's certifications as required on products, materials, finish, and equipment indicated in the technical sections. Certifications shall be documents prepared specifically for this Contract. Pre-printed certifications and copies of previously submitted documents will not be acceptable. The manufacturer's certifications shall name the appropriate products, equipment, or materials and the publication specified as controlling the quality of that item. Certification shall not contain statements to imply that the item does not meet requirements specified, such as "as good as"; or "achieve the same end use and results as materials formulated in accordance with the referenced publications"; or "equal or exceed the service and performance of the specified material." Certifications shall simply state that the item conforms to the requirements specified. Certificates shall be printed on the manufacturer's letterhead and shall be signed by the manufacturer's official authorized to sign certificates of compliance or conformance.

1.10 PROJECT RECORD DOCUMENTS

- A. All changes, deviations and information recorded on the "Project Record Drawings" set during Construction shall be redrafted onto the latest version of AutoCAD or Revit, where applicable.
- B. Submit completed shop drawings to the Owner prior to completion in AutoCAD format.
- C. Contractor hand marked or drafted redlined "Project Record Drawings" will not be accepted.

1.11 OPERATING INSTRUCTIONS

- A. Furnish approved operating instructions for systems and equipment indicated in the technical sections for use by operation and maintenance personnel.

1.12 MANUFACTURER'S RECOMMENDATIONS

- A. Where installation procedures or any part thereof are required to be in accordance with manufacturer's recommendations, furnish printed copies of the recommendations prior to installation. Installation of the item shall not proceed until recommendations are received. Failure to furnish recommendations shall be cause for rejection of the equipment or material.

1.13 DELIVERY AND STORAGE

- A. Handle, store, and protect equipment and materials in accordance with the manufacturer's recommendations and with the requirements of NFPA 70B P, Appendix I, titled "Equipment Storage and Maintenance During Construction." Replace damaged or defective items with new items.

1.14 GUARANTEE

- A. Except as may be specified under other sections in the Specifications, guarantee all equipment furnished under the Specifications for a period of one year from date of project acceptance against defective workmanship and material and improper installation. Upon notification of failure, correct deficiency immediately and without cost to the Owner.
- B. Standard warranty of manufacturer shall apply for replacement of parts after expiration of the above period. Manufacturer shall furnish replacement parts to the Owner for their service agency as directed.

1.15 COMMISSIONING

- A. Division 23 will be responsible to carry out the commissioning requirements.
- B. Management:
 - 1. The Commissioning Agent (CA) is hired directly by the Owner.
 - 2. The CA directs and coordinates the commissioning activities and reports to the Owner's Representative.
 - 3. All members work together to fulfill their contracted responsibilities and meet the objectives of the Contract Documents.
 - 4. All contractors shall include the cost of commissioning in the contract price. The contractors should be prepared to provide commissioning assistance and follow through until all the commissioned systems have been signed off by the commissioning provider and the Owner Representative.
 - 5. In each purchase order or subcontract written, include requirements for submittal data, commissioning documentation, O&M data and training.
- C. Commissioning requires the participation of Division 23 Mechanical Contractor to work to ensure that all systems are operating in a manner consistent with the Design Intent.
- D. The mechanical contractor is responsible for assisting the commissioning agent throughout the entire commissioning process. The work is not complete until the commissioning agent and the Owner Representative has signed off on the commissioned systems.

1.16 COMMISSIONING RESPONSIBILITIES

- A. Mechanical Contractor: The commissioning responsibilities applicable to the mechanical contractor are as follows (all references apply to commissioned equipment only):
 - 1. All contractors shall include the cost of commissioning in the contract price. The contractors should be prepared to provide commissioning assistance and follow through until all the commissioned systems have been signed off by the commissioning provider and the Owner Representative.
 - 2. In each purchase order or subcontract written, include requirements for submittal data, commissioning documentation, O&M data and training.
 - 3. General Contractor shall attend a commissioning kickoff meeting and other meetings necessary to facilitate the commissioning process.
 - 4. General Contractor shall provide the Commissioning Provider with normal cut sheets and shop drawing submittals of commissioned equipment.
 - 5. General Contractor shall provide additional requested documentation, prior to normal O&M manual submittals, to the Commissioning Provider for development of start-up and functional testing procedures.

- a. Typically, this will include detailed manufacturer installation and start-up, operating, troubleshooting and maintenance procedures. In addition, the installation, start-up and checkout materials that are actually shipped inside the equipment and the actual field checkout sheet forms to be used by the factory or field technicians shall be submitted to the Commissioning Provider.
 - b. The Commissioning Provider may request further documentation necessary for the commissioning process.
 6. General Contractor shall provide a copy of the O&M manuals and submittals of commissioned equipment, through normal channels, to the Commissioning Provider for review.
 7. Sub-Contractors and design engineers shall assist in clarifying the operation and control of commissioned equipment in areas where the specifications, control drawings or equipment documentation is not sufficient for writing detailed testing procedures.
 8. General Contractor shall provide limited assistance to the Commissioning Provider in preparing the specific functional performance test procedures. Sub-Contractors shall review test procedures to ensure feasibility, safety and equipment protection and provide necessary written alarm limits to be used during the tests.
 9. General Contractor shall develop a full start-up and initial checkout plan using manufacturer's start-up procedures and the pre-functional checklists from the Commissioning Provider for all commissioned equipment. Submit to Commissioning Provider for review prior to startup.
 10. During the startup and initial checkout process, execute the mechanical related portions of the pre-functional checklists for all commissioned equipment.
 11. Perform and clearly document all completed startup and system operational checkout procedures, providing a copy to the Commissioning Provider.
 12. Address current Engineer of Record punch list items before functional testing. Air and water TAB shall be completed with discrepancies and problems remedied before functional testing of the respective air- or water-related systems.
 13. Provide skilled technicians to execute starting of equipment and to execute the functional performance tests. Ensure that they are available and present during the agreed upon schedules and for sufficient duration to complete the necessary tests, adjustments and problem solving.
 14. Provide skilled technicians to perform functional performance testing under the direction of the Commissioning Provider. Assist the Commissioning Provider in interpreting the monitoring data, as necessary.
 15. Correct deficiencies (differences between specified and observed performance) as interpreted by the Commissioning Provider, Owner's Representative and Engineer of Record and retest the equipment.
 16. Prepare O&M manuals according to the Contract Documents, including clarifying and updating the original sequences of operation to as-built conditions.
 17. During construction, maintain as-built redline drawings for all drawings and final CAD as-builts for contractor-generated coordination drawings. Update after completion of commissioning.
 18. Provide training for the Owner Representative's operating staff using expert qualified personnel, as specified.
 19. Coordinate with equipment manufacturers to determine specific requirements to maintain the validity of the warranty.
 20. Execute any deferred functional performance testing, witnessed by the Commissioning Provider, according to the specifications.
 21. Correct deficiencies and make necessary adjustments to O&M manuals and as-built drawings for applicable issues identified in any seasonal testing.
- B. Mechanical Contractor. The responsibilities of the HVAC mechanical contractor, during construction and acceptance phases in addition to those listed in (A) are:

1. Provide startup for all HVAC equipment, except for the building automation control system.
2. Assist and cooperate with the TAB contractor and Commissioning Provider by:
 - a. Putting all HVAC equipment and systems into operation and continuing the operation during each working day of TAB and commissioning, as required.
 - b. Including cost of sheaves and belts that may be required by TAB.
 - c. Providing test holes in ducts and plenums where directed by TAB to allow air measurements and air balancing. Provide an approved plug.
 - d. Providing temperature and pressure taps according to the Construction Documents for TAB and commissioning testing.
3. Install a P/T plug at each water sensor, which is an input point to the control system.
4. List and clearly identify on the as-built drawings the locations of all air-flow stations.
5. Prepare a preliminary schedule for pipe and duct system testing, flushing and cleaning, equipment start-up and TAB start and completion for use by the Commissioning Provider. Update the schedule as appropriate.
6. Notify the Owner's Representative when pipe and duct system testing, flushing, cleaning, startup of each piece of equipment and TAB will occur. Be responsible to notify the Owner's Representative or Commissioning Provider, ahead of time, when commissioning activities not yet performed or not yet scheduled will delay construction. Be proactive in seeing that commissioning processes are executed and that the Commissioning Provider has the scheduling information needed to efficiently execute the commissioning process.

PART 2 PRODUCTS (NOT APPLICABLE).

PART 3 EXECUTION

3.01 GENERAL

- A. Obtain and pay for all permits and inspections, including any independent testing required to verify standard compliance, and deliver certificates for same to the Owner's Representative.

3.02 WORK RESPONSIBILITIES

- A. The drawings indicate diagrammatically the desired locations or arrangement of piping, equipment, etc., and are to be followed as closely as possible. Proper judgment must be exercised in executing the work to secure the best possible installation in the available space and to overcome local difficulties due to space limitations or interference with structural conditions.
- B. The Contractor is responsible for the correct placing of Work and the proper location and connection of Work in relation to the work of other trades. Advise appropriate trade as to locations of access panels.
- C. In the event changes in the indicated locations or arrangements are necessary, due to developed conditions in the building construction or rearrangement of furnishings or equipment, such changes shall be made without extra cost, providing the change is ordered before the ductwork, piping, etc. and work directly connected to same is installed and no extra materials are required.
- D. Where equipment is furnished by others, verify dimensions and the correct locations of this equipment before proceeding with the roughing-in of connections.
- E. All scaled and figured dimensions are approximate of typical equipment of the class indicated. Before proceeding with any work, carefully check and verify all dimensions, sizes, etc. with the

drawings to see that the equipment will fit into the spaces provided without violation of applicable codes.

- F. Should any changes to the Work indicated on the Drawings or described in the Specifications be necessary in order to comply with the above requirements, notify the Owner immediately and cease work on all parts of the contract, which are affected until approval for any required modifications to the construction has been obtained from the Owner.
- G. Be responsible for any cooperative work, which must be altered due to lack of proper supervision or failure to make proper provisions in time. Such changes shall be under direction of the Owner and shall be made to his satisfaction. Perform all Work with competent and skilled personnel.
- H. All work, including aesthetic as well as mechanical aspects of the Work, shall be of the highest quality consistent with the best practices of the trade.
- I. Replace or repair, without additional compensation, any Work, which, in the opinion of the Owner, does not comply with these requirements.

3.03 PAINTING

- A. Refer to Division 09 for additional requirements.
- B. Factory Applied:
 - 1. Mechanical equipment shall have factory-applied painting systems, which shall, as a minimum, meet the requirements of NEMA ICS 6 corrosion-resistance test, except equipment specified to meet requirements of ANSI C37.20 shall have a finish as specified in ANSI C37.20.
 - 2. Refer to individual sections of this Division for more stringent requirements.
- C. Field Applied:
 - 1. Paint all mechanical equipment as required to touch up, to match finish on other equipment in adjacent spaces or to meet safety criteria.
 - 2. Paint all exposed, uninsulated mechanical piping, valves, supports, hangers and appurtenances. Provide minimum 5 mils dry film thickness.
 - 3. Paint ductwork flat black that are visible behind air outlets and inlets.
 - 4. Paint all exposed and rooftop ductwork, roof mounted mechanical equipment, ductwork supports, hangers and appurtenances.
 - 5. Paint shall be a high-performance polyurethane enamel coating system.
 - a. Acceptable paint manufacturers include Ameron, Tnemec or engineer approved equal.
 - b. Acceptable primer manufacturers include Ameron Amershield VOC, Tnemec's Series 1075 (1074) Endura-Shield, semi-gloss (gloss) sheen or equal.
 - c. Provide minimum 5 mils dry film thickness.

3.04 COMMISSIONING TRAINING OF OWNER'S REPRESENTATIVE PERSONNEL

- A. The General Contractor shall be responsible for training coordination and scheduling and ultimately to ensure that training is completed.
- B. The Commissioning Provider shall be responsible for reviewing the content and adequacy of the training of Owner's Representative personnel for commissioned equipment.
- C. Mechanical Contractor. The mechanical contractor shall have the following training responsibilities:
 - 1. Provide the Commissioning Provider and A/E with a training plan at least two weeks before the planned training.

2. Provide designated Owner personnel with comprehensive orientation and training in the understanding of the systems and the operation and maintenance of each piece of HVAC equipment.
3. Training shall normally start with classroom sessions followed by hands-on training on each piece of equipment, which shall illustrate the various modes of operation, including startup, shutdown, fire/smoke alarm, power failure, etc.
4. During any demonstration, should the system fail to perform in accordance with the requirements of the O&M manual or sequence of operations, the system will be repaired or adjusted as necessary and the demonstration repeated.
5. The appropriate trade or manufacturer's representative shall provide the instructions on each major piece of equipment. This person may be the start-up technician for the piece of equipment, the installing contractor or manufacturer's representative. Practical building operating expertise as well as in-depth knowledge of all modes of operation of the specific piece of equipment are required. More than one party may be required to execute the training.
6. The controls contractor shall attend sessions other than the controls training, as requested, to discuss the interaction of the controls system as it relates to the equipment being discussed.
7. The training sessions shall follow the outline in the Table of Contents of the operation and maintenance manual and illustrate whenever possible the use of the O&M manuals for reference.
8. Training shall include:
 - a. Use of the printed installation, operation and maintenance instruction material included in the O&M manuals.
 - b. A review of the written O&M instructions emphasizing safe and proper operating requirements, preventative maintenance, special tools needed and spare parts inventory suggestions. The training shall include start-up, operation in all modes possible, shutdown, seasonal changeover and any emergency procedures.
 - c. Discussion of relevant health and safety issues and concerns.
 - d. Discussion of warranties and guarantees.
 - e. Common troubleshooting problems and solutions.
 - f. Explanatory information included in the O&M manuals and the location of all plans and manuals in the facility.
 - g. Discussion of any peculiarities of equipment installation or operation.
 - h. Classroom sessions shall include the use of overhead projections, slides, video/audio-taped material as might be appropriate.
9. Hands-on training shall include start-up, operation in all modes possible, including manual, shutdown and any emergency procedures and preventative maintenance for all pieces of equipment.
10. The mechanical contractor shall fully explain and demonstrate the operation, function and overrides of any local packaged controls, not controlled by the central control system.
11. Training shall occur after functional testing is complete, unless approved otherwise by the Owner's Representative.

END OF SECTION

**SECTION 230513
COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT**

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on ac power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

1.02 COORDINATION

- A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:
 - 1. Motor controllers.
 - 2. Torque, speed, and horsepower requirements of the load.
 - 3. Ratings and characteristics of supply circuit and required control sequence.
 - 4. Ambient and environmental conditions of installation location.

PART 2 PRODUCTS

2.01 GENERAL MOTOR REQUIREMENTS

- A. Comply with NEMA MG 1 unless otherwise indicated.
- B. Comply with IEEE 841 for severe-duty motors.

2.02 MOTOR CHARACTERISTICS

- A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet above sea level.
- B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

2.03 POLYPHASE MOTORS

- A. Description: NEMA MG 1, Design B, medium induction motor.
- B. Efficiency: Premium efficient, as defined in NEMA MG 1.
- C. Service Factor: 1.15.
- D. Multispeed Motors: Separate winding for each speed.
- E. Rotor: Random-wound, squirrel cage.
- F. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.
- G. Temperature Rise: Match insulation rating.
- H. Insulation: Class F.
- I. Code Letter Designation:

1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
 2. Motors smaller than 15 HP: Manufacturer's standard starting characteristic.
- J. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

2.04 ADDITIONAL REQUIREMENTS FOR POLYPHASE MOTORS

- A. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.
- B. Motors Used with Variable Frequency Controllers:
1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
 2. Premium-Efficient Motors: Class B temperature rise; Class F insulation.
 3. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
 4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.
- C. Severe-Duty Motors: Comply with IEEE 841, with 1.15 minimum service factor.

2.05 SINGLE-PHASE MOTORS

- A. Motor shall be an electronic commutation (EC) motor specifically designed for HVAC applications. AC induction type motors are not acceptable.
- B. Motors shall be permanently lubricated with heavy-duty ball bearings to match the fan load and prewired to the specific voltage and phase.
- C. Internal motor circuitry shall convert AC power supplied to the fan to DC power to operate the motor. Motor shall be speed controllable down to 20% of full speed (80% turndown).
- D. Motor shall be a minimum of 85% efficient at all speeds.

PART 3 EXECUTION (NOT APPLICABLE)

END OF SECTION

SECTION 230514
VARIABLE FREQUENCY DRIVES

PART 1 GENERAL

1.01 RELATED DOCUMENTS:

- A. Electrical General Requirements are part of this section and apply to this section as full as if repeated herein.
- B. Mechanical General Requirements, specification sections for Pumps, Electrical Motors, Air Handling Units, Fans, Energy Management System.

1.02 SCOPE

- A. Furnish labor and related materials, appliances, tools and equipment necessary for and incident to performing all operations in connection with furnishing, delivery, installation, and start up of Variable Frequency Drive.

1.03 QUALITY ASSURANCE AND STANDARDS

- A. The latest revision of the standards listed below form an integral part of this specification:
- B. American National Standard Institute (ANSI).
 - 1. Institute of Electrical and Electronic Engineers, Inc. (IEEE).
 - 2. National Electrical Manufacturer's Association (NEMA)
 - 3. National Fire Protection Association (NFPA)
 - 4. State of California Electrical Code (CEC).
 - 5. Underwriters Laboratories (UL)
- C. Shall not have less than ten (10) years of experience in the manufacture of variable frequency drives similar to the type and size specified on this project.
 - 1. Shall be ISO-9002 certified.
 - 2. Manufacturer shall have nationwide technical support organization available 24 hours a day from a toll-free telephone number. Capabilities shall include factory coordinated start-up service and on-site training of customer personnel.
 - 3. Shall have a local service facility located within (50) miles radius of the project site and be able to provide field service with twenty (24) hours.

1.04 SUBMITTALS

- A. Technical cut-sheets, product data on adjustable frequency controllers, relays, pilot devices and switching and over-current protective devices.
- B. Factory Test Reports.
- C. Manufacturer's installation and operating instructions.
- D. Start-up service report.

1.05 WARRANTY

- A. The drive manufacturer shall guarantee the operation of the drive against failure due to defects a minimum period of 24 months from the date of acceptance by Owner. Warranty shall cover all labor and parts required to repair/replace on site.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
1. ABB.
 2. Danfoss Inc: Danfoss Drives Div.
 3. Yaskawa Electric America, Inc.

2.02 GENERAL:

- A. The alternating current variable speed drive shall include the microprocessor based variable controller, the required signal logic and control. The drive component specified including the variable frequency controller and its associated microprocessor control system shall be of the same manufacture. Coordinate with fan supplier to ensure compatibility between drive and AC motors.
- B. The drive shall be UL listed and CSA approved, and shall comply with all applicable requirements of the latest standard of ANSI, IEEE and NEMA.
- C. The drive shall be mounted in NEMA 12 enclosure. Drives not located indoors shall have NEMA 4 enclosure. The entire VFD package shall be in a free-standing metal enclosure and be completely factory assembled. Plastic enclosure is not acceptable.
- D. The cabinet shall be front access only. The unit shall be suitable for operation in ambient temperature – 14 F to 104 F (up to 122 F with cover removed).
- E. The drive shall be a PWM (Pulse Width Modulated) transistorized inverter using IGBTs (Insulated Gate Bipolar Transistors) and must be fully digital.
- F. The drive shall have a common design for all horsepower models required for this project.

2.03 VARIABLE FREQUENCY DRIVE

- A. Standard Features
- B. Main input power shall be 400V – 460V/60Hz.
1. The drive shall have a tolerance for voltage $\pm 10\%$ and frequency $\pm 2\text{Hz}$. Overload current shall be 100% continuous and 110% for 1 minute.
 2. Interrupting rating (AIC): 65,000 AIC (RMS symmetrical) unless otherwise noted. The use of input fuses to achieve this rating shall not be acceptable. Contractor to verify the rating from the short circuit study prior to furnishing submittal.
 3. Automatic cooling fan control based on heat sink temperature for extended fan life.
 4. Shall have a built-in control system for commercial power/standby power switching.
 5. Shall have an adjustable retry function after a fault, both number of attempts (at least 10) and time between (1-10 sec).
 6. Shall have an analog input filter adjustment to limit the effects of noise on the control signal.
 7. Shall have the ability to automatically restart after an over current, over voltage, under voltage, or loss of input signal protective trip. The number of restart attempts and trials shall be programmable.
 8. Shall have the following user selectable contingencies in the event of loss of analog control signal while the drive is running before loss:
 - a. Run at the user set lower frequency limit.
 - b. Run at the user set upper frequency limit.
 - c. Trip with a signal loss fault.
 - d. Run at user selected percentage of the last valid frequency signal.

- C. Shall be equipped with both local/remote and manual/auto keys on touchpad.
 - 1. Hand-Off-Auto keypad control and manual speed shall be provided on the keypad. When in "Hand", the VFD will be started, and the speed will be controlled from the speed up or speed down button. Then in "Off", the VFD will be stopped. When in "Auto", the VFD will start via an external contact enclosure, and its speed will be controlled via an external speed reference.
 - 2. Shall have the capability of storable special custom user setting.
 - 3. Shall restart into a rotating motor operating in either the forward or reverse direction and match that frequency.
 - 4. Shall have adjustable soft stall (10% - 150%) which reduces frequency and voltage of the inverter to sustain a run in an overload situation.
 - 5. Shall have adjustable UL listed electronic overload protection (10% - 100%). The drive shall have a custom programmable volt/hertz pattern.
 - 6. Serial RS232C communication standard
 - 7. Provide BACnet interface for EMS control.
- D. Protective Features
 - 1. Provide phase reversal protection.
 - a. Provide input and output line reactors to reduce harmonic noise to 5% THD rms.
 - b. Shall have main disconnecting integral input circuit breaker with minimum interrupting rating not less than 110% of the available fault level. Circuit breaker shall be by Square D, General Electric, or equal. The circuit breaker operating mechanism shall be lockable and readily accessible on the outside of the enclosure.
 - c. The drive shall be capable of re-setting faults remotely and locally.
 - d. The drive shall be programmable to alert the following alarms:
 - 1) Over torque alarm
 - (a) Motor overload pre-alarm
 - (b) Undercurrent alarm
 - (c) Over current pre-alarm
 - (d) Communication error alarm
 - e. The drive shall identify and display the following faults:
 - 1) Over current (350% instantaneous or 170% RMS) during normal run, acceleration or deceleration trip.
 - (a) Over current on the DC Bus during normal run trip, acceleration trip, or deceleration trip.
 - (b) Over voltage (130% of VFD's rated voltage) during normal (constant speed) run trip, acceleration trip, or deceleration trip.
 - (c) Under voltage (65% of the VFD's rated voltage) trip.
 - (d) Over temperature.
 - (e) Ground Fault either running or at start
 - (f) Emergency off trip message.
 - (g) RAM, ROM, CPU error
 - (h) Communication interruption error
 - (i) Output current detection circuit error
 - (j) Over torque trip
 - 2. Monitor Functions
 - a. The drive digital display shall be capable of displaying the following: frequency, % current, current amps, % voltage I/O, voltage in volts I/O, RPM, GPM, I/O Watts, torque, and input reference signal, kWh.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine areas, surfaces, and substrates to receive VFCs, with Installer present, for compliance with requirements for installation tolerances, and other conditions affecting performance of the Work.
- B. Examine VFC before installation. Reject VFCs that are wet, moisture damaged, or mold damaged.
- C. Examine roughing-in for conduit systems to verify actual locations of conduit connections before VFC installation.
- D. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Wall-Mounting Controllers: Install with tops at uniform height and with disconnect operating handles not higher than 48 inches above finished floor, unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For controllers not on walls, provide freestanding racks complying with Division 26 "Hangers and Supports for Electrical Systems." Installation of Variable Frequency Drives shall be in accordance with OSP approval.
- B. Seismic Bracing: Comply with requirements specified in Division 26 "Vibration and Seismic Controls for Electrical Systems."
- C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- D. Install fuses in each fusible-switch VFC.
- E. Install fuses in control circuits if not factory installed. Comply with requirements in Division 26 "Fuses."
- F. Install, connect, and fuse thermal-protector monitoring relays furnished with motor-driven equipment.
- G. Comply with NECA 1.

3.03 CONTROL WIRING INSTALLATION

- A. Install wiring between VFCs and remote devices and facility's central-control system. Comply with requirements in Division 26 "Control-Voltage Electrical Power Cables."
- B. Bundle, train, and support wiring in enclosures.
- C. Connect selector switches and other automatic-control devices where applicable.
 - 1. Connect selector switches to bypass only those manual- and automatic-control devices that have no safety functions when switches are in manual-control position.
 - 2. Connect selector switches with control circuit in both manual and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor-overload protectors.

3.04 IDENTIFICATION

- A. Identify VFCs, components, and control wiring. Comply with requirements for identification specified in Division 26 "Electrical Identification."
 - 1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
 - 2. Label each VFC with engraved nameplate.

3. Label each enclosure-mounted control and pilot device.
- B. Operating Instructions: Frame printed operating instructions for VFCs, including control sequences and emergency procedures. Fabricate frame of finished metal, and cover instructions with clear acrylic plastic. Mount on front of VFC units.

3.05 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. Acceptance Testing Preparation:
 1. Test insulation resistance for each VFC element, bus, component, connecting supply, feeder, and control circuit.
 2. Test continuity of each circuit.
- C. Tests and Inspections:
 1. Inspect VFC, wiring, components, connections, and equipment installation. Test and adjust controllers, components, and equipment.
 2. Test insulation resistance for each VFC element, component, connecting motor supply, feeder, and control circuits.
 3. Test continuity of each circuit.
 4. Verify that voltages at VFC locations are within 10 percent of motor nameplate rated voltages. If outside this range for any motor, notify Architect and Construction Manager before starting the motor(s).
 5. Test each motor for proper phase rotation.
 6. Perform tests according to the Inspection and Test Procedures for Adjustable Speed Drives stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 7. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
 8. Perform the following infrared (thermographic) scan tests and inspections, and prepare reports:
 - a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each VFC. Remove front panels so joints and connections are accessible to portable scanner.
 - b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each VFC 11 months after date of Substantial Completion.
 - c. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
 9. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
- D. VFCs will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports, including a certified report that identifies the VFC and describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations made after remedial action.

3.06 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
 1. Complete installation and startup checks according to manufacturer's written instructions.

3.07 ADJUSTING

- A. Program microprocessors for required operational sequences, status indications, alarms, event recording, and display features. Clear events memory after final acceptance testing and prior to Substantial Completion.
- B. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload-relay pickup and trip ranges.
- C. Adjust the trip settings of instantaneous-only circuit breakers and thermal-magnetic circuit breakers with adjustable, instantaneous trip elements. Initially adjust to 6 times the motor nameplate full-load amperes and attempt to start motors several times, allowing for motor cool-down between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without tripping. Do not exceed 8 times the motor full-load amperes (or 11 times for NEMA Premium Efficient motors if required). Where these maximum settings do not allow starting of a motor, notify Architect and Construction Manager before increasing settings.
- D. Set the taps on reduced-voltage autotransformer controllers.
- E. Set field-adjustable circuit-breaker trip ranges as specified in Division 26 "Overcurrent Protective Device Coordination Study."
- F. Set field-adjustable pressure switches.

3.08 PROTECTION

- A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions until controllers are ready to be energized and placed into service.
- B. Replace VFCs whose interiors have been exposed to water or other liquids prior to Substantial Completion.

3.09 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, reprogram, and maintain VFCs.

END OF SECTION

**SECTION 230529
HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT**

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section Includes:
 - 1. Metal pipe hangers and supports.
 - 2. Trapeze pipe hangers.
 - 3. Metal framing systems.
 - 4. Thermal-hanger shield inserts.
 - 5. Fastener systems.
 - 6. Equipment supports.
- B. Related Sections:
 - 1. Division 05 "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
 - 2. Division 23 "Metal Ducts" for duct hangers and supports.

1.03 DEFINITIONS

- A. MSS: Manufacturers Standardization Society of The Valve and Fittings Industry Inc.

1.04 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design trapeze pipe hangers and equipment supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- 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. See Division 23 "Seismic Restraint of Suspended Mechanical Utilities".

1.05 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. 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. Pipe stands.
4. Equipment supports.
5. Delegated-Design Submittal: For trapeze hangers indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
6. Detail fabrication and assembly of trapeze hangers.
7. Design Calculations: Calculate requirements for designing trapeze hangers.

1.06 INFORMATIONAL SUBMITTALS

- A. Welding certificates.

1.07 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.

PART 2 PRODUCTS

2.01 METAL PIPE HANGERS AND SUPPORTS

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

2.02 TRAPEZE PIPE HANGERS

- A. Description: MSS SP-69, 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.

2.03 METAL FRAMING SYSTEMS

- A. MFMA Manufacturer Metal Framing Systems:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 2. Allied Tube & Conduit
 3. Cooper B-Line, Inc.

4. Flex-Strut Inc.
5. GS Metals Corp.
6. Thomas & Betts Corporation.
7. Unistrut Corporation; Tyco International, Ltd.
8. Wesanco. Inc.
9. Description: Shop- or field-fabricated pipe-support assembly for supporting multiple parallel pipes.
10. Standard: MFMA-4.
11. Channels: Continuous slotted steel channel with inturned lips.
12. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
13. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel or stainless steel.
14. Metallic Coating: Hot-dipped galvanized for outdoor or corrosive environments.
15. Paint Coating: Epoxy for dry indoor locations.

2.04 THERMAL-HANGER SHIELD INSERTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Carpenter & Paterson, Inc.
 2. Clement Support Services.
 3. ERICO International Corporation.
 4. National Pipe Hanger Corporation.
 5. PHS Industries, Inc.
 6. Pipe Shields, Inc.; a subsidiary of Piping Technology & Products, Inc.
 7. Piping Technology & Products, Inc.
 8. Rilco Manufacturing Co., Inc.
 9. Value Engineered Products, Inc.
- B. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with 100-psig or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength and vapor barrier.
- C. Insulation-Insert Material for Hot Piping: ASTM C 552, Type II cellular glass with 100-psig or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength.
- D. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
- E. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
- F. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.05 FASTENER SYSTEMS

- A. Mechanical-Expansion Anchors: Insert-wedge-type, steel 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. Outdoor or wet areas: stainless steel anchors.
 2. Indoor, dry areas: Zinc-coated steel anchors.

2.06 EQUIPMENT SUPPORTS

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

2.07 MISCELLANEOUS MATERIALS

- A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.
- B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
 - 1. Properties: Nonstaining, noncorrosive, and nongaseous.
 - 2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 EXECUTION

3.01 HANGER AND SUPPORT INSTALLATION

- A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.
- B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. 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 A 36/A 36M, 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 mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- F. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
- G. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- H. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- I. Install lateral bracing with pipe hangers and supports to prevent swaying.
- J. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.
- K. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- L. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

M. Insulated Piping:

1. Attach clamps and spacers to piping.
 - a. Piping Operating below or above Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
2. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.
3. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
4. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
5. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
6. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
7. Shield Dimensions for Pipe: Not less than the following:
8. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
9. NPS 4: 12 inches long and 0.06 inch thick.
10. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
11. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
 - a. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.
12. Pipes NPS 8 and Larger: Reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
13. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.
14. Shield and insert lengths may be reduced to a minimum of 6" long (3" in each direction from the centerline of the hanger) at locations where obstructions prevent the shield and insert from being installed to the full length. All other locations shall conform to the specifications.

3.02 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.

3.03 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.

3.04 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.

3.05 PAINTING

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 - 1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.
- B. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 09 "Exterior Painting"
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

3.06 HANGER AND SUPPORT SCHEDULE

- A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.
- B. Comply with MSS SP-69 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 be installed outdoors or in wet locations.
- D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- E. Use carbon-steel pipe hangers and supports, metal trapeze pipe hangers, and metal framing systems and attachments for general service applications.
- F. Use stainless-steel pipe hangers and strut systems and stainless-steel attachments for MRI (magnetic resonance imaging) rooms. ABSOLUTELY, NO FERROUS METAL PIPE SUPPORTS ALLOWED IN MRI ROOMS.
- G. Use thermal-hanger shield inserts for insulated piping and tubing.
 - 1. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 2. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30.
 - 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. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of non-insulated, stationary pipes NPS 3/8 to NPS 3.
 - 6. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
 - 7. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
 - 8. 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.

9. 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.
10. 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.
 - a. 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 might occur.
- H. 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 might occur.
- I. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
- J. 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 might occur and vertical adjustment is not necessary.
- K. 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 might be required in addition to expansion and contraction.
- L. 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.
- M. 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 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.
- N. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
 2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joint construction, to attach to top flange of structural shape.
 3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
 4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
 5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
 6. C-Clamps (MSS Type 23): For structural shapes.
 7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
 8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
 9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.

10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
 11. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
 12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:
 13. Light (MSS Type 31): 750 lb.
 14. Medium (MSS Type 32): 1500 lb.
 - a. Heavy (MSS Type 33): 3000 lb.
 15. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
 16. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
 17. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.
- O. 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.
- P. 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:
 9. Horizontal (MSS Type 54): Mounted horizontally.
 10. Vertical (MSS Type 55): Mounted vertically.
 11. Trapeze (MSS Type 56): Two vertical type supports and one trapeze member.
 12. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.
 13. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.
 14. Use mechanical-expansion anchors instead of building attachments where required in concrete construction.

END OF SECTION

SECTION 230548
VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. This Section includes the following:
 - 1. Isolation pads.
 - 2. Isolation mounts.
 - 3. Restrained elastomeric isolation mounts.
 - 4. Freestanding and restrained spring isolators.
 - 5. Housed spring mounts.
 - 6. Spring hangers.
 - 7. Spring hangers with vertical-limit stops.
 - 8. Restrained vibration isolation roof-curb rails.
 - 9. Restraining braces and cables.

1.03 DEFINITIONS

- A. IBC: International Building Code.
- B. ICC-ES: ICC-Evaluation Service.

1.04 SUBMITTALS

- A. Product Data: For the following:
 - 1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
 - 2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of seismic-restraint component used.
 - a. Tabulate types and sizes of seismic restraints, complete with report numbers and rated strength in tension and shear as evaluated by an agency acceptable to authorities having jurisdiction.
 - b. Annotate to indicate application of each product submitted and compliance with requirements.
 - 3. Interlocking Snubbers: Include ratings for horizontal, vertical, and combined loads.
 - 4. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, spring deflection changes, and seismic loads. Include certification that riser system has been examined for excessive stress and that none will exist.
 - 5. Vibration Isolation Base Details: Detail overall dimensions, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, base weights, equipment static loads, power transmission, component misalignment, and cantilever loads.
 - 6. Seismic-Restraint Details:

- a. Design Analysis: To support selection and arrangement of seismic restraints. Include calculations of combined tensile and shear loads.
 - b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices.
 - c. Coordinate seismic-restraint and vibration isolation details with wind-restraint details required for equipment mounted outdoors. Comply with requirements in other Division 22 Sections for equipment mounted outdoors.
 - d. Preapproval and Evaluation Documentation: By an agency acceptable to authorities having jurisdiction, showing maximum ratings of restraint items and the basis for approval (tests or calculations).
7. Coordination Drawings: Show coordination of seismic bracing for HVAC piping and equipment with other systems and equipment in the vicinity, including other supports and seismic restraints.
 8. Welding certificates.
 9. Qualification Data: For professional engineer and testing agency.
 10. Field quality-control test reports.
 11. Operation and Maintenance Data: For air-mounting systems to include in operation and maintenance manuals.

1.05 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
- B. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.
- C. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
 1. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear anchorage preapproval OPA number from OSHPD, preapproval by ICC-ES, or preapproval by another agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If pre-approved ratings are not available, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by a qualified professional engineer.

PART 2 PRODUCTS

2.01 ISOLATORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. M.W. Sausse & Company, Inc.
 2. Mason Industries.
- B. Basis of Design is M.W. Sausse & Company, Inc. If contractor submits on listed alternates, he shall assume monetary and logistical responsibility for any and all necessary structural,

electrical, plumbing, architectural and HVAC modifications. Contractor shall also compensate the Architect of Record (AOR) and Mechanical Engineer of Record (MEOR) for efforts related to reviewing submittals to establish acceptability and updating energy compliance calculations.

- C. Pads: Arranged in single or multiple layers of sufficient stiffness for uniform loading over pad area, molded with a nonslip pattern and galvanized-steel baseplates, and factory cut to sizes that match requirements of supported equipment.
 - 1. Resilient Material: Oil- and water-resistant rubber.
- D. Mounts Insert drawing designation: Double-deflection type, with molded, oil-resistant rubber, hermetically sealed compressed fiberglass, or neoprene isolator elements with factory-drilled, encapsulated top plate for bolting to equipment and with baseplate for bolting to structure. Color-code or otherwise identify to indicate capacity range.
 - 1. Materials: Cast-ductile-iron or welded steel housing containing two separate and opposing, oil-resistant rubber or neoprene elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.
 - 2. Neoprene: Shock-absorbing materials compounded according to the standard for bridge-bearing neoprene as defined by AASHTO.
- E. Restrained Mounts: All-directional mountings with seismic restraint.
 - 1. Materials: Cast-ductile-iron or welded steel housing containing two separate and opposing, oil-resistant rubber or neoprene elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.
 - 2. Neoprene: Shock-absorbing materials compounded according to the standard for bridge-bearing neoprene as defined by AASHTO.
- F. Spring Isolators: Freestanding, laterally stable, open-spring isolators.
 - 1. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 - 2. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 - 3. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 - 4. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
 - 5. Baseplates: Factory drilled for bolting to structure and bonded to 1/4-inch- thick, rubber isolator pad attached to baseplate underside. Baseplates shall limit floor load to 500 psig.
 - 6. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.
 - 7. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic or limit-stop restraint.
 - 8. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to weight being removed; factory-drilled baseplate bonded to 1/4-inch- thick, neoprene or rubber isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.
 - 9. Restraint: Seismic or limit stop as required for equipment and authorities having jurisdiction.
 - 10. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 - 11. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 - 12. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 - 13. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
- G. Housed Spring Mounts: Housed spring isolator with integral seismic snubbers.
 - 1. Housing: Ductile-iron or steel housing to provide all-directional seismic restraint.
 - 2. Base: Factory drilled for bolting to structure.

3. Snubbers: Vertically adjustable to allow a maximum of 1/4-inch travel up or down before contacting a resilient collar.
- H. Spring Hangers: Combination coil-spring and elastomeric-insert hanger with spring and insert in compression.
 1. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
 2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
 6. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
 7. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.
- I. Spring Hangers with Vertical-Limit Stop: Combination coil-spring and elastomeric-insert hanger with spring and insert in compression and with a vertical-limit stop.
 1. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
 2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
 6. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
 7. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.
 8. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.

2.02 VIBRATION ISOLATION ROOF-CURB RAILS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. M.W. Sausse & Company, Inc.
 2. Mason Industries.
 - a. Basis of Design is M.W. Sausse & Company, Inc. If contractor submits on listed alternates, he shall assume monetary and logistical responsibility for any and all necessary structural, electrical, plumbing, architectural and HVAC modifications. Contractor shall also compensate the Architect of Record (AOR) and Mechanical Engineer of Record (MEOR) for efforts related to reviewing submittals to establish acceptability and updating energy compliance calculations.
 - b. General Requirements for Restrained Vibration Isolation Roof-Curb Rails: Factory-assembled, fully enclosed, insulated, air- and watertight curb rail designed to resiliently support equipment and to withstand seismic forces.
 - c. Lower Support Assembly: Formed sheet-metal section containing adjustable and removable steel springs that support upper frame. Upper frame shall provide

- continuous support for equipment and shall be captive to resiliently resist seismic forces. Lower support assembly shall have a means for attaching to building structure and a wood nailer for attaching roof materials, and shall be insulated with a minimum of 2 inches of rigid, glass-fiber insulation on inside of assembly.
- d. Spring Isolators: Adjustable, restrained spring isolators shall be mounted on 1/4-inch-thick, elastomeric vibration isolation pads and shall have access ports, for level adjustment, with removable waterproof covers at all isolator locations. Isolators shall be located so they are accessible for adjustment at any time during the life of the installation without interfering with the integrity of the roof.
 - e. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic restraint.
 - 1) Housing: Steel with resilient vertical-limit stops and adjustable equipment mounting and leveling bolt.
 - 2) Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 - 3) Minimum Additional Travel: 50 percent of the required deflection at rated load.
 - 4) Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 - 5) Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
 - 3. Pads: Arranged in single or multiple layers of sufficient stiffness for uniform loading over pad area, molded with a nonslip pattern and galvanized-steel baseplates, and factory cut to sizes that match requirements of supported equipment.
 - 1) Resilient Material: Oil- and water-resistant natural rubber.
 - 2) Snubber Bushings: All-directional, elastomeric snubber bushings at least 1/4 inch thick.
 - 3) Water Seal: Galvanized sheet metal with EPDM seals at corners, attached to upper support frame, extending down past wood nailer of lower support assembly, and counter flashed over roof materials.

2.03 ISOLATION EQUIPMENT BASES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. M.W. Sausse & Company, Inc.
 - 2. Mason Industries.
- B. Basis of Design is M.W. Sausse & Company, Inc. If contractor submits on listed alternates, he shall assume monetary and logistical responsibility for any and all necessary structural, electrical, plumbing, architectural and HVAC modifications. Contractor shall also compensate the Architect of Record (AOR) and Mechanical Engineer of Record (MEOR) for efforts related to reviewing submittals to establish acceptability and updating energy compliance calculations.
- C. Steel Base: Factory-fabricated, welded, structural-steel bases and rails.
 - 1. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.
 - a. Include supports for suction and discharge elbows for pumps.
 - 2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Bases shall have shape to accommodate supported equipment.
 - 3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.

2.04 SEISMIC-RESTRAINT DEVICES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. M.W. Sausse & Company, Inc.
 - 2. Mason Industries.
- B. Basis of Design is M.W. Sausse & Company, Inc. If contractor submits on listed alternates, he shall assume monetary and logistical responsibility for any and all necessary structural, electrical, plumbing, architectural and HVAC modifications. Contractor shall also compensate the Architect of Record (AOR) and Mechanical Engineer of Record (MEOR) for efforts related to reviewing submittals to establish acceptability and updating energy compliance calculations.
- C. General Requirements for Restraint Components: Rated strengths, features, and applications shall be as defined in reports by an agency acceptable to authorities having jurisdiction.
 - 1. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least four times the maximum seismic forces to which they will be subjected.
- D. Snubbers: Factory fabricated using welded structural-steel shapes and plates, anchor bolts, and replaceable resilient isolation washers and bushings.
 - 1. Anchor bolts for attaching to concrete shall be seismic-rated, drill-in, and stud-wedge or female-wedge type.
 - 2. Resilient Isolation Washers and Bushings: Oil- and water-resistant neoprene.
 - 3. Maximum 1/4-inch air gap, and minimum 1/4-inch- thick resilient cushion.
 - a. Channel Support System: MFMA-3, shop- or field-fabricated support assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; and rated in tension, compression, and torsion forces.
 - b. Restraint Cables: ASTM A 603 galvanized-steel cables with end connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for restraining cable service; and with a minimum of two clamping bolts for cable engagement.
 - c. Hanger Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections to hanger rod.
 - d. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings and matched to type and size of anchor bolts and studs.
 - e. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings and matched to type and size of attachment devices used.
 - f. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.
 - g. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488. Minimum length of eight times diameter.
 - h. Adhesive Anchor Bolts: Drilled-in and capsule anchor system containing polyvinyl or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

2.05 FACTORY FINISHES

- A. Finish: Manufacturer's standard prime-coat finish ready for field painting.

- B. Finish: Manufacturer's standard paint applied to factory-assembled and -tested equipment before shipping.
 - 1. Powder coating on springs and housings.
 - 2. All hardware shall be galvanized. Hot dip galvanize metal components for exterior use.
 - 3. Baked enamel or powder coat for metal components on isolators for interior use.
 - 4. Color-code or otherwise mark vibration isolation and seismic-control devices to indicate capacity range.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 APPLICATIONS

- A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by an agency acceptable to authorities having jurisdiction.
- B. Hanger Rod Stiffeners: Install hanger rod stiffeners where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to seismic forces.
- C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static and seismic loads within specified loading limits.

3.03 CONTROL AND SEISMIC-RESTRAINT DEVICE INSTALLATION

- A. Comply with requirements in Division 07 Section "Roof Accessories" for installation of roof curbs, equipment supports, and roof penetrations.
- B. Equipment Restraints:
 - 1. Install seismic snubbers on HVAC equipment mounted on vibration isolators. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure.
 - 2. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.
 - 3. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction providing required submittals for component.
 - 4. Install cables so they do not bend across edges of adjacent equipment or building structure.
 - 5. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction providing required submittals for component.
- C. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.
- D. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.
- E. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.

F. Drilled-in Anchors:

1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid pre-stressed tendons, electrical and telecommunications conduit, and gas lines.
2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
4. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
5. Set anchors to manufacturer's recommended torque, using a torque wrench.
6. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

3.04 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

- A. Install flexible connections in piping where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where the connections terminate with connection to equipment that is anchored to a different structural element from the one supporting the connections as they approach equipment.

3.05 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Perform tests and inspections.
- C. Tests and Inspections:
1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
 2. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless post connection testing has been approved), and with at least seven days' advance notice.
 3. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
 4. Test at least four of each type and size of installed anchors and fasteners selected by Architect.
 5. Test modify all installations of same type and retest until satisfactory results are achieved.
- D. Remove and replace malfunctioning units and retest as specified above.
- E. Prepare test and inspection reports.

3.06 ADJUSTING

1. Adjust isolators after piping system is at operating weight.
- B. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

- C. Adjust air-spring leveling mechanism.
- D. Adjust active height of spring isolators.
 - 1. Adjust restraints to permit free movement of equipment within normal mode of operation.

3.07 DEMONSTRATION

- 1. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air-mounting systems. Refer to demonstration and training requirements in Division 01 Section.

END OF SECTION

**SECTION 230553
IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT**

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Equipment labels.
 - 2. Warning signs and labels.
 - 3. Pipe labels.
 - 4. Duct Labels.
 - 5. Valve tags.
 - 6. Warning tags.

1.02 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. The manufacturer, contractor or supplier shall resubmit the specification section and shall include a written statement that the submitted equipment, hardware or accessory complies with the requirement of that particular section. Next to each specification item, indicate the following:
 - 1. "No Exception Taken".
 - 2. "Exception". All exceptions shall be clearly identified by referencing respective paragraph and other requirements along with proposed alternative.
- C. Samples: For color, letter style, and graphic representation required for each identification material and device.
- D. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.
- E. Valve numbering scheme. See paragraph 2.7.B.
- F. Valve Schedules: For each piping system to include in maintenance manuals.

1.03 COORDINATION

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

PART 2 PRODUCTS

2.01 GENERAL

- A. Manufacturers:
 - 1. Craftmark Identification Systems
 - 2. Seton Identification Products
 - 3. MSI Marking Services
 - 4. Setmark

2.02 EQUIPMENT LABELS

- A. Metal Labels for Equipment:
 - 1. Material and Thickness: Brass or anodized aluminum, 0.032-inch minimum thickness and having predrilled or stamped holes for attachment hardware.
 - 2. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
 - 3. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
 - 4. Fasteners: Stainless-steel rivets or contact-type permanent adhesive, compatible with label and substrate.
 - 5. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- B. Plastic Labels for Equipment:
 - 1. Material and Thickness: Three-layer, multicolor, plastic labels for mechanical engraving, 1/16-inch-thick and having predrilled holes for attachment hardware.
 - 2. Color Coding:
 - a. Letter Color: White.
 - b. Background Color: Red.
 - 3. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
 - 4. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
 - 5. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
 - 6. Fasteners: Stainless-steel rivets or contact-type permanent adhesive, compatible with label and substrate.
- C. Label Content: Include equipment's Drawing designation or unique equipment number, drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified.
- D. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.03 WARNING SIGNS AND LABELS

- A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8-inch-thick, and having predrilled holes for attachment hardware.
- B. Color Coding:
 - 1. Background Color: Yellow.
 - 2. Letter Color: Black.
- C. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
- D. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
- E. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
- F. Fasteners: Stainless-steel rivets or self-tapping screws.

- G. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- H. Label Content: Include caution and warning information, plus emergency notification instructions.

2.04 PIPE LABELS

- A. Do not use pipe labels or plastic tapes for bare pipes conveying fluids at temperatures of 125 deg F (52 deg C) or higher.
- B. General Requirements for Manufactured Pipe Labels: Factory fabricated, flexible, semi-rigid plastic, preformed to fit around pipe or pipe covering. Larger pipe sizes may have maximum sheet size with separate fastener.
- C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing. Either marker shall show accepted color-coded background, proper color of legend in relation to background color, accepted legend letter size, accepted marker length.
- D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.
 - 1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
 - 2. Lettering Size: At least 1-1/2 inches high.

2.05 DUCT LABELS

- A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
- B. Letter Color: White.
- C. Background Color: Blue.
- D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
- E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
- F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
- G. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- H. Duct Label Contents: Include identification of duct service using same designations or abbreviations as used on Drawings; also include duct size and an arrow indicating flow direction.
 - 1. Flow-Direction Arrows: Integral with duct system service lettering to accommodate both directions or as separate unit on each duct label to indicate flow direction.

2.06 VALVE TAGS

- A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2 inch sequenced numbers.
 - 1. Tag Material: Brass, 0.032-inch minimum thickness and having predrilled or stamped holes for attachment hardware.
 - 2. Fasteners: Brass wire-link or beaded chain; or S-hook.
- B. Valve Schedules: For each piping system, on 8-1/2 by 11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.

1. Valve tag schedule shall be included in operation and maintenance data.

2.07 WARNING TAGS

- A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.
 1. Size: Approximately 4 by 7 inches.
 2. Fasteners: Brass grommet and wire.
 3. Nomenclature: Large-size primary caption such as "DANGER", "CAUTION" or "DO NOT OPERATE."
 4. Color:
 - a. Background Color: Yellow.
 - b. Letter Color: Black.

PART 3 EXECUTION

3.01 PREPARATION

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

3.02 GENERAL INSTALLATION REQUIREMENTS

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

3.03 EQUIPMENT LABEL INSTALLATION

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

3.04 PIPE LABEL INSTALLATION

- A. Retain "Piping Color Coding" Paragraph below to identify piping systems by color-coded painting. Labels will still be required to identify service, pipe size, and flow direction.
- B. Piping Color Coding: Painting of piping is specified in Section 099123 "Interior Painting."
- C. Revise "Pipe Label Locations" Paragraph below to suit Project.
- D. Pipe Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
 1. Near each valve and control device.
 2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
 3. Near penetrations and on both sides of through walls, floors, ceilings, and inaccessible enclosures.
 4. At access doors, manholes, and similar access points that permit view of concealed piping.
 5. Near major equipment items and other points of origination and termination.

6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
 7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.
- E. Directional Flow Arrows" Paragraph below is in compliance with ASME A13.1.
- F. Directional Flow Arrows: Arrows shall be used to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.
- G. Pipe Label Color Schedule:
- H. Retain first option in "Refrigerant Piping" Subparagraph below if refrigerant fluid is toxic or corrosive. All other options listed are user-defined options per ASME A13.1.
1. Refrigerant Piping: White letters on a red background.
- I. Retain, in subparagraphs below, one of the user-defined color schemes per ASME A13.1.

3.05 DUCT LABEL INSTALLATION

- A. Install plastic-laminated duct labels with permanent adhesive on air ducts in the following color codes:
1. Green: For cold-air supply ducts.
 2. Red: For hot-air supply ducts.
 3. Brown: For exhaust-, and return-air ducts.
- B. Retain "Stenciled Duct Label Option" Paragraph below only if stenciled labels are permitted.
- C. Locate labels near points where ducts enter into and exit from concealed spaces and at maximum intervals of 50 feet in each space where ducts are exposed or concealed by removable ceiling system.

3.06 VALVE-TAG INSTALLATION

- A. Revise this article as required to delete an entire piping system from tagging or other changes. A schedule is helpful for complex projects. Retain and revise first paragraph below if a schedule is prepared.
- B. Install tags on valves and control devices in piping systems, except check valves, valves within factory-fabricated equipment units, faucets, convenience and lawn-watering hose connections, and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.
- C. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:
- D. Other valve-tag sizes and shapes may be available if required.
1. Valve-Tag Size and Shape:
 - a. Refrigerant: 2 inches, round.
- E. Tag colors, if used, should follow the color schemes defined by ASME A13.1.

3.07 WARNING-TAG INSTALLATION

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

END OF SECTION

**SECTION 230593
TESTING, ADJUSTING, AND BALANCING FOR HVAC**

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
- B. Balancing Air Systems:
 - 1. Constant-volume air systems.
 - 2. Variable-air-volume systems.
- C. Testing, Adjusting, and Balancing Equipment:
 - 1. Heat exchangers.
 - 2. Motors.
 - 3. Condensing units.
- D. Testing, adjusting, and balancing existing systems and equipment.
- E. Sound tests.
- F. Vibration tests.
- G. Duct leakage tests.
- H. Control system verification.

1.02 DEFINITIONS

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

1.03 PREINSTALLATION MEETINGS

- A. TAB Conference: Conduct a TAB conference at Project site with the Engineer and Commissioning Agent 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.

1.04 INFORMATIONAL SUBMITTALS

- A. Qualification Data: 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: Submit the Contract Documents review report as specified in Part 3.

- C. Strategies and Procedures Plan: Submit TAB strategies and step-by-step procedures as specified in "Preparation" Article.
- D. System Readiness Checklists: 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.

1.05 QUALITY ASSURANCE

- A. TAB Specialists Qualifications: Engage an independent TAB Contractor certified by AABC or NEBB.
 - 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 as a TAB technician.
- B. Instrumentation Type, Quantity, Accuracy, and Calibration: Comply with requirements in ASHRAE 111, Section 4, "Instrumentation."
- C. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 7.2.2 - "Air Balancing."
- D. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.7.2.3- "System Balancing."

1.06 FIELD CONDITIONS

- A. Partial Owner Occupancy: Owner may occupy completed areas before areas of the building before Substantial Completion. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

PART 2 PRODUCTS (NOT APPLICABLE)

PART 3 EXECUTION

3.01 TAB SPECIALISTS

- A. Subject to compliance with requirements, available TAB specialists that may be engaged include, but are not limited to the following:
 - 1. American Air Balance Co., Inc.
 - 2. Air Balance Company, Inc.
 - 3. Los Angeles Air Balance Company, Inc.

3.02 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, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are applicable for intended purpose and are accessible.
- C. Examine the approved submittals for HVAC systems and equipment.
- D. Examine design data including HVAC system descriptions, statements of design assumptions for environmental conditions and systems output, and statements of philosophies and assumptions about HVAC system and equipment controls.
- E. Examine ceiling plenums and underfloor air plenums used for supply, return, or relief air to verify that they are properly separated from adjacent areas. Verify that penetrations in plenum walls are sealed and fire-stopped if required.
- F. Examine equipment performance data including fan and pump curves.
 - 1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
 - 2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.
- G. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.
- H. Examine test reports specified in individual system and equipment Sections.
- I. Examine HVAC equipment and verify that bearings are greased, belts are aligned and tight, filters are clean, and equipment with functioning controls is ready for operation.
- J. Examine heat-transfer coils for correct piping connections and for clean and straight fins.
- K. Examine system pumps to ensure absence of entrained air in the suction piping.
- L. Examine operating safety interlocks and controls on HVAC 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.

3.03 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 HVAC systems and equipment to verify system readiness for TAB work. Include, at a minimum, the following:
 - 1. Airside:
 - a. Verify that leakage and pressure tests on air distribution systems have been satisfactorily completed.
 - b. Duct systems are complete with terminals installed.
 - c. Volume, smoke, and fire dampers are open and functional.
 - d. Clean filters are installed.

- e. Fans are operating, free of vibration, and rotating in correct direction.
 - f. Variable-frequency controllers' startup is complete and safeties are verified.
 - g. Automatic temperature-control systems are operational.
 - h. Ceilings are installed.
 - i. Windows and doors are installed.
 - j. Suitable access to balancing devices and equipment is provided.
2. Hydronics:
- a. Verify leakage and pressure tests on water distribution systems have been satisfactorily completed.
 - b. Piping is complete with fan coils installed.
 - c. Variable-frequency controllers' startup is complete and safeties are verified.
 - d. Suitable access to balancing devices and equipment is provided.

3.04 GENERAL PROCEDURES FOR TESTING AND BALANCING

- A. Perform testing and balancing procedures on each system according to the procedures contained in ASHRAE Standard 111 or SMACNA's "HVAC Systems - Testing, Adjusting, and Balancing" and in this Section.
- B. 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, install test ports and duct access doors that comply with requirements in Section 233300 "Air Duct Accessories."
 - 2. Install and join new insulation.
- C. 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.
- D. Take and report testing and balancing measurements in inch-pound (IP) units.

3.05 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

- A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Cross-check 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 233113 "Metal Ducts."

3.06 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. Set outside-air, return-air, and relief-air dampers for proper position that simulates minimum outdoor-air conditions.
 - b. Where duct conditions allow, measure airflow by Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses to obtain total airflow.
 - c. Where duct conditions are not suitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.
 - d. If a reliable Pitot-tube traverse or coil traverse is not possible, measure airflow at terminals and calculate the total airflow.
 - 2. Measure fan static pressures as follows:
 - a. Measure static pressure directly at the fan outlet or through the flexible connection.
 - b. Measure static pressure directly at the fan inlet or through the flexible connection.
 - c. Measure static pressure across each component that makes up the air-handling system.
 - d. Report artificial loading of filters at the time static pressures are measured.
 - 3. Review Record Documents to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.
 - 4. Obtain approval from Architect 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.
 - 5. 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 occurs. 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.
 - 1. Measure airflow of submain and branch ducts.
 - 2. Adjust submain and branch duct volume dampers for specified airflow.
 - 3. Re-measure each submain and branch duct after all have been adjusted.
- C. Adjust air inlets and outlets for each space to indicated airflows.
 - 1. Set airflow patterns of adjustable outlets for proper distribution without drafts.
 - 2. Measure inlets and outlets airflow.
 - 3. Adjust each inlet and outlet for specified airflow.
 - 4. Re-measure each inlet and outlet after they have been adjusted.
- D. Verify final system conditions.
 - 1. Re-measure and confirm that minimum outdoor, return, and relief airflows are within design. Readjust to design if necessary.
 - 2. Re-measure and confirm that total airflow is within design.
 - 3. Re-measure all final fan operating data, rpms, volts, amps, and static profile.
 - 4. Mark all final settings.
 - 5. Test system in economizer mode. Verify proper operation and adjust if necessary.
 - 6. Measure and record all operating data.
 - 7. Record final fan-performance data.

3.07 PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS

- A. Adjust the variable-air-volume systems as follows:

1. Verify that the system static pressure sensor is located at least two-thirds of the distance down the duct from the fan discharge or as shown on the Drawings.
2. Verify that the system is under static pressure control.
3. Select the terminal unit that is most critical to the supply-fan airflow. Measure inlet static pressure and adjust system static pressure control set point 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.
4. Calibrate and balance each terminal unit for maximum and minimum design airflow as follows:
 - a. Adjust controls so that terminal is calling for maximum airflow. Some controllers require starting with minimum airflow. Verify calibration procedure for specific project.
 - b. Measure airflow and adjust calibration factor as required for design maximum airflow. Record calibration factor.
 - c. When maximum airflow is correct, balance the air outlets downstream from terminal units.
 - d. Adjust controls so that terminal is calling for minimum airflow.
 - e. Measure airflow and adjust calibration factor as required for design minimum airflow. Record calibration factor. If no minimum calibration is available, note any deviation from design airflow.
 - f. On constant volume terminals, in critical areas where room pressure is to be maintained, verify that the airflow remains constant over the full range of full cooling to full heating. Note any deviation from design airflow or room pressure.
5. After terminals have been calibrated and balanced, test and adjust system for total airflow. Adjust fans to deliver total design airflows within the maximum allowable fan speed listed by fan manufacturer.
 - a. Set outside-air, return-air, and relief-air dampers for proper position that simulates minimum outdoor-air conditions.
 - b. Set terminals for maximum airflow. If system design includes diversity, adjust terminals for maximum and minimum airflow so that connected total matches fan selection and simulates actual load in the building.
 - c. Where duct conditions allow, measure airflow by Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses to obtain total airflow.
 - d. Where duct conditions are not suitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.
 - e. If a reliable Pitot-tube traverse or coil traverse is not possible, measure airflow at terminals and calculate the total airflow.
6. Measure fan static pressures as follows:
 - a. Measure static pressure directly at the fan outlet or through the flexible connection.
 - b. Measure static pressure directly at the fan inlet or through the flexible connection.
 - c. Measure static pressure across each component that makes up the air-handling system.
 - d. Report any artificial loading of filters at the time static pressures are measured.
7. Set final return and outside airflow to the fan while operating at maximum return airflow and minimum outdoor airflow.
 - a. Balance the return-air ducts and inlets the same as described for constant-volume air systems.
 - b. Verify that terminal units are meeting design airflow under system maximum flow.
8. Re-measure the inlet static pressure at the most critical terminal unit and adjust the system static pressure set point to the most energy-efficient set point to maintain the optimum system static pressure. Record set point and give to controls contractor.
9. Verify final system conditions as follows:

- a. Re-measure and confirm that minimum outdoor, return, and relief airflows are within design. Readjust to match design if necessary.
- b. Re-measure and confirm that total airflow is within design.
- c. Re-measure final fan operating data, rpms, volts, amps, and static profile.
- d. Mark final settings.
- e. Test system in economizer mode. Verify proper operation and adjust if necessary. Measure and record all operating data.
- f. Verify tracking between supply and return fans.
- g. Verify building pressurization control by measuring building pressure at various operating conditions.

3.08 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.

3.09 PROCEDURES FOR CONDENSING UNITS

- A. Verify proper rotation of fans.
- B. Measure entering- and leaving-air temperatures.
- C. Record fan and motor operating data.

3.10 SOUND TESTS

- A. After the systems are balanced and construction is Substantially Complete, measure and record sound levels at locations as designated by the Architect.
- B. Instrumentation:
 1. The sound-testing meter shall be a portable, general-purpose testing meter consisting of a microphone, processing unit, and readout.
 2. The sound-testing meter shall be capable of showing fluctuations at minimum and maximum levels and measuring the equivalent continuous sound pressure level (LEQ).
 3. The sound-testing meter must be capable of using 1/3 octave band filters to measure mid-frequencies from 31.5 Hz to 8000 Hz.
 4. The accuracy of the sound-testing meter shall be plus or minus one decibel.
- C. Test Procedures:
 1. Perform test at quietest background noise period. Note cause of unpreventable sound that affects test outcome.
 2. Equipment should be operating at design values.
 3. Calibrate the sound-testing meter prior to taking measurements.
 4. Use a microphone suitable for the type of noise levels measured that is compatible with meter. Provide a windshield for outside or in-duct measurements.

5. Record a set of background measurements in dBA and sound pressure levels in the eight un-weighted octave bands 63 Hz to 8000 Hz (NC) with the equipment off.
 6. Take sound readings in dBA and sound pressure levels in the eight un-weighted octave bands 63 Hz to 8000 Hz (NC) with the equipment operating.
 7. Take readings no closer than 36 inches from a wall or from the operating equipment and approximately 60 inches from the floor, with the meter held or mounted on a tripod.
 8. For outdoor measurements, move sound-testing meter slowly and scan area that has the most exposure to noise source being tested. Use A-weighted scale for this type of reading.
- D. Reporting:
1. Report shall record the following:
 - a. Location.
 - b. System tested.
 - c. dBA reading.
 - d. Sound pressure level in each octave band with equipment on and off.
 2. Plot sound pressure levels on NC worksheet with equipment on and off.

3.11 VIBRATION TESTS

- A. After systems are balanced and construction is Substantially Complete, measure and record vibration levels on equipment having motor horsepower equal to or greater than 25.
- B. Instrumentation:
1. Use portable, battery-operated, and microprocessor-controlled vibration meter with or without a built-in printer.
 2. The meter shall automatically identify engineering units, filter bandwidth, amplitude, and frequency scale values.
 3. The meter shall be able to measure machine vibration displacement in mils of deflection, velocity in inches per second, and acceleration in inches per second squared.
 4. Verify calibration date is current for vibration meter before taking readings.
- C. Test Procedures:
1. To ensure accurate readings, verify that accelerometer has a clean, flat surface and is mounted properly.
 2. With the unit running, set up vibration meter in a safe, secure location. Connect transducer to meter with proper cables. Hold magnetic tip of transducer on top of the bearing, and measure unit in mils of deflection. Record measurement, then move transducer to the side of the bearing and record in mils of deflection. Record an axial reading in mils of deflection by holding nonmagnetic, pointed transducer tip on end of shaft.
 3. Change vibration meter to velocity (inches per second) measurements. Repeat and record above measurements.
 4. Record CPM or rpm.
 5. Read each bearing on motor, fan, and pump as required. Track and record vibration levels from rotating component through casing to base.
- D. Reporting:
1. Report shall record location and the system tested.
 2. Include horizontal-vertical-axial measurements for tests.
 3. Verify that vibration limits follow Specifications, or, if not specified, follow the General Machinery Vibration Severity Chart or Vibration Acceleration General Severity Chart from the AABC National Standards. Acceptable levels of vibration are normally "smooth" to "good."
 4. Include in report General Machinery Vibration Severity Chart, with conditions plotted.

3.12 DUCT LEAKAGE TESTS

- A. Witness the duct pressure testing performed by Installer.
- B. Verify that proper test methods are used and that leakage rates are within specified tolerances.
- C. Report deficiencies observed.

3.13 CONTROLS VERIFICATION

- A. In conjunction with system balancing, perform the following:
 - 1. Verify temperature control system is operating within the design limitations.
 - 2. Confirm that the sequences of operation are in compliance with Contract Documents.
 - 3. Verify that controllers are calibrated and function as intended.
 - 4. Verify that controller set points are as indicated.
 - 5. Verify the operation of lockout or interlock systems.
 - 6. Verify the operation of valve and damper actuators.
 - 7. Verify that controlled devices are properly installed and connected to correct controller.
 - 8. Verify that controlled devices travel freely and are in position indicated by controller: open, closed, or modulating.
 - 9. Verify location and installation of sensors to ensure that they sense only intended temperature, humidity, or pressure.
- B. Reporting: Include a summary of verifications performed, remaining deficiencies, and variations from indicated conditions.

3.14 TOLERANCES

- A. Set HVAC system's airflow rates and water flow rates within the following tolerances:
 - 1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus or minus 10 percent.
 - 2. Air Outlets and Inlets: Plus or minus 10 percent.
 - 3. Heating-Water Flow Rate: Plus or minus 10 percent.
 - 4. Cooling-Water Flow Rate: Plus or minus 10 percent.
- B. Maintaining pressure relationships as designed shall have priority over the tolerances specified above.

3.15 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 systems balancing devices. Recommend changes and additions to systems balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.
- B. Status Reports: Prepare monthly 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.

3.16 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. 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 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:
 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:
 19. Settings for outdoor-, return-, and exhaust-air dampers.
 20. Conditions of filters.
 21. Cooling coil, wet- and dry-bulb conditions.
 22. Face and bypass damper settings at coils.
 23. Fan drive settings including settings and percentage of maximum pitch diameter.
 24. Inlet vane settings for variable-air-volume systems.
 25. Settings for supply-air, static-pressure controller.
 26. Other system operating conditions that affect performance.
 27. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:
 28. Quantities of outdoor, supply, return, and exhaust airflows.
 29. Duct, outlet, and inlet sizes.
 30. Pipe and valve sizes and locations.
 31. Position of balancing devices.
- D. 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, and bore.

- i. Center-to-center dimensions of sheave and amount of adjustments in inches.
 - 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, and bore.
 - f. Center-to-center dimensions of sheave and amount of adjustments in inches.
 - g. Test Data (Indicated and Actual Values):
 - h. Total airflow rate in cfm.
 - i. Total system static pressure in inches wg.
 - j. Fan rpm.
 - k. Discharge static pressure in inches wg.
 - l. Filter static-pressure differential in inches wg.
 - m. Coil static-pressure differential in inches wg.
 - n. Supply airflow in cfm.
 - o. Return airflow in cfm.
 - p. Outdoor airflow in cfm.
 - q. Relief airflow in cfm.
 - r. Outdoor-air damper position.
- E. Apparatus-Coil Test Reports:
 - 1. Coil Data:
 - a. System identification.
 - b. Location.
 - c. Coil type.
 - d. Number of rows.
 - e. Fin spacing in fins per inch o.c.
 - f. Make and model number.
 - g. Face area in sq. ft.
 - h. Tube size in NPS.
 - i. Tube and fin materials.
 - j. Circuiting arrangement.
 - 2. Test Data (Indicated and Actual Values):
 - a. Airflow rate in cfm.
 - b. Average face velocity in fpm.
 - c. Air pressure drop in inches wg.
 - d. Outdoor-air, wet- and dry-bulb temperatures in deg F.
 - e. Return-air, wet- and dry-bulb temperatures in deg F.
 - f. Entering-air, wet- and dry-bulb temperatures in deg F.
 - g. Leaving-air, wet- and dry-bulb temperatures in deg F.
 - h. Refrigerant expansion valve and refrigerant types.
 - i. Refrigerant suction pressure in psig.
 - j. Refrigerant suction temperature in deg F.
- F. 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, and bore.
- h. Center-to-center dimensions of sheave and amount of adjustments in inches.
- 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, and bore.
 - f. Center-to-center dimensions of sheave, and amount of adjustments in inches.
 - g. Number, make, and size of belts.
- 3. Test Data (Indicated and Actual Values):
 - a. Total airflow rate in cfm.
 - b. Total system static pressure in inches wg.
 - c. Fan rpm.
 - d. Discharge static pressure in inches wg.
 - e. Suction static pressure in inches wg.
- G. 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.
 - d. Duct static pressure in inches wg.
 - e. Duct size in inches.
 - f. Duct area in sq. ft.
 - g. Indicated airflow rate in cfm.
 - h. Indicated velocity in fpm.
 - i. Actual airflow rate in cfm.
 - j. Actual average velocity in fpm.
 - k. Barometric pressure in psig.
- H. Instrument Calibration Reports:
 - 1. Report Data:
 - a. Instrument type and make.
 - b. Serial number.
 - c. Application.
 - d. Dates of use.
 - e. Dates of calibration.

3.17 VERIFICATION OF TAB REPORT

- 1. The TAB specialist's test and balance engineer shall conduct the inspection in the presence of commissioning authority.
- 2. Commissioning authority 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.

3. 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."
4. 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.
5. If TAB work fails, proceed as follows:
 - a. TAB specialists shall recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection.
 - b. If the second final inspection also fails, Owner may contract the services of another TAB specialist to complete TAB work according to the Contract Documents and deduct the cost of the services from the original TAB specialist's final payment.
 - c. If the second verification also fails, Owner may contact AABC or NEBB Headquarters regarding the Performance Guaranty.
 - d. Prepare test and inspection reports.

3.18 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 230713
DUCT INSULATION**

PART 1 GENERAL

1.01 SUMMARY

- A. This Section includes mechanical insulation for duct, equipment, and pipe, including the following:
 - 1. Insulation Materials:
 - a. Mineral-Fiber blanket.
 - 2. Adhesives.
 - 3. Tapes.
 - 4. Securements.
 - 5. Corner angles.
- B. Related Sections include the following:
 - 1. Division 23 Section "Metal Ducts" for duct liners.

1.02 DEFINITIONS

- A. FSK: Foil, scrim, kraft paper.
- B. FSP: Foil, scrim, polyethylene.
- C. SSL: Self-sealing lap.

1.03 SUBMITTALS

- A. Product Data: For each type of product indicated, identify thermal conductivity, thickness, and jackets (both factory and field applied, if any).
- B. Shop Drawings: Show details for the following:
 - 1. Application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
 - 2. Insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
 - 3. Removable insulation at piping specialties, equipment connections, and access panels.
 - 4. Application of field-applied jackets.
 - 5. Application at linkages of control devices.
 - 6. Field application for each equipment type.
- C. Installer Certificates: Signed by Contractor certifying that installers comply with requirements.
- D. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.

1.04 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. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per ASTM E 84, by a test

ing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, and cement material containers, with appropriate markings of applicable testing and inspecting agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.05 DELIVERY, STORAGE, AND HANDLING

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

1.06 COORDINATION

- A. Coordinate size and location of supports, hangers, and insulation shields specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."
- B. Coordinate clearance requirements with piping Installer for piping insulation application, duct Installer for duct insulation application, and equipment Installer for equipment insulation application. Before preparing piping and ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

1.07 SCHEDULING

- A. Schedule insulation application after pressure testing systems. Insulation application may begin on segments that have satisfactory test results.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, products specified.
 2. Products: Subject to compliance with requirements, provide one of the products specified.
 3. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include but are not limited to manufacturers specified.
 4. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.02 INSULATION MATERIALS

- A. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- B. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
- C. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

- D. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- E. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type III with factory applied FSK jacket. Factory-applied jacket requirements are specified in Part 2 "Factory-Applied Jackets" Article.
 - 1. Products:
 - a. Johns Manville; Microlite.
 - b. Knauf Insulation; Duct Wrap.
 - c. Owens Corning; All-Service Duct Wrap.
 - d. Certainteed Corp.; Soft Touch Duct Wrap.

2.03 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.
- B. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.
 - 1. Products:
 - a. Aeroflex USA Inc.; Aero seal.
 - b. Armacell LCC; 520 Adhesive.
 - c. Foster Products Corporation, H. B. Fuller Company; 85-75.
 - d. RBX Corporation; Rubatex Contact Adhesive.
- C. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
 - 1. Products:
 - a. Childers Products, Division of ITW; CP-82.
 - b. Foster Products Corporation, H. B. Fuller Company; 85-20.
 - c. ITW TACC, Division of Illinois Tool Works; S-90/80.
 - d. Marathon Industries, Inc.; 225.
 - e. Mon-Eco Industries, Inc.; 22-25.

2.04 TAPES

- A. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive and UL listed.
 - 1. Products:
 - a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0800.
 - b. Compac Corp.; 120.
 - c. Ideal Tape Co., Inc., an American Biltrite Company; 488 AWF.
 - d. Venture Tape; 3520 CW.
 - 2. Width: 2 inches.
 - 3. Thickness: 3.7 mils.
 - 4. Adhesion: 100 ounces force/inch in width.
 - 5. Elongation: 5 percent.
 - 6. Tensile Strength: 34 **lbf/inch** in width.

2.05 SECUREMENTS

- A. Insulation Pins and Hangers:
 - 1. 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.
 - a. Products:
 - 1) AGM Industries, Inc.; CWP-1.

- 2) GEMCO; CD.
 - 3) Midwest Fasteners, Inc.; CD.
 - 4) Nelson Stud Welding; TPA, TPC, and TPS.
 2. 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.
 - a. Products:
 - 1) AGM Industries, Inc.; CWP-1.
 - 2) GEMCO; Cupped Head Weld Pin.
 - 3) Midwest Fasteners, Inc.; Cupped Head.
 - 4) Nelson Stud Welding; CHP.
 3. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, and securely in position indicated when self-locking washer is in place. Comply with the following requirements:
 - a. Products:
 - 1) AGM Industries, Inc.; Tactoo Insul-Hangers, Series T.
 - 2) GEMCO; Perforated Base.
 - 3) Midwest Fasteners, Inc.; Spindle.
 - b. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
 - c. Spindle: Copper- or zinc-coated, low carbon steel, fully annealed, 0.106-inch- diameter shank, length to suit depth of insulation indicated.
 - d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
 4. Insulation-Retaining Washers: Self-locking washers formed from **0.016-inch-** thick, galvanized-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than **1-1/2 inches** in diameter.
 - a. Available Products:
 - 1) AGM Industries, Inc.; RC-150.
 - 2) GEMCO; R-150.
 - 3) Midwest Fasteners, Inc.; WA-150.
 - 4) Nelson Stud Welding; Speed Clips.
 - b. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.
- B. Staples: Outward-clinching insulation staples, nominal 3/4-inch- wide, stainless steel or Monel.
- C. Wire: 0.062-inch soft-annealed, galvanized steel.
 1. Manufacturers:
 - a. ACS Industries, Inc.
 - b. C & F Wire.
 - c. Childers Products.
 - d. PABCO Metals Corporation.
 - e. RPR Products, Inc.

2.06 CORNER ANGLES

- A. PVC Corner Angles: 30 mils thick, minimum 1 by 1 inch, PVC according to ASTM D 1784, Class 16354-C. White or color-coded to match adjacent surface.
- B. Aluminum Corner Angles: 0.040-inch-thick, minimum 1 by 1 inch, aluminum according to ASTM B 209, Alloy 3003, 3005, 3105 or 5005; Temper H-14.

PART 3 EXECUTION

3.01 EXAMINATION

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

3.02 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

3.03 COMMON INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces, free of voids throughout the length of equipment, ducts and fittings, and piping including fittings, valves, and specialties.
- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment, duct system, and pipe system as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- G. Keep insulation materials dry during application and finishing.
- H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- I. Install insulation with least number of joints practical.
- J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
 - 1. Install insulation continuously through hangers and around anchor attachments.
 - 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
 - 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
 - 4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
- K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- L. Install insulation with factory-applied jackets as follows:
 - 1. Draw jacket tight and smooth.

2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
 3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at **2 inches** o.c.
 - a. For below ambient services, apply vapor-barrier mastic over staples.
 4. Cover joints and seams with tape as recommended by insulation material manufacturer to maintain vapor seal.
 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct and pipe flanges and fittings.
- M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.
- P. For above ambient services, do not install insulation to the following:
1. Vibration-control devices.
 2. Testing agency labels and stamps.
 3. Nameplates and data plates.
 4. Manholes.
 5. Handholes.
 6. Cleanouts.

3.04 PENETRATIONS

- A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
1. Seal penetrations with flashing sealant.
 2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
 4. Seal jacket to roof flashing with flashing sealant.
- B. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
1. Seal penetrations with flashing sealant.
 2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
 4. Seal jacket to wall flashing with flashing sealant.
- C. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

D. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions. Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches.

1. Firestopping and fire-resistive joint sealers are specified in Division 07 Section "Through-Penetration Firestopping."

3.05 MINERAL-FIBER INSULATION INSTALLATION

A. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.
2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
 - a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
 - b. On duct sides with dimensions larger than 18 inches, place pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
 - c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
 - d. Do not over compress insulation during installation.
 - e. Impale insulation over pins and attach speed washers.
 - f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches (50 mm) from 1 edge and 1 end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch (13-mm) outward-clinching staples, 1-inch (25 mm) o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
 - a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
 - b. Install vapor stops for ductwork and plenums operating below 50 deg F (10 deg C) at 18-foot (5.5-m) intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to 2 times the insulation thickness but not less than 3 inches (75 mm).
5. Overlap unfaced blankets a minimum of **2 inches** on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of **18 inches** o.c.
6. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
7. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with **6-inch**- wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced **6 inches** o.c.

3.06 FINISHES

- A. Duct, Equipment, and Pipe Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material:
Paint jacket with paint system identified below and as specified in Division 09 painting Sections.
 - 1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
 - a. Finish Coat Material: Interior, flat, latex-emulsion size.
- B. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.
- C. Do not field paint aluminum or stainless-steel jackets.

3.07 DUCT INSULATION SCHEDULE, GENERAL

- A. Plenums and Ducts Requiring Insulation:
 - 1. Supply and return air ducts.
 - a. Concealed supply and return ducts.
 - b. Supply and return ducts that are within an attic return plenum and above a ceiling.
- B. Items Not Insulated:
 - 1. Fibrous-glass ducts.
 - 2. Metal ducts with duct liner of sufficient thickness to comply with energy code and ASHRAE/IESNA 90.1.
 - 3. Factory-insulated flexible ducts.
 - 4. Factory-insulated plenums and casings.
 - 5. Flexible connectors.
 - 6. Vibration-control devices.
 - 7. Factory-insulated access panels and doors.
 - 8. Exposed-to-view ducts within conditioned space they serve, unless otherwise indicated on plans.
 - 9. Exhaust ducts.

3.08 INDOOR DUCT AND PLENUM INSULATION SCHEDULE

- A. Exposed supply, return, outside air and relief ducts located in mechanical rooms:
 - 1. 2-inch-thick duct liner-see Metal Ducts Section.
- B. Concealed supply, return, and outside air ducts:
 - 1. Mineral-Fiber Blanket: 3 **inches** thick and **0.75-lb/cu. ft.** nominal density. Minimum installed R-Value of 8.0.

3.09 ABOVEGROUND, SUPPLY, RETURN, AND OUTSIDE AIR DUCT AND PLENUM INSULATION SCHEDULE

- A. Duct liner- see specification section 233113 Metal Ducts.

END OF SECTION

SECTION 230900
INSTRUMENTATION AND CONTROL FOR HVAC – BUILDING AUTOMATION SYSTEM

PART 1 GENERAL

1.01 SUMMARY

- A. Related Sections:
 - 1. Division 0
 - 2. Division 1
 - 3. Divisions 22 and 23 Sections for General Mechanical Provisions.
 - 4. Division 26 Sections for General Electrical Provisions.
 - 5. Division 27 Sections for Communication Provisions.
- B. This section describes the scope of work for the Building Automation System (BAS) that must be installed by a qualified BAS Contractor and integrated to the Long Beach Unified District, herein after referred to as "District", Campus Supervisor Server (if available for particular manufacturer) by the BAS Contractor/Developer.
- C. Provide Building Automation System incorporating Direct Digital Control (DDC), energy management and equipment monitoring consisting of the following elements:
 - 1. Microprocessor based remote control panels interfacing directly with sensors, actuators, and environmental delivery systems to provide complete standalone DDC/EMS functionality. (i.e., HVAC equipment, lab monitoring, energy metering, etc.).
- D. BAS will be centralized and hosted by District's network in a virtual space. Physical servers will not be accepted unless an exception is granted by District. If there is an existing virtual space provided by the BAS contractor, new BAS sites should be connected to the existing virtual space. If the installing contractor currently does not have a centralized BAS virtual server, then the BAS contractor should provide and install a central enterprise level server within District's network.
- E. Provide communication network to allow data exchange between remote panels and central web supervisor servers.
- F. Human Machine Interface (HMI) control:
 - 1. Controls installer shall interface the BAS systems with the BAS panel provided by the equipment manufacturer. Control installer shall provide integrator panel and all wiring from BAS to equipment panel and from equipment panel to other equipment. Equipment panel communications protocol shall be BACnet MSTP to a system. BACnet IP must be a separate network communicating through the system secondary IP port.
 - 2. Provide devices that adhere and meet District minimum network connectivity standards and protocols
 - a. Wired Ethernet Standards
 - 1) 1000BASE-T connection over Category 6 cable – CONFIRM JACKET COLOR WITH DISTRICT
 - b. Wi-Fi Network Standards
 - 1) IEEE 802.11ac
 - 2) 2.4/5 GHz radio support (5 Hz preferred)
 - (a) WPA2 Enterprise Authentication support
 - (1) 802.1X
 - (2) Assigned Certificate (Preferred)
 - (3) Radius (Username/password)

- (b) Endpoint Devices should support
 - (1) TCP/IP standards and protocols
 - (2) DHCP automatic IP assignment
 - (3) Manual IP, subnet, gateway, DNS and NTP time source
 - (4) Modification of host name
- G. Provide Submittals, installation, data entry, programming, startup, test and validation of BAS, instruction to District representative on maintenance and operation of BAS, as built documentation, and system warranty.
- H. Coordinate work of other trades.
- I. Provide electric and electronic control for all items indicated including dampers, valves, panels, and pneumatic and electrical installation.
- J. It is District's goal to implement an open system that will allow products from various suppliers to be integrated into a unified system to provide flexibility for expansion, maintenance, and service of the system. District shall be the named license holder of all software associated with any and all incremental work on the project(s).
- K. Provide labor, material, equipment, and software not specifically referred to herein or on the plans, that is required to meet the functional intent of this specification, without additional cost to District.
- L. Integrator to communicate with the equipment manufacturer/distributor to ensure all necessary control points are available to meet the design criteria and District design standards.
- M. The BAS shall not be used to control lighting fixtures or lighting controls
- N. The BAS shall not be used to control equipment in single occupancy restrooms

1.02 DEFINITIONS

- A. BACnet: An open communications protocol for building automation and latest ASHRAE 135 control networks. It is an ASHRAE, ANSI, and ISO standard protocol developed under the auspices of the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE).
- B. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.
- C. TCP/IP: Short for Transmission Control Protocol/Internet Protocol. A protocol for communication between computers, used as a standard for transmitting data over networks and as the basis for standard Internet protocols.

1.03 SCOPE OF WORK

- A. Supervisor software and network controllers are required for the supervisor and network levels of the BAS. Communication at these levels shall be Secure TCP/IP-based protocol. Access to the system, locally in each building, shall be accomplished using a technician's login in the online platform.
- B. Contractor to provide (1) one new laptop per project site with the following specifications:
 - 1. HP ZBook Standard Laptop
 - a. HP ZBook 15 **G10** Mobile Workstation
 - b. Intel **Core i7-13700H 5.0 GHz Processor**
 - c. **32GB DDR5-5200 MHz RAM Memory**
 - d. 1000 GB (terabyte) Solid State Drive
 - e. NVIDIA **2000 8 GB**

- f. 15.6" diagonal Anti-Glare LED-backlit FHD (1920 x 1080) Display
 - g. HD 720p WebCam
 - h. Wireless Networking and Bluetooth 5
 - i. RJ45 Ethernet port for wired network connectivity.
 - j. **1 Superspeed USB Type A port 5 Gbps signaling rate**
 - k. **2 superspeed USB Type A ports 5Gbps signaling rate (charging)**
 - l. **1 Thunderbolt4™ (USB-C) port**
 - m. SD card reader and Smart Card reader
 - n. 1 HDMI **2.1 nano** video output for projector connectivity*
 - o. CA eWaste Recycling Fee (included in the total)
- 2. Or Approved Equal
- 3. Contractor to provide all necessary mechanical service tools.
 - a. Service tool shall be able to connect to mechanical equipment to service and perform system diagnostics.
 - b. Provide manufacturer approved service tools.
 - c. Provide two (2) sets of tools per project site.
 - 1) If multiple manufacturers, Contractor to provide two (2) sets of services tools per manufacturer installed.
- 4. District shall have access all points in the BAS. Reports and trends shall be accessible through wizards.
- C. Each system shall communicate directly to BACnet MSTP (BNC) devices and other open and legacy protocol systems/devices provided under this Division.
- D. The work provided in this specification shall be performed by multiple entities. The BAS Contractor shall have overall responsibility for the Division work.
- E. BAS Contractor shall provide overall management, coordination, and responsibility for delivering integrated BAS systems. The BAS Contractor shall review work performed by other Specialty Contractors such as low voltage, IT, security, and control system subcontractors and coordinate the connection of these systems to District's IT infrastructure in conjunction with District IT staff.
 - 1. Coordination with LBUSD Technology department is the responsibility of the control's contractor for any installation of new Building Automation System (BAS) or updating of existing BAS. Any new installations of a BAS user interface must be approved by District in writing.
- F. All materials and equipment used shall be standard components. All systems and components shall have been thoroughly tested and proven in actual use for at least (2) two-years.
- G. All wiring shall be done in accordance with all local and national codes.
- H. Additional Integration Option (to be approved by District): The Building Automation System (BAS) shall be comprised of Niagara platform for different type controllers within each facility. Integration with the software Framework shall be accomplished through a BAS contractor-installed controller.
- I. Additional Integration Option (to be approved by District): Each copy of software shall be available for one year with additional options for a three to five-year Software Maintenance Agreement.

1.04 DIVISION OF WORK

- A. This section contains specifications pertaining to the (new/expansion of existing) software-based Building Automation System controls at "Project Site".
- B. All work including provision of materials and installation is to be performed by the BAS Contractor with input from the District BAS Energy Management and Maintenance Department

- C. System programming
 - 1. Contractor provides system programming and graphics per District BAS Department Standards.
- D. Functional Acceptance Testing
 - 1. Third-Party Commissioning Agent will provide proof of point to point documentation for all hardware and terminations provided. The Contractor and/or author of Sequence shall provide written Functional Acceptance Test Scripts based on the Sequence provided prior to the actual functional test date.
- E. The BAS Contractor shall be responsible for all communicating thermostats, any miscellaneous BACnet controllers, control devices, control panels, controller programming, and controller programming software, controller input/output and power wiring and controller network wiring.
- F. The BAS Contractor shall be responsible for Control Engine(s), software and programming, graphical user interface software (GUI), and connection of the system to the local or wide area network. BAS Contractor shall also be responsible for development of all graphical screens, Web browser pages, setup of schedules, logs and alarms, and network management for all BNC devices.
- G. BNC devices not provided by BAS Contractor shall be configured and commissioned by appropriate contractor and later managed in the controller shall be integrated by BAS contractor.
- H. For security and consistency, it is District's intention to divide the work defined in this section into two sections:
 - 1. Work performed at the controller level and below shall be performed by a qualified BAS Contractor Systems Integrator.
 - a. District BAS Department will provide access to the Campus Construction Server for graphics development
 - 2. All work provided at the District Server and between the District Server shall be provided by District personnel and District IT approved contractor. **BAS Contractor should be responsible for the cost of hiring District approved sub-contractor.** District personnel shall also be responsible for all Security integration at the Supervisor Server level, if applicable.
- I. All work pertaining to global strategies across sites and other intelligent building systems including between the software and other subsystems shall be done by the BAS Contractor.

1.05 QUALITY ASSURANCE

- A. DDC System Manufacturer Qualification:
- B. **Carrier i-Vu**
- C. Or Approved Equal
- D. All new DDC controllers shall be programmed utilizing most up to date software as specified and shall be capable of communicating with the District front end software via the campus LAN. Supervisor to software version hierarchy must be followed.
- E. Licensing of controllers and software must be open license allowing complete admin abilities to end user. Proprietary devices, licensing, and networks are not acceptable. All controllers/devices must adhere to Best Practices.
- F. For compatibility with existing systems' all facets and units of data must be U.S. standard.
- G. All electronic equipment shall conform to the requirements of FCC Regulation, Part 15, and Governing Radio Frequency Electromagnetic Interference and be labeled.

- H. UPS to be installed for 120v feeding power supply to controller system and battery backup between 30 to 90 minutes with approval from District. This is to be installed with physical servers only.
- I. System to be installed by competent technicians, with full responsibility for proper operation of BAS, including debugging and proper calibration of each component in entire system.
- J. Codes and approvals:
 - 1. Complete BAS installation to be in strict accordance with national and local electrical codes. All devices designed for or used in line voltage applications to be UL listed. Also, latest ASHRAE standard 135 compliant.
- K. All system components shall be fault tolerant.
 - 1. Provide satisfactory operation without damage at 110 percent and 85 percent of rated voltage, and at +/- 3 hertz variation in line frequency.
 - 2. Provide static, transient, short circuit, and surge protection on all inputs and outputs. Communication lines to be protected against incorrect wiring, static transients, and induced magnetic interference. Bus connected devices to be AC coupled, or equivalent so that any single device failure will not disrupt or halt bus communication.

1.06 QUALIFICATIONS

- A. Detailed design, & installation of the Building Automation System shall be by a BAS Contractor that meets the following requirements:
 - 1. Contractor's primary personnel that will be working on this project will have successfully completed required training at the time of bid. Contractor to provide proof of mechanics / technicians having completed this training as part of Submittals. These mechanics / technicians are to be designated as the primary designers / installers / integrators. They will be the responsible parties to be on site during the installation. In addition, they will be required to attend all pre-construction, construction, and post construction meetings, including acceptance testing and training.
 - 2. Experience installing at least three networked BAS systems utilizing specified control systems integrating controls utilizing BACnet communications protocol in the last 3 years. Submit information documenting this experience including contact information of client representative familiar with the contractors work on each project.

1.07 BASIC BAS REQUIREMENTS

- A. Panel Locations:
 - 1. BAS panels should be under cover and centrally located relative to controlled equipment.
 - 2. BAS panels shall be protected from pipe leakage, dust, and other hazards and shall have a minimum 36" working clearance in front of each panel.
 - 3. BAS panels will be located as indicated on project mechanical drawings. The exact panel location will be determined by the Contractor and the District's Representative prior to the installation process.
 - 4. All panels shall be fully accessible without space restrictions to allow easy service and troubleshooting. Contractor shall obtain District approval of panel locations prior to proceeding with the work.
 - 5. Anything not factory installed should be installed per manufacturers guidelines
- B. DDC controllers and remote IO's shall provide the capability to manually override both digital and analog outputs at the BAS panel.
 - 1. Interface Relays: BAS output points shall not be used for direct switching of motor control circuits. Provide an interface relay at the BAS panel, between the DDC controller and motor starter or equipment.

2. Status Monitoring: Electric current sensor switches shall be used for BAS status monitoring. (As opposed to differential pressure switches or flow switches). These shall be located in the motor starter panel.
- C. All thermostat devices must be directly powered and hardwired to each mechanical unit. Wireless thermostats will not be accepted unless prior approval from the District is received.
- D. Start-Up Testing (Commissioning):
 1. BAS Commissioning shall consist of pre-functional and functional testing phases as described under section 3 Execution. The Contractor shall include BAS commissioning in the construction schedule.
 2. Commissioning in phases does not substitute the requirement of full commissioning of the systems when fully integrated. Full commissioning is required when the system is completely integrated.

1.08 SUBMITTALS

- A. Shop Drawings: Provide individuals experienced with the installation and startup of equipment related to this type of integration.
 1. One copy of shop drawings of the entire BAS shall be submitted and shall consist of a complete list of equipment and materials, including manufacturers catalog data sheets and installation instructions.
 2. List of all labelling nomenclature
 3. Points list must include:
 - a. Equipment description that is being controlled
 - b. Room number that it serves
 - c. Location of control point/sensor
 4. Complete system design information including:
 - a. Data entry forms for initial parameters. All text and graphics to be approved prior to data entry.
 - b. Data graphics nomenclature should be consistent throughout the District, unless agreed upon with District
 - c. Valve, and damper schedules showing:
 - 1) Size
 - 2) Configuration
 - 3) Capacity
 - 4) Location
 - d. Wiring and piping interconnection diagrams, including panel and device power and sources.
 - e. Equipment lists (bill of materials) of all proposed devices and equipment.
 - f. Software design data including
 - 1) Flow chart of each DDC program showing interrelationship between inputs, PID functions, all other functions, outputs, etc.
 - 2) Sequence of operation relating to all flow chart functions
 - g. Control sequence
 - h. DDC installation, block diagrams, and wiring diagrams for each piece of equipment
 - i. DDC panel physical layout and schematics
 - j. The network topology diagram shall indicate the location and room number of all DDC controllers
 - k. The BAS Contractor shall submit an architecture layout that depicts devices from the initial point design point down to the device level
 - l. The BAS Contractor shall submit an architecture layout that depicts network diagrams for controller to controller communications as well as controller to server

- m. BACnet specific designs:
- n. The BAS Contractor shall submit a network topology diagram that includes the following on all BACnet devices
 - 1) TCP/IP Address
 - 2) MAC Address
 - 3) Device instance number
 - 4) BACnet Port
 - 5) Devices configured for BBMD (BACnet/IP Broadcast Management Device)
 - 6) BACnet routers and subnets
- 5. Sequence of Operations
 - a. A complete written Sequence of Operation shall also be included with the submittal package. The BAS Contractor shall coordinate data from other contractors supplying products and systems, as part of their package and shall provide catalog data sheets, wiring diagrams and point lists to District for proper coordination of work
- 6. If a project is considered a renovation project the BAS Contractor shall update all existing master diagrams to keep as-built drawings completely accurate for the entire building.
 - a. Digital Visio updateable drawings to be provided on an USB.
- 7. A copy of all networks must be drawn on the actual physical chain as installed. This is the actual blueprint showing the floorplan, equipment location and the route in which the network was run.
- B. Product Data
 - 1. Complete list of product data including:
 - a. Data sheets of all products
 - b. Valve, damper, and well and tap schedules showing size, configuration, capacity, and location of all equipment
- C. Project Information
 - a. Certification of installer qualifications
- D. Submittal shall also include a copy of each of the graphics developed for the Graphic User Interface including a flowchart (site map) indicating how the graphics are to be linked to one another for system navigation. The graphics are intended to be 80% - 90% complete upon submittal with the only remaining changes to be based on review comments from the A/E design team and/or District. It is expected that the BAS Contractor shall utilize the District graphic templates as much as possible. District will provide an example of an acceptable graphic template. Where a particular graphic template does not exist, the Integrator shall create a similar template and gain approval during submittal process.
- E. Upon completion of the work, provide a complete set of 'as-built' drawings and application software on USB. Drawings shall be provided as AutoCAD or Visio as well as PDF compatible files.
- F. Contract Closeout Information:
 - 1. Operating and maintenance manuals
 - 2. Instruction report for District
 - 3. Certification that Training for District has been provided by BAS installer
 - 4. As Built Instrumentation and Control Diagrams
- G. Any software needed to program or calibrate controls system will be provided along with any setup, configurations, and data files. Also, any hardware needed to communicate with the controllers and/or devices must also be included

1.09 JOB CONDITIONS

- A. Cooperation with other Trades:

- a. Coordinate the Work of this section with that of other Sections to ensure that the work will be carried out in an orderly fashion. It shall be the Systems Integrator's responsibility to check the Contract documents for possible conflicts between his work and that of other crafts in equipment location, pipe, duct, and conduit runs, electrical outlets and fixtures, air diffusers and structural and architectural features.

1.10 WARRANTY

- A. Warranty shall cover all costs for parts, labor, associated travel, and expenses for a period of one (1) year from completion of system acceptance.
- B. Provide all services, materials, and equipment necessary for the successful operation of the entire BAS after acceptance by District representative and provide hardware and software upgrade support during that period that corresponds with any upgrades performed by the BAS Contractor Systems Integrator.
- C. Upon discovery of any defects in the work provided under this section due to faulty materials, methods of installation or workmanship shall be promptly repaired or replaced. Systems or parts found defective shall be provided and installed at no cost to District by the BAS Contractor including, but not limited to:
 - a. Building Controls System Server software, project-specific software, graphic software, database software, and firmware updates that resolve known software deficiencies, as identified by the Contractor or District, shall be provided, and installed at no charge during the warranty period.
 - b. Contractor to apply all software updates and security patches immediately as they become available, from the start of the project until the end of the warranty period.
 - c. All corrective software modifications made during the warranty period shall be updated on all user documentation and on user and manufacturer archived software disks.
 - d. All parts shall be replaced with the exact products. If exact parts are not available, then the equivalency determination rests with District.
- D. During warranty period, provide quarterly Preventative Maintenance checks (allow 4 hours per visit).
 - a. Contractor shall provide quarterly Preventive Maintenance checks report to the District maintenance manager after each visit.
 - b. Contractor to provide maintenance schedule with close out documents and shall include:
 - 1) Date and time
 - 2) Must coordinate for site access with District at least one week in advance
- E. District will initiate service calls when the system is not functioning properly. Qualified personnel shall be available to provide service to the complete system. Provide District with a telephone number where service representative can always be reached. Hardware and software personnel supporting this warranty agreement shall provide on-site and/or off-site service in a timely manner after failure notification to the vendor. The distributor shall have company owned service and installation branch capable of a (4) four-hour response time, 24 hours a day, 7 days a week, for emergency on-site service.
- F. At the end of the warranty period, Contractor shall ensure every instance of software has the latest software maintenance release installed.
- G. Expiration of the warranty period does not relieve Contractor of the responsibility for correcting all deficiencies identified during the warranty period. Expiration of the warranty period does not relieve Contractor of the responsibility for fulfilling all specified obligations during warranty period.

1.11 OPERATIONS AND MAINTENANCE MANUAL

- A. Each Operations and Maintenance Manual shall contain the following:
 - 1. List of all equipment with Manufacturer's name, performance rating, nameplate rating, model number, local representative, service facilities, and normal channel of supply for each item
 - 2. Manufacturer's literature describing each piece of equipment with a detailed Parts list.
 - 3. Guarantees and Warranties.
 - 4. Certificates.
 - 5. Record Drawings.
 - 6. Control Manual & Documentation.
- B. The following information shall be provided at Project completion:
 - 1. Shop drawings of control system showing all devices, interconnections between devices, and connections to items provided under other divisions.
 - 2. Specification data sheets.

1.12 TRAINING FOR DISTRICT

- A. In no case shall training be scheduled until all graphics are approved and accepted by District BAS Department representative.
- B. Training shall not proceed until District BAS Department representative has reviewed and approved the Training Submittal.
- C. Provide a minimum of 8 hours of training, organized into 2 separate sessions (see Appendix A – Training Timeline).
- D. Provide a factory-trained instructor or representative to give full instructions to designated personnel in the operation, maintenance, and programming of each piece of equipment or system. Instructors shall be thoroughly familiar with all aspects of the subject matter. The Contractor shall provide all equipment and material required for classroom training.
- E. Qualifications of proposed training instructor are subject to District approval.
- F. The training shall be specifically oriented to the system and interfacing equipment installed.
- G. Organize training per user group and into different training sessions. District to provide user groups (see Appendix A – Training Timeline).
- H. Provide classroom instruction and field demonstration.
- I. Classroom instruction should include at a minimum:
 - 1. Detailed review of as-built documentation and conditions with general equipment layout
 - 2. In depth discussion of theory of sequence of operations
 - 3. Review organization and usability of O&M documentation
 - 4. Maintenance (preventative, sensor calibration, etc.) procedures and schedules
 - 5. Pertinent safety requirement
 - 6. Operator control functions including graphic operation and navigation
 - 7. Explanation of adjustment, calibration, and replacement procedures
 - 8. Explanation of procedures to restore any building level controller or building control system server database. Training manual shall include screen captures, including instructional annotation, of each step required to accomplish the task.
 - 9. Explanation of procedures to restore any local control unit database. Scenarios to explain include: restoring a database that is corrupted in an existing unit; restoring a database in a new unit that replaces an identical existing unit; and restoring a database in a new unit that is a different controller than the failed unit being replaced. Training manual shall include screen captures, including instructional annotation, of each step required to accomplish the task, for each type of DDC controller installed.

10. Detailed review of all DDC logic, programming, and programming documentation. Control logic shall be graphical and annotated to describe how it accomplishes the sequence of operation. Annotations shall be sufficient to allow District's BAS Integrators to relate each program component block to corresponding portions of the specified Sequence of Operation. Training manual shall include screen captures, including instructional annotation, of all DDC logic, programming, and programming documentation, for each type of DDC controller installed.
- J. Field instruction, if determined by District to be required for this project, should include at a minimum:
 1. Normal maintenance procedures
 2. Demonstration of operation
 3. Demonstration of safeties and interlocks
 4. Walk-through of the job to locate control components

1.13 SYSTEM ARCHITECTURE

- A. General
 1. System architecture should accommodate the most current infrastructure of District.
 2. The BAS shall be comprised of a network of interoperable, stand-alone digital controllers, a computer system, graphical user interface software, network devices and other devices as specified.
 3. The intent of this specification is to provide a peer-to-peer networked, stand-alone, distributed control system with the capability to integrate the most current ANSI/ASHRAE Standard BACnet (ASHRAE 135), and other existing open and proprietary communication protocols if applicable in one open, interoperable system.
 4. The supplied Building Automation System shall employ component-based technology for representation of all data and control devices within the system. In addition, adherence to industry standards including the most current standard, BACnet to assure interoperability between all system components is required. For each BACnet device, the device supplier must provide a PICS (Protocol Implementation Conformance Statement) document showing the installed device's compliance level. Physical connection of BACnet devices shall be via BACnet MSTP or Ethernet (BACnet Ethernet/IP), only by exception with prior District BAS Department/personnel approval and only through the controllers' secondary IP port.
 5. The supplied system must incorporate the ability to access all data using standard Web browsers without requiring proprietary operator interface and configuration programs. An Open Database Connectivity (ODBC) or Structured Query Language (SQL) compliant server database is required for all system database parameter storage. This data shall reside on a supplier-installed central server preferably hosted in District's primary data center for all database access. Contractor must receive IT approval before installation. Systems requiring proprietary database and user interface programs shall not be acceptable.
 6. A hierarchical topology is required to assure reasonable system response times and to manage the flow and sharing of data without unduly burdening internal network. Systems employing a "flat" single tiered architecture will not be acceptable.
 7. The installed system shall provide secure passwords access to all features, functions and data contained in the overall BAS.
 8. System architecture shall consist of at least (3) three levels of LAN and/or communication busses as stated below:
 - a. Level one – Administrator/ Programmer level
 - b. Level two – Building Operator/ Technician level
 - c. Level three – Read only level

1.14 NETWORK ACCESS AND SECURITY

- A. Remote Access
 - 1. For Local Area Network Installations District shall provide a connection to the Internet to enable access via the customer's Intranet to a corporate server. BAS Contractor shall connect to IP switchport provided by District IT representative.
- B. System IP communications
 - 1. BAS Contractor will use DNS for IP communication.
 - 2. Static IPs or "hardcoded" IP addresses shall be needed for all the components in the system.
 - 3. The BAS Contractor shall request from District IT representative all required primary port TCP/IP network configuration settings for all systems utilizing District's IP Address Request Form The BAS Contractor shall not assign any of the following configuration settings without District BAS Department/personnel approval:
 - a. Domain name
 - b. Host name
 - c. Station Name
 - d. Secondary port
 - 1) For troubleshooting purposes, the BAS Contractor shall configure the system's secondary port to a static IP address.
- C. SSL requirements
 - 1. All communications between devices and the Supervisor server or user interface software shall be secured using SSL encryption

1.15 WEB BROWSER CLIENTS

- A. The system shall allow use of an unlimited number of clients using a standard Web browser including Chrome and others. The system shall be capable of providing a rich user experience (including full use of the engineering toolset) through the use of a simple user interface.
- B. The Web browser shall provide the same view of the graphics, schedules calendars, logs etc., as provided by the GUI and match the look and feel of graphics in the Web browser.
 - 1. Graphic screens on the Web Browser client shall support hypertext links to other locations on the Internet or on Intranet sites, by specifying the Uniform Resource Locator (URL) for the desired link.

1.16 BACNET/MSTP NETWORK MANAGEMENT

- A. The Application Control Engine shall support the integration of device data from BACnet TCP/IP or BACnet MSTP system devices. The connection to the BACnet system shall be via an RS485, or Ethernet IP as required by the device prior District approval is required for IP/Ethernet controls.
- B. Provide the required components in the library, included with the Graphical User Interface programming software, to support the integration of the BACnet system data into the BAS.
- C. The BAS supplier shall provide a BACnet system communications driver. The equipment system vendor that provided the equipment utilizing BACnet shall provide documentation of the system's interface and shall provide factory support at no charge during system commissioning.
- D. BACnet Conformance:
 - 1. Logic controllers shall as a minimum support MS/TP BACnet LAN type. They shall communicate directly via this BACnet LAN. Logic controllers shall be of BACnet conformance class 3 and support all BACnet services necessary to provide the following BACnet functional groups:

- a. Files Functional Group
- b. Reinitialize Functional Group
- c. Device Communications Functional Group
- d. All proprietary services, if used in the system, shall be pre-approved by District, thoroughly documented and provided as part of the Submittal data. All necessary tools shall be supplied for working with proprietary information

1.17 HARDWARE

- A. Environmental Conditions for Controllers, Gateways, Instruments and Actuators:
 - 1. Products shall operate without performance degradation under ambient environmental temperature, pressure and humidity conditions encountered for installed location.
 - 2. If product alone cannot comply with requirement, install product in a protective enclosure that is isolated and protected from conditions impacting performance. Enclosure shall be internally insulated, electrically heated, cooled and ventilated as required by product and application.
 - 3. Products shall be protected with enclosures satisfying the minimum requirements specified later in this section unless more stringent requirements are indicated.
- B. DDC System Reliability and Redundancy:
 - 1. Design, install, and configure DDC control system, to match mechanical/electrical systems and equipment reliability and redundancy design
- C. Electric Power Quality:
 - 1. When building is equipped with UPS or emergency power, these sources, in respective order should be used to power all DDC system products if capacity is available.
 - 2. Power Conditioning:
 - a. When building UPS power is used to power DDC system products, no additional power conditioning is required.
 - 3. Ground Fault:
 - a. Protect products from ground fault by providing suitable grounding. Products shall not fail due to ground fault condition. Install grounding wires as shown in manufacturer's instructions.
- D. Backup Power Source
 - 1. Mechanical/electrical systems and equipment served by a backup power source shall have associated DDC system products that control such systems and equipment also served from the same or equivalent backup power source
- E. Continuity of Operation after Electric Power Interruption:
 - 1. Equipment and associated factory-installed controls, field-installed controls, electrical equipment, and power supply connected to building normal and backup power systems shall automatically return equipment and associated controls to operating state occurring immediately before loss of normal power, without need for manual intervention by operator when power is restored either through backup power source or through normal power if restored before backup power is brought online.
- F. BAS Backup
 - 1. A backup of all points, graphics, logic, setpoints, schedules, etc. necessary to ensure proper function of the system installed needs to be backed up and provided to the District in a USB drive upon project close out and stored by the controls contractor and provided to the District upon request. The BAS backup needs to have all necessary data to bring the system and all equipment back online to its original state in case of equipment failure.

PART 2 GRAPHICS

2.01 SYSTEM DESCRIPTION

- A. Provide a complete BACnet based Building Automation System (BAS), including the most updated version, including any software necessary for system functionality and operation. BAS should be able to connect to multiple platforms and devices. BAS shall be based on a distributed control system in accordance with this specification. All building controllers, application controllers, unitary controllers, and all input/output devices shall communicate using the protocols and network standards as defined in section 1, "General", shall have achieved listing by BACnet Testing Laboratories, and shall be native BACnet devices.
- B. The BACnet-based BAS shall be a complete system designed for use with the Site and District IT systems. This functionality shall extend into the equipment rooms, Main Distribution Frame Room (MDF), Head End Equipment Rooms, and Intermediate Distribution Frame Rooms (IDF). Devices residing on the automation network located in equipment rooms, MDF, or IDF rooms shall be fully IT compatible devices that communicate directly on the IT infrastructure within the facility. Contractor shall perform Work including, but not limited to the following:
 - 1. Provide a fully integrated open protocol BACnet BAS, UL Listed, providing equipment monitoring and control, alarm management, and historical data collection.
 - 2. Coordinate with electrical contractor for fire/life system for air conditioning units and/or fan shut down.
 - 3. Interface with electronic control system with controller's valve/damper actuators.
 - 4. Be responsible for all electrical work associated with BAS.
- C. It is the intention of the contract documents (including Specifications and Drawings) to provide finished Work that is tested and ready for operation and complete in every regard. Contractor shall provide Work not shown or specified but required through the intent of the Drawings and Specifications to make the Work complete and ready for operation.
- D. Provide all necessary BACnet-compliant hardware and software to meet the system's functional specifications.
- E. Implement the detailed design for all analog and binary objects, system databases, graphic displays, logs, and management reports based on control descriptions, logic drawings, configuration data, and bid documents.
 - 1. Clearly label all points, equipment status and display equipment that it controls
 - a. Provide ability to change or rename display names for locations
 - 2. Clearly label room and mechanical equipment on controls and equipment
 - a. i.e. Classroom 1101 – (AC 1-1)
 - 3. Provide the following mechanical information to each graphical user interface detailed tab:
 - a. Equipment Model Number
 - b. Equipment Serial Number
- F. Room sensors shall be provided with digital readout that allows the user to view room temperature, adjust the room set point within preset limits and set desired override time. The automatic thermostats are set for 74 degrees Fahrenheit cooling and 68 Fahrenheit degrees heating, with two (2) degrees plus or minus. If HVAC system is in ventilation (mechanical) mode with economizer, the economizer shall be equipped with an alarm stating damper positioning. Core working times are 7:00 am to 4:00 pm, refer to the latest approved District standards, and the override interval is one (1) hour. The unoccupied setting (setback) shall be 40- and 99-degrees Fahrenheit. User shall also be able to start and stop unit from the digital sensor. Include all necessary wiring and firmware such that room sensor includes field service mode.
 - 1. Identify the HVAC unit that is controlled by each space thermostat or temperature sensor on the outside edge.

2.02 GRAPHIC QUALITY ASSURANCE

- A. All graphics and mapped out points shall be stored in server and provide the District with a back-up file on a Universal Serial Bus (USB).
- B. The BAS shall display all point values in real-time without requiring a manual "refresh".
- C. Admin users shall have the capability of defining access privileges to newly created users. Depending on privileges assigned to user, the user shall be able to perform the following:
 - 1. Modify schedules, calendars, and set points.
- D. BAS must have the following scheduling/grouping requirements.
 - 1. Schedule individual equipment/rooms
 - 2. Schedule and group rooms by buildings
 - 3. BAS to schedule ventilation mode, 2 hours before and after normal schedule.
 - 4. When creating a new BAS user, the District should have the ability to select and assign users from the following roles:
 - 5. Administrator (District)/ Programmer
 - a. User will have highest clearance and priority number
 - b. Ability to customize access level for each user
 - c. Building Operator / Technician
 - d. User will have ability to override set points and acknowledge alarms.
 - e. Ability to customize access level for each user
 - 6. Read Only
 - a. User will be able to viewpoint values and view BAS schedule.
- E. BAS shall show all information in easy-to-read daily format including current calendar next calendar month. All schedules shall show actual ON/OFF times for day based on scheduling priority. Priority for scheduling shall be regular events, holidays and special events being the highest priority.
- F. Provide global, site and zone programming availability. Holiday and special event schedules shall display data in calendar format. BAS user shall be able to schedule holidays and special events directly from these calendars.
 - 1. BAS user shall be able to change all information for a given weekly or exception schedule if logged on as Administrator / Programmer access.
- G. Scheduling shall include optimum start based on outside air temperature, current heating/cooling set points, indoor temperature, and history of previous starts at global, site, zone, and equipment level. Every individual zone shall have optimum start time independently calculated based on all parameters listed. User shall input schedules to set time that occupied set point is to be attained. Optimum start feature shall calculate the startup time needed to match zone temperature to set point. User shall be able to set a limit for the maximum startup time allowed. Administrator / Programmer shall have ability to disable optimum start feature.
- H. All temperature readings shall be displayed in degrees Fahrenheit.
- I. Unless indicated, the following decimal precision shall be used for the following:
 - 1. Temperatures and temperature set points:
 - a. 1 decimal place.
 - 2. Airflow (CFM) and airflow set points:
 - a. No decimal places.
 - 3. Water flow (GPM) and water flow set points:
 - a. 1 decimal place.
 - 4. Duct static pressure (inch wc) and duct static pressure set points:
 - a. 2 decimal places.
 - 5. Building static pressure (inch wc) and building static pressure set points:
 - a. 2 decimal places.
 - 6. Humidity (%RH) and humidity set points:

- a. 1 decimal place.
- J. All valve and damper positions should be denoted as percent (%) open.
- K. All points not displayed on the graphical interface but are readable should be displayed in a tabular form.

2.03 GRAPHIC GENERATION

- A. Each graphic shall include all control points, devices and set points associated with BAS.
- B. All point values shall be listed in a points list table and be adjustable.
- C. BAS graphics will be equipped with a navigation bar to maneuver with organized link buttons. Typical selections shall include but not limited to the following:
 - 1. Floor Maps
 - 2. Summary or Overview Page
 - 3. Spaces or Zones
 - 4. HVAC Equipment
 - 5. Schedules
 - 6. Historical Trend Data Reports
 - 7. Users List
 - 8. Sequence of Operations or Logic
- D. Provide security system that prevents unauthorized use unless user is logged on. Access shall be limited to user's assigned role and priority level when user is logged on.
 - 1. Each user shall have an individual user ID, username, and password. Entries are alphanumeric and special characters only and are case sensitive (except for User ID).
 - 2. System shall include an auto logout feature that shall automatically logout user when there has been no keyboard or mouse activity for 10 minutes. Auto Logout may be enabled and disabled by system administrator.

2.04 REPORTS

- A. BAS should generate reports for the following:
 - 1. Analog and binary point values.
 - a. Enabled points
 - b. Disabled points
 - c. Points in override
 - 2. Alarms
 - a. Active alarms
 - 3. Acknowledged alarms
 - 4. Schedules and special events
 - 5. Users
 - a. Users log
 - b. Activity log
- B. User shall have capability of adjusting time interval by:
 - 1. Hourly
 - 2. Daily
 - 3. Weekly
 - 4. Monthly
 - 5. Annually
 - 6. Custom
- C. User shall be able to view data in tabular or graphical form.

- D. User shall also be able to download data through the web interface to local computer.
 - 1. Data shall be in CSV format.

2.05 DDC CONTROLLERS

- A. Provide all database generation with standard labelling nomenclature that corresponds to the serving unit.
 - a. Displays:
 - b. System displays shall show all analog and binary object types within the system. They shall be logically laid out for easy use by the owner. Provide enthalpy and/or outside air temperature indication on all system displays associated with economizer cycles.
 - 2. Run Time Totalization:
 - a. At a minimum, run time totalization shall be logged for each monitored supply fan, return fan, exhaust fan, hot water, and chilled water pumps. Warning limits for each point shall be entered for alarm and or maintenance purposes.
 - 3. Trend log:
 - a. All binary and analog object types (including zones) shall have the capability to be automatically trended for minimum one year.
 - 4. Alarm:
 - a. All analog inputs (High/Low Limits) and selected binary input alarm points shall be prioritized and routed (locally or remotely) with alarm message per owner's requirements.
 - 5. Database Save:
 - a. Provide back-up database for all stand-alone application controllers on USB.
- B. DDC controllers shall perform monitoring, control, energy optimization and other requirements indicated.
- C. Memory shall support controller's operating system, database and shall include the following:
 - 1. Monitoring and control
 - 2. Energy optimization, operation, and optimization
 - 3. Alarm
 - 4. Historical trend data
 - 5. Manual overrides

2.06 NETWORK CONTROLLERS

- A. Include adequate number of controllers needed to achieve performance required by system.
- B. System shall consist of one or more independent, standalone, microprocessor-based network controllers to manage global strategies required by the system.
- C. Controller shall contain enough memory to support its operating system, database, and programming logic.
- D. Controllers shall be fully programmable. Only users with specified access will have ability to make modifications.
- E. Controllers shall be capable of routing necessary information or software licenses
- F. Controllers shall be equipped with LEDs to diagnose power, communication, and processor.
- G. Controller shall maintain basic input and output system (BIOS) in the event of power loss for at least 48 hours.

2.07 CONTROL VALVE DEVICES

- A. Control Valve Manufacturer Qualification:

1. Belimo
2. Or Approved Equal

2.08 NAMING NOMENCLATURE

- A. All points and logic shall have consistent nomenclature
- B. BAS equipment points shall follow the following nomenclature:
 1. Building # - Room # - Unit #
- C. The District shall have the capability to rename any point
- D. The newest building # and room number shall be used, it is the responsibility of the contractor to ensure the newest information is used when completing graphics

2.09 HISTORY TRENDING – TYPICAL

- A. Entire point name shall be included in every trend name.
- B. All history trends shall store at a minimum one (1) year worth of data before data is overwritten.
- C. All historical trend data shall be served on a local server provided by contractor. Alternatively, if the BAS has a central server, the contractor is permitted to store data on the central server.
- D. All numerical point data shall be trended in 15-minute intervals. The following points shall be trended by the BAS:
 1. VRF/VRV (Heat Recovery or Heat Pump)
 - a. Outside air setpoints
 - b. Master setpoints
 - c. Airflow (CFM)
 - d. Outside airflow (CFM)
 - e. Damper position for DOAS unit
 - f. Discharge/leaving air temperature
 - g. Return air temperature
 - h. Reversing valve position
 - i. Fan status
 - j. Fan speed
 - k. High and Low side saturation temperature
 2. Split system
 - a. Discharge/leaving temperature
 - b. Return air temperature
 - c. Fan status
 - d. Fan speed
 - e. Airflow (CFM)
 3. Packaged Units or Rooftop Units
 - a. Damper position
 - b. Speed/Speed
 - c. Discharge/leaving temperature
 - d. Airflow (CFM)
 - e. Outside airflow (CFM)
 4. General points to be trended
 - a. Space temperature
 - b. Supply temperature
 - c. Humidity
 - d. CO2 level in ppm

- e. Cooling percentage
 - f. Heating percentage
 - g. External Static Pressure
- E. All binary data shall be trended and logged whenever the value changes state.
- F. All temperature points shall be displayed and recorded in Fahrenheit (°F)

2.10 CONTROL FUNCTIONALITY

- A. BAS and Logic shall reside and operate in system controllers. Applications shall be configurable through web browser interface.
- B. All controllers shall be capable of providing all control functions of the HVAC system without use of a computer or software.
- C. All HVAC equipment shall include application software necessary for sequence of operations.

2.11 ELECTRICAL POWER DEVICES

- A. Transformers must meet the following:
 - 1. Sized for 125 percent of the total connected load.
 - 2. UL Listed.
 - 3. Shall have a secondary resettable breaker.
- B. DC Power Supply
 - 1. Controllers shall include universal inputs with 10-bit resolution that accept 3K and 10K thermistors, 0–10VDC, 0–5 VDC, 4–20 mA and dry contact signals. Any input on a controller may be either analog or digital with a minimum of 3 inputs that accept pulses. Controller shall also include support and modifiable programming for interface to intelligent room sensor with digital display. Controller shall include binary and analog outputs on board. Analog outputs shall be switch selectable as either 0–10VDC or 4–20mA. Software shall include scaling features for analog outputs.
 - 2. Controller shall include 24VDC output voltage supply for use as power supply to external sensors.
 - 3. Input voltage nominally 120VAC, 60HZ.

PART 3 EXECUTION

3.01 INSPECTION

- A. Prior to starting work, carefully inspect installed work of other trades and verify that such work is complete to the point where work of this Section may properly commence.
- B. Drawings are diagrammatic and are intended to convey scope of work and to indicate general architecture of system and points. They are not intended to show every detail including exact panel locations, wiring diagrams, or appurtenances required for a complete and functional system. Except as otherwise indicated, locations of items are approximate only. Exact locations necessary to secure proper conditions and results must be determined at Project Site and must be approved by the Engineer and District representative.
- C. Except as otherwise indicated, make reasonable modifications in layout as needed to prevent conflict with other Work or for proper execution of Work. Coordinate all panel supports and anchorage with structural engineer and all required electrical power supplies with electrical engineer and District representative.

3.02 SYSTEM INTEGRATION

- A. The BAS shall include appropriate hardware equipment and software to allow bi-directional data communication between BAS and third-party manufacturer's control panels. The BAS shall receive, react to, and return information from multiple building systems, including but not limited to chillers, boilers variable speed drivers, power monitoring systems, when specified. Point inputs and outputs from the third-party controllers shall have real time interoperability with BAS software features, such as: control software, energy management, custom processing programming, alarm management, historical data and trend analysis, totalization, and local area network communications.
- B. DDC system shall have communication interface with equipment and building systems having integral controls and having a communication interface for remote monitoring or control.
- C. Perform all steps necessary for integration, these steps may include:
 - 1. Research and gathering effort to identify how to integrate each piece of equipment and identify the significance of each integrated point.
 - 2. Trial and error troubleshooting time as required. May require time to contact equipment manufacturer's technical support.
 - 3. Testing of interface. Disconnect communication bus and confirm that points do indeed display as "down". Confirm values are accurate by comparing with onboard equipment display screen. Test writable points and confirm written values are accepted by comparing with onboard equipment display screen and equipment operation.
 - 4. Create a meaningful graphic screen displaying integrated points in a logical fashion with accompanying system schematic diagram.
 - 5. Add trending and alarming as appropriate and/or as shown on point lists.

3.03 GENERAL INSTALLATION REQUIREMENTS

- A. Install all equipment per manufacturer's recommendations.
- B. Provide all miscellaneous devices, hardware, software, interconnections installation and programming required to ensure a complete operating system in accordance with the sequences of operation and point schedules.
- C. Install products level, plumb, parallel, and perpendicular with building construction.
- D. Location and Installation of Components:
 - 1. Install components for easy accessibility; in general, mount 48 inches above floor with minimum 3'-0" clear access space in front of units and in accordance with the drawings. Obtain approval on locations from District representative prior to installation.
 - a. Thermostats installed on exterior walls shall be mounted with insulated backing plate.
 - 2. All instruments, switches, transmitters, etc., shall be suitably wired and mounted to protect them from vibration, moisture and high or low temperatures.
 - 3. Provide stainless steel or brass thermowells suitable for respective application and for installation under other sections—sized to suit pipe diameter without restricting flow.

3.04 SUPERVISOR SERVER CONFIGURATION

- A. Perform all steps necessary to provide a fully functional supervisor server as specified earlier in this document. Steps to include, but not limited to operating system configuration, supervisor software installation and licensing, site specific supervisor server software configuration, graphics, schedules, trends, alarms, scheduling, operator setup, etc.

3.05 LAN, ROUTER AND GATEWAY INSTALLATION

- A. Install level two LAN network and network equipment if required for DDC system communication interface requirements indicated, when installed up to two (2) devices shall be connected per equipment
- B. Test LAN and LAN equipment to verify that communication interface functions properly
- C. Provide a temporary LAN if required to keep pace with construction schedule.
- D. Permanent Client LAN drops may be delayed, and it is not acceptable to delay any control work as a result of these delays. Temporary construction LAN may be abandoned, and permanent Client LAN connected when available.

3.06 CONTROLLER INSTALLATION

- A. Install controllers in enclosures to comply with indicated requirements
- B. Connect controllers to field power supply
- C. Install controller with latest version of applicable software and configure to execute requirements indicated
- D. Test and adjust controllers to verify operation of connected I/O to achieve performance indicated requirements while executing sequences of operation
- E. Installation of Network Controllers
 - 1. Quantity and location of network controllers shall be determined by DDC system manufacturer to satisfy requirements indicated
 - 2. Install controllers in a protected location that is easily accessible by operators
- F. Installation of Programmable Application Controllers
 - 1. Quantity and location of programmable application controllers shall be determined by DDC system manufacturer to satisfy requirements indicated
 - 2. Install controllers in a protected location that is easily accessible by operators
- G. Application-Specific Controllers
 - 1. Quantity and location of application-specific controllers shall be determined by DDC system manufacturer to satisfy requirements indicated
 - 2. For controllers not mounted directly on equipment being controlled, install controllers in a protected location that is easily accessible by operator

3.07 ENCLOSURE INSTALLATION

- A. All controllers, power supplies and relays shall be mounted in enclosures.
- B. Enclosures may be NEMA 1 when located in a clean, dry, indoor environment. Indoor enclosures shall be compliant with NEMA Standard 250.
- C. Enclosures shall have hinged, locking doors.
- D. Provide laminated plastic nameplates for all enclosures in any mechanical room or electrical room. Include location and unit served on nameplate. Laminated plastic shall be 1/8" thick sized appropriately to make label easy to read.
- E. Provide permanently mounted tags for all panels.
 - 1. Identify all equipment and panels.

3.08 ELECTRIC POWER CONNECTIONS

- A. Connect electrical power to DDC system products requiring electrical power connection
- B. Design of electrical power to products not indicated with electric power is delegated to DDC system provider and installing trade. Work shall comply with NFPA 70 and other requirements indicated

- C. Comply with requirements for electrical power circuit breakers
- D. Comply with requirements for electrical power conductors and cables
- E. Comply with requirements for electrical power raceways and boxes

3.09 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification products and installation
- B. Where product is installed above ceiling, also install location identification on ceiling grid directly below. This includes all terminal units such as VAV boxes, fan coil units, etc.
- C. Include identification on all DDC devices including room sensors, duct sensors, pipe sensors, relays, power supplies, controllers, control dampers and controls valves

3.10 NETWORK NAMING AND NUMBERING

- A. Coordinate with District to provide unique naming and addressing for networks and devices

3.11 CONTROL WIRE, CABLE AND RACEWAY INSTALLATION

- A. Comply with NECA 1.
- B. Provide all interlock and control wiring. All wiring shall be installed neatly and professionally, in accordance with Division 26 and all national, state, and local electrical codes.
- C. Provide wiring as required by functions as specified and as recommended by equipment manufacturers, to serve specified control functions. Provide shielded low capacitance wire for all communications trunks.
- D. Control wiring shall not be installed in power circuit raceways. Magnetic starters and disconnect switches shall not be used as junction boxes. Provide auxiliary junction boxes as required. Coordinate location and arrangement of all control equipment with the District Representative prior to install.
- E. Provide auxiliary pilot duty relays on motor starters as required for control function.
- F. Provide power for all control components from nearest electrical control panel or as indicated on the electrical drawings—coordinate with electrical contractor.
- G. All control wiring in the mechanical, electrical, telephone and boiler rooms to be installed in raceways. All other wiring to be installed neatly and inconspicuously per local code requirements. Control wiring above accessible ceiling spaces may be run with plenum rated cable (without conduit). Wire in walls shall be run in conduit. Conduit shall conform to specified product in electrical Sections.

3.12 DDC SYSTEM I/O CHECKOUT PROCEDURES

- A. Check instruments for proper location and accessibility
- B. Check instruments for proper installation on direction of flow, elevation, orientation, insertion depth, or other applicable considerations that will impact performance
- C. Check instrument tubing for proper isolation, fittings, slope, dirt legs, drains, material, and support
- D. Control Damper Checkout
 - 1. Verify that control dampers are installed correctly for flow direction
 - 2. Verify that proper blade alignment, either parallel or opposed, has been provided
 - 3. Verify that damper frame attachment is properly secured and sealed
 - 4. Verify that damper actuator and linkage attachment is secure

5. Verify that actuator wiring is complete, enclosed and connected to correct power source
6. Verify that damper blade travel is unobstructed
7. Verify that any configurable switches on device are set properly
- E. Control Valve Checkout
 1. Verify that control valves are installed correctly for flow direction
 2. Verify that valve body attachment is properly secured and sealed
 3. Verify that valve actuator and linkage attachment is secure.
 4. Verify that actuator wiring is complete, enclosed and connected to correct power source
 5. Verify that valve ball, disc or plug travel is unobstructed
 6. After piping systems have been tested and put into service, but before insulating and balancing, inspect each valve for leaks. Adjust or replace packing to stop leaks. Replace the valve if leaks persist
 7. Verify that any configurable switches on device are set properly
- F. Instrument Checkout
 1. Verify that instrument is correctly installed for location, orientation, direction, and operating clearances
 2. Verify that attachment is properly secured and sealed
 3. Verify that conduit connections are properly secured and sealed
 4. Verify that wiring is properly labeled with unique identification, correct type and size and is securely attached to proper terminals
 5. Inspect instrument tag against approved Submittal
 6. For instruments with tubing connections, verify that tubing attachment is secure and isolation valves have been provided
 7. For flow instruments, verify that recommended upstream and downstream distances have been maintained
 8. For temperature instruments
 9. Verify sensing element type and proper material
 10. Verify length and insertion
 11. Verify that any configurable switches on device are set properly

3.13 DDC SYSTEM I/O ADJUSTABLEUSTMEN, CALIBRATION AND TESTING

- A. Calibrate each instrument installed that is not factory calibrated and/or provided with calibration documentation. Calibrate according to instrument instruction manual supplied by manufacture
- B. Provide traceable diagnostic and test equipment for calibration and adjustable adjustment
- C. Comply with field testing requirements and procedures indicated by ASHRAE's Guideline 11, "Field Testing of HVAC Control Components," in the absence of specific requirements, and to supplement requirements indicated
- D. Control Dampers
 1. Stroke and adjustable adjust control dampers following manufacturer's recommended procedure, from 100 percent open to 100 percent closed and back to 100 percent open
 2. For control dampers equipped with positive position indication, check feedback signal at multiple positions to confirm proper position indication
- E. Control Valves
 1. Stroke and adjustable adjust control valves following manufacturer's recommended procedure, from 100 percent open to 100 percent closed and back to 100 percent open
 2. For control valves equipped with positive position indication, check feedback signal at multiple positions to confirm proper position indication
- F. Switches

1. Calibrate switches to make or break contact at set points indicated

3.14 DDC CONTROLLER CHECKOUT

- A. Verify power supply
 1. Verify voltage, polarity, and protection
 2. Verify that ground fault protection is installed
 3. If applicable, verify that power conditioning units are installed
- B. Verify that wire and cabling is properly secured to terminals and labeled with unique identification

3.15 DDC CONTROLLER I/O CONTROL LOOP TEST

- A. Test every control loop to verify operation is stable and accurate

3.16 COMMISSIONING, TESTING, AND ACCEPTANCE

- A. **Contractor Startup:** Sub-phase of Contractor's work ending with Acceptance of Work, during which Contractor performs a pre-planned program of activities including starting, testing, inspecting, adjusting balancing, correcting deficiencies and other similar activities.
 1. The District, Construction Manager and Architect and the Inspector shall be present to observe, inspect and identify deficiencies in building systems operations.
- B. The completion of startup means the entire Construction Project including startup and fine tuning has been performed to the requirements of the Contract Documents and is verified in writing by the District, Construction Manager and Architect.
- C. **Fine Tuning:** Fine tuning is the responsibility of Contractors after District occupancy and ending one (1) year after District occupancy. During this time the Contractor is responsible for optimizing systems and correcting deficiencies arising under normal operating conditions.
 1. Includes a period after occupancy where systems are optimized under "live" operating conditions and any outstanding construction deficiencies are corrected.
 2. Fine Tuning shall extend from date of District occupancy to one year after occupancy.
 3. Except from a startup, maximum allowable variance from set point for controlled variables under normal load fluctuations shall be as follows for general space conditioning applications. Within three (3) minutes of any upset (for which the system has the capability to respond) in the control loop, tolerances shall be maintained
 - a. Duct air temperature: $\pm 2^{\circ}\text{F}$.
 - b. Space Temperature: $\pm 2^{\circ}\text{F}$.
 - c. Chilled Water: $\pm 1^{\circ}\text{F}$.
 - d. Hot water temperature: $\pm 3^{\circ}\text{F}$.
 - e. Duct pressure: $\pm 0.25''$ w.c.
 - f. Water pressure: ± 1 psi
 - g. Duct or space Humidity: $\pm 5\%$.
 - h. Air flow control: $\pm 5\%$ of setpoint velocity
- D. Point to Point Installation Verification Procedure to consist of the following
 1. Documentation - An Excel spreadsheet listing all I/O in the system per the design specs/sequence of operations from mechanical engineer including point name, address, Controller ID#, analog range or digital normal state and engineering units. Provide results BAS Contractor's representative and district's BAS Department Representative to accept and approve.
 2. Digital Inputs: Jumper or open the wires at the device and verify change of state at controller and/or GUI. Record results on spreadsheet.

3. Analog Inputs: Lift wire at device to see change of state and record default value on spreadsheet.
 4. Digital/Analog Outputs: Command the field device from the controller and verify corresponding change of state at the field device. Record results on spreadsheet.
- E. Contractor must evaluate performance deficiencies identified in test reports and, in collaboration with entity responsible for system and equipment installation, recommend corrective action.
- F. Contractor must review and comment on final commissioning documentation.

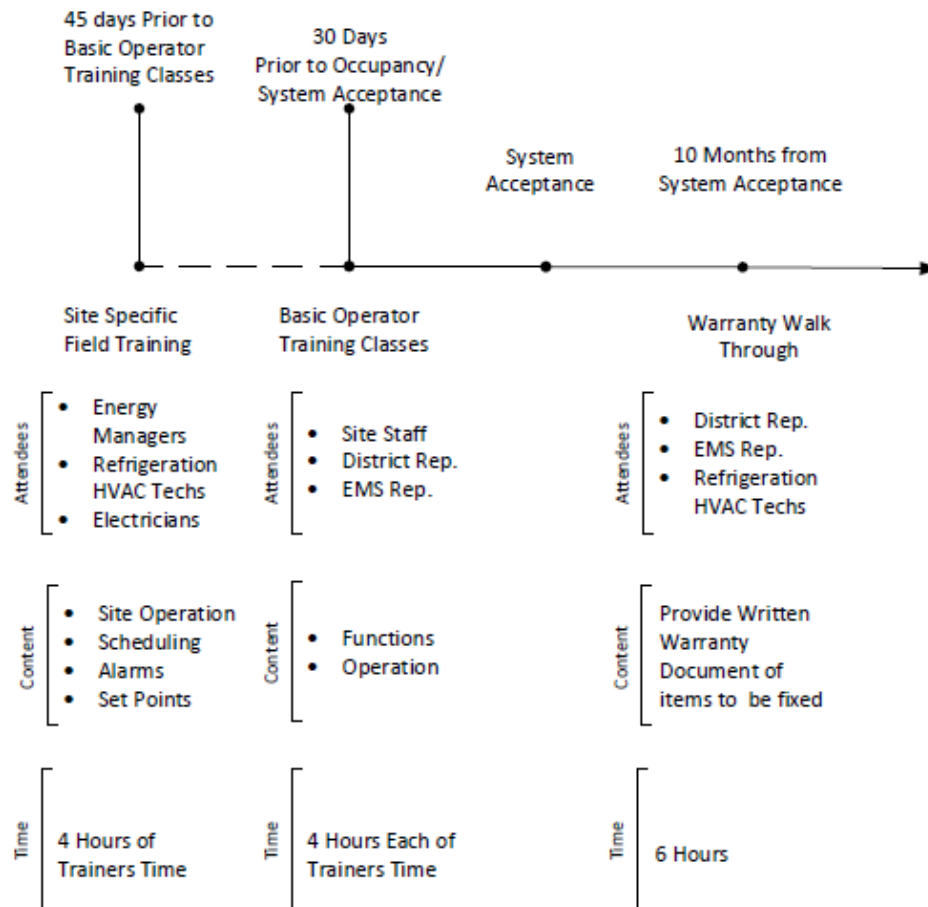
3.17 PROTECTION

- A. Protect installation against and be liable for damage to work and to material caused by Contractor's work or employees
- B. Maintain protection for work and equipment until inspected, tested, and accepted
- C. Close open ends of work with temporary covers or plugs during storage and construction to prevent entry of foreign objects
- D. Materials sensitive to temperature, dust, humidity, or other elements found unprotected shall be replaced
- E. Materials showing signs of exposures shall be replaced

END OF SECTION

APPENDIX

Training Timeline



NOTE: Training shall not proceed until District BAS Department/personnel has reviewed and approved the Training Submittal and BAS graphics

**SECTION 232300
REFRIGERANT PIPING**

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01, 07, 08 and 23 Specification Sections, apply to this Section.
- B. Related Sections include the following:
 - 1. Section 07 84 00 – Firestopping.
 - 2. Section 07 92 00 – Joint Sealants.
 - 3. Section 08 31 00 – Access Doors and Panels.
 - 4. Section 23 05 29 – Hangers and Supports for HVAC.
 - 5. Section 23 05 53 – Identification for HVAC Piping and Equipment.
 - 6. Section 23 09 00 – Instrumentation and Control for HVAC – Building Automation.

1.02 SUMMARY

- A. This Section includes refrigerant piping used for air-conditioning applications.

1.03 PERFORMANCE REQUIREMENTS

- A. Line Test Pressure for Refrigerant R-410A/R-454B:
 - 1. Suction Lines for Air-Conditioning Applications: 300 psig.
 - 2. Suction Lines for Heat-Pump Applications: 535 psig.
 - 3. Hot-Gas and Liquid Lines: 535 psig.

1.04 SUBMITTALS

- A. Product Data: For each type of valve and refrigerant piping specialty indicated. Include pressure drop, based on manufacturer's test data, for the following:
 - 1. Thermostatic expansion valves.
 - 2. Solenoid valves.
 - 3. Hot-gas bypass valves.
 - 4. Filter dryers.
 - 5. Strainers.
 - 6. Pressure-regulating valves.
- B. Shop Drawings: Show layout of refrigerant piping and specialties, including pipe, tube, and fitting sizes, flow capacities, valve arrangements and locations, slopes of horizontal runs, oil traps, double risers, wall and floor penetrations, and equipment connection details. Show interface and spatial relationships between piping and equipment.
 - 1. Shop Drawing Scale: 1/4-inch equals 1 foot.
 - 2. Refrigerant piping indicated on Drawings is schematic only. Size piping and design actual piping layout, including oil traps, double risers, specialties, and pipe and tube sizes to accommodate, as a minimum, equipment provided, elevation difference between compressor and evaporator, and length of piping to ensure proper operation and compliance with warranties of connected equipment.
- C. Welding certificates.
- D. Field quality-control test reports.

- E. Operation and Maintenance Data: For refrigerant valves and piping specialties to include in maintenance manuals.

1.05 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
- B. Comply with ASHRAE 15, "Safety Code for Refrigeration Systems."
- C. Comply with ASME B31.5, "Refrigeration Piping and Heat Transfer Components."

1.06 PRODUCT STORAGE AND HANDLING

- A. Store piping in a clean and protected area with end caps in place to ensure that piping interior and exterior are clean when installed.
 - 1. COORDINATION
- B. Coordinate size and location of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 7.

PART 2 PRODUCTS

2.01 COPPER TUBE AND FITTINGS

- A. Copper Tube: ASTM B 88, Type K.
- B. Wrought-Copper Fittings: ASME B16.22.
- C. Wrought-Copper Unions: ASME B16.22.
- D. Brazing Filler Metals: AWS A5.8.
- E. Flexible Connectors:
 - 1. Body: Tin-bronze bellows with woven, flexible, tinned-bronze-wire-reinforced protective jacket.
 - 2. End Connections: Socket ends.
 - 3. Offset Performance: Capable of minimum 3/4-inch misalignment in minimum 7-inch- long assembly.
 - 4. Pressure Rating: Factory test at minimum 500 psig.
 - 5. Maximum Operating Temperature: 250 deg F.

2.02 VALVES AND SPECIALTIES

- A. Diaphragm Packless Valves:
 - 1. Body and Bonnet: Forged brass or cast bronze; globe design with straight-through or angle pattern.
 - 2. Diaphragm: Phosphor bronze and stainless steel with stainless-steel spring.
 - 3. Operator: Rising stem and hand wheel.
 - 4. Seat: Nylon.
 - 5. End Connections: Socket, union, or flanged.
 - 6. Working Pressure Rating: 500 psig.
 - 7. Maximum Operating Temperature: 275 deg F.
- B. Packed-Angle Valves:
 - 1. Body and Bonnet: Forged brass or cast bronze.
 - 2. Packing: Molded stem, back seating, and replaceable under pressure.

3. Operator: Rising stem.
 4. Seat: Nonrotating, self-aligning polytetrafluoroethylene.
 5. Seal Cap: Forged brass or valox hex cap.
 6. End Connections: Socket, union, threaded, or flanged.
 7. Working Pressure Rating: 500 psig.
 8. Maximum Operating Temperature: 275 deg F.
- C. Check Valves:
1. Body: Ductile iron, forged brass, or cast bronze; globe pattern.
 2. Bonnet: Bolted ductile iron, forged brass, or cast bronze; or brass hex plug.
 3. Piston: Removable polytetrafluoroethylene seat.
 4. Closing Spring: Stainless steel.
 5. Manual Opening Stem: Seal cap, plated-steel stem, and graphite seal.
 6. End Connections: Socket, union, threaded, or flanged.
 7. Maximum Opening Pressure: 0.50 psig.
 8. Working Pressure Rating: 500 psig.
 9. Maximum Operating Temperature: 275 deg F.
- D. Service Valves:
1. Body: Forged brass with brass cap including key end to remove core.
 2. Core: Removable ball-type check valve with stainless-steel spring.
 3. Seat: Polytetrafluoroethylene.
 4. End Connections: Copper spring.
 5. Working Pressure Rating: 500 psig.
- E. Solenoid Valves: Comply with ARI 760 and UL 429; listed and labeled by an NRTL.
1. Body and Bonnet: Plated steel.
 2. Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless steel.
 3. Seat: Polytetrafluoroethylene.
 4. End Connections: Threaded.
 5. Electrical: Molded, watertight coil in NEMA 250 enclosure of type required by location with ½ inch conduit adapter.
 6. Working Pressure Rating: 500 psig.
 7. Maximum Operating Temperature: 275 deg F.
 8. Manual operator.
- F. Safety Relief Valves: Comply with ASME Boiler and Pressure Vessel Code; listed and labeled by an NRTL.
1. Body and Bonnet: Ductile iron and steel, with neoprene O-ring seal.
 2. Piston, Closing Spring, and Seat Insert: Stainless steel.
 3. Seat Disc: Polytetrafluoroethylene.
 4. End Connections: Threaded.
 5. Working Pressure Rating: 500 psig.
 6. Maximum Operating Temperature: 275 deg F.
- G. Thermostatic Expansion Valves: Comply with ARI 750.
1. Body, Bonnet, and Seal Cap: Forged brass or steel.
 2. Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.
 3. Packing and Gaskets: Non-asbestos.
 4. Capillary and Bulb: Copper tubing filled with refrigerant charge.
 5. Reverse-flow option (for heat-pump applications).
 6. End Connections: Socket, flare, or threaded union.
 7. Working Pressure Rating: 500 psig.
- H. Hot-Gas Bypass Valves: Comply with UL 429; listed and labeled by an NRTL.

1. Body, Bonnet, and Seal Cap: Ductile iron or steel.
 2. Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.
 3. Packing and Gaskets: Non-asbestos.
 4. Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless steel.
 5. Seat: Polytetrafluoroethylene.
 6. Equalizer: as recommended by manufacturer.
 7. Electrical: Molded, watertight coil in NEMA 250 enclosure of type required by location with ½ inch conduit adapter, and coil.
 8. End Connections: Socket.
 9. Set Pressure: as recommended by manufacturer.
 10. Throttling Range: as recommended by manufacturer.
 11. Working Pressure Rating: 500 psig.
 12. Maximum Operating Temperature: 240 deg F.
- I. Straight-Type Strainers:
1. Body: Welded steel with corrosion-resistant coating.
 2. Screen: 100-mesh stainless steel.
 3. End Connections: Socket or flare.
 4. Working Pressure Rating: 500 psig.
 5. Maximum Operating Temperature: 275 deg F.
- J. Angle-Type Strainers:
1. Body: Forged brass or cast bronze.
 2. Drain Plug: Brass hex plug.
 3. Screen: 100-mesh monel.
 4. End Connections: Socket or flare.
 5. Working Pressure Rating: 500 psig.
 6. Maximum Operating Temperature: 275 deg F.
- K. Moisture/Liquid Indicators:
1. Body: Forged brass.
 2. Window: Replaceable, clear, fused glass window with indicating element protected by filter screen.
 3. Indicator: Color coded to show moisture content in ppm.
 4. Minimum Moisture Indicator Sensitivity: Indicate moisture above 60 ppm.
 5. End Connections: Socket or flare.
 6. Working Pressure Rating: 500 psig.
 7. Maximum Operating Temperature: 240 deg F.
- L. Permanent Filter Dryers: Comply with ARI 730.
1. Body and Cover: Painted-steel shell.
 2. Filter Media: 10 micron, pleated with integral end rings; stainless-steel support.
 3. Desiccant Media: Activated alumina.
 4. Designed for reverse flow (for heat-pump applications).
 5. End Connections: Socket.
 6. Access Ports: NPS 1/4 connections at entering and leaving sides for pressure differential measurement.
 7. Maximum Pressure Loss: 2 psig.
 8. Rated Flow: as per equipment manufacturer.
 9. Working Pressure Rating: 500 psig.
 10. Maximum Operating Temperature: 240 deg F.
- M. Mufflers:
1. Body: Welded steel with corrosion-resistant coating.

2. End Connections: Socket or flare.
 3. Working Pressure Rating: 500 psig.
 4. Maximum Operating Temperature: 275 deg F.
- N. Receivers: Comply with ARI 495.
1. Comply with ASME Boiler and Pressure Vessel Code; listed and labeled by an NRTL.
 2. Comply with UL 207; listed and labeled by an NRTL.
 3. Body: Welded steel with corrosion-resistant coating.
 4. Tappings: Inlet, outlet, liquid level indicator, and safety relief valve.
 5. End Connections: Socket or threaded.
 6. Working Pressure Rating: 500 psig.
 7. Maximum Operating Temperature: 275 deg F.
- O. Liquid Accumulators: Comply with ARI 495.
1. Body: Welded steel with corrosion-resistant coating.
 2. End Connections: Socket or threaded.
 3. Working Pressure Rating: 500 psig.
 4. Maximum Operating Temperature: 275 deg F.

2.03 REFRIGERANTS

- A. Manufacturers:
1. Atofina Chemicals, Inc.
 2. DuPont Company; Fluorochemicals Div.
 3. Honeywell, Inc.; Genetron Refrigerants.
 4. INEOS Fluor Americas LLC.
- B. ASHRAE 34, R-410A: Pentafluoroethane/Difluoromethane; R-454B.

PART 3 EXECUTION

3.01 PIPING APPLICATIONS FOR REFRIGERANT R-410A/R-454B

- A. Suction Lines NPS 1 ½ (DN40) and Smaller. Copper, Type K(A) annealed-temper tubing and wrought-copper fittings with brazed joints.
- B. Suction Lines NPS 2 to NPS 3 ½ (DN 50 to DN90). Copper, Type K(A), drawn-temper tubing and wrought-copper fittings with brazed joints.
- C. Suction Lines NPS 4 (DN 100). Copper, Type K(A) drawn temper tubing and wrought-copper fittings with brazed joints.
- D. Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications: Copper Type K(A), annealed-or drawn-temper tubing and wrought-copper fittings with brazed joints.
- E. Safety relief valve discharge piping: Copper, type K(A) annealed or drawn temper tubing and wrought copper fittings with brazed joints.

3.02 VALVE AND SPECIALTY APPLICATIONS

- A. Install diaphragm packless valves in suction and discharge lines of compressor.
- B. Install service valves for gage taps at inlet and outlet of hot-gas bypass valves and strainers if they are not an integral part of valves and strainers.
- C. Install a check valve at the compressor discharge and a liquid accumulator at the compressor suction connection.

- D. Except as otherwise indicated, install diaphragm packless valves on inlet and outlet side of filter dryers.
- E. Install a full-sized, three-valve bypass around filter dryers.
- F. Install solenoid valves upstream from each expansion valve and hot-gas bypass valve. Install solenoid valves in horizontal lines with coil at top.
- G. Install thermostatic expansion valves as close as possible to distributors on evaporators.
 - 1. Install valve so diaphragm case is warmer than bulb.
 - 2. Secure bulb to clean, straight, horizontal section of suction line using two bulb straps. Do not mount bulb in a trap or at bottom of the line.
 - 3. If external equalizer lines are required, make connection where it will reflect suction-line pressure at bulb location.
- H. Install safety relief valves where required by ASME Boiler and Pressure Vessel Code. Pipe safety-relief-valve discharge line to outside according to ASHRAE 15.
- I. Install moisture/liquid indicators in liquid line at the inlet of the thermostatic expansion valve or at the inlet of the evaporator coil capillary tube.
- J. Install strainers upstream from and adjacent to the following unless they are furnished as an integral assembly for device being protected:
 - 1. Solenoid valves.
 - 2. Thermostatic expansion valves.
 - 3. Hot-gas bypass valves.
 - 4. Compressor.
- K. Install filter dryers in liquid line between compressor and thermostatic expansion valve and in the suction line at the compressor.
- L. Install receivers sized to accommodate pump-down charge.

3.03 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems; indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Shop Drawings.
- B. Install refrigerant piping according to ASHRAE 15.
- C. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- F. Install piping adjacent to machines to allow service and maintenance.
- G. Install piping free of sags and bends.
- H. Install fittings for changes in direction and branch connections.
- I. Select system components with pressure rating equal to or greater than system operating pressure.
- J. Refer to Sections 230900 - Instrumentation and Control for HVAC – Building Automation.
- K. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.

- L. Arrange piping to allow inspection and service of refrigeration equipment. Install valves and specialties in accessible locations to allow for service and inspection. Install access doors or panels as specified in Section 08 31 00 - Access Doors and Panels if valves or equipment requiring maintenance is concealed behind finished surfaces.
- M. Install refrigerant piping in protective conduit where installed below ground.
- N. Install refrigerant piping in rigid or flexible conduit in locations where exposed to mechanical injury.
- O. Slope refrigerant piping as follows:
 - 1. Install horizontal hot-gas discharge piping with a uniform slope downward away from compressor.
 - 2. Install horizontal suction lines with a uniform slope downward to compressor.
 - 3. Install traps and double risers to entrain oil in vertical runs.
 - 4. Liquid lines may be installed level.
- P. When brazing or soldering, remove solenoid-valve coils and sight glasses; also remove valve stems, seats, and packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion-valve bulb.
- Q. Before installation of steel refrigerant piping, clean pipe and fittings using the following procedures:
 - 1. Shot blast the interior of piping.
 - 2. Remove coarse particles of dirt and dust by drawing a clean, lintless cloth through tubing by means of a wire or electrician's tape.
 - 3. Draw a clean, lintless cloth saturated with trichloroethylene through the tube or pipe. Continue this procedure until cloth is not discolored by dirt.
 - 4. Draw a clean, lintless cloth, saturated with compressor oil, squeezed dry, through the tube or pipe to remove remaining lint. Inspect tube or pipe visually for remaining dirt and lint.
 - 5. Finally, draw a clean, dry, lintless cloth through the tube or pipe.
 - 6. Safety-relief-valve discharge piping is not required to be cleaned but is required to be open to allow unrestricted flow.
- R. Install pipe sleeves at penetrations in exterior walls and floor assemblies.
- S. Seal penetrations through fire and smoke barriers according to Section 07 84 00 - "Fire Stopping."
- T. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.
- U. Install sleeves through floors, walls, or ceilings, sized to permit installation of full-thickness insulation.
- V. Seal pipe penetrations through exterior walls according to Section 07 92 00 - Joint Sealants for materials and methods.
- W. Identify refrigerant piping and valves according to Section 23 05 53 - Identification for HVAC Piping and Equipment.
- X. Protection against mechanical and physical damage shall be installed over refrigerant piping at roof tops where piping is susceptible to being stepped on. No less than 16-gauge sheet metal line set cover is acceptable.

3.04 PIPE JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

- C. Fill pipe and fittings with an inert gas (nitrogen or carbon dioxide), during brazing or welding, to prevent scale formation.
- D. Soldered Joints: Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook."
- E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," Chapter "Pipe and Tube."
 - 1. Use Type BcuP, copper-phosphorus alloy for joining copper socket fittings with copper pipe.
 - 2. Use Type BAg, cadmium-free silver alloy for joining copper with bronze or steel.
- F. Threaded Joints: Thread steel pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads unless dry-seal threading is specified.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- G. Steel pipe can be threaded, but threaded joints must be seal brazed or seal welded.
- H. Welded Joints: Construct joints according to AWS D10.12/D10.12M.
- I. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.05 HANGERS AND SUPPORTS

- A. Hanger, support, and anchor products are specified in Section 230529 - Hangers and Supports for HVAC Piping and Equipment.
- B. Install the following pipe attachments:
 - 1. Adjustable steel clevis hangers for individual horizontal runs less than 20 feet long.
 - 2. Roller hangers and spring hangers for individual horizontal runs 20 feet or longer.
 - 3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.
 - 4. Spring hangers to support vertical runs.
 - 5. Copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.
- C. Install hangers for copper tubing with the following maximum spacing and minimum rod sizes:
 - 1. NPS ½ inch: Maximum span, 60 inches; minimum rod size, 1/4 inch.
 - 2. NPS 5/8: Maximum span, 60 inches; minimum rod size, 1/4 inch.
 - 3. NPS 1: Maximum span, 72 inches; minimum rod size, 1/4 inch.
 - 4. NPS 1-1/4: Maximum span, 96 inches; minimum rod size, 3/8 inch.
 - 5. NPS 1 ½ inch: Maximum span, 96 inches; minimum rod size, 3/8 inch.
 - 6. NPS 2: Maximum span, 96 inches; minimum rod size, 3/8 inch.
 - 7. NPS 2½ inch: Maximum span, 108 inches; minimum rod size, 3/8 inch.
 - 8. NPS 3: Maximum span, 10 feet; minimum rod size, 3/8 inch.
 - 9. NPS 4: Maximum span, 12 feet; minimum rod size, ½ inch.

3.06 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports.
- B. Tests and Inspections:
 - 1. Comply with ASME B31.5, Chapter VI.

2. Test refrigerant piping, specialties, and receivers. Isolate compressor, condenser, evaporator, and safety devices from test pressure if they are not rated above the test pressure.
3. Test high- and low-pressure side piping of each system separately at not less than the pressures indicated in Part 1 "Performance Requirements" Article.
 - a. Fill system with nitrogen to the required test pressure.
 - b. System shall maintain test pressure at the manifold gage throughout duration of test.
 - c. Test joints and fittings with electronic leak detector or by brushing a small amount of soap and glycerin solution over joints.
 - d. Remake leaking joints using new materials, and retest until satisfactory results are achieved.

3.07 SYSTEM CHARGING

- A. Charge system using the following procedures:
 1. Install core in filter dryers after leak test but before evacuation.
 2. Evacuate entire refrigerant system with a vacuum pump to 500 micrometers. If vacuum holds for 12 hours, system is ready for charging.
 3. Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig.
 4. Charge system with a new filter-dryer core in charging line.
 5. Document associated equipment in attached HVAC Information Log. Contractor shall ask the District or Architect to provide editable spreadsheet file.

3.08 ADJUSTING

- A. Adjust thermostatic expansion valve to obtain proper evaporator superheat.
- B. Adjust high- and low-pressure switch settings to avoid short cycling in response to fluctuating suction pressure.
- C. Adjust set-point temperature of air-conditioning or chilled-water controllers to the system design temperature.
- D. Perform the following adjustments before operating the refrigeration system, according to manufacturer's written instructions:
 1. Open shutoff valves in condenser water circuit.
 2. Verify that compressor oil level is correct.
 3. Open compressor suction and discharge valves.
 4. Open refrigerant valves except bypass valves that are used for other purposes.
 5. Check open compressor-motor alignment and verify lubrication for motors and bearings.
- E. Replace core of replaceable filter dryer after system has been adjusted and after design flow rates and pressures are established.

END OF SECTION

SECTION 233113 METAL DUCTS

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Single-wall rectangular ducts and fittings.
 - 2. Single-wall round and flat-oval ducts and fittings.
 - 3. Sheet metal materials.
 - 4. Duct liner.
 - 5. Sealants and gaskets.
 - 6. Hangers and supports.
 - 7. Seismic-restraint devices.
- B. Related Sections:
 - 1. Section 230593 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing requirements for metal ducts.
 - 2. Section 233300 "Air Duct Accessories" for dampers, duct-mounting access doors and panels, turning vanes, and flexible ducts.

1.02 PERFORMANCE REQUIREMENTS

- A. Delegated Duct Design: Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and performance requirements and design criteria indicated in "Duct Schedule" Article.
- B. Structural Performance: Duct hangers and supports and seismic restraints shall 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 SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems."
- C. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

1.03 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. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
 - 2. Factory- and shop-fabricated ducts and fittings.
 - 3. Duct layout indicating sizes, configuration, liner material, and static-pressure classes.
 - 4. Elevation of top of ducts.
 - 5. Dimensions of main duct runs from building grid lines.
 - 6. Fittings.
 - 7. Reinforcement and spacing.
 - 8. Seam and joint construction.
 - 9. Penetrations through fire-rated and other partitions.

10. Equipment installation based on equipment being used on Project.
 11. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.
 12. Hangers and supports, including methods for duct and building attachment, seismic restraints, and vibration isolation.
- C. Delegated-Design Submittal:
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.

1.04 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
1. Duct installation in congested spaces, indicating coordination with general construction, building components, and other building services. Indicate proposed changes to duct layout.
 2. Suspended ceiling components.
 3. Structural members to which duct will be attached.
 4. Size and location of initial access modules for acoustical tile.
 5. Penetrations of smoke barriers and fire-rated construction.
 6. Items penetrating finished ceiling including the following:
 - a. Lighting fixtures.
 - b. Air outlets and inlets.
 - c. Speakers.
 - d. Access panels.
- B. Welding certificates.
- C. Field quality-control reports.

1.05 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to the following:
1. AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports.
 2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum," for aluminum supports.
 3. AWS D9.1M/D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.
- B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-up."
- C. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."
- D. Exhaust system shall comply with CMC Section 505 and 506. Hot gas exhaust ductwork shall conform to CMC Section 816, 817 and 818. Both systems shall comply also to NFPA 91.

PART 2 PRODUCTS

2.01 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

- A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.

- B. 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."
- C. 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."
- D. 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."

2.02 SINGLE-WALL ROUND AND FLAT-OVAL DUCTS AND FITTINGS

- A. 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.
- B. 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).
- C. 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.
- D. 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.
- E. 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."

2.03 SHEET METAL MATERIALS

- A. General Material Requirements:
 - 1. Comply with SMACNA's "HVAC Duct Construction Standards. Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
- B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.

1. Galvanized Coating Designation: G90.
2. Finishes for Surfaces Exposed to View: Mill phosphatized.
- C. Carbon-Steel Sheets: Comply with ASTM A 1008/A 1008M, with oiled, matte finish for exposed ducts.
- D. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304 or 316, as indicated on the "Duct Schedule" Article; cold rolled, annealed, sheet. Exposed surface finish shall be No. 2B, No. 2D, No. 3, or No. 4 as indicated in the "Duct Schedule" Article.
- E. Aluminum Sheets: Comply with ASTM B 209 Alloy 3003, H14 temper; with mill finish for concealed ducts, and standard, one-side bright finish for duct surfaces exposed to view.
- F. Reinforcement Shapes and Plates: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
 1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.
- G. 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.

2.04 DUCT LINER

- A. Fibrous-Glass Duct Liner: Comply with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."
 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. CertainTeed Corporation; Insulation Group.
 - b. Johns Manville.
 - c. Knauf Insulation.
 - d. Owens Corning.
 - e. Or approved equal.
 - f. Maximum Thermal Conductivity:
 - 1) Type I, Flexible: 0.27 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.
 - 2) Type II, Rigid: 0.23 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.
 2. For outdoor application use 2-inch thick lining and for indoor application use 1-inch thick lining.
 3. Line all ductwork as indicated on Drawings.
 4. 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.
 5. Water-Based Liner Adhesive: Comply with NFPA 90A or NFPA 90B and with ASTM C 916.
 - a. 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).
 - b. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- B. 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 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. 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.
 8. 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.
 9. Secure insulation between perforated sheet metal inner duct of same thickness as specified for outer shell. Use mechanical fasteners that maintain inner duct at uniform distance from outer shell without compressing insulation.
 - a. Sheet Metal Inner Duct Perforations: 3/32-inch diameter, with an overall open area of 23 percent.
 10. Terminate inner ducts with buildouts attached to fire-damper sleeves, dampers, turning vane assemblies, or other devices. Fabricated buildouts (metal hat sections) or other buildout means are optional; when used, secure buildouts to duct walls with bolts, screws, rivets, or welds.

2.05 SEALANT AND GASKETS

- A. 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.
- B. Two-Part Tape Sealing System:
 1. Tape: Woven cotton fiber impregnated with mineral gypsum and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.
 2. Tape Width: 3 inches.
 3. Sealant: Modified styrene acrylic.
 4. Water resistant.
 5. Mold and mildew resistant.
 6. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
 7. Service: Indoor and outdoor.
 8. Service Temperature: Minus 40 to plus 200 deg F.

9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum.
 10. 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).
 11. Sealant shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- C. Water-Based Joint and Seam Sealant:
1. Application Method: Brush on.
 2. Solids Content: Minimum 65 percent.
 3. Shore A Hardness: Minimum 20.
 4. Water resistant.
 5. Mold and mildew resistant.
 6. VOC: Maximum 75 g/L (less water).
 7. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
 8. Service: Indoor or outdoor.
 9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.
- D. Solvent-Based Joint and Seam Sealant:
1. Application Method: Brush on.
 2. Base: Synthetic rubber resin.
 3. Solvent: Toluene and heptane.
 4. Solids Content: Minimum 60 percent.
 5. Shore A Hardness: Minimum 60.
 6. Water resistant.
 7. Mold and mildew resistant.
 8. 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).
 9. VOC: Maximum 395 g/L.
 10. Sealant shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
 11. Maximum Static-Pressure Class: 10-inch wg, positive or negative.
 12. Service: Indoor or outdoor.
 13. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.
- E. Flanged Joint Sealant: Comply with ASTM C 920.
1. General: Single-component, acid-curing, silicone, elastomeric.
 2. Type: S.
 3. Grade: NS.
 4. Class: 25.
 5. Use: O.
 6. 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).
 7. Sealant shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- F. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.
- G. Round Duct Joint O-Ring Seals:

1. Seal shall provide maximum 3 cfm/100 sq. ft. at 1-inch wg and shall be rated for 10-inch wg static-pressure class, positive or negative.
2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.
3. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.

2.06 HANGERS AND SUPPORTS

- A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.
- B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.
- C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."
- D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.
- E. Steel Cables for Stainless-Steel Ducts: Stainless steel complying with ASTM A 492.
- F. 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.
- G. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.
- H. Trapeze and Riser Supports:
 1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
 2. Supports for Stainless-Steel Ducts: Stainless-steel shapes and plates.
 3. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.

2.07 SEISMIC-RESTRAINT DEVICES

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 1. Hilti Corp.
 2. TOLCO; a brand of NIBCO INC.
 3. Unistrut Corporation; Tyco International, Ltd.
 4. Or approved equal.
- B. General Requirements for Restraint Components: Rated strengths, features, and applications shall be as defined in reports by the Office of Statewide Health Planning and Development for the State of California.
- C. Channel Support System: Shop- or field-fabricated support assembly made of slotted steel channels rated in tension, compression, and torsion forces and with accessories for attachment to braced component at one end and to building structure at the other end. Include matching components and corrosion-resistant coating.
- D. Restraint Cables: ASTM A 603, galvanized-steel cables with end connections made of cadmium-plated steel assemblies with brackets, swivel, and bolts designed for restraining cable service; and with an automatic-locking and clamping device or double-cable clips.
- E. Hanger Rod Stiffener: Reinforcing steel angle clamped to hanger rod.
- F. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

PART 3 EXECUTION

3.01 DUCT INSTALLATION

- A. Coordinate duct layout and duct accessory arrangement with Drawings.
- B. 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.
- C. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.
- D. Install ducts in maximum practical lengths.
- E. Install ducts with fewest possible joints.
- F. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.
- G. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.
- H. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
- I. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.
- J. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.
- K. Ducts shall not be located in the dedicated space of Electrical equipment as defined by California Electrical Code Section 110.26
- L. 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.
- M. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers. Comply with requirements in Section 233300 "Air Duct Accessories" for fire and smoke dampers.
- N. 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."
- O. Duct sizes as indicated on the drawings are the net inside dimensions.
 - 1. INSTALLATION OF EXPOSED DUCTWORK
- P. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.
- Q. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.
- R. 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.
- S. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.
- T. Repair or replace damaged sections and finished work that does not comply with these requirements.

3.02 DUCT SEALING

- A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" on the drawings. Article according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- B. Seal ducts before external insulation is applied.
 - 1. HANGER AND SUPPORT INSTALLATION
- C. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."
- D. Verify attachment selection and spacing in first two paragraphs below with structural engineer.
- E. 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.
 - a. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
 - b. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.
 - c. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.
 - d. Do not use powder-actuated concrete fasteners for seismic restraints.
- F. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "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.
- G. Hangers Exposed to View: Threaded rod and angle or channel supports.
- H. 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 interval of 16 feet.
- I. 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.
- J. Do not support ductwork from fans or any other equipment.

3.03 SEISMIC-RESTRAINT-DEVICE INSTALLATION

- A. Install ducts with hangers and braces designed to support the duct and to restrain against seismic forces required by applicable building codes. Comply with SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems."
 - 1. Space lateral supports a maximum of 40 feet o.c., and longitudinal supports a maximum of 80 feet o.c.
 - a. Brace a change of direction longer than 12 feet.
- B. Select seismic-restraint devices with capacities adequate to carry present and future static and seismic loads.
- C. Install cables so they do not bend across edges of adjacent equipment or building structure.
- D. Install cable restraints on ducts that are suspended with vibration isolators.
- E. Install seismic-restraint devices using methods approved by the Office of Statewide Health Planning and Development for the State of California.
- F. Attachment to Structure: If specific attachment is not indicated, anchor bracing and restraints to structure, to flanges of beams, to upper truss chords of bar joists, or to concrete members.
- G. Drilling for and Setting Anchors:

1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcement or embedded items during drilling. Notify the Architect if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
 - a. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
 - b. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
 - c. Set anchors to manufacturer's recommended torque, using a torque wrench.
 - d. Install zinc-coated steel anchors for interior applications and stainless-steel anchors for applications exposed to weather.

3.04 CONNECTIONS

- A. Coordinate duct installations and specialty arrangements with Drawings.
- B. Make connections to equipment with flexible connectors complying with Section 233300 "Air Duct Accessories."
- C. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.05 PAINTING

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

3.06 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Leakage Tests:
 1. Comply with SMACNA's "HVAC Air Duct Leakage Test Manual." Submit a test report for each test.
 - a. Test representative duct sections totaling no less than the percentage of installed duct area identified on the "Duct Schedule" on the drawings.
 - b. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
 - c. Test for leaks before applying external insulation.
 - d. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If static-pressure classes are not indicated, test system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure.
 - e. Give seven days' advance notice for testing.
- C. Duct System Cleanliness Tests:
 1. Visually inspect duct system to ensure that no visible contaminants are present.
 - a. Test sections of metal duct system, chosen randomly by Owner, for cleanliness according to "Vacuum Test" in NADCA ACR, "Assessment, Cleaning and Restoration of HVAC Systems."
 - b. Acceptable Cleanliness Level: Net weight of debris collected on the filter media shall not exceed 0.75 mg/100 sq. cm.

- D. Duct system will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

3.07 DUCT CLEANING

- A. Clean new duct system(s) before testing, adjusting, and balancing.
- B. Use service openings for entry and inspection.
 - 1. Create new openings and install access panels appropriate for duct static-pressure class if required for cleaning access. Provide insulated panels for insulated or lined duct. Patch insulation and liner as recommended by duct liner manufacturer. Comply with Section 233300 "Air Duct Accessories" for access panels and doors.
 - a. Disconnect and reconnect flexible ducts as needed for cleaning and inspection.
 - b. Remove and reinstall ceiling to gain access during the cleaning process.
- C. Particulate Collection and Odor Control:
 - 1. When venting vacuuming system inside the building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron-size (or larger) particles.
 - a. When venting vacuuming system to outdoors, use filter to collect debris removed from HVAC system, and locate exhaust downwind and away from air intakes and other points of entry into building.
- D. Clean the following components by removing surface contaminants and deposits:
 - 1. Air outlets and inlets (registers, grilles, and diffusers).
 - a. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
 - b. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.
 - c. Coils and related components.
 - d. Return-air ducts, dampers, actuators, and turning vanes except in ceiling plenums and mechanical equipment rooms.
 - e. Supply-air ducts, dampers, actuators, and turning vanes.
 - f. Dedicated exhaust and ventilation components and makeup air systems.
- E. Mechanical Cleaning Methodology:
 - 1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.
 - a. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.
 - b. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts, duct liner, or duct accessories.
 - c. Clean fibrous-glass duct liner with HEPA vacuuming equipment; do not permit duct liner to get wet. Replace fibrous-glass duct liner that is damaged, deteriorated, or delaminated or that has friable material, mold, or fungus growth.
 - d. Clean coils and coil drain pans according to NADCA 1992. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.
 - e. Provide drainage and cleanup for wash-down procedures.
 - f. Antimicrobial Agents and Coatings: Apply EPA-registered antimicrobial agents if fungus is present. Apply antimicrobial agents according to manufacturer's written instructions after removal of surface deposits and debris.

3.08 START UP

- A. Air Balance: Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC."

3.09 DUCT SCHEDULE

- A. Refer to drawings for duct fabrication duct schedule.
- B. Elbow Configuration:
 - 1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."
 - a. Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
 - b. Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
 - c. Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."
 - 2. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "Round Duct Elbows."
 - a. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 3-1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.
 - b. Radius-to Diameter Ratio: 1.5.
 - c. Round Elbows, 12 Inches and Smaller in Diameter: Stamped or pleated.
 - d. Round Elbows, 14 Inches and Larger in Diameter: Welded.
 - 3. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-6, "Branch Connection."
 - a. Rectangular Main to Rectangular Branch: 45-degree entry.
 - b. Rectangular Main to Round Branch: Spin in.
 - 4. Round and Flat Oval: Comply with SMACNA's "HVAC Duct Construction"
 - a. Velocity 1000 fpm or Lower: 90-degree tap.
 - b. Velocity 1000 to 1500 fpm: Conical tap.
 - c. Velocity 1500 fpm or Higher: 45-degree lateral.

END OF SECTION

SECTION 23 33 00
AIR DUCT ACCESSORIES

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section Includes:
 - 1. Backdraft and pressure relief dampers.
 - 2. Barometric relief dampers.
 - 3. Manual volume dampers.
 - 4. Control dampers.
 - 5. Fire dampers.
 - 6. Combination fire and smoke dampers.
 - 7. Flange connectors.
 - 8. Turning vanes.
 - 9. Remote damper operators.
 - 10. Duct-mounted access doors.
 - 11. Flexible connectors.
 - 12. Flexible ducts.
 - 13. Duct accessory hardware.
 - 14. Duct silencers.
- B. Related Sections:
 - 1. Division 23 Section "HVAC Gravity Ventilators" for roof-mounted ventilator caps.
 - 2. Division 28 Section "Fire Detection and Alarm" for duct-mounted fire and smoke detectors.

1.03 SUBMITTALS

- A. Product Data: For each type of product indicated.
 - 1. For duct silencers, include pressure drop and dynamic insertion loss data. Include breakout noise calculations for high transmission loss casings.
- B. Shop Drawings: For duct accessories. Include plans, elevations, sections, details and attachments to other work.
 - 1. Detail duct accessories fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances; and method of field assembly into duct systems and other construction. Include the following:
 - a. Special fittings.
 - b. Manual volume damper installations.
 - c. Control damper installations.
 - d. Fire-damper, smoke-damper, combination fire- and smoke-damper, ceiling, and corridor damper installations, including sleeves; and duct-mounted access doors and remote damper operators.
 - e. Duct security bars.
 - f. Wiring Diagrams: For power, signal, and control wiring.

- C. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which ceiling-mounted access panels and access doors required for access to duct accessories are shown and coordinated with each other, using input from Installers of the items involved.
- D. Source quality-control reports.
- E. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.

1.04 QUALITY ASSURANCE

- A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."
- B. Comply with AMCA 500-D testing for damper rating.

1.05 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.
- B. Fusible Links: Furnish quantity equal to 10 percent of amount installed.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
- B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
 - a. Galvanized Coating Designation: [G60] [G90].
 - b. Exposed-Surface Finish: Mill phosphatized.
- C. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304.
- D. Aluminum Sheets: Comply with ASTM B 209, Alloy 3003, Temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.
- E. Extruded Aluminum: Comply with ASTM B 221, Alloy 6063, Temper T6.
- F. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.
- G. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches .

2.02 BACKDRAFT AND PRESSURE RELIEF DAMPERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Air Balance Inc.; a division of Mestek, Inc.
 - 2. Greenheck Fan Corporation.
 - 3. Pottorff; a division of PCI Industries, Inc.
 - 4. Ruskin Company.
- B. Description: Gravity balanced.

- C. Maximum Air Velocity: 2000 fpm.
- D. Maximum System Pressure: 2-inch wg.
- E. Frame: 0.052-inch- thick, galvanized sheet steel, with welded corners.
- F. Blades: Multiple single-piece blades, maximum 6-inch width, 0.025-inch-thick, roll-formed aluminum with sealed edges.
- G. Blade Action: Parallel.
- H. Blade Seals: Extruded vinyl, mechanically locked or Neoprene, mechanically locked.
- I. Blade Axles:
 - 1. Material: Galvanized steel.
 - 2. Diameter: 0.20 inch.
- J. Tie Bars and Brackets: Galvanized steel.
- K. Return Spring: Adjustable tension.
- L. Accessories:
 - 1. Adjustment device to permit setting for varying differential static pressure.
 - 2. Counterweights and spring-assist kits for vertical airflow installations.
 - 3. Electric actuators.
 - 4. Chain pulls.
 - 5. Screen Mounting: Front mounted in sleeve.
 - a. Sleeve Thickness: 20-gage minimum.
 - b. Sleeve Length: 6 inches minimum.
 - c. Screen Mounting: Rear mounted.
 - d. Screen Material: Galvanized steel.
 - e. Screen Type: Bird.
 - f. 90-degree stops.

2.03 BAROMETRIC RELIEF DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Air Balance Inc.; a division of Mestek, Inc.
 - 2. Greenheck Fan Corporation.
 - 3. Pottorff; a division of PCI Industries, Inc.
 - 4. Ruskin Company.
- B. Suitable for horizontal or vertical mounting.
- C. Maximum Air Velocity: 2000 fpm.
- D. Maximum System Pressure: 2-inch wg.
- E. Frame: 0.064-inch- thick, galvanized sheet steel, with welded corners.
- F. Blades:
 - 1. Multiple, 0.025-inch-thick, roll-formed aluminum.
 - 2. Maximum Width: 6 inches.
 - 3. Action: Parallel.
 - 4. Balance: Gravity.
 - 5. Eccentrically pivoted.
- G. Blade Seals: Vinyl or Neoprene.
- H. Blade Axles: Galvanized steel.
- I. Tie Bars and Brackets:
 - 1. Material: Galvanized steel.

2. Rattle free with 90-degree stop.
- J. Return Spring: Adjustable tension.
 1. Accessories:
 2. Flange on intake.
 3. Adjustment device to permit setting for varying differential static pressures.

2.04 MANUAL VOLUME DAMPERS

- A. Standard, Steel, Manual Volume Dampers:
 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Air Balance Inc.; a division of Mestek, Inc.
 - b. Pottorff; a division of PCI Industries, Inc.
 - c. Ruskin Company.
 2. Standard leakage rating, with linkage outside airstream.
 3. Suitable for horizontal or vertical applications.
 4. Frames:
 - a. Hat-shaped, galvanized, 0.064-inch minimum thickness.
 - b. Mitered and welded corners.
 - c. Flanges for attaching to walls and flangeless frames for installing in ducts.
 - d. Blades:
 - e. Multiple or single blade.
 - f. Parallel- or opposed-blade design.
 - g. Stiffen damper blades for stability.
 - h. Galvanized-steel, 0.064 inch thick.
 5. Blade Axles: Galvanized steel.
 6. Bearings:
 - a. Oil-impregnated bronze.
 - b. Dampers in ducts with pressure classes of 3-inch wg. or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
 7. Tie Bars and Brackets: Galvanized steel.
- B. Low-Leakage, Steel, Manual Volume Dampers:
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Air Balance Inc.; a division of Mestek, Inc.
 - 2) Pottorff; a division of PCI Industries, Inc.
 - 3) Ruskin Company.
 - b. Low-leakage rating, with linkage outside airstream, and bearing AMCA's Certified Ratings Seal for both air performance and air leakage.
 - c. Suitable for horizontal or vertical applications.
 - d. Frames:
 - 1) Hat shaped.
 - 2) Galvanized-steel channels, 0.064 inch thick.
 - 3) Mitered and welded corners.
 - 4) Flanges for attaching to walls and flangeless frames for installing in ducts.
 - e. Blades:
 - 1) Multiple or single blade.
 - 2) Parallel- or opposed-blade design.
 - 3) Stiffen damper blades for stability.

- 4) Galvanized, roll-formed steel, 0.064 inch thick.
2. Blade Axles: Galvanized.
3. Bearings:
 - a. Oil-impregnated bronze.
 - b. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
4. Blade Seals: Vinyl or Neoprene.
5. Jamb Seals: Cambered stainless steel.
6. Tie Bars and Brackets: Galvanized steel.
7. Accessories:
 - a. Include locking device to hold single-blade dampers in a fixed position without vibration.
- C. Jackshaft:
 1. Size: 1-inch diameter.
 2. Material: Galvanized-steel pipe rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.
 3. Length and Number of Mountings: As required to connect linkage of each damper in multiple-damper assembly.
- D. Damper Hardware:
 1. Zinc-plated, die-cast core with dial and handle made of 3/32-inch thick zinc-plated steel, and a 3/4-inch hexagon locking nut.
 2. Include center hole to suit damper operating-rod size.
 3. Include elevated platform for insulated duct mounting.

2.05 CONTROL DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. American Warming and Ventilating; a division of Mestek, Inc.
 2. Greenheck Fan Corporation.
 3. Ruskin Company.
- B. Low-leakage rating, with linkage outside airstream, and bearing AMCA's Certified Ratings Seal for both air performance and air leakage.
- C. Frames:
 1. Hat shaped.
 2. Galvanized-steel channels, 0.064 inch thick.
 3. Mitered and welded corners.
- D. Blades:
 1. Multiple blade with maximum blade width of 8 inches.
 2. Opposed-blade design.
 3. Galvanized steel.
 4. 0.064 inch thick.
 5. Blade Edging: Closed-cell neoprene edging.
 6. Blade Edging: Inflatable seal blade edging, or replaceable rubber seals.
- E. Blade Axles: 1/2-inch-diameter; galvanized steel; blade-linkage hardware of zinc-plated steel and brass; ends sealed against blade bearings.
 1. Operating Temperature Range: From minus 40 to plus 200 deg F.
- F. Bearings:
 1. Oil-impregnated bronze.

2. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
3. Thrust bearings at each end of every blade.

2.06 FIRE DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Greenheck Fan Corporation.
 2. Pottorff; a division of PCI Industries, Inc.
 3. Ruskin Company.
- B. Type: Fire dampers shall be labeled according to UL 555 by an NRTL.
- C. Fire Rating: 1-1/2 or 3 hours.
- D. Frame: Curtain type with blades outside airstream; fabricated with roll-formed, 0.034-inch-thick galvanized steel; with mitered and interlocking corners.
- E. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel.
 1. Minimum Thickness: 0.052 or 0.138 inch thick, as indicated, and of length to suit application.
 2. Exception: Omit sleeve where damper-frame width permits direct attachment of perimeter mounting angles on each side of wall or floor; thickness of damper frame must comply with sleeve requirements.
- F. Mounting Orientation: Vertical or horizontal as indicated.
- G. Blades: Roll-formed, interlocking, 0.034-inch- thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch- thick, galvanized-steel blade connectors.
- H. Horizontal Dampers: Include blade lock and stainless-steel closure spring.
- I. Heat-Responsive Device: Replaceable, 165 deg F rated, fusible links.

2.07 COMBINATION FIRE AND SMOKE DAMPERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Greenheck Fan Corporation.
- C. Pottorff
- D. Ruskin Company.
- E. Combination fire and smoke dampers shall be labeled according to UL 555 and UL 555S by an NRTL.
- F. Fire Rating: 1-1/2 or 3 hours.
- G. Frame: Curtain type with blades outside airstream; fabricated with roll-formed, 0.034-inch- thick galvanized steel; with mitered and interlocking corners.
- H. Heat-Responsive Device: Replaceable, 165 deg F rated, fusible links.
- I. Heat-Responsive Device: Electric resettable link and switch package, factory installed, rated.
- J. Smoke Detector: Integral, factory wired for single-point connection.
- K. Frame: Curtain type with blades outside airstream; fabricated with roll-formed, 0.034-inch- thick galvanized steel; with mitered and interlocking corners.
- L. Blades: Roll-formed, horizontal, interlocking, 0.034-inch- thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch- thick, galvanized-steel blade connectors.
- M. Leakage: Class I.

- N. Rated pressure and velocity to exceed design airflow conditions.
- O. Mounting Sleeve: Factory-installed, 0.052-inch- thick, galvanized sheet steel; length to suit wall or floor application.
- P. Master control panel for use in dynamic smoke-management systems.
- Q. Damper Motors: Modulating and two-position action.
- R. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."
 - 1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
 - 2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 26 Sections.
 - 3. Permanent-Split-Capacitor or Shaded-Pole Motors: With oil-immersed and sealed gear trains.
 - 4. Spring-Return Motors: Equip with an integral spiral-spring mechanism where indicated. Enclose entire spring mechanism in a removable housing designed for service or adjustments. Size for running torque rating of 150 in. x lbf and breakaway torque rating of 150 in. x lbf .
 - 5. Outdoor Motors and Motors in Outdoor-Air Intakes: Equip with O-ring gaskets designed to make motors weatherproof. Equip motors with internal heaters to permit normal operation at minus 40 deg F.
 - 6. Nonspring-Return Motors: For dampers larger than 25 sq. ft., size motor for running torque rating of 150 in. x lbf and breakaway torque rating of 300 in. x lbf .
 - 7. Electrical Connection: 115 V, single phase, 60 Hz.

2.08 FLANGE CONNECTORS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Ductmate Industries, Inc.
 - 2. Nexus PDQ; Division of Shilco Holdings Inc.
 - 3. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
- B. Description: Add-on or roll-formed, factory-fabricated, slide-on transverse flange connectors, gaskets, and components.
- C. Material: Galvanized steel.
- D. Gage and Shape: Match connecting ductwork.

2.09 TURNING VANES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Ductmate Industries, Inc.
 - 2. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
- B. Manufactured 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.
- C. Manufactured Turning Vanes for Nonmetal Ducts: Fabricate curved blades of resin-bonded fiberglass with acrylic polymer coating; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.

- D. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 4-3, "Vaness and Vane Runners," and 4-4, "Vane Support in Elbows."
- E. Vane Construction: Double wall.
- F. Vane Construction: Single wall for ducts up to 48 inches wide and double wall for larger dimensions.

2.10 DUCT-MOUNTED ACCESS DOORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Ductmate Industries, Inc.
 - 2. Greenheck Fan Corporation.
 - 3. Pottorff; a division of PCI Industries, Inc.
- B. Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 7-2, "Duct Access Doors and Panels," and 7-3, "Access Doors - Round Duct."
 - 1. Door:
 - a. Double wall, rectangular.
 - b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
 - c. Vision panel.
 - d. Hinges and Latches: 1-by-1-inch butt or piano hinge and cam latches.
 - e. Fabricate doors airtight and suitable for duct pressure class.
 - 2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
 - 3. Number of Hinges and Locks:
 - a. Access Doors Less Than 12 Inches Square: No hinges and two sash locks.
 - b. Access Doors up to 18 Inches Square: Two hinges and two sash locks.
 - c. Access Doors up to 24 by 48 Inches: Three hinges and two compression latches with outside and inside handles.
 - d. Access Doors Larger Than 24 by 48 Inches: Four hinges and two compression latches with outside and inside handles.

2.11 FLEXIBLE CONNECTORS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Ductmate Industries, Inc.
 - 2. Duro Dyne Inc.
 - 3. Ventfabrics, Inc.
- 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 0.028-inch- thick, galvanized sheet steel or 0.032-inch- thick aluminum sheets. Provide metal compatible with connected ducts.
- E. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.
 - 1. Minimum Weight: 26 oz./sq. yd. .
 - 2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
 - 3. Service Temperature: Minus 40 to plus 200 deg F.
- F. Outdoor System, Flexible Connector Fabric: Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and ozone.

1. Minimum Weight: 24 oz./sq. yd. .
 2. Tensile Strength: 530 lbf/inch in the warp and 440 lbf/inch in the filling.
 3. Service Temperature: Minus 50 to plus 250 deg. F.
- G. High-Temperature System, Flexible Connectors: Glass fabric coated with silicone rubber.
1. Minimum Weight: 16 oz./sq. yd.
 2. Tensile Strength: 285 lbf/inch in the warp and 185 lbf/inch in the filling.
 3. Service Temperature: Minus 67 to plus 500 deg. F.
- H. High-Corrosive-Environment System, Flexible Connectors: Glass fabric with chemical-resistant coating.
1. Minimum Weight: 14 oz./sq. yd.
 2. Tensile Strength: 450 lbf/inch in the warp and 340 lbf/inch in the filling.
 3. Service Temperature: Minus 67 to plus 500 deg. F.
- I. Thrust Limits: 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.
1. 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.
 2. Outdoor Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
 6. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
 7. Coil Spring: Factory set and field adjustable for a maximum of 1/4-inch movement at start and stop.

2.12 FLEXIBLE DUCTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Casco Silentflex II.
 - a. Insulated, Flexible Duct: UL 181, Class 1, black polymer film supported by helically wound, spring-steel wire; fibrous-glass insulation; polyethylene vapor-barrier film.
 2. Pressure Rating: 4-inch wg positive and 0.5-inch wg negative.
 3. Maximum Air Velocity: 4000 fpm.
 4. Temperature Range: Minus 20 to plus 175 deg F.
 5. Insulation R-Value: Comply with Title 24.

2.13 DUCT ACCESSORY HARDWARE

- A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.
- B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

2.14 DUCT SILENCER

- A. Manufacturers:
1. Industrial Acoustics Company (IAC)

2. Commercial Acoustics.
 3. Vibro-Acoustics.
- B. General Description: Factory-fabricated and -tested, round or rectangular silencers with performance characteristics and physical requirements as indicated on the drawings.
- C. Fire Performance: Adhesives, sealants, packing materials, and accessory materials shall have fire ratings not exceeding 25 for flame-spread index and 50 for smoke-developed index when tested according to ASTM E 84.
- D. Rectangular Units: Fabricate casings with a minimum of 0.034-inch- thick, solid galvanized sheet metal for outer casing and 0.022-inch- thick, ASTM A 653/A 653M, G60, perforated galvanized sheet metal for inner casing. Outdoor units shall be provided with weatherproofing features, including a sloped roof and air/water sealant.
- E. Sheet Metal Perforations: 1/8-inch diameter for inner casing and baffle sheet metal.
- F. Fill Material: Inert and vermin-proof fibrous material, packed under not less than 5 percent compression.
1. Erosion Barrier: Polymer bag enclosing fill and heat-sealed before assembly.
- G. Fabricate silencers to form rigid units that will not pulsate, vibrate, rattle, or otherwise react to system pressure variations.
1. Do not use nuts, bolts, or sheet metal screws for unit assemblies.
 2. Lock form and seal or continuously weld joints.
 3. Suspended Units: Factory-installed suspension hooks or lugs attached to frame in quantities and spaced to prevent deflection or distortion.
 4. Reinforcement: Cross or trapeze angles for rigid suspension.
- H. Source Quality Control:
1. Acoustic Performance: Test according to ASTM E 477.
 2. Record acoustic ratings, including dynamic insertion loss and self-noise power levels with an airflow of at least 2000-fpm face velocity.
 3. Leak Test: Test units for airtightness at 200 percent of associated fan static pressure or 6-inch wg static pressure, whichever is greater.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.
- B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.
- C. Install backdraft dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.
- D. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.
- E. Install steel volume dampers in steel ducts.
- F. Install aluminum volume dampers in aluminum ducts.
- G. Set dampers to fully open position before testing, adjusting, and balancing.

- H. Install test holes at fan inlets and outlets and elsewhere as indicated.
- I. Install fire and smoke dampers according to UL listing.
- J. Connect ducts to duct silencers with flexible duct connectors.
- K. 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. Downstream from duct filters.
 - 3. At outdoor-air intakes and mixed-air plenums.
 - 4. At drain pans and seals.
 - 5. Downstream from manual volume dampers, control dampers, backdraft dampers, and equipment.
 - 6. Adjacent to and close enough to fire or smoke dampers, to reset or reinstall fusible links. Access doors for access to fire or smoke dampers having fusible links shall be pressure relief access doors and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.
 - 7. At each change in direction and at maximum 50-foot spacing.
 - 8. Downstream from turning vanes.
 - 9. Upstream or downstream from duct silencers.
 - 10. Control devices requiring inspection.
 - 11. Elsewhere as indicated.
- L. Install access doors with swing against duct static pressure.
- M. Access Door Sizes:
 - 1. One-Hand or Inspection Access: 8 by 5 inches.
 - 2. Two-Hand Access: 12 by 6 inches.
 - 3. Head and Hand Access: 18 by 10 inches.
 - 4. Head and Shoulders Access: 21 by 14 inches.
 - 5. Body Access: 25 by 14 inches.
 - 6. Body plus Ladder Access: 25 by 17 inches.
- N. Label access doors according to Division 23 Section "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.
- O. Install flexible connectors to connect ducts to equipment.
- P. For fans developing static pressures of 5-inch wg and more, cover flexible connectors with loaded vinyl sheet held in place with metal straps.
- Q. Connect terminal units to supply ducts directly or with maximum 84-inch lengths of flexible duct. Do not use flexible ducts to change directions.
- R. Connect diffusers or light troffer boots to ducts directly or with maximum 60-inch lengths of flexible duct clamped or strapped in place.
- S. Connect flexible ducts to metal ducts with adhesive plus sheet metal screws.
- T. Install duct test holes where required for testing and balancing purposes.
- U. Install thrust limits at centerline of thrust, symmetrical on both sides of equipment. Attach thrust limits at centerline of thrust and adjust to a maximum of 1/4-inch movement during start and stop of fans.
- V. All equipment and components requiring access above hardlid ceiling shall be provided with adequate service clearance and ceiling access panels. Coordinate ceiling access panel location based upon installation location in field and in accordance with Section 08 31 00 – Access Doors and Panels.

3.02 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 233416
CENTRIFUGAL FANS**

PART 1 GENERAL

1.01 WORK INCLUDED

- A. CENTRIFUGAL HVAC FANS consists of furnishing transportation, labor, materials, and equipment to furnish and install centrifugal fans and vent sets.

1.02 RELATED WORK

- A. TESTING, ADJUSTING AND BALANCING: Section 230593

1.03 REFERENCES

- A. AMCA
- B. American Society for Testing and Materials (ASTM International)
- C. ISO
- D. ISTA
- E. National Electrical Manufacturers Association (NEMA)
- F. National Fire Protection Association (NFPA)
- G. Underwriters Laboratories, Incorporated (UL)

1.04 PERFORMANCE REQUIREMENTS

- A. Project Altitude: Base air ratings on actual site elevations.
- B. Operating Limits: Classify according to AMCA 99.

1.05 SUBMITTALS

- A. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated and include the following:
 - 1. Certified fan performance curves with system operating conditions indicated.
 - 2. Certified fan sound-power ratings.
 - 3. Motor ratings and electrical characteristics, plus motor and electrical accessories.
 - 4. Material gages and finishes, including color charts.
 - 5. Dampers, including housings, linkages, and operators.
- B. 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. Wiring Diagrams: Power, signal, and control wiring. Differentiate between manufacturer-installed and field-installed wiring.
 - 2. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
 - 3. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, and base weights.
- C. Maintenance Data: For centrifugal fans to include in maintenance manuals.

1.06 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. AMCA Compliance: Products shall comply with performance requirements and shall be licensed to use the AMCA-Certified Ratings Seal.
- C. NEMA Compliance: Motors and electrical accessories shall comply with NEMA standards.
- D. Fans shall be UL and CUL listed per UL 705 safety standard.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Deliver fans as factory-assembled units, to the extent allowable by shipping limitations, with protective crating and covering.
- B. Disassemble and reassemble units, as required for moving to the final location, according to manufacturer's written instructions.
- C. Lift and support units with manufacturer's designated lifting or supporting points.

1.08 COORDINATION

- A. Coordinate size and location of structural-steel support members.
- B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in CAST-IN-PLACE CONCRETE Section.
- C. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in ROOF ACCESSORIES Section.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Non-Laboratory Exhaust Fans
 - 1. Greenheck.
 - 2. Cook, Loren Company.
 - 3. Twin City Fans
- B. Laboratory Exhaust Fan
 - 1. Greenheck, basis of design
 - 2. Strobic
 - 3. Alternate by MK Plastics

2.02 LABORATORY EXHAUST FAN

- A. Conform to AMCA standard 210 and 300. Fans must be tested in accordance with AMCA 210 and 300 in an AMCA accredited laboratory and certified for air and sound performance. Fan shall be licensed to bear the AMCA ratings seal for air performance (AMCA 210), sound performance (AMCA 300).
- B. Fans shall be UL and CUL listed per U: 705 safety standards.
- C. Classification for Spark Resistant Construction shall conform to AMCA 99.
- D. Fans shall meet the criteria of NFPA-45.

- E. Impellers shall be mounted directly to the motor shaft to provide a direct drive arrangement 4 type fan. Motors shall be isolated from the primary exhaust air stream and shall be visible and accessible from the fan exterior for inspection and service.
- F. Mixed flow impellers shall consist of combination axial/backward curved blades and shall be of welded steel construction. The impellers shall have non-stall and non-overloading performance characteristics with aerodynamically stable operation at any point on the fan curves.
- G. Fan and all drive components shall have a combined bearing life of $L_{10} = 150,000$ hours minimum.
- H. Maintenance shall only be required on a minimum of 18-month intervals. This maintenance shall be limited to re-greasing of the motor bearings.
- I. Stationary discharge guide vane sections shall be provided to increase fan efficiencies.
- J. Fan dynamic balance not to exceed 0.5 mil, peak-to-peak for nominal 900RPM, 1200 RPM, and 1800 RPM fans, or 0.055 in/sec-peak for 1800 RPM, 0.035 in/sec-peak for 1200 PRM, and 0.030 in/sec-peak for 900 RPM fans measured at the blade pass area when operating at fan frequency. Vibration isolation shall be limited to rubber-in-shear pad type isolators unless otherwise specified.
- K. Factory test reports detailing vibration levels at the blade pass area shall be provided. Vibration levels shall be reported in both the axial and radial direction. If fan vibration is greater than 0.5 mils peak-to-peak at the blade pass area, fan manufacturer shall be responsible for providing vibration isolators on each fan and flexible connection at each duct inlet. Manufacturer shall add 0.5" additional static pressure to the fan system to compensate for losses through the flexible connection. Vibration isolators, 2" deflection seismic rated spring, must be installed on each individual fan with a minimum of four per fan. In addition, fan manufacturer shall be responsible for providing a method to repair or replace flexible connection or vibration isolators without shut down of the fan system. This includes any engineering, additional ductwork, and isolation dampers required to perform repairs while the system is still fully operational. Fan manufacturer shall also provide labor to change out or repair flexible connection and vibration isolators for a seven (7) year period from shipment.
- L. Each fan shall feature a factory installed piezometric ring on the fan inlet bell. The Pneumatic tubing shall be extended to the fans exterior to be connected to transmitter provided by Controls contractor.
- M. Fan assemblies shall be designed for mounting on conventional roof curb without the need for guy wire supports.
- N. Discharges shall include twin FRP nozzles with passive third central stacks that are capable of generating aspiration. The FRP shall be chemically and UV resistant.
- O. Entrainment wind bands shall provide secondary induction of outside air. Induction shall take place downstream of the fan impeller and shall not influence BHP or static pressure requirements. Wind bands shall discharge up to 270% of the design flow rates. The manufacturer shall publish discharge volumes for all fans at specified primary exhaust flow.
- P. The fan supplied must meet the system exhaust CFM and the motor BHP shall not be larger than that shown on the fan schedule
- Q. Fan shall be constructed to AMCA "C" standards with a non-ferrous inlet bell shall be provided in order to reduce sparking in the event of a motor bearing failure.
- R. Fans shall be modular construction and capable of being assembled on the roof.
- S. Chemical resistant gaskets shall be provided at all companion-flanged joints.
- T. Fasteners shall be stainless steel.
- U. A bolted access door shall be provided for impeller inspection on each fan.
- V. Fans and accessories shall have internal drain systems to prevent rainwater from entering building duct system.

- W. Electric motors shall be TEFC Mill & Chemical duty with a 1.15 service factor and an L-10 bearing life of 400,000 hours. Premium Efficient motors shall have re-greaseable bearings with Zerk fittings in every NEMA frame. Fan motors shall be C-Face and foot mounted. All motors shall comply with efficiencies listed in U.S. Energy Policy Act of 1992. Premium Efficient motors shall be covered by a 7-year parts warranty from the date of shipment.
- X. Extended motor lube lines of Teflon tubing covered with braided stainless steel shall be provided. Extended lube lines shall be mounted to a bracket located on the fan housing with grease relief fittings on each line
- Y. A NEMA 3R non-fused disconnect switch shall be provided, mounted and wired to the motor.
- Z. All steel and aluminum surfaces components within the airstream that are not stainless steel or fiberglass must be surface prepped by abrasive blast clean to SSPC-SP10. Chemically cleaning of these components as a form of surface preparation is not acceptable. These components must be coated with a high solids epoxy with low VOC chemical resistant barrier coating epoxy. The coating system, total thickness of up to 12 mils, is not affected by the UV component of sunlight (does not chalk), and has superior corrosion resistance to acid, alkali, and solvents. Coating system shall exceed 7000-hour ASTM B117 Salt Spray Resistance.

AA. Accessories:

- 1. Inlet mixing plenums shall be provided by the fan manufacturer. Each plenum shall be sized to support the weight and performance requirement of the number of fans listed on the schedule. Multiple fan plenums shall be single wall construction with structural stiffeners. Multiple fan plenums shall be able to withstand a minimum of 12 in. w.g. of negative pressure. Single fan plenums shall be of continuously welded, heavy gauge steel construction. Coatings shall be same as applied to the fan noted above. All plenums shall be capable of supporting the fan(s) without guy wires or supports. The plenums shall include hinged access doors and safety screens over fan inlets. The primary air inlets shall be located on the bottom or side as noted on construction drawings. Unless otherwise specified, plenums shall be suitable for mounting on roof curbs.
 - 2. Bypass dampers shall be provided with all mixing plenums for outside air with primary exhaust.
 - 3. Dampers will be:
 - a. Opposed blade low leakage airfoil control dampers with extended shaft for connection to an operator. The dampers shall be all aluminum construction. Rain hoods shall be provided with each damper. The dampers shall be controlled by 24V electric operators. The operators shall be provided by fan manufacturer.
 - b. Low leakage isolation dampers shall be constructed of aluminum airfoil extrusions and coated with epoxy. Operators shall be 2 position, spring return and shall be 20-PSI pneumatic/24V/110V electric unless variable frequency drives are specified. Electric operators shall be factory wired via a transformer, to the fan disconnect switch to open when the fan is energized and close via a spring return when de-energized. When the fan ships separate from the plenum, all wiring and conduit shall be factory supplied for easy connection in the field.
 - c. Vortex breakers shall be provided on all multiple fan plenums.
 - 4. Roof Curb:
 - a. LEF-1, 2, LEF-3, 4 - A galvanized steel roof curb shall be provided to support the fans/plenums. The curb shall be minimum 14 gauge and canted for rigidity in wind loads. The curb shall include a rigid fiberglass liner and a wood nailer.
- BB. Warranty: Fan manufacturer shall provide a 7-year parts warranty from time of purchase to include fan, plenum, motor and all drive mechanisms including pillow blocks, sheaves, shafts, couplings and belts. This warranty shall be held solely by the fan manufacturer. It is unacceptable to extend the warranty of a provided component supplies (i.e. motors, dampers, actuators). All warranty claims shall be the sole responsibility of the fan manufacturer.

2.03 ROOF MOUNTED CENTRIFUGAL FAN

- A. Description: Fan shall be a spun aluminum, roof mounted, belt driven, high pressure centrifugal exhaust ventilator.
- B. Certifications: Fan shall be manufactured at an ISO 9001 certified facility. Fan shall be listed by Underwriters Laboratories (UL 705). Fan shall bear the AMCA certified ratings seal for sound and air performance.
- C. Construction: Fan shall be of bolted and welded construction utilizing corrosion resistant fasteners. The spun aluminum structural components shall be constructed of minimum 16 gage marine alloy aluminum, bolted to a rigid aluminum support structure. The aluminum base shall have a one-piece inlet spinning and continuously welded curb cap corners for maximum leak protection. The windband shall have a rolled bead for added strength. A two-piece top cap shall have stainless steel quick release latches to provide access into the motor compartment without the use of tools. An integral conduit chase shall be provided into the motor compartment to facilitate wiring connections. The motor, bearings and drives shall be mounted on a minimum 14 gage steel power assembly, isolated from the unit structure with rubber vibration isolators. These components shall be enclosed in a weather-tight compartment, separated from the exhaust airstream. Lifting lugs shall be provided to help prevent damage from improper lifting. Unit shall bear an engraved aluminum nameplate. Nameplate shall indicate design CFM, static pressure, and maximum fan RPM. Unit shall be shipped in ISTA certified transit tested packaging.
- D. Wheel: Wheel shall be centrifugal backward inclined, constructed of 100 percent aluminum, including a precision machined cast aluminum hub. Wheel inlet shall overlap an aerodynamic aluminum inlet cone to provide maximum performance and efficiency. Wheel shall be balanced in conformance with AMCA Standard 204-96.
- E. Motor: Motor shall be heavy duty type with permanently lubricated sealed ball bearings and furnished at the specified voltage, phase and enclosure.
- F. Bearings: Bearings shall be designed and individually tested specifically for use in air handling applications. Construction shall be heavy duty regreasable ball type in a cast iron pillow block housing selected for a minimum L50 life in excess of 200,000 hours at maximum cataloged operating speed.
- G. Belts and Drives: Belts shall be oil and heat resistant, non-static type. Drives shall be precision machined cast iron type, keyed and securely attached to the wheel and motor shafts. Drives shall be sized for 150 percent of the installed motor horsepower. The variable pitch motor drive must be factory set to the specified fan RPM.
- H. Where indicated on plans, provide fan with grease drain, UL 762 listed assembly, and applicable accessories for kitchen exhaust duty.

2.04 SOURCE QUALITY CONTROL

- A. Sound-Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-certified ratings seal.
- B. Fan Performance Ratings: Establish flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests and ratings conforming to AMCA 210, "Laboratory Methods of Testing Fans for Rating."

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install centrifugal fans level and plumb.
- B. Support suspended units from structure using threaded steel rods and spring hangers. Vibration-control devices are specified in MECHANICAL VIBRATION CONTROLS AND SEISMIC RESTRAINTS Section.
- C. Install units with clearances for service and maintenance.
- D. Label fans in conformance with MECHANICAL IDENTIFICATION Section.

3.02 CONNECTIONS

- A. Duct installation and connection requirements are specified in other Division 15 Sections. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in DUCT ACCESSORIES Section.
- B. Install ducts adjacent to fans to allow service and maintenance.
- C. Ground equipment.
- D. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.03 FIELD QUALITY CONTROL

- A. Equipment Startup Checks:
 - 1. Verify that shipping, blocking, and bracing are removed.
 - 2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
 - 3. Verify that cleaning and adjusting are complete.
 - 4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
 - 5. Verify lubrication for bearings and other moving parts.
 - 6. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
- B. Starting Procedures:
 - 1. Energize motor and adjust fan to indicated rpm.
 - 2. Measure and record motor voltage and amperage.
- C. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation. Remove malfunctioning units, replace with new units, and retest.
- D. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- E. Shut unit down and reconnect automatic temperature-control operators.
- F. Refer to TESTING, ADJUSTING, AND BALANCING Section for testing, adjusting, and balancing procedures.
- G. Replace fan and motor pulleys as required to achieve design airflow.
- H. Repair or replace malfunctioning units. Retest as specified above after repairs or replacements are made.

3.04 ADJUSTING

- A. Adjust damper linkages for proper damper operation.
- B. Adjust belt tension.
- C. Lubricate bearings.

3.05 CLEANING

- A. On completion of installation, internally clean fans according to manufacturer's written instructions. Remove foreign material and construction debris. Vacuum fan wheel and cabinet.
- B. After completing system installation, including outlet fitting and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finishes.

3.06 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Department maintenance personnel to adjust, operate, and maintain centrifugal fans.
 - 1. Train maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, and maintaining equipment and schedules.
 - 2. Review data in maintenance manuals.
 - 3. Review data in maintenance manuals.

END OF SECTION

SECTION 23 34 23
HVAC POWER VENTILATORS

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Centrifugal Roof Ventilators

1.02 PERFORMANCE REQUIREMENTS

- A. Project Altitude: Base fan-performance ratings on actual Project site elevations.
- B. Operating Limits: Classify according to AMCA 99.

1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Also include the following:
 - 1. Certified fan performance curves with system operating conditions indicated.
 - 2. Certified fan sound-power ratings.
 - 3. Motor ratings and electrical characteristics, plus motor and electrical accessories.
 - 4. Material thickness and finishes, including color charts.
 - 5. Dampers, including housings, linkages, and operators.

1.04 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For power ventilators to include in emergency, operation, and maintenance manuals.

1.05 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. Belts: One set for each belt-driven unit.

1.06 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. AMCA Compliance: Fans shall have AMCA-Certified performance ratings and shall bear the AMCA-Certified Ratings Seal.
- C. UL Standards: Power ventilators shall comply with UL 705. Power ventilators for use for restaurant kitchen exhaust shall also comply with UL 762.

1.07 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.

PART 2 PRODUCTS

2.01 CENTRIFUGAL ROOF VENTILATORS

- A. Manufacturers: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - 1. Greenheck
 - 2. Loren Cook
 - 3. Twin City Fans
- B. Basis of Design is Greenheck. If contractor submits on listed alternates, he shall assume monetary and logistical responsibility for any and all necessary structural, electrical, plumbing, architectural and HVAC modifications. Contractor shall also compensate the Architect of Record (AOR) and Mechanical Engineer of Record (MEOR) for efforts related to reviewing submittals to establish acceptability and updating energy compliance calculations
- C. Housing: Removable, spun-aluminum, dome top and outlet baffle; square, one-piece, aluminum base with venturi inlet cone.
- D. Fan Wheels: Aluminum hub and wheel with backward-inclined blades.
- E. Accessories:
 - 1. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted inside fan housing, factory wired through an internal aluminum conduit.
 - 2. Bird Screens: Removable, 1/2-inch mesh, aluminum or brass wire.
 - 3. Dampers: Counterbalanced, parallel-blade, backdraft dampers mounted in curb base; factory set to close when fan stops.
- F. Roof Curbs: Galvanized steel; mitered and welded corners; 1-1/2-inch-thick, rigid, fiberglass insulation adhered to inside walls; and 1-1/2-inch wood nailer. Size as required to suit roof opening and fan base.
 - 1. Configuration: Self-flashing without a cant strip, with mounting flange.
 - 2. Overall Height: 8 inches.
 - 3. Sound Curb: Curb with sound-absorbing insulation.
 - 4. Pitch Mounting: Manufacture curb for roof slope.
 - 5. Metal Liner: Galvanized steel.
- G. Provide with VariGreen ECM

2.02 SOURCE QUALITY CONTROL

- A. Certify sound-power level ratings according to AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install power ventilators level and plumb.
- B. Support suspended units from structure using threaded steel rods and spring hangers having a static deflection of 1 inch. Vibration-control devices are specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."
- C. Install unit with clearances for service and maintenance.
- D. Label units according to the requirement specified in Division 23 Section "Identification for HVAC Piping and Equipment."

3.02 CONNECTIONS

- A. Duct installation and connection requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Division 23 Section "Air Duct Accessories."
- B. Install ducts adjacent to power ventilators to allow service and maintenance.
- C. Connect wiring and ground equipment according to Division 26.

3.03 FIELD QUALITY AND CONTROL

- A. Perform test and inspections.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- B. Test and Inspections.
 - 1. Verify that shipping, blocking, and bracing are removed.
 - 2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload
- C. Protection is installed in motors, starters, and disconnect switches.
 - 1. Verify that cleaning and adjusting are complete.
 - 2. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
 - 3. Adjust belt tension.
 - 4. Adjust damper linkages for proper damper operation.
 - 5. Verify lubrication for bearings and other moving parts.
 - 6. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
 - 7. Disable automatic temperature-control operators, energize motor and adjust fan to indicated rpm, and measure and record motor voltage and amperage.
 - 8. Shut unit down and reconnect automatic temperature-control operators.
 - 9. Remove and replace malfunctioning units and retest as specified above.

3.04 ADJUSTING

- A. Adjust damper linkages for proper damper operation.
- B. Comply with requirements in Division 23 Section "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing procedures.
- C. Lubricate bearings.

END OF SECTION

SECTION 23 37 13
DIFFUSERS, REGISTERS, AND GRILLES

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section Includes:
 - 1. Adjustable core ceiling diffusers.
 - 2. Linear slot diffusers.
 - 3. Fixed and adjustable face grilles.
 - 4. Diffuser/grille types not listed herein shall be provided as scheduled on the drawings.
- B. Related Sections:
 - 1. Division 23 "Air Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to diffusers, registers, and grilles.

1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated, include the following:
 - 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. Diffuser, Register, and Grille Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.

1.04 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:
 - 1. Ceiling suspension assembly members.
 - 2. Method of attaching hangers to building structure.
 - 3. Size and location of initial access modules for acoustical tile.
 - 4. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
 - 5. Duct access panels.
- B. Source quality-control reports.

PART 2 PRODUCTS

2.01 CEILING DIFFUSERS

- A. Square Ceiling Diffusers
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Price Industries.

- b. Titus.
 - c. Krueger.
- 2. Material: Steel unless noted otherwise on plans.
- 3. Finish: Baked enamel or powder coat, white.
- 4. Face Size: As scheduled.
- 5. Face Style: Adjustable core.
- 6. Mounting: Concealed. Lay-in panel, plaster mounting panel accessory for gypsum board ceilings.
- 7. Pattern: 4-way unless noted otherwise on plans.

2.02 CEILING LINEAR SLOT OUTLETS

- A. Linear Slot Diffuser
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Price Industries.
 - b. Titus.
 - c. Krueger.
 - 2. Material - Shell: Aluminum, insulated unless noted otherwise on plans.
 - 3. Material - Pattern Controller and Tees: Aluminum.
 - 4. Finish - Face and Shell: Baked enamel or powder coat, black.
 - 5. Finish - Pattern Controller: Baked enamel or powder coat, black.
 - 6. Finish - Tees: Baked enamel or powder coat, white.
 - 7. Slot Width: See plans.
 - 8. Number of Slots: See plans.
 - 9. Length: See plans.
 - 10. Provide with lined sheet metal plenum for supply diffusers. No fiberglass shall be exposed to the airstream in any supply outlet plenum.
 - 11. Mounting: Concealed with mud-in border.

2.03 REGISTERS AND GRILLES

- A. Fixed and Adjustable Face Grille
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Price Industries.
 - b. Titus.
 - c. Krueger.
 - 2. Material: Steel unless noted otherwise on plans.
 - 3. Finish: Baked enamel or powder coat, white.
 - 4. Face Arrangement: $\frac{3}{4}$ inch blade spacing, 30 to 45 degree angle.
 - 5. Core Construction: Integral.
 - 6. Mounting: Concealed. Lay-in panel, plaster mounting panel accessory for gypsum board ceilings.

2.04 SOURCE QUALITY CONTROL

- A. Verification of Performance: Rate diffusers, registers, and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine areas where diffusers, registers, and grilles are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Install diffusers, registers, and grilles level and plumb.
- B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.
- C. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.03 ADJUSTING

- A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION

SECTION 236313
AIR-COOLED REFRIGERANT CONDENSERS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section Includes:
 - 1. Packaged air-cooled refrigerant condensers.

1.03 ACTION SUBMITTALS

- A. Product Data: For each air-cooled refrigerant condenser.
 - 1. Include rated capacities, operating characteristics, furnished specialties, and accessories.
 - a. Include equipment dimensions, weights and structural loads, required clearances, method of field assembly, components, and location and size of each field connection.
- B. Shop Drawings: For air-cooled refrigerant condensers.
 - 1. Include plans, elevations, sections, and mounting details.
 - a. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - b. Include diagrams for power, signal, and control wiring.
- C. Delegated-Design Submittal: For air-cooled refrigerant condensers 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. 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.
 - a. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.

1.04 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Plans, or BIM model, drawn to scale, showing the items described in this Section, and coordinated with all building trades.
- B. Seismic Qualification Data: For air-cooled refrigerant condensers, accessories, and components, from manufacturer.
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - a. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - b. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- C. Field quality-control reports.

1.05 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For air-cooled refrigerant condensers to include in emergency, operation, and maintenance manuals.

1.06 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Section 033000 "Cast-in-Place Concrete."
- B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Section 077200 "Roof Accessories."
- C. Coordinate location of refrigerant piping and electrical rough-ins.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturers:
 - 1. Mitsubishi.
 - 2. Toshiba-Carrier.
 - 3. LG.
 - 4. Daikin.
- B. Source Limitations: Obtain air-cooled refrigerant condensers from single source from single manufacturer.

2.02 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. Fabricate and label refrigeration system according to ASHRAE 15 and ASHRAE 34.
- C. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."
- D. Seismic Performance: Air-cooled refrigerant condensers shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
 - 1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
 - a. Component Importance Factor: 1.0.

2.03 PACKAGED AIR-COOLED REFRIGERANT CONDENSERS

- A. Description: Factory assembled and tested; consisting of casing, condenser coils, condenser fans and motors, and unit controls.
- B. Refrigerant: R-454B, or R-410A.
- C. Condenser Coil: Factory tested at 425 psig (2930 kPa).
 - 1. Tube: 1/2-inch- (13-mm-) diameter seamless copper or 5/8-inch- (16-mm-) diameter seamless copper.
 - a. Coil Fin: Copper.
 - b. Motors: Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."

- a. Motor Sizes: Minimum size as indicated. If not indicated, large enough, so driven load will not require motor to operate in service factor range above 1.0.
 - b. Mount unit-mounted disconnect switches on exterior of unit.
- D. Condenser Fans and Drives:
 - 1. Directly driven propeller fans with aluminum or galvanized-steel fan blades, for vertical air discharge; manufactured with permanently lubricated ball-bearing motors with integral current- and thermal-overload protection.
 - a. Forward-curved centrifugal fans for vertical air discharge.
 - b. Fan on steel shaft with self-aligning ball bearings.
 - c. V-belt drive with minimum of two belts; variable-pitch drive pulley.
 - d. Motor mounted on adjustable slide base.
 - 2. Fan Motors:
 - a. Weather-proof motors with rain shield and shaft slinger.
 - b. Totally enclosed air-over (TEAO).
 - c. Variable speed.
- E. Operating and Safety Controls: Include condenser fan motor thermal and overload cutouts; 24-V control transformer, if required; magnetic contactors for condenser fan motors and a non-fused factory-mounted and -wired disconnect switch for single external electrical power connection.
 - 1. Fan Cycling Control: Head pressure sensors.
- F. Casings: Galvanized-steel or zinc-coated-steel treated and finished with manufacturer's standard paint coating, designed for outdoor installation with weather protection for components and controls, and with the following:
 - 1. Removable panels for access to controls, condenser fans, motors, and drives.
 - a. Coating: Corrosion resistant.
 - b. Vinyl-coated steel fan guards.
 - c. Lifting holes.
 - d. Removable legs, 20 inches (500 mm) high.

2.04 MATERIALS

- A. Steel:
 - 1. ASTM A36/A36M for carbon structural steel.
 - a. ASTM A568/A568M for steel sheet.
- B. Stainless Steel:
 - 1. Manufacturer's standard grade for casing.
 - a. Manufacturer's standard type, ASTM A240/A240M for bare steel exposed to airstream or moisture.
- C. Galvanized Steel: ASTM A653/A653M.
- D. Aluminum: ASTM B209 (ASTM B209M).
- E. Corrosion-Resistant Coating: Coat with a corrosion-resistant coating capable of withstanding a 1000-hour salt-spray test according to ASTM B117.
 - 1. Standards:
 - a. ASTM B117 for salt spray.
 - b. ASTM D2794 for minimum impact resistance of 100 in-lb (11.3 N-m).
 - c. ASTM B3359 for cross hatch adhesion of 5B.
 - 2. Application: Spray.
 - a. Thickness: 1 mil (0.025 mm).
 - b. Gloss: Minimum gloss of 60 on a 60 degree meter.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of air-cooled refrigerant condensers.
- B. Examine roughing-in for refrigerant piping systems to verify actual locations of piping connections before equipment installation.
- C. Examine walls, floors, and roofs for suitable conditions where air-cooled condensers will be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Install units level and plumb, firmly anchored in locations indicated; maintain manufacturer's recommended clearances.
- B. Equipment Mounting:
 - 1. Install air-cooled condenser refrigerant condensers on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
 - a. Comply with requirements for vibration isolation and seismic-control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
- C. Maintain manufacturer's recommended clearances for service and maintenance.
- D. Loose Components: Install electrical components, devices, and accessories that are not factory mounted.

3.03 PIPING CONNECTIONS

- A. Piping installation requirements are specified in Section 232300 "Refrigerant Piping." Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to machine to allow service and maintenance.
- C. Refrigerant Piping: Where indicated on Drawings, connect piping to unit with pressure-relief, service valve, filter-dryer, and moisture indicator on each refrigerant-circuit liquid line.
- D. Apply labels to refrigerant lines in accordance with Section 230553, "Identification for HVAC Piping and Equipment."

3.04 ELECTRICAL CONNECTIONS

- A. Install field power to each condenser unit electrical power connection.
- B. Connect wiring in accordance with Division 26 specifications.
- C. Ground equipment in accordance with Division 26 specifications.
- 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.
 - 1. Nameplate shall be laminated acrylic or melamine plastic signs, as specified in Division 26 specifications.
 - a. Nameplate shall be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least 1/2 inch (13 mm) high.

3.05 CONTROL CONNECTIONS

- A. Install control and electrical power wiring to field-mounted control devices.
- B. Connect control wiring in accordance with Division 26 specifications.
- C. Install nameplate for each control connection, indicating field control panel designation and I/O control designation feeding connection.

3.06 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
 - 1. Complete installation and startup checks according to manufacturer's written instructions and perform the following:
 - a. Inspect for physical damage to unit casing.
 - b. Verify that access doors move freely and are weathertight.
 - c. Clean units and inspect for construction debris.
 - d. Verify that all bolts and screws are tight.
 - e. Adjust vibration isolation and flexible connections.
 - f. Verify that controls are connected and operational.
 - 2. Lubricate bearings on fan motors.
 - a. Verify that fan wheel is rotating in the correct direction and is not vibrating or binding.
 - b. Adjust fan belts to proper alignment and tension.
 - c. Start unit according to manufacturer's written instructions and complete manufacturer's startup checklist.
 - d. Measure and record airflow and air-temperature rise over coils.
 - e. Verify proper operation of capacity control device.
 - f. Verify that vibration isolation and flexible connections properly dampen vibration transmission to structure.
 - g. After startup and performance test, lubricate bearings.

3.07 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- D. Perform tests and inspections with the assistance of a factory-authorized service representative.
- E. Tests and Inspections:
 - 1. Perform electrical test and visual and mechanical inspection.
 - a. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 - b. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation. Complete manufacturer's starting checklist.
 - c. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 - d. Verify proper airflow over coils.
- F. Verify that vibration isolation and flexible connections properly dampen vibration transmission to structure.
- G. Air-cooled refrigerant condensers will be considered defective if they do not pass tests and inspections.
- H. Prepare test and inspection reports.

3.08 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air-cooled refrigerant condensers.

END OF SECTION

SECTION 23 73 43.19
OUTDOOR, CUSTOM AIR-HANDLING UNITS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section includes outdoor, custom air-handling units with capacities, characteristics and configurations indicated on Drawings.

1.03 ACTION SUBMITTALS

- A. Product Data: For each air-handling unit.
 - 1. Product information organized to show compliance with each performance requirement of "Performance Requirements" article.
 - 2. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
 - 3. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
 - 4. Include unit dimensions and weight.
 - 5. Include cabinet material, metal thickness, finishes, insulation, and accessories.
 - 6. Fans:
 - a. Include certified fan-performance curves with system operating conditions indicated. For fans operating at variable speeds include curves in 10 percent speed increments starting at design speed down to minimum speed.
 - b. Include fan-sound power ratings in all eight octave bands. Include inlet or outlet sound power levels to coincide with sound requirements indicated on Drawings.
 - c. Include fan construction and accessories. Submit sufficient information to show product compliance with requirements indicated.
 - d. Include dimensions and weight.
 - e. Include motor ratings, electrical characteristics, and motor accessories.
 - 7. Vibration isolation product data with performance ratings. Uniquely identify and include information for each different isolator type and indicate for each air-handling unit where each isolator type is being used.
 - 8. Include certified coil-performance ratings with system operating conditions indicated. Product data to include: dimensions, dry and operating weight, volume of fluid contained, materials of construction, and performance ratings with system operating conditions indicated.
 - 9. Casing insulation product data and performance ratings.
 - 10. Access door and access panel product data and performance ratings.
 - 11. Roofing product data and performance ratings.
 - 12. Louver product data and performance ratings.
 - 13. Paint product data and performance ratings.
 - 14. Electrical product data and performance ratings.
 - 15. Metal grating product data and performance ratings.
 - 16. Electric heater product data with performance ratings.
 - 17. Steam humidifier product data with performance ratings.

18. Dampers product data, including housings, linkages, and operators with performance ratings.
 19. Filters product data with performance characteristics.
 20. Fixed plate heat exchangers product data with performance ratings.
 21. Air blender product data with dimensions, weights, materials of construction, performance ratings, and installation requirements.
 22. Pumps product data with performance ratings.
 23. Pipe insulation and jacket product data.
 24. Roof curbs product data.
- B. Shop Drawings: For each type and configuration of indoor, custom air-handling unit.
1. Prepared by manufacturer's factory employees with review and sign-off by those individuals responsible for manufacturing the air-handling units.
 2. Include plans, elevations, sections, and mounting details.
 3. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, methods of field assembly, components, and location and size of each field connection.
 4. Detail fabrication and assembly of indoor, custom air-handling units, as well as procedures and diagrams.
 5. Indicate details of construction with materials description including applicable specified standards and material grades in sufficient detail for reviewers to evaluate point by point compliance with requirements indicated for each air-handling unit.
 6. Use actual dimensions of internal equipment in preparing Shop Drawings. Identify mechanical equipment shown on Shop Drawings with equipment designations on Drawings.
 7. Thickness and finish of all casing materials with cross references indicated where each is used. Uniquely identify and include information for each different casing construction.
 8. Details for each unique casing joint and reinforcing. Indicate wall joints, wall to floor joints, wall to roof joints, floor joints, and roof joints.
 9. Roofing details.
 10. Assembly details of base and casing for units consisting of multiple sections requiring field assembly.
 11. Sizes and dimensioned locations of field connections for ductwork, piping, electrical, and controls.
 12. Base and casing penetration and sealing details for factory-installed conduit.
 13. Base and casing penetration and sealing details for factory-installed piping including coils.
 14. Details of casing connections to field-installed ductwork.
 15. Size, shape and layout of base members including localized support of internal components.
 16. Base materials, thickness, finishes, lifting provisions, and mounting requirements. Uniquely identify and include information for each different base construction. Clearly indicate for each air-handling unit.
 17. Recommended points of field attachment with dimensioned locations.
 18. Size and location of each access door, including clearing opening size, with door swing indicated.
 19. Size and location of each access panel with service equipment superimposed to show relationship of panel to internal equipment.
 20. Drain pans and associated piping, with sizes and locations dimensioned, including relationship to internal equipment.
 21. Floor drains and associated piping, with sizes and locations dimensioned, including relation to internal equipment.
 22. Coil framework and support including enlarged details showing framework attachment to air-handling unit base, coil attachment to framework, and means for individual coil removal.
 23. Mounting details of all internal components, such as fans, filters, and dampers.

24. Hoist rails layout for internal equipment showing size of members, attachments to structure, and serviced equipment superimposed to indicate relationships.
 25. Size and location of catwalks, handrails, ladders, and safety cages including construction details and details of attachment to air-handling unit base.
 26. Location of receptacles, service lights, and switches.
 27. Location of motor controllers and disconnect switches.
 28. Size and location of junction boxes used for interface with field electrical power.
 29. Point-to-point electrical power wiring diagrams including wire size, conduit size, motor controllers sizes, switch types and ratings, receptacle types and ratings, service light fixture types and ratings.
 30. Point-to-point control wiring diagrams including cable types and sizes, conduit sizes, and connected control devices.
 31. Point-to-point control tubing diagrams including tubing types and sizes, conduit sizes, and connection controls devices.
 32. Control panel drawings drawn to scale showing detailed internal layout.
 33. Indicate code, operating, and maintenance clearances drawn to scale using dashed lines.
 34. Indicate weights of internal components, weight of each separately shipped section, and air-handling unit total weight.
- C. Comparison Schedule:
1. Submit a schedule to indicate performance of equipment scheduled on Drawings directly compared to performance of submitted equipment.
 2. Clearly identify each line in schedule to indicate "Scheduled" where indicating performance scheduled on Drawings and "Submitted" where indicating performance of submitted equipment.
 3. Organize schedule to first indicate performance scheduled on Drawings on one line followed by line directly below that indicates performance of submitted equipment.
 4. Comparison schedule shall follow arrangement and organization of scheduled information indicated on Drawings.
 5. Submitted equipment shall have a value for each scheduled value indicated.

1.04 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Floor plans, sections, and other details, or BIM model, drawn to scale, showing the items described in this Section and coordinated with all building trades.
- B. Seismic Qualification Data: Certificates for air-handling 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.
 4. Restraint of internal components.
- C. Source quality-control reports.
- D. Startup service reports.
- E. Field quality-control reports.
- F. Sample Warranty: For manufacturer's warranty.

1.05 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For air-handling units to include in emergency, operation, and maintenance manuals.

1.06 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Panel Filters: One set(s) for each air-handling unit.
 - 2. Access Door Gaskets: One set(s) for each access door.
 - 3. Fan Belts: One set(s) for each fan with belt-drive assembly.
 - 4. Tool Kit: Manufacturer to provide a tool kit including special tools required for air-handling unit service. See "Accessories" Article for additional requirements.

1.07 COORDINATION

- A. Coordinate sizes and locations of concrete bases with actual equipment provided.
- B. Coordinate sizes and locations of structural-steel support members, if any, with actual equipment provided.

1.08 DELIVERY, STORAGE, HANDLING

- A. Deliver air-handling units with factory-installed shipping skids and lifting lugs; pack small components in factory-fabricated protective containers. Cover units with heat-shrinkable plastic sheeting suitable for shipping from point of manufacture to Project.
- B. Handle air-handling units carefully to avoid damage to components, casing, and finish. Do not install damaged components; replace and return damaged components to air-handling unit manufacturer.
- C. Store air-handling units in a clean dry place and protect them from weather and construction activities.
- D. Keep air-handling units fully covered and protected during construction. Remove dirt and debris and clean units to a factory-cleaned condition.
- E. Comply with manufacturer's written rigging and installation instructions for unloading air-handling units and moving them to their final locations.
- F. For air-handling units equipped with key locks on access doors, keep doors locked during construction.
 - 1. If access is required within air-handling units, only open the doors to sections that require access and lock doors at the end of each workday.
 - 2. Protect inside of air-handling units from damage and keep inside of units as clean as the factory-cleaned condition.
 - 3. Report observed abuse to owner for immediate corrective action.

1.09 WARRANTY

- 1. Warranty: Manufacturer agrees to repair or replace components of air-handling units that fails in materials or workmanship within specified warranty period.
Warranty Period: 5 year(s) from date of Substantial Completion.
- 2. Extended warranties include, but are not limited to, the following:
 - a. Complete Air-Handling Unit: Five years from date of Substantial Completion for entire air-handling unit and longer where indicated for individual components.
 - b. Air-Handling Unit Casing: 25 years from date of Substantial Completion.
 - c. Air-Handling Unit Roofing: 30 years from date of Substantial Completion.
 - d. Motors: Five years from date of Substantial Completion

PART 2 PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
- B. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of air-handling units and components.
- C. ASHRAE 62.1 Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
- D. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."
- E. Casing Leakage Performance, ASHRAE 111: Class 3 leakage or better at plus or minus 8 inches wg (2000 Pa).
- F. Casing Leakage Performance: Comply with more stringent of the following requirements:
 - 1. ASHRAE 111, Class 3 leakage or better at plus or minus 8 inches wg (2000 Pa).
 - 2. Not more than 0.5 percent of the total unit airflow at 8 inches wg (2000 Pa).
- G. Casing Thermal Performance:
 - 1. Surface Condensation: Air-handling manufacturer shall evaluate potential for condensation and design and manufacture entire unit casing to prevent condensation at most extreme operating conditions encountered.
 - 2. Thermal Break: Incorporate a thermal break at each through metal path to prevent condensation from occurring on interior and exterior of casing.
 - 3. U-Value: Overall U-value or equivalent R-value of casing shall not exceed governing codes and ASHRAE/IES 90.1 while considering the effects of metal-to-metal contact and thermal bridging in calculations.
- H. Air Tunnel Aerodynamic Performance: Position air-handling unit internal components and transition between internal components to maintain uniform airflow; minimize sound levels and energy consumption. Use methods indicated and other means to ensure compliance.
 - 1. Use turning vanes if necessary to direct the air path.
 - a. Design, manufacture, and install vanes in accordance with applicable requirements in ASHRAE and SMACNA guidelines, handbooks, and standards.
 - b. Install vanes firmly in place so that no vane movement occurs at worst-case airflow capacity possible.
 - 2. Use fan inlet and discharge transitions and other devices to maximize system regain and minimize airborne sound levels.
 - 3. Center system components such as coils, fans, and filters, vertically and horizontally, in the airstream.
 - 4. Maintain spacing between components such that airflow patterns to adjacent components are as uniform as possible and that component "dead spots" or "jetted areas" are avoided.
 - 5. Design and install internal structural supports, piping, and conduit that do not block airflow and impede performance of coils, fans, filters, and other unit components, and service space clearances.
- I. Durability Performance: Design and manufacture air-handling units with underlying requirement to provide a highly durable piece of equipment.
 - 1. Unit Life Expectancy: 25 years.
 - 2. Supporting Documentation: Submit documentation showing proposed products to consider and include design features, components, and materials to satisfy requirement.
- J. Extreme Operating Conditions:
 - 1. Corrosive Environments: Air-handling unit manufacturer shall evaluate the quality and potential corrosiveness of air passing through air-handling units and propose additional

- protective finishes and better-quality materials of a heavier thickness if required to comply with requirements indicated.
- a. Unless otherwise indicated, air-handling units for HVAC applications may use up to 100 percent of outdoor air or a mix of outdoor air with return air from habitable areas served. Projects located in coastal and industrial areas may require added protection.
 2. Humidity and Temperatures: Materials and components of air-handling units shall be suitable for use in low and high humidity and temperature extremes when operating under normal and abnormal conditions without permanent degradation or loss in material performance.
- K. Outdoor Environment:
1. Air-handling units specially designed to withstand effects of wind, rain, ice, snow, seismic, air quality, sun, and other influences associated with outdoor installations.
 2. Comply with requirements of air-handling unit and governing codes.
- L. Safety:
1. Comply with OSHA regulations.
 2. Exposed sharp edges and corners of metal shall be protected or rounded to prevent injury to personnel not wearing gloves.
 3. Cover exposed ends of screws with plastic or metal covers to prevent injury to personnel coming in contact with screws.
- M. Serviceability:
1. Hoisting Provisions: Fans and motors weighing more than 200 lb (91 kg) shall have full-length hoist rails mounted over the equipment to facilitate service, removal, and replacement.
 2. Mounting Location: Install internal components in readily accessible locations to facilitate ease of service and replacement.
 3. Service Access:
 - a. Internal components shall be serviceable through access sections with doors indicated on Drawings.
 - b. Internal components shall be removable and replaceable through access doors or panels.
 - c. Review requirements for access doors and panels indicated and recommend additional access doors and panels if required for uninhabited service, removal, and replacement of components.
 4. Tripping Hazards: Floors in accessible sections of air-handling unit shall be free of standing seams, reinforcing, supports, or section splits located in the walking path that is capable of causing a tripping hazard. Locate section splits immediately adjacent to internal walls.
- N. Quality: Type and thickness of materials indicated are the minimum acceptable. Provide better-quality materials of a heavier thickness if required to comply with performance requirements indicated.
1. If manufacturer's standard construction exceeds requirements indicated, use manufacturer's standard construction.
 2. If manufacturer's standard construction does not comply with requirements indicated, modify manufacturer's standard construction to comply with requirements.
 3. Seismic Performance: Air-handling units shall withstand the effects of earthquake motions determined in accordance with ASCE/SEI 7.
 - a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
 - b. Component Importance Factor: 1.0.
 4. Vibration Performance: Air-handling unit manufacturer shall evaluate vibration of internal components installed inside of air-handling units and include internal vibration isolation

required to limit the vibration transmitted to the building at a low enough level that vibration is not perceived by building occupants.

2.02 SOURCE LIMITATIONS

- A. Source all outdoor custom air-handling units from same manufacturer.
- B. Like components furnished with air-handling units shall be from same manufacturer.
- C. Air-handling units shall be manufactured in North America.

2.03 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Carrier.
- B. Basis of Design is Carrier. If contractor submits on listed alternates, he shall assume monetary and logistical responsibility for any and all necessary structural, electrical, plumbing, architectural and HVAC modifications. Contractor shall also compensate the Architect of Record (AOR) and Mechanical Engineer of Record (MEOR) for efforts related to reviewing submittals to establish acceptability and updating energy compliance calculations.

2.04 UNIT ARRANGEMENT AND CONFIGURATION

- A. Arrangement: Project-specific arrangement and configuration of air-handling units indicated on Drawings. Do not deviate from requirements indicated without submitting a formal request clearly describing each deviation and reason for each deviation, and only after receiving Architect's written acceptance.
- B. Mounting Requirements: Units mounted on roof curbs.
- C. Multiple Sections: Each air-handling unit shall consist of multiple sections for field assembly to comply with requirements indicated on Drawings.
- D. Multiple Sections, Splits: Air-handling unit manufacturer to determine number of sections and location of section splits required for each air-handling unit in accordance with the following criteria:
 - 1. Physical size and weight of each section, on-site path of travel, and methods for erection and installation. Air-handling manufacturer to review criteria with Installer before preparing Shop Drawings.
 - 2. Maximize physical size of each air-handling unit section considering, shipping, moving, erecting, and installation.
 - 3. Minimize the number of air-handling unit sections requiring field assembly. Preference is for single-piece air-handling units where possible.

2.05 AIR-HANDLING UNIT BASE

- A. Performance:
 - 1. Air-handling unit manufacturer shall design and assemble air-handling unit casing and internal components for attachment and support by air-handling unit structural base.
 - 2. Design air-handling units to be lifted from only the air-handling unit structural base and not the casing.
 - 3. Support air-handling units from only the perimeter base unless otherwise indicated on Drawings.
 - 4. Air-handling unit manufacturer to size and locate intermediate structural base supports as required to comply with structural performance indicated for air-handling unit floors.

5. Level base before factory assembly of air-handling unit casing and internal components to ensure proper fit and alignment.
- B. Structural Member Size:
 1. Air-handling unit manufacturer shall select size of base members and construction of base to withstand the rigors of loading, unloading, shipping, and rigging without damage to air-handling unit components or misalignment of factory-assembled components.
 2. Depth and weight of structural members shall be selected by air-handling unit manufacturer to comply with performance requirements indicated.
 3. Depth of perimeter base members is not less than 8 inches (200 mm) deep.
- C. Structural Member Spacing: Positioned as required to comply with requirements indicated, but not to exceed 24 inches (600 mm).
- D. Materials: structural stainless steel, ASTM A276/A276M, Type304L or structural stainless steel, ASTM A276/A276M, Type 316L.
 1. Perimeter Members: channel, I or W beam shapes tube.
 2. Intermediate Members (Spanning Full Width of Unit): channel or I or W beam shapes.
 3. Cross Members (Spanning Intermediate Members): Angle channel or tube.
- E. Carbon-Steel Finish: Carbon-steel bases shall be shot-blasted, cleaned, prepared, and painted or hot-dip galvanized after fabrication.
- F. Welding Filler Metals: Comply with AWS welding codes for welding materials appropriate for thickness and chemical analysis of material being welded.
 1. Use welding materials with corrosion properties equal to material being welded.
- G. Welding Procedures:
 1. Structural Welding Codes: AWS D1.1/D1.1M for carbon steel, AWS D1.2/D1.2M for aluminum, AWS D1.6/D1.6M for stainless steel.
 2. Join structural members to one another using continuous welds.
 3. After welding and fabrication, deburr and grind exposed welds to provide smooth surfaces free of sharp edges.
- H. Penetrations through Base Perimeter: Seal weld pipe, tubing, and conduit penetrations through se perimeter members to provide a watertight assembly.
- I. Section Joints: Air-handling units consisting of multiple sections for field assembly shall be joined with structural joining plates.
 1. Joining plate material type to match base.
 2. Joining plate of thickness required to join sections without resulting in a permanent deflection, minimum 1/2 inch (13 mm) thick.
 3. Continuously weld joining plates to each mating end of base.
 4. Joining plates shall not extend beyond outer edge of adjoining base.
 5. Plates to include at least three equally spaced holes for field connection using factory-furnished threaded hardware of a nominal diameter of at least 1/2 inch (13 mm).
- J. Lifting Provisions: Air-handling unit manufacturer to design and install lifting lugs of size and location required to comply with performance requirements indicated. Lifting lugs extending beyond the base shall be easily removable in the field after unit is installed.
- K. Curb Cap:
 1. For air-handling units installed on a continuous perimeter curb, provide air-handling unit base with a continuous structural angle counterflashing.
 2. Angle shall extend down vertical face of curb to completely cover wood nailer.
 3. Coordinate inside dimension of angle counterflashing with curb dimension and roofing. Provide adequate clearance between angle counterflashing and roofing over curb.

2.06 UNIT CASINGS

- A. Casing Assembly:

1. Appearance:
 - a. Exposed exterior surfaces of casing shall have a neat and finished appearance free of standing seams, exposed reinforcing, and other casing protrusions more than 0.25 inch (7 mm) beyond the exterior skin surface.
 - b. Interior surfaces of casing shall have a neat and finished appearance free of standing seams, exposed reinforcing, and other casing protrusions more than 0.25 inch (7 mm) beyond the skin surface.
2. Dissimilar Metals: Isolate dissimilar metals that are in contact to prevent galvanic action and corrosion.
3. Framing and Supports: Interconnect and support individual casing wall and roof panels using either formed panel construction or framed construction with structural support members. For framed casing construction, materials used to construct casing of structural support members shall be as follows:
 - a. Casings with Aluminum Outer and Inner Skins: Aluminum extrusions in accordance with ASTM B211 Alloy 6063 T6.
 - b. Casings with Galvanized-Steel Outer and Inner Skins: Galvanized steel.
 - c. Casings with Galvanized-Steel Outer Skin and Aluminum or Stainless Steel Inner Skins: Stainless steel.
 - d. Casings with Stainless Steel Outer and Inner Skins: Stainless steel.
4. Seals: Seal interior and exterior joints and seams to make casing air- and watertight. Trim factory-applied sealant flush with adjacent surface.
5. Double-Wall Casings: Consisting of insulation sandwiched between an outer and inner metal wall. Use double-wall casings to construct air-handling units unless septum casings are required.
6. Septum Casings: Triple-wall construction consisting of a solid metal inner wall sandwiched between insulation layers that are covered with metal walls. Use septum casings for applications having performance requirements that are not achievable with double-wall casings.
7. Penetrations: Seal voids around conduit, piping and tubing penetrations.
 - a. Walls and Roofs:
 - 1) Conduit, Pipe, and Tube Sizes NPS 3 (DN 80) and Smaller:
 - (a) Seal void through casing with a nonhardening vapor-barrier caulk covered by an escutcheon on both interior and exterior sides of casing. Back caulk using formed insulation within a sheet metal sleeve.
 - (b) Seal void using a friction fit neoprene or EPDM sheet material attached to casing using a bed of adhesive.
 - (c) Cover penetration and sealing sheet material with metal escutcheon matching adjacent casing material.
 - 2) Larger Conduit, Pipe, and Tube Sizes: Seal annular void using an adjustable compression-type sealing sleeve.
 - b. Floors: Route conduit, pipe, and tube within a floor-mounted pipe sleeve.
 - 1) Sleeve:
 - (a) Fabricate sleeve of aluminum, galvanized-steel, or stainless steel pipe.
 - 2) Extend top of sleeve above adjacent floor surface to prevent standing water on floor from entering annular space of sleeve.
 - 3) Seal weld sleeve to top of floor for an air- and watertight seal.
 - 4) Seal annular void of sleeve using an adjustable compression seal.
8. Floor Openings with Metal Grating:
 - a. Factory install walk-on safety gratings over any floor opening large enough to create a safety hazard for operators including, but not be limited to, supply-, return-, and exhaust-air openings.
 - b. Bar Grating:
 - 1) Materials: Use stainless steel grating for stainless steel floors.

- 2) Air-handling unit manufacturer shall select depth and thickness of grating bars to limit deflection to 1/360 of span when subjected to a dynamic load of not less than 500 lb (227 kg).
- 3) Industry-standard welded grating with bars at least 1-1/2 inches (38 mm) deep by at least 3/16 inch (5 mm) thick with nominal 1-3/16-inch (30-mm) main bar spacing and 4-inch (100-mm) cross bar spacing.
- 4) Source: Product manufacturer specializing in metal gratings.
- 5) Grating bearing surface shall extend beyond clear opening in floor at least 2 inches (50 mm).
- c. Mounting Frame:
 - 1) Mount grating in a continuous structural angle or bar frame so no ends of grating bars are exposed. Top of frame to be flush with top of grating.
 - 2) Secure grating to frame with threaded hardware so grating does not move when walked on but can be easily removed from top to gain access behind grating.
 - 3) Continuously weld mounting frame to air-handling unit floor.
 - 4) For applications with automatic dampers installed at floor openings, elevate height of mounting frame and grating to enclose entire damper assembly including jackshaft so walk-on surface of grating is above damper assembly.
- d. Waterproof Floors: Continuously weld floor joints, seams, and penetrations to completely seal floor. Roll all edges of floor up at least 1 inch (25 mm) to create a shallow tub capable of holding standing water.
- e. Duct Connections - Direct to Casing: Frame and reinforce unit casing around perimeter of unit duct openings to accommodate direct attachment of field-installed ductwork. Coordinate requirements with Installer to accommodate field connection.
- B. Materials for Outer Skin of Casing Walls and Roofs:
 1. Stainless Steel Solid Sheet: ASTM A240/A240M or ASTM A480/A480M, Type 304; No. 2D finish; minimum (nominal) 16 gauge (1.6 mm) thick.
 2. Application: See Drawings for application of different materials indicated.
- C. Materials for Inner Skin of Casing Walls and Roofs:
 1. Aluminum Solid and Perforated Sheet: ASTM B209 (ASTM B209M); Alloy 3003-H14, smooth finish; minimum (nominal) 0.040 inch (1.1 mm) thick.
 2. Stainless Steel Solid and Perforated Sheet: ASTM A240/A240M or ASTM A480/A480M; Type 304; No. 2D finish; minimum (nominal) 18 gauge (1.3 mm) thick.
- D. Materials for Floor Walking Surface:
 1. Stainless Steel Solid Sheet: ASTM A240/A240M or ASTM A480/A480M, Type 304; No. 2D finish; minimum (nominal) 12 gauge (2.8 mm) thick.
 2. Aluminum Diamond Treadplate: ASTM B632/B632M, Alloy 6061 T6; mill finish; minimum (nominal) 0.1875 inch (4.8 mm) thick.
 3. Stainless Steel Diamond Treadplate: ASTM A240/A240M or ASTM A480/A480M, Type 304; No. 2D finish; minimum (nominal) 12 gauge (2.8 mm) thick.
 4. Application: See Drawings for application of different materials indicated.
- E. Materials for Underside of Floor Insulation:
 1. Stainless Steel Solid Sheet: ASTM A240/A240M or ASTM A480/A480M; ASTM A240/A240M or ASTM A480/A480M, Type 304; No. 2D finish; minimum (nominal) 12 gauge (2.8 mm) thick.
 2. Application: See Drawings for application of different materials indicated.
- F. Materials for Internal Walls:
 1. Stainless Steel Solid Sheet: ASTM A240/A240M or ASTM A480/A480M, Type 304; No. 2D finish; minimum (nominal) 12 gauge (2.8 mm) thick.
 2. Application: See Drawings for application of different materials indicated.
- G. Surfaces in Contact with Airstream:
 1. Comply with ASHRAE 62.1 and NFPA 90A.

2. Glass or mineral-fiber insulation installed behind perforated metal shall be encapsulated to prevent insulation fibers from entering the airstream by using a polymer sheet material.
- H. Insulation for Casing Walls and Roofs Not Exposed to Airstream:
 1. Materials Not Exposed to Airstream: injected or sprayed polyurethane foam or polyurethane foam board insulation with a minimum nominal density of 2 lb/cu. ft. (32 kg/cu. m).
 2. R-Value: Minimum R-10.
 3. Thickness: Minimum 2 inches (50 mm).
 4. Insulation shall completely fill the casing cavity so no voids exist.
- I. Insulation for Casing Walls and Roofs Exposed to Airstream:
 1. Materials Exposed to Airstream: Glass or mineral-fiber board insulation with a minimum density of 2 lb/cu. ft. (32 kg/cu. m).
 2. R-Value: Minimum R-10.
 3. Thickness: Minimum 2 inches (50 mm).
 4. Insulation shall completely fill the casing cavity so no voids exist.
- J. Access Doors:
 1. Application: Install access doors downstream and upstream of all internal components.
 2. Adjustment: Design doors for field adjustment capable of maintaining specified leakage rate.
 3. Mounting Height: Install bottom of door frame within 2 inches (50 mm) of air-handling unit floor walking surface. Where internal conditions require access doors to be mounted higher above air-handling unit floor, include permanent retractable stairs inside and outside of air-handling unit to limit stair risers to 6 inches (150 mm).
 4. Performance: Leakage as required to satisfy overall unit leakage performance indicated, but not more than 1.0 cfm (0.47 L/s) per door when tested at 10 inches wg (2500 kPa).
 5. Fabrication: Formed and reinforced, constructed of same materials and thicknesses as casing. Where doors are installed in casing walls with perforated interior, install doors with solid interior.
 6. Swing: Arrange doors to be opened against pressure, unless otherwise indicated on Drawings.
 7. Frame: Extruded stainless steel with welded mitered corners.
 8. Handles:
 - a. Secure door closed using not less than two roller-style latches with handles located at quarter points along door height.
 - b. If three latches with handles are included, install one at midpoint of door height and equally space others.
 - c. Air-handling unit manufacturer has option to use a multipoint latching mechanism that is operable from a single door handle located at midpoint of door height, but secures door to frame at top, bottom, and handle location.
 - d. Include door handles on outside and inside of door to allow operator access to open and close door from outside and inside of unit.
 - e. Field adjustable to accommodate changes to fit and gasket compression.
 - f. Durable product capable of withstanding repeated opening and closing of door while operating under design pressure without damage.
 9. Hinges: minimum of three hinges or full-length, concealed, stainless steel piano hinge.
 10. Gasket:
 - a. Design: Specially formed with an internal air chamber specifically designed to seal on two surfaces without taking a permanent set.
 - b. Dual Gaskets: Primary and secondary gasket.
 - c. Location: Install gaskets around entire perimeter of doors or frames.
 - d. Material: EPDM, neoprene, or santoprene.
 - e. Protection: Seat gasket in a protective metal ribbed chamber integral to door or door frame to protect gasket from damage by operator incidental contact.

- f. Service: Field replaceable.
 - g. Adhesive-backed tape-type gaskets adhered to a single flat surface are unacceptable.
- 11. Size of Door Frame Clear Opening: Large enough to allow for unobstructed access for inspection and maintenance of air-handling unit's internal components.
 - a. Width: At least 18 inches (450 mm) clear inside of door frame.
 - b. Height: Full clear height of unit casing up to a maximum height of 60 inches (1500 mm) clear inside of door frame.
 - c. Door sizes indicated on Drawings.
- 12. Safety Latches and Stops:
 - a. Safety Latches: Install safety latch with retainers on outward swing doors that do not open against pressure to allow restricted travel for purpose of pressure relief and so that doors do not open uncontrollably due to inside pressure.
 - b. Stops: Install cushioned door stops on inward swinging doors where necessary to limit door travel that could potentially damage the door or internal components.
- 13. Tie-Backs: Install tie-backs with retainers on outward-swinging access doors to hold doors in an open position during service.
- 14. Locks: Include each access door with an integral key lock. Pad locks are unacceptable.
 - a. Incorporate key lock into door handle where feature is available.
 - b. A common key shall be used to lock and unlock access doors of each air-handling unit(s).
 - c. Include two keys for each air-handling unit.
 - d. Lock access doors at factory to ensure that unauthorized access is in place before air-handling unit packaging and shipment.
- 15. Nameplates:
 - a. On each access door, include a nameplate defining the access to service within. Nameplates shall be included for, but not be limited to, the following:
 - 1) Dampers.
 - 2) Filters.
 - 3) Cooling Coils.
 - 4) Heating Coils.
 - 5) Supply Fans.
 - 6) Exhaust Fans.
 - 7) Return Fans.
 - 8) Humidifiers.
 - 9) Air-handling unit designation.
 - 10) Where door access is to multiple components, list all components accessed. For example: Filter/Cooling Coil.
 - 11) For each door that does not open against static pressure, include a warning sign stating: "DANGER: DOOR UNDER PRESSURE. DO NOT OPEN WITH FAN ON."
 - b. Lettering Size and Style: At least 1-inch- (25-mm-) high, block style.
 - 1) Material: Lettering engraved in black plastic on a white plastic back. Engraving shall penetrate through black plastic so lettering reads white.
 - 2) Attachment: Attach nameplates to door using high-strength bonding cement and stainless steel screws.
 - 3) Mounting Location:
 - (a) For access doors without windows, locate top of nameplate 6 inches (150 mm) from top of door and center in door width.
 - (b) Align nameplates of all doors for uniform placement.
- K. Access Door Gutters and Downspouts: Install rain gutters directly above each access door to deflect rain away from doors.

1. Construct gutters of same materials and finish as casing exterior.
 2. Extend gutters beyond vertical edge of doors at least 3 inches (75 mm).
- L. Access Panels:
1. Performance: Leakage as required to satisfy overall unit leakage performance indicated.
 2. Fabrication: Formed and reinforced panels of same material and thickness as casing.
 3. Fasteners: Adjustable, reusable type for multiple operations without degradation due to reuse. Do not use screws capable of stripping.
 4. Arrangement: Panels removable from exterior side of casing.
 5. Gasket: EPDM, neoprene, or santoprene similar to access doors, applied around entire perimeter of panels or frames.
 6. Location and Size:
 - a. Coils: Oversized access panel to allow removal and replacement without impacting adjacent casing.
 - b. Fans: Oversized access panel to allow removal and replacement of entire fan assembly without impacting adjacent casing.
 7. Nameplates:
 - a. On each access panel, include a nameplate defining the access to service within. Nameplates shall be included for, but not be limited to, the following:
 - b. Cooling Coils.
 - c. Heating Coils.
 - d. Supply Fans.
 - e. Exhaust Fans.
 - f. Return Fans.
 8. Standing-Seam Metal Roof: Construct air-handling unit roof casing with standing seams designed for waterproof roofing applications.
 - a. Construct air-handling unit roof using same materials and finish as walls.
 - b. Slope roof away from primary access side of unit at not less than 2 percent.
 - c. For air-handling units shipped in multiple sections, include standing-seam joiners at each split with adhesive, hardware, and cover strips for field joining by Installer.

2.07 WALL LOUVERS

- A. Wall Louvers, Wind-Driven Rain:
1. Source Limitations: Obtain louvers from single source from single manufacturer.
 2. Performance:
 - a. Air Pressure Drop, Rating: Less than 0.1 inch wg (2.5 Pa) at free area intake face velocity of 800 fpm (4.1 m/s).
 - b. Face Velocity: If louver size is not indicated on Drawings, size louver for 500-fpm (2.5-m/s) velocity across louver free area.
 - c. Free Area: 47 percent or more for a 48-by-48-inch (1200-by-1200-mm) representative sample.
 - d. AMCA 500-L:
 - 1) Wind-Driven Rain Penetration Class: Class A, with wind-driven rain penetration effectiveness of 99 percent at core velocity up to 408 fpm (2.1 m/s) with 50-mph (80-kph) wind and rainfall of 8 inches (200 mm) per hour.
 - 2) Intake Discharge Loss Class: Class 2.
 3. Features:
 - a. Depth: 5 inches (125 mm).
 - b. Frame: 0.080 inch (2 mm) thick, ASTM B211, Grade 6063, T5 temper, extruded-aluminum alloy.
 - c. Blades: 0.063 inch (1.6 mm) thick, ASTM B211, Grade 6063, T5 temper, extruded-aluminum alloy; stationary in horizontal position, double drainable, and sightproof.

- d. Stationary vertically positioned blades.
- e. Bird Screen: 0.5-by-0.040-inch (13-by-1.0-mm) expanded flattened aluminum attached to back of louver.
- f. Finish: Match exterior casing.
- 4. Air-Handling Unit Factory Assembly:
 - a. Install louver face flush with exterior of casing and seal to provide a weathertight installation.
 - b. Secure louver in casing and include additional bracing if required to handle loading of extreme outdoor environmental performance indicated.
- 5. Application: Factory install louvers in air-handling casing for each outdoor intake and exhaust discharge.

2.08 INTERNAL STRUCTURAL SUPPORTS

- A. General:
 - 1. Air-handling unit manufacturer shall design and assemble air-handling unit internal structural supports for attachment and support by air-handling unit structural base.
 - 2. Factory install structural supports for internal support casing if required to comply with casing structural performance.
 - 3. Factory install hoist beams and rails over equipment to comply with performance requirements for service.
- B. Structural Member Size and Spacing:
 - 1. Size: Air-handling unit manufacturer shall select size of members and construction to do the following:
 - a. Withstand the rigors of loading, unloading, shipping and rigging without damage to air-handling unit components or misalignment of factory-assembled casing and components.
 - b. Comply with performance requirements indicated.
 - 2. Spacing: Positioned as required to comply with requirements.

2.09 FACTORY-MANUFACTURED ROOF CURBS

- A. General:
 - 1. Air-handling unit manufacturer shall furnish a continuous perimeter curb for each roof-mounted air-handling unit.
 - 2. Design curb to support operating air-handling unit from its base with attachments to withstand environmental forces. Curbs with intermediate reinforcing as required.
 - 3. Frame curb for ductwork, piping, and conduit located within curb.
 - 4. Fabricate curb to maintain top of curb level even where installed on sloping substrate.
 - 5. Furnish top of curb to provide for field attachment of unit base to curb.
 - 6. Furnish curb with a fully mitered and raised cant where required by adjacent insulation and roofing.
 - 7. Include bottom of curb with attachment flange that extends beyond base of curb and is suitable for attachment to substrate.
 - 8. Furnish curb with integral crickets if required by roof installation.
- B. Size:
 - 1. Size curb to provide continuous support of unit base and to fit within footprint of unit perimeter base.
 - 2. Height: 12 inches (300 mm) from top of curb to finished roofing surface at highest point along perimeter of curb.
- C. Materials:
 - 1. Stainless Steel Solid Sheet: ASTM A240/A240M or ASTM A480/A480M, Type 304 grade; No. 2D finish; minimum (nominal) 12 gauge (2.8 mm) thick.

- D. Insulation:
 - 1. Insulate curb to provide thermal performance equal to unit casing.
 - 2. Completely encapsulate insulation within metal curb.
- E. Gaskets:
 - 1. Include a continuous gasket between air-handling unit base and top of curb for an air and watertight seal.
 - 2. Select gasket materials suitable for installation while complying with requirements indicated.
 - 3. Furnish gasket materials with air-handling units and curbs for field installation.
 - 4. Air-handling unit manufacturer to provide instruction to installer on proper installation techniques.

2.10 CENTRIFUGAL PLENUM FANS

- A. Source Limitations: Obtain fans from single source from single manufacturer.
- B. Operating Performance:
 - 1. Air-handling unit manufacturer shall account for, and include in, submitted fan selections any static pressure drops associated with unit, and system effect due to fan operating in the air-handling unit.
 - a. Add additional static pressure to fan scheduled total static pressure.
 - b. If fan motor horsepower is increased, notify Architect.
 - 2. Fans shall have sharply rising pressure characteristics at operating point and stable in operation. Fan horsepower characteristics shall be self-limiting and non-loading.
 - 3. Fan speed, brake horsepower, and sound power levels indicated are maximum acceptable.
 - 4. Motor horsepower, airflow rate, and static pressure are minimum acceptable. Motor horsepower shall be capable of handling maximum horsepower of fan at scheduled speed.
 - 5. Fan air performance ratings shall be based on tests in accordance with ASHRAE 51/AMCA 51 and AMCA 210.
 - 6. Base fans sound ratings on AMCA 300 and calculation methods in accordance with AMCA 301.
 - 7. At a minimum, fans shall have AMCA class indicated on Drawings.
 - a. Fan operating limits shall be in accordance with AMCA 99 for AMCA class indicated.
 - b. If AMCA class is not indicated, use AMCA 99 as basis for determining AMCA class.
 - c. AMCA class selected shall be capable of accommodating a plus 10 percent increase to fan static pressure indicated on Drawings.
 - 8. Motor starting torque shall exceed fans speed-torque requirements.
- C. Vibration Balance:
 - 1. Each fan/motor assembly shall be factory balanced to AMCA 204, BV-4, Balance Quality Grade G2.5 or better through entire operating speed range from minimum speed to maximum speed. If minimum speed is not indicated on Drawings, assume minimum speed to be 20 percent of design speed.
 - 2. Identify and record each speed and speed range within the fan operating range that could cause potential vibration problems.
 - 3. Submit test reports as an information submittal for Project record.
- D. Operation and Service Requirements:
 - 1. Each fan/motor assembly shall be capable of lock-out/tag-out procedure without interrupting operation of other fans in air-handling unit.
 - 2. Design and incorporate features to permit safe, rapid, and economical maintenance.
- E. Fan Base:

1. Mount fan, motor, and drive on a structural-steel or an aluminum base; except, where indicated on Drawings, install fan on a concrete-filled inertia base.
 2. Include base and vibration isolators in accordance with requirements indicated.
 3. Electrically weld the base.
 4. Size and design the base construction to withstand the rigors of shipping and rigging.
 5. Include the base with lifting lugs or holes.
 6. Construct base with gusseted brackets to accommodate spring isolators indicated.
- F. Fan Panel:
1. Construct fan panel of aluminum or powder-coated steel.
 2. Support fan wheel and bearings from a structural aluminum or powder-coated steel framework.
 3. Reinforce and brace fan panel to prevent vibration and pulsation.
 4. Include stiffeners to form a rigid panel that is free of structural resonance and vibration.
- G. Fan Inlet and Wheel Cone:
1. Precision-spun or die-formed, matched inlet and wheel cone to ensure streamlined airflow into the wheel and full loading of blades.
 2. Inlet and wheel cones shall be hyperbolic.
 3. Inlet cone shall be a single piece, constructed of aluminum or powder-coated carbon steel.
 4. Fasten inlet cone to fan panel using bolts, nuts and washers to provide a positive and secure attachment that can be field removable.
 5. Inlet cones that are held in place using retaining clips are unacceptable.
- H. Fan Wheel:
1. Fan blades shall be a true hollow airfoil shape, continuously welded to backplate and wheel cone.
 2. Construct blades of aluminum, reinforced for AMCA fan class and operating conditions scheduled.
 3. Design blades to provide smooth and aerodynamic airflow over all surfaces of blade.
 4. Construct fan hubs of cast aluminum or cast-iron ASTM A48/A48M Class 20A and better, with integral bracing for extra strength and stiffness.
 - a. Castings shall be sound and free of shrink holes, blow holes, cracks, scale, blisters, or other similar injurious defects.
 - b. Clean surfaces of castings by blasting, pickling, or other standard method.
 - c. Mold-parting fins and remains of gates and risers shall be chipped, filed, and ground flush.
 - d. Design hubs to maintain a high resistance to fatigue and low relative wheel imbalance.
 5. Hubs shall be keyed and setscrewed to shaft for positive attachment.
 6. Construct the wheel backplates of aluminum.
 7. Statically and dynamically balance fan wheel before fan is assembled.
 8. Select entire rotating assembly so first critical speed is at least 30 percent greater than fan design speed and at least 20 percent greater than maximum AMCA class speed.
- I. Fan Drive:
1. Direct drive, arrangement 4 in accordance with AMCA 99 for single-width, single-inlet fans.
 2. Adjust wheel width and diameter to match motor speed while providing performance scheduled.
 3. Fasten fan wheel directly to motor shaft using a key and setscrew as previously specified.
 4. Construct motor base and pedestal of aluminum or powder-coated carbon-steel plate.
 5. Fan Speed Limitation: Fan speed at design conditions indicated shall not exceed speed on motor nameplate for direct-drive applications. Do not select fans to operate at motor speeds greater than motor nameplate.
- J. Protective Screens: Factory furnish and install protective screens on fan inlet and discharge.
1. Screens shall comply with OSHA requirements.
 2. Screens shall be constructed of painted carbon or stainless steel.

3. Fasten screens to fan frame for easy removal by maintenance personnel.
- K. Welding:
 1. Use AWS- or ASME-certified welders to weld materials required by application.
 2. All welds shall be continuous full penetration welds.
- L. Hardware: Hex-head, high-strength carbon steel or 300 series stainless steel.
- M. Nameplates:
 1. Construct nameplates and rotation arrows of aluminum or 300 series stainless steel.
 2. Securely fasten nameplate and rotation arrow to fan housing using pins or sheet metal screws.
 3. Locate nameplates in a highly visible location on motor side of fan.
 4. Engrave or stamp the following information on nameplate:
 - a. Manufacturer, address, phone number, and website address.
 - b. Manufacturer model number.
 - c. Serial number.
 - d. Manufacturing date.
 - e. Fan size.
 - f. Fan schedule equipment designation (may be listed on a separate nameplate if there is insufficient space).
 - g. Design airflow.
 - h. Design static pressure.
 - i. Design fan speed.
 - j. AMCA fan class.
- N. Air-Handling Unit Factory Assembly:
 1. Internal Access: Include each fan with internal access from upstream sides as indicated on Drawings.
 2. Removal and Replacement: Each fan shall be independently removable and replaceable through a removable access panel installed in air-handling unit casing.
 3. Fan Supports:
 - a. Construct a freestanding and self-supporting structural framework to support each fan individually from and independent of adjacent fans.
 - b. Construct frame work from aluminum, galvanized steel, or painted steel, or stainless steel.

2.11 FAN MOTORS

- A. Source Limitations: Obtain motors from single source from single manufacturer.
- B. Standard: Comply with NEMA MG 1 unless more stringent requirements are indicated.
- C. Description: NEMA MG 1, Design B, as required to comply with capacity and torque characteristics; medium-induction motor.
 1. Performance:
 - a. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.
 - b. Efficiency: NEMA Premium Efficiency rating complying with NEMA MG 1.
 - c. Motor Horsepower: Minimum size as indicated on Drawings. Motor shall operate fan under all conditions indicated without exceeding motor nameplate and without use of motor service factor.
 - d. Inverter-Duty Rating: Comply with minimum requirements of Class F or Class H insulation, suitable for "inverter-duty" or "drive-duty" applications in accordance with

- NEMA MG 1. Motor operation through a variable-frequency controller shall not adversely affect the motor performance, operation, useful life, and warranty.
- e. Service Factor: 1.15.
 - f. Temperature Rise: Match insulation rating.
- D. Enclosure Type: TEFC.
- E. Shaft Grounding System:
- 1. Shaft grounding system to protect bearings from induced voltage.
 - 2. Shaft grounding system shall have low drag (less than 0.05 percent of motor horsepower), and shall operate for a minimum of three years without periodic maintenance or adjustments.
 - 3. Mounting: External or internal to motor enclosure.
- F. Frame:
- 1. Frames with integrally cast feet unless other requirements of driven equipment require a different arrangement.
 - 2. Frame, front and back end brackets, and front and back end bearing intercaps constructed of cast iron, ASTM A48/A48M, Class 25 or better.
- G. Rotor:
- 1. Fabricate rotor frame from die-cast aluminum, copper, or associated alloys.
 - 2. Key rotors to motor shaft.
 - 3. Rotating assembly shall be dynamically balanced to within limits defined in NEMA MG 1.
 - 4. Motors shall have the entire rotating assembly between bearing inner caps coated with a corrosion-resistant coating.
- H. Stator:
- 1. Copper windings shall be spike resistant to withstand 1600 peak V.
 - 2. Entire wound and insulated stator coated with a coating to protect against moisture and corrosion.
- I. Shaft:
- 1. Solid shaft fabricated of carbon steel, accurately turned, ground and polished, and inspected for accuracy.
 - 2. End of shaft with drilled hole for use in field measurements.
- J. Bearings:
- 1. Grease-lubricated ball or roller bearings.
 - 2. ABMA 11 L-10 motor bearing life of 100,000 hours.
 - 3. Bearing Lubrication:
 - a. Factory lubricate motor bearings using a premium moisture-resistant polyurea thickened grease with rust inhibitors suitable for extreme operating temperatures encountered.
 - b. Coordinate special requirements that may impact lubrication and include appropriate lubrication.
 - 4. Grease Fittings:
 - a. Equip each bearing housing with an easily accessible grease inlet.
 - b. Fit grease inlets with a grease fitting and protective fitting cap.
 - c. Equip inlets with an automatic grease relief fitting to prevent excessive greasing.
 - d. Equip each bearing housing with grease drain and threaded plug.
- K. Conduit Box:
- 1. Material same as frame.
 - 2. For motor frames 365T and below, furnish conduit boxes sized with internal volumes in accordance with NEMA MG 1.
 - 3. For motor frames larger than 365T, furnish conduit boxes one size larger than NEMA MG 1.
 - 4. Coordinate the location and mounting of conduit box with driven equipment manufacturer.

- 5. Factory mount conduit box on motor.
- L. Grounding: NRTL-listed clamp-type grounding lug mounted in conduit box.
- M. Motor Leads:
 - 1. Non-wicking type, Class F temperature rating or better and permanently numbered over entire length for identification.
 - 2. Lead terminals shall be manufacturer's standard.
- N. Condensate Drains:
 - 1. Motor with drain holes at the lowest point for drainage of condensate.
 - 2. Each drain hole with a threaded removable plug.
- O. TEFC Motor Fans: Corrosion-resistant construction, non-sparking, metallic or non-metallic, bi-directional, and keyed to shaft.
 - 1. Motor Fan Cover: Same material as frame.
- P. Hardware: Hex-head, high-strength, zinc-plated carbon steel or stainless steel.
- Q. Lifting Eyebolts: Eyebolt threaded into frame receptacle and design to prevent moisture and other foreign material from entering motor cavity when eyebolt is removed.
- R. Nameplates:
 - 1. Construct nameplates of aluminum or stainless steel and attach to motor frame with aluminum, stainless steel, or brass drive pins.
 - 2. Engrave or stamp data on the nameplate.
 - 3. At a minimum, include nameplate data in accordance with NEMA MG 1. Also include ABMA bearing designation for the drive and opposite end bearing.
- S. Paint: Successfully pass 1000-hour salt spray test for corrosion in accordance with ASTM B117.

2.12 VIBRATION ISOLATION

- A. General:
 - 1. Provide fans inside air-handling units with base and vibration isolation indicated on Drawings.
- B. Inertia Bases:
 - 1. Description: Reinforced structural base designed for concrete infill with integral bolting provisions for fan mounting.
 - 2. Design and Performance:
 - a. Weight of inertia base including concrete infill a minimum of 1.5 times the operating weight of fan.
 - b. Base thickness not less than 1/12 of longest span.
 - c. Minimum base thickness is as follows:
 - 1) Up to 15 HP (11 kW): 6 inches (150 mm).
 - 3. Construction:
 - a. Base Materials: Structural carbon steel, ASTM A36/A36M.
 - 1) Carbon-Steel Finish, Mill Galvanized: Mill-galvanized carbon-steel bases with weld-damaged areas cleaned, prepared, and painted with galvanized paint after fabrication.
 - b. Isolator Brackets: Gusseted, height-saving brackets.
 - c. Welding Filler Metals: Comply with AWS welding codes for welding materials appropriate for thickness and chemical analysis of material being welded.
 - 4. Air-Handling Unit Factory Assembly: Install fans with inertia bases where indicated on Drawings.
 - a. Coordinate placement of inertia bases with design of air-handling unit structural base. Make provisions for attachment and support.

- b. Coordinate inertia base mounting provisions with spring isolators.
- C. Spring Isolators:
 - 1. Performance:
 - a. Deflection: Minimum deflection indicated on Drawings. Use a greater deflection if required to maintain an isolator efficiency of at least 98 percent under all operating conditions encountered. Calculate isolator efficiency using actual support conditions considering the rigidity of structure.
 - b. Laterally stable freestanding open-spring mounting.
 - c. Spring diameter not less than 0.8 of compressed spring height at rated load and in the installed and operating condition.
 - d. Reserve travel to solid shall be equal to a minimum of 50 percent of rated deflection and in no case less than 25 percent of rated deflection in an installed and operating condition.
 - e. Ratio of horizontal stiffness to vertical stiffness equal to approximately one.
 - f. Design and install so that ends of springs remain parallel.
 - g. Select springs that are non-resonant with equipment related frequencies and natural frequencies of support structure.
 - h. Springs shall not take a permanent set when compressed to coil bind.
 - i. Seismic restraints to limit motion under seismic forces to 1/4 inch (6 mm).
 - 2. Construction:
 - a. Coat springs with PVC or neoprene. Color-code springs to allow positive identification after installation.
 - b. Construct baseplates, spring retainers, and other components of stainless steel. Etch and paint aluminum components.
 - c. Use nuts, bolts, and washers and other associated hardware constructed of zinc-electroplated carbon steel or stainless steel.
 - d. Isolators with integral leveling bolts.
 - e. Baseplates with holes and isolation grommets for bolting.
 - f. Bond nominal 1/4-inch- (6-mm-) thick, neoprene friction pad to baseplate.
- D. Thrust Restraints:
 - 1. In sets of two or more, thrust restraints shall consist of springs in series with neoprene isolators.
 - 2. Coordinate and select deflection of thrust restrains with equipment being restrained.
 - 3. Thrust restraints complete with rods and adjustment nuts, plus angle brackets and backing plates for attachment to substrate and equipment being restrained.
- E. Elastomeric Grommets:
 - 1. Elastomeric grommets shall be a combination of neoprene washer and bushing.
 - 2. Elastomer shall be 56-durometer maximum.
 - 3. Grommets formed to prevent bolts from directly contacting the secured item.
- F. Flexible Connections:
 - 1. Construct flexible connection galvanized-steel or stainless steel edges firmly attached to waterproof and fire-retardant fabric.
 - 2. Fabric shall be 6 inches (150 mm) wide or more.
 - 3. Suitable for operation in extreme temperatures encountered.
 - 4. NRTL listed for application and complying with NFPA 90A.
- G. Air-Handling Unit Factory Assembly:
 - 1. Use precompression -type height-saving brackets with isolators having 2-1/2 inch (65-mm) deflection or greater, to limit exposed bolt length.
 - 2. Install spring isolators plumb and adjust isolators that are not plumb under operating conditions to make plumb.
 - 3. Adjust isolators to prevent stress transfer to equipment.

4. Verify that installed isolators and mounting systems permit equipment motion in all directions.
5. Restraint fans with isolated thrust resistors to limit displacement to 1/4 inch (6 mm). Design for the maximum lateral thrust the fan can develop.
6. Adjust or include additional resilient restraints to flexibly limit fan lateral motion to 1/4 inch (6 mm) during startup and operation of equipment.
7. Anchor restraints to fixed supports having a stiffness greater than the thrust encountered.
8. Include at least 2-inch (50-mm) operating clearance between fan bases and walking surface of air-handling unit floor. Before startup, clean out foreign matter between bases and equipment to prevent short circuit.
9. Flexible Connections:
 - a. Install flexible connections at connections to fans.
 - b. Install flexible connections in accordance with SMACNA standards and manufacturer's written instructions.
 - c. Make fabric joints on the flat run, not the corners, with overlap to provide an area sufficient to make a positive seal.
 - d. Apply adhesive between fabric layers.
 - e. Attach connections using screws or bolts.
 - f. Reinforce fabric if required to keep fabric from collapsing and impacting airflow into fan.

2.13 DRAIN PANS

- A. General:
 1. Include a drain pan for each cooling and heating coil and at other locations indicated.
 2. Continuously weld drain pan seams, joints, and mitered corners to make the assembled drain pan watertight.
 3. Drain pans shall be located under the entire coil and provide full coil coverage including coil return bends and headers.
 4. Slope drain pans in multiple directions toward low point drain connection at a uniform slope of at least 2 percent from high point to low point.
 5. Include stainless steel blank-offs to prevent air from bypassing around coil.
- B. Intermediate Drain Pans:
 1. Where multiple individual horizontally mounted coils are vertically stacked to make a coil bank, install intermediate drain pans under each stacked coil in the coil bank.
 2. Material: Type 304L stainless steel ASTM A240/A240M or ASTM A480/A480M, a minimum of 16 gauge (1.6 mm) thick.
 3. Minimum Depth: 1.5 inches (38 mm).
 4. Extend drain pan beyond air entering face of coil casing at least 3 inches (75 mm).
 5. Extend drain pan beyond air leaving face of coil casing at least 6 inches (150 mm).
 - a. Where moisture eliminators are required to prevent moisture carryover, extend drain pan beyond leaving face of moisture eliminator in lieu of leaving face of coil.
 6. Drain Pan Connection:
 - a. Stainless steel threaded coupling welded to underside of drain pan at lowest point.
 - b. Minimum Nominal Connection Size: NPS 1 (DN 25).
 7. Drain Pipe:
 - a. Air-handling unit manufacturer to connect full-size drain pipe to each drain pan connection. Option to use one of following pipe materials:
 - 1) Copper tube with a bronze threaded male adapter, brazed or solder to end.
 - b. Extend drain pipe to top of drain pan immediately below.
 - c. Include a removable stainless steel support to secure bottom of drain pipe from drain pan below to prevent lateral movement.

- d. In applications where multiple drain pans are stacked, align stacked drains pan connections and pipes for clear vertical flow.
- C. Bottom Drain Pans:
- 1. Mounting Location, Recessed in Floor: Air-handling unit manufacturer has option to recess bottom drain pan into the floor or install drain pan above air-handling unit floor walking surface.
 - 2. Mounting Location, Above Floor: Bottom drain pan shall be installed above air-handling unit floor walking surface. Do not recess drain pan into unit base.
 - 3. Grating: Install removable stainless steel grating on top of drain pan.
 - 4. Double-Wall Construction: Double-wall sheet with space between walls filled with 1-inch (25-mm) insulation.
 - 5. Material: Type 304L stainless steel ASTM A240/A240M or ASTM A480/A480M, a minimum of 16 gauge (1.6 mm) thick.
 - 6. Minimum Depth: 1.5 inches (38 mm).
 - 7. Extend drain pan beyond air entering face of coil casing at least 3 inches (75 mm).
 - 8. Extend drain pan beyond air leaving face of coil casing at least 12 inches (150 mm).
 - a. Where moisture eliminators are required to prevent moisture carryover, extend drain pan beyond leaving face of moisture eliminator in lieu of the leaving face of coil.
 - 9. Drain Pan Connection:
 - a. Stainless steel threaded half-coupling welded to lowest point of drain pan.
 - b. Location: Both ends.
 - c. Minimum Nominal Connection Size: NPS 1 (DN 25).
 - 10. Drain Pipe:
 - a. Air-handling unit manufacturer to connect full size drain pipe to each drain pan connection. Option to use one of following pipe materials:
 - 1) Copper tube with threaded male adapter, brazed or soldered to ends.
 - 2) Aluminum pipe with threaded MNPT ends.
 - 3) Stainless steel pipe with threaded MNPT ends.
 - b. Extend drain pipe and terminate 3 inches (75 mm) beyond exterior face of casing.

2.14 PLEATED PANEL FILTERS

- A. Source Limitations: Obtain filters from single source from single manufacturer.
- B. Description: Factory-fabricated, self-supported, extended-surface, pleated, panel-type, disposable air filters.
- C. Performance:
 - 1. Filtration Efficiency, ASHRAE 52.2 MERV Rating: See Drawings.
 - 2. Energy Cost Index: Five star rating.
 - 3. Initial Air Pressure Drop: With face velocity of 500 fpm (2.5 m/s), clean filter pressure drop shall not exceed the following:
 - a. MERV 8 and MERV 8A:
 - 1) Depth 1 Inch (25 mm): 0.23 inch wg (58 Pa).
 - 2) Depth 2 Inches (50 mm): 0.31 inch wg (78 Pa).
 - 3) Depth 4 Inches (100 mm): 0.27 inch wg (68 Pa).
 - b. MERV 9 and MERV 9A:
 - 1) Depth 2 Inches (50 mm): 0.30 inch wg (75 Pa).
 - 2) Depth 4 Inches (100 mm): 0.27 inch wg (68 Pa).
 - 4. Manufacturer-Recommended Final Air Pressure Drop: 1.0 inch wg (250 Pa).
 - 5. Pressure Differential without Failure: 2 inches wg (500 Pa).
 - 6. Temperature Rating: 200 deg F (93 deg C).
 - 7. Certification:
 - 8. AHRI: Tolerances in accordance with AHRI 850 (I-P) and AHRI 851 (SI).

9. ASHRAE: Tested and rated in accordance with ASHRAE 52.2.
10. UL: UL 900 listed.

2.15 ASHRAE-RATED FILTER HOLDING FRAMES

- A. Filter Holding Frames for ASHRAE-Rated Filters:
 1. Fabricate filter holding frames with mitered corners and reinforce frame to maintain a durable, rugged, true square shape.
 2. Construct frames of galvanized or stainless steel. Use stainless steel frames in applications exposed to corrosive airstreams.
 3. For applications with pre-filter and final filters sharing the same filter holding frame, frames shall be suitable for supporting and holding both pre-filter and final filters in frame with both filters serviceable from upstream (entering air) side.
 4. Frame Depth: At least 2.75 inches (70 mm).
 5. Gaskets: Continuous, suitable for same operating temperature as filters.
 6. Filter Clips: Each filter holding frame with spring clip fasteners at each corner. Spring clips shall allow filters to be removed and replaced without use of tools.
 7. Frames shall be industry-standard size to provide interchangeability of filters from other manufacturers.
- B. Air-Handling Unit Factory Installation:
 1. Air-handling unit manufacturer shall furnish filters and provide filter holding frames, retaining clips, and filter support structures.
 2. Furnish filter quantity, size, type, and performance indicated on Drawings.
 3. Install filter frames in a flat vertical position for horizontal airflow.
 4. Install holding frames in accordance with manufacturer's written instructions and to prevent passage of unfiltered air. Include additional gaskets as necessary.
 5. Secure individual holding frames together to build a multiple filter bank.
 6. Construct aluminum, galvanized-steel, or stainless steel support structure to hold frames and filters.
 - a. Design support structure for maximum system operating pressures encountered equal to fan shutoff pressure.
 - b. Design and fabricate support structure to limit deflection across filter bank to 1/360 of the span when subjected to a 200-lb (890-N) lateral force applied at any point on the filter holding frame assembly.

2.16 AUTOMATIC DAMPERS

- A. General: Provide air-handling units with automatic dampers where indicated on Drawings.
 1. Unless otherwise indicated, use parallel-blade configuration for two-position control, for equipment isolation service, and when mixing two airstreams. For other applications, use opposed-blade configuration.
 2. Factory assemble multiple damper sections to provide a single damper assembly of size required by application.

2.17 MANUAL BALANCING DAMPERS

- A. General: Air-handling unit manufacturer shall furnish and factory install manual balancing dampers inside air-handling units where indicated on Drawings.

2.18 FACTORY ASSEMBLED ELECTRICAL

- A. Factory install service light fixtures and switches, and receptacles for each air-handling unit.
 1. Locate in a convenient and field-accessible location.

2. Installation shall comply with NFPA 70.
3. Wire, Conduit, and Enclosures:
 - a. Minimum Conduit Size: 3/4 inch (20 mm).
 - b. Materials: Metal, with a corrosion-resistant finish.
 - c. Supports: Support conduits, boxes, and enclosures using corrosion-resistant fastening hardware constructed of stainless steel.
 - d. Conduit: Locate conduit inside the air-handling unit casing. Conduit installed on exterior of air-handling unit casing is unacceptable.
 - e. Wire:
 - 1) Copper, rated for 600 V, solid wire for size No. 10 AWG and smaller and stranded wire for larger sizes.
 - 2) Minimum Wire Size: No. 12 AWG.
 - 3) Each circuit shall have a ground wire.
 - 4) Install wire in conduit.
 - f. Boxes, Conduit Outlet Bodies, and Enclosures:
 - 1) Located in Airstream: NEMA 250, Type 4X.
 - 2) Located on Exterior of Air-Handling Unit Casing: NEMA 250, Type 4X.
 - g. Seals: Seal pathways to prevent air leakage between air-handling unit exterior and interior, and between internal component sections.
 - h. Service Lighting Applications:
 - 1) Provide quantity of 20-A branch circuits required to power service light fixtures.
 - 2) For air-handling units consisting of multiple stacked tiers, provide separate circuits for top and bottom tiers of air-handling units.
 - 3) Factory install a main disconnect switch and field power junction box for interfacing air-handling power for service lighting with single-point field power wiring connection.
 - i. Receptacle Applications:
 - 1) For air-handling units consisting of multiple stacked tiers, provide separate circuits for top and bottom tiers of air-handling units.
 - 2) Factory wire receptacles to a [main disconnect switch] [field power junction box] for interfacing air-handling power for receptacles with a single-point field power wiring connection.
- B. Main Disconnect Switches: Factory-install main disconnect switch mounted on air-handling unit casing exterior for interface of factory power wiring with field power wiring.
 1. Specification Grade; "Heavy Duty Type"; "quick-make," "quick-break" construction.
 2. Three pole, fused or nonfused.
 3. 600 V rated.
 4. Minimum Short-Circuit Current Rating: As required by electrical power distribution system, but not less than 65,000 A.
 5. Enclosure:
 - a. Located on Exterior of Air-Handling Unit Casing: NEMA 250, Type 4X.
 - b. Operating handle shall be of box-mounted type that directly drives switch mechanism.
 - c. Disconnect switch shall use a flange-operated visible blade that is close coupled to a vertical-lift-type handle that achieves a positive visible indication of disconnect with cover open or closed.
 - d. Disconnect switch shall have a defeatable, front-accessible, mechanical interlock to prevent opening of cover when switch is in "ON" position, and to prevent turning switch "ON" when the door is open.
 - e. Include a solid neutral as required by authorities having jurisdiction.
 - f. Disconnect switch shall have a ground lug for ground wire termination.
 - g. Operating handle shall be lockable in open position.
 - h. Horsepower rated.

- i. Feed through or double lugged.
- C. Field Power Junction Box: Factory-install junction box with internal wire terminal block mounted on air-handling unit casing exterior for interface of factory power wiring with field power wiring.
- D. Exterior Service Light Fixtures:
 - 1. LED Luminaires for Outdoors:
 - a. Finish: Selected by Architect from available finishes offered by manufacturer.
 - b. Mounting: Wall.
 - c. Intended for direct exposure in outdoor locations and operation in cold- and hot-temperature extremes encountered; dust and moisture resistant.
 - d. On/Off Operation: Local toggle switch.
 - 2. Vaportight Fixtures:
 - a. Finish: Selected by Architect from available finishes offered by manufacturer.
 - b. Mounting: Wall.
 - c. Intended for direct exposure in outdoor locations and operation in cold- and hot-temperature extremes encountered; dust and moisture resistant.
 - d. Cast-aluminum housing and guard with heat-resistant, tempered, clear glass globe.
 - e. LED A21 Series Lamps:
 - 3. Application: Provide one service light fixture on each side of air-handling unit with access doors. Position fixture at midpoint of most remote access doors.
- E. Interior Service Light Fixtures:
 - 1. LED Luminaires:
 - a. Suitable for wet locations and operation in cold- and hot-temperature extremes encountered; dust and moisture resistant.
 - b. High-impact, UV-stabilized fiberglass housing and acrylic lens.
 - c. Driver: 1 percent dimming.
 - 2. Vaportight Fixtures:
 - a. Suitable for wet locations and operation in cold- and hot-temperature extremes encountered; dust and moisture resistant.
 - b. Cast-aluminum housing and guard with heat-resistant, tempered, clear glass globe.
 - c. LED A21 Series Lamps:
 - 3. Application: Provide service light fixtures where indicated on Drawings.
 - 4. Application: Provide one service light fixture in each accessible section of air-handling units.
 - 5. Application: Provide one service light fixture in fan[, coil] [filter] <Insert section> sections of air-handling units.
- F. Toggle Switches for Service Light Fixtures:
 - 1. Single-Pole Switches, 120/277 V, 20 A: Comply with UL 20 and FS W-S-896.
 - 2. Lighted Single-Pole Switches, 120/277 V, 20 A: Comply with NEMA WD 1, UL 20, and FS W-S-896.
 - 3. Description: Handle illuminated when switch is on.
 - 4. Toggle Switch Box and Cover: Mount toggle switch in a metal outlet box with cast-aluminum or stainless steel cover. Weatherproof where exposed to outdoors.
 - 5. Application: Factory install a single service light switch to switch all service light fixtures from a single location.
 - 6. Switches with Lighted Handles Applications: Lighted handle feature may be omitted where on/off status of internal lights can be viewed through an access door window.
- G. Receptacles:
 - 1. Duplex GFCI Receptacles, 125 V, 20 A:
 - a. Description: Integral GFCI with "Test" and "Reset" buttons and LED indicator light. Two pole, three wire, and self-grounding.
 - b. Configuration: NEMA WD 6, Configuration 5-20R.

- c. Type: Non-feed through.
 - d. Standards: Comply with UL 498, UL 943 Class A, and FS W-C-596.
- 2. Receptacle Box and Cover: Mount receptacle in a metal outlet box with cast-aluminum or stainless steel cover. Weatherproof where exposed to outdoors.
- 3. Applications: Factory install a receptacle in a convenient and field-accessible location on air-handling unit exterior of casing near access doors accessing fans.
- H. Power Supply to Fan Motors: As indicated on Drawings.
- I. Power Supply to Fan Motors: Factory install a variable-frequency controller for each fan motor.
 - 1. Locate in a convenient and field-accessible location on unit exterior.
 - 2. Installation shall comply with NFPA 70.
 - 3. Wire, Conduit, and Enclosures:
 - a. Minimum Conduit Size: 3/4 inch (20 mm).
 - b. Materials: Metal, corrosion resistant and constructed of stainless steel.
 - c. Motor Termination: Flexible conduit, NRTL listed, not to exceed 36 inches (900 mm) long.
 - d. Supports: Support conduits, boxes, and enclosures using corrosion-resistant fastening hardware constructed of stainless steel.
 - e. Wire:
 - 1) Copper, rated for 600 V, solid wire for size No. 10 AWG and smaller and stranded wire for larger sizes.
 - 2) Minimum Wire Size: No. 12 AWG.
 - 3) Each circuit shall have a ground wire.
 - 4) Install wire in conduit.
 - f. Boxes, Conduit Outlet Boxes, and Enclosures:
 - 1) Located in Airstream: NEMA 250, Type 4X.
 - 2) Located on Exterior of Air-Handling Unit Casing: NEMA 250, Type 4X.
- J. Disconnect Switches:
 - 1. Specification Grade; "Heavy Duty Type"; "quick-make," "quick-break" construction.
 - 2. 2.18.10.2 Three pole, fused or non-fused.
 - 3. 600 V rated.
 - 4. Minimum Short-Circuit Current Rating: As required by electrical power distribution system, but not less than 65,000 A.
 - 5. Enclosure:
 - a. Located on Exterior of Air-Handling Unit Casing: NEMA 250, Type 4X.
 - 6. Operating handle shall be of box-mounted type that directly drives switch mechanism.
 - 7. Disconnect switch shall use a flange-operated visible blade that is close coupled to a vertical-lift-type handle that achieves a positive visible indication of disconnect with cover open or closed.
 - 8. Disconnect switch shall have a defeatable, front-accessible, mechanical interlock to prevent opening of cover when switch is in "ON" position, and to prevent turning switch "ON" when the door is open.
 - 9. Include a solid neutral as required by authorities having jurisdiction.
 - 10. Disconnect switch shall have a ground lug for ground wire termination.
 - 11. Operating handle shall be lockable in open position.
 - 12. Horsepower rated.
 - 13. Feed through or double lugged.
- K. Variable-Frequency Controllers:
 - 1. Description: NEMA ICS 2; arranged to achieve motor variable speed by adjusting output voltage and frequency.
 - 2. Enclosure: Unit mounted, with hinged full-front access door with lock and key.
 - a. Located on Exterior of Air-Handling Unit Casing: NEMA 250, Type 4X.

- 1) Externally Operated, Door-Interlocked Disconnect: Fused disconnect switch with lockable handle.
- 2) Minimum Short-Circuit Current Rating: As required by electrical power distribution system, but not less than 100,000 A.
- 3) Technology: Pulse-width-modulation (PWM) output with insulated gate bipolar transistors (IGBT); suitable for variable torque loads.
- 4) Controller shall consist of a rectifier converter section, a digital/analog driver regulator section, and an inverter output section.
- 5) Output Rating: Three phase; with voltage proportional to frequency throughout voltage range.
- 6) Output signal shall be programmed to not cause mechanical vibration issues with fan drive assembly.
- 7) Operating Requirements:
 - (a) Input AC Voltage Tolerance: 10 percent.
 - (b) Input frequency tolerance of 60 Hz, plus or minus 2 Hz.
 - (c) Capable of driving full motor load, without derating.
 - (d) Minimum Efficiency: 96 percent at 60 Hz, full load.
 - (e) Minimum Displacement Primary-Side Power Factor: 95 percent.
 - (f) Overload Capability: 1.05 times the full-load current for 7 seconds.
 - (g) Starting Torque: As required by fan and motor drive assembly.
 - (h) Speed Regulation: 1 percent.
 - (i) Speed Range: 10:1 speed range.
 - (j) To avoid equipment resonant vibrations, include critical speed lockout circuitry to allow bands of operating frequency at which controller shall not operate continuously.
 - (k) Capable of being restarted into a motor coasting in either the forward or reverse direction without tripping.
3. Controller Adjustability Capabilities: Minimum and maximum output frequency, acceleration and deceleration, and current limit.
4. Self-Protection and Reliability Features: Subjecting the controller to any of the following conditions shall not result in component failure or need for replacement:
 - a. Surge suppression.
 - b. Loss of input signal protection.
 - c. Critical frequency rejection.
 - d. Overtemperature.
 - e. Short circuit at controller output.
 - f. Ground fault at controller output. Variable-frequency controller shall be able to start a grounded motor.
 - g. Open circuit at controller output.
 - h. Input undervoltage.
 - i. Input overvoltage.
 - j. Loss of input phase.
 - k. Reverse phase.
 - l. AC line switching transients.
 - m. Instantaneous overload, line to line or line to ground.
 - n. Sustained overload exceeding 100 percent of controller rated current.
 - o. Starting a rotating motor.
5. Motor Protection: Controller shall protect motor against overvoltage and undervoltage, phase loss, reverse phase, overcurrent, overtemperature, and ground fault.
6. Automatic Reset and Restart:
 - a. Capable of multiple restarts after controller fault or on return of power after an interruption and before shutting down for manual reset or fault correction.

- b. Capable of automatic restart on phase-loss and overvoltage and undervoltage trips.
- 7. Visual Indication: On face of controller; indicating the following conditions:
 - a. Power on.
 - b. Run.
 - c. Overcurrent and overvoltage.
 - d. Motor speed (percentage).
 - e. Various faults with alarm status.
 - f. Input kilovolt amperes.
 - g. Power factor.
 - h. Input kilowatts and kilowatt-hours.
 - i. Three-phase input and output voltage.
 - j. Three-phase input and output current.
 - k. Output frequency.
 - l. Elapsed operating time (hours).
 - m. Diagnostic and service parameters.
- 8. Operator Interface: Start-stop and auto-manual selector with manual-speed-control potentiometer.
- 9. Hardwired Control Signal Interface: A minimum of two analog inputs (0 to 10 V or 0/4 to 20 mA) and four programmable digital inputs.
- 10. Remote Communication Interface: ASHRAE 135 BACnet IP.
- 11. Conditioning:
 - a. Input line conditioning.
 - b. Output filtering.
 - c. EMI/RFI filtering.
- 12. Bypass Controller:
 - a. Bypass Controller/Variable-Frequency Controller Selector Switch: Include manual selector switch on face of enclosure for local operator control of preferred controller.
 - b. Bypass Mode: Field-selectable automatic or manual.
 - c. In automatic mode, include fail-safe control logic to automatically transfer fan motor operation from failed variable-frequency controller to bypass controller.
 - d. Type: Integrated NEMA ICS 2, Class A, full-voltage, non-reversing, motor-rated controller to operate fan motor if variable-frequency controller is not operational.
 - e. Arrangement: Configure power supply to bypass controller and variable-frequency controller to completely isolate power to variable-frequency controller while operating fan motor through bypass controller for safe servicing of variable-frequency controller.
 - f. Enclosure: Install bypass controller in same enclosure as variable-frequency controller.
 - g. Remote Monitoring: Include control relay for remote indication of bypass controller operation.

2.19 SMOKE DETECTORS

- A. System, Duct Smoke Detectors: For connection to conventional fire-alarm system.
 - 1. Operating at 24-V dc, nominal.
 - 2. Detectors shall be four-wire type.
 - 3. Base Mounting: Detector and associated electronic components shall be mounted in a twist-lock module that connects to a fixed base. Provide terminals in the fixed base for connection to building wiring.
 - 4. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
 - 5. Integral Visual-Indicating Light: LED type, indicating detector has operated and power-on status.

- B. Non system, Single-Station Duct Smoke Detectors:
 - 1. Non system smoke detectors shall be listed as compatible with fire-alarm equipment installed or shall have a contact closure interface listed for the connected load.
 - 2. Non system smoke detectors shall meet the monitoring for integrity requirements in NFPA 72.
 - 3. Comply with UL 268A; operating at 120 V ac.
 - 4. Base Mounting: Detector and associated electronic components shall be mounted in a twist-lock module that connects to a fixed base. The fixed base shall be designed for mounting directly to mounting brackets air-handling unit. Provide terminals in the fixed base for connection to building wiring.
 - 5. Enclosure: NEMA 250, Type 4X; listed for use with the supplied detector.
 - 6. Sampling Tubes: Design and dimensions as recommended by manufacturer for specific size, air velocity, and installation conditions where applied.
 - 7. Relay Fan Shutdown: Rated to interrupt fan motor-control circuit.
- C. Air-Handling Unit Factory Assembly:
 - 1. Furnish and install smoke detectors inside air-handling units to comply with governing building codes.
 - 2. Install smoke detectors in accordance with smoke detector manufacturer's written installation instructions.
 - a. Sampling tubes shall extend the full width of airstream.
 - b. Sampling tubes greater than 36 inches (900 mm) long shall be supported on both ends.
 - 3. Install smoke detectors within air-handling units in a location that is easily accessible for inspection, repair, and replacement of smoke detector, and in a location that does not hinder access to other internal components.
- D. Air-Handling Unit Factory Testing: Functionally test smoke detectors to ensure proper operation in accordance with smoke detector manufacturer's written instructions.

2.20 PAINTING

- A. General:
 - 1. Painted OEM components do not require additional coating other than touch-up to damaged areas. Match the touchup coating to surrounding undamaged surfaces.
 - 2. Finish miscellaneous surfaces to match continuous surfaces.
 - 3. Protect mill galvanized surfaces that are exposed to view, such as raw steel cuts and damage by welding, with multiple coats of matching galvanized paint.
 - 4. Protect mill galvanized surfaces that are concealed, such as raw steel cuts and damage by welding, with multiple coats of zinc-rich paint or matching galvanized paint.
 - 5. Touch up or entirely repaint surface finishes, damaged during shipment and installation, to the original condition, using original materials and methods.
- B. Preparation:
 - 1. Submit proposed manufacturer's written preparation and application instructions for information.
 - 2. If paint manufacturer's recommended preparation requirements differ from those indicated, use the more stringent requirements.
 - 3. Structural carbon steel to be painted shall be deburred, ground smooth, cleaned, and blasted in accordance with SSPC-SP 6/NACE No. 3 or SSPC-SP 10/NACE No. 5.
 - 4. Before applying a primer and a finish coat, remove oil and grease from surfaces to be coated using clean rags soaked in thinner in accordance with SSPC-SP 1.
 - 5. Treat surfaces to be painted to ensure that paint adheres.
- C. Primer:
 - 1. Rust-inhibiting type, with a minimum dry film thickness of 2 mil(s) per coat.

2. Apply at least two coats of primer to unfinished carbon-steel surfaces and at least one coat of primer to other surfaces.
 3. Use primer that is compatible with substrate and finish coat.
- D. Finish Coat:
1. Finish coat painting system shall be alkyd-enamel.
 2. Use dry film thickness recommended by paint manufacturer for each coat. Total dry film thickness of all finish coats not less than 5 mils.
 3. Painted Surfaces Minimum Properties:
 - a. Salt Spray ASTM B117: 5 percent salt solution fog at 95 deg F (35 deg C) for 2000 hours with no deterioration.
 - b. Adhesion, ASTM D3359: When the coating is cut into 0.0625-inch (1.6-mm) squares and 3M No. 600 tape is suddenly removed, there is no loss of adhesion.
 - c. Acid Resistance ASTM D3260: 15-minute exposure to 10 percent hydrochloric acid at room temperature with no effect.
 - d. Alkali Resistance ASTM D1647: 15-minute exposure to 10 percent sodium hydroxide at room temperature with no effect.
 - e. Humidity Resistance ASTM D2247: 850-hour exposure to 100 deg F (38 deg C) and at least 95 percent relative humidity with no effect.
 - f. Pencil Hardness ASTM D3363: A hardness of 1H.
 4. Finish coat color shall be selected by Architect and not be limited to manufacturer's standard offering.
 - a. Submit a written request for color selection and indicate in the request the date color selection must be returned without impacting schedule.
- E. Application: Paint the following surfaces with primer and finish coat indicated:
1. Unfinished carbon-steel surfaces.
 2. Exposed mill galvanized-steel surfaces of air-handling unit casing exterior.
 3. Exposed aluminum surfaces of air-handling unit casing exterior.
 4. Exposed stainless steel surfaces of air-handling unit casing exterior.

2.21 CLEANLINESS REQUIREMENTS

- A. General:
1. Provide equipment that has been manufactured, shipped, stored, and installed maintaining highest degree of cleanliness possible.
 2. Owner Cleanliness Inspection: Air-handling unit(s) cleanliness is subject to Owner cleanliness inspection and must pass a white glove test before packaging for shipment.
- B. During Manufacturing:
1. Clean materials to be free of mill grease, oxidation, dirt, dust, and other impurities before manufacturing and assembly.
 2. Protect casing materials from contamination during manufacturing and assembly.
 3. Use sealing materials that do not outgas.
 4. Provide OEM components and equipment from their respective manufacturers free of grease, oxidation, and dirt. Store OEM components and equipment indoors. Cover and protect OEM components and equipment to maintain cleanliness. Follow OEM instructions for equipment storage.
- C. After Manufacturing:
1. Before shipment, after unit is completely assembled, clean unit inside and out.
 - a. Vacuum entire inside to remove dirt, dust, and debris using HEPA-filtered vacuum equipment.
 - b. Purge hard to reach surfaces with dry, oil-free, compressed or bottled nitrogen.
 - c. Wipe down all surfaces, inside and out, with a residue-free cleaning agent.
 2. Protect unit to maintain cleanliness.

- D. Shipping:
 - 1. Protect interior and exterior of air-handling unit from exposure to weather dirt, dust, and debris during shipment and rigging.
 - 2. Cover openings with puncture-resistant durable coverings to ensure that cleanliness is maintained inside unit while providing an air- and watertight seal.
- E. On-Site Storage:
 - 1. If air-handling unit is to be stored before installation, Installer shall work closely with air-handling unit manufacturer for air-handling unit manufacturer to provide adequate protection at the factory to ensure that cleanliness for both unit interior and unit exterior is maintained. This protection shall remain in place until unit startup is performed.
 - 2. For extended periods of storage, provide a means to rotate fan and motor assemblies on a periodic basis (as recommended in writing by manufacturer) without compromising unit cleanliness.

2.22 SOURCE QUALITY CONTROL

- A. AHRI Compliance:
 - 1. AHRI 260 (I-P): Air-handling unit sound ratings shall be in accordance with AHRI 260 (I-P), "Sound Rating of Ducted Air Moving and Conditioning Equipment."
 - 2. AHRI 261 (SI): Air-handling unit sound ratings shall be in accordance with AHRI 261 (SI), "Sound Rating of Ducted Air Moving and Conditioning Equipment."
 - 3. AHRI 410: Air-handling unit coils shall be rated in accordance with AHRI 410 and shall be listed by AHRI and labeled in accordance with AHRI.
- B. AMCA Compliance:
 - 1. AMCA 201: Air-handling unit manufacturer shall evaluate fan's performance within the air-handling unit in accordance with AMCA 201, "Fans and Systems" and account for conditions within the air-handling unit that could be detrimental to fan's performance by adjusting the fan performance indicated on Drawings.
 - 2. AMCA 205 Certification: Air-handling unit fan's fan efficiency grade (FEG) shall be rated in accordance with AMCA 205, "Energy Efficiency Classifications for Fans" and shall bear the AMCA-certified fan efficiency grade seal.
 - 3. AMCA 210 Certification: Air-handling unit fan's air performance shall be rated in accordance with AMCA 210, "Laboratory Methods of Testing Fans for Aerodynamic Performance Rating" and shall bear the AMCA-certified air ratings seal.
 - 4. AMCA 300: Air-handling unit fan's sound performance shall be rated in accordance with AMCA 300, "Reverberant Room Method for Sound Testing of Fans."
 - 5. AMCA 301 Certification: Air-handling unit fans sound performance shall be rated in accordance with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data" and shall bear the AMCA-certified sound ratings seal.
 - 6. AMCA 500-D: Air-handling unit damper's performance shall be rated in accordance with AMCA 500-D, "Laboratory Methods of Testing Dampers for Rating" and shall bear the AMCA-certified air ratings seal.
- C. NFPA Compliance:
 - 1. NFPA 70: Electrical components, devices, and accessories shall be listed and labeled by a qualified testing agency, and marked for intended location and application.
 - 2. NFPA 90A: Design, fabrication, and installation of air-handling units and components shall comply with NFPA 90A.
- D. UL Compliance:
 - 1. UL 1598 Certification: Air-handling unit UVGI shall be NRTL listed and labeled in accordance with UL 1598, "Luminaires."
 - 2. UL 1995 Certification: Where indicated, air-handling unit components shall be NRTL listed and labeled in accordance with UL 1995, "Standard for Safety Heating and Cooling Equipment."

2.23 SOURCE QUALITY CONTROL - INDEPENDENT LABORATORY TESTING

- A. General:
 - 1. Project-specific testing by an independent laboratory is not required if air-handling unit manufacturer has written independent laboratory test results of past tests performed on same casing construction proposed for use on this Project.
 - 2. If Project-specific testing is required, testing shall be performed in ample time to include test reports with submittals and before manufacturing of air-handling units. Include sufficient lead time for unit delivery, installation, and testing required by construction schedule.
- B. Casing Structural Deflection Test:
 - 1. Include service of an independent testing laboratory to verify casing structural deflection requirements indicated.
 - a. In lieu of independent laboratory testing, manufacturer may perform factory deflection testing of proposed construction to prove compliance if witnessed by Architect and Owner. Manufacturer shall bear cost of labor and travel expenses to witness testing.
 - 2. Test casing construction to performance criteria indicated.
 - 3. Test casing construction proposed for use on Project. Include, at a minimum, particulars such as metal materials and thickness, internal support and reinforcing, and insulation material and thickness.
 - 4. Test largest full-size casing panel proposed for use on Project.
 - 5. Test proposed construction of walls, floor, and roof. Include a separate test for each unique casing construction proposed.
 - 6. Submit test reports for each test to show compliance with performance indicated.
- C. Casing Airborne Sound Transmission Test:
 - 1. Include services of an independent testing laboratory to test proposed casing construction for sound transmission. Include a separate test for each unique casing construction proposed.
 - 2. Conduct tests in accordance with ASTM E90.
 - 3. Determine sound transmission class by using ASTM E413.
 - 4. Test proposed construction of walls and roof.
 - 5. Test proposed construction of floor assembly only if air-handling unit is not installed on a concrete housekeeping pad or building structural floor.
 - 6. Submit test reports for each test to show compliance with performance indicated.
- D. Casing Sound Absorption Test:
 - 1. Include services of an independent testing laboratory to verify casing sound absorption coefficients for perforated casing panels. Provide a separate test for each unique casing construction proposed.
 - 2. Conduct tests in accordance with ASTM C423 and ASTM E795.
 - 3. Test proposed construction of walls and roof.
 - 4. Submit test reports to show compliance with performance indicated.

2.24 SOURCE QUALITY CONTROL - AIR-HANDLING UNIT FACTORY TESTS

- A. Casing Structural Deflection Test:
 - 1. Perform a structural deflection test for each assembled air-handling unit.
 - 2. Pressurize and load air-handling units to the performance criteria indicated for structural deflection. Test air-handling unit floors, walls and roofs.
 - 3. Test results shall indicate that units comply with deflection requirements indicated. Make changes to noncompliant air-handling units and retest until units comply with requirements.
 - 4. Submit test reports indicating test location, documentation of test equipment used, test procedures, test results, test date and time, and full names of personnel performing tests

and witnesses. If multiple tests are required to achieve compliance for a single air-handling unit, report shall include test date and time, test results, and full names of personnel performing tests and witnesses of each test with a detailed description and photographs of interim corrective measures made before each retest.

B. Functional Run Test:

1. Run test each unit before shipment.
2. Test and balance fans to comply with vibration requirements indicated.
3. Energize each electrical device to ensure it is operational.
 - a. Take meter readings for volts, amperes, and kVAr on each phase leg of each motor.
 - b. Take meter readings for volts, amperes, and kVAr on each single-phase power connection to field power.
4. Exercise each damper to ensure proper operation.
5. Exercise each access door to ensure proper fit.
6. Exercise each valve to ensure proper operation.
7. Submit a written report for each unit tested. Written report shall include, at a minimum, full name of each person witnessing test, detailed list of each unit component tested, condition observed, and corrective action required. Each line item shall have full name of the person doing the checkout and date and time the checkout was performed.

C. Fan Vibration Test:

1. Perform a fan vibration test for [each assembled air-handling unit] [each assembled air-handling unit of unique size and performance] <Insert requirement>.
2. Energize each fan within the air-handling unit after air-handling unit final assembly and perform a vibration analysis with fan operating at design speed[and at all speeds throughout the range from design to minimum speed].
3. Three vibration measurements shall be taken for each bearing in horizontal, vertical, and axial directions. Vibration measurements shall be recorded and consist of vibration amplitude verses frequency[with filter-in].
4. Fan bearing measurement points shall be marked or scribed on bearings for permanent record.
5. Test results shall indicate that units comply with vibration requirements indicated. Make changes to noncompliant air-handling units and retest until units comply with requirements.
6. Submit test reports indicating test location, documentation of test equipment used, test procedures, test results, test date and time, and full names of personnel performing tests and witnesses. If multiple tests are required to achieve compliance for a single air-handling unit, report shall include test date and time, test results, and full names of personnel performing tests and witnesses of each test with a detailed description and photographs of interim corrective measures made before each retest.

D. Acoustical Performance Test:

1. Perform an acoustical performance test for [each assembled air-handling unit] [each assembled air-handling unit of unique size and performance] <Insert requirement>.
2. Air-handling unit acoustic performance shall be verified by factory test in accordance with AHRI 260 (I-P) or AHRI 261 (SI).
3. Air-handling unit supply-air discharge, return-air inlet, and casing radiated sound components shall be measured with air-handling unit operating at design conditions.
4. Testing Location: Perform testing in a location complying with AHRI 220, "Reverberation Room Qualification and Testing Procedures for Determining Sound Power of HVAC Equipment."
 - a. Test location shall be broadband qualified in accordance with AHRI 220 Section 5.1 and discrete frequency qualified in accordance with Section 5.2.
5. Operating conditions used in acoustic testing shall be verified by test in accordance with AMCA 210[in an AMCA-accredited facility].

6. Test results shall indicate that units comply with acoustical requirements indicated. Make changes to noncompliant air-handling units and retest until units comply with requirements.
 7. Submit test reports indicating test location, documentation of test equipment used, test procedures, test results, test date and time, and full names of personnel performing tests and witnesses. If multiple tests are required to achieve compliance for a single air-handling unit, report shall include test date and time, test results, and full names of personnel performing tests and witnesses of each test with a detailed description and photographs of interim corrective measures made before each retest.
- E. Airflow Capacity Performance Test:
1. Perform an airflow capacity performance test for [each assembled air-handling unit] [each assembled air-handling unit of unique size and performance] <Insert requirement>.
 2. Operating conditions shall be verified by test in accordance with AMCA 210[in an AMCA-accredited facility].
 3. Test results shall indicate that units comply with design airflow requirements indicated. Make changes to noncompliant air-handling units and retest until units comply with requirements.
 4. Submit test reports indicating test location, documentation of test equipment used, test procedures, test results, test date and time, and full names of personnel performing tests and witnesses. If multiple tests are required to achieve compliance for a single air-handling unit, report shall include test date and time, test results, and full names of personnel performing tests and witnesses of each test with a detailed description and photographs of interim corrective measures made before each retest.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine air-handling units before installation. Reject units with physical damage, and air-handling unit components that are wet, moisture damaged, or mold damaged.
- C. Examine roughing-in for the following before installation of air-handling units:
 1. Structural substrate mounting and anchorage to verify actual sizes, types, and locations.
 2. Piping systems to verify actual sizes, types, and locations of connections.
 3. Ductwork and plenums to verify actual sizes, types, and locations of connections.
 4. Electrical services and controls to verify actual sizes, types, and locations of connections.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Equipment Mounting: Install air-handling units at locations indicated on Drawings. Unless, otherwise indicated on Drawings, install air-handling units on concrete equipment bases.
 1. Units Mounted to Structural-Steel Supports: Level unit air-handling bases using aluminum or stainless steel shims compatible with air-handling unit base material. Continuously seal between structural supports and air-handling unit bases with nonhardening sealant.
 2. Install air-handling units on curbs following air-handling unit manufacturer's written procedures.
 - a. Install gaskets before setting air-handling units on curbs.
 - b. Secure air-handling units to curbs using stainless steel fasteners.
 - c. Install curb and fasten to structure.

- d. Coordinate curb requirements, attachment, and location before installation.
- B. Roof Openings:
 - 1. Provide exact size and location of roof openings to trade installing structural framing and roof structure.
 - 2. Supervise framing of openings to ensure coordinated installation with air-handling units.
- C. Seismic Control: Comply with requirements for seismic-control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
- D. Equipment Clearances and Access:
 - 1. Arrange installation of air-handling units to provide access space around air-handling units for service and maintenance and for removal and replacement of internal components.
 - 2. Provide clearance and access required by governing codes and NFPA 70.
 - 3. At a minimum, comply with requirements indicated on Drawings and air-handling unit manufacturer's written instructions.

3.03 PROTECTION DURING CONSTRUCTION

- A. Exterior Covers: Cover air-handling units during construction with sealed covers to protect air-handling unit casing and externally mounted components from physical damage, dirt, dust and debris, paint splatter, and any other construction materials.
 - 1. Minor physical damage, as determined by Owner, shall be repaired by air-handling unit factory service personnel to factory-finished condition.
 - 2. Replace air-handling units with damage that in any way compromises the performance indicated.
- B. Internal Access: Keep access doors locked to maximum extent possible and restrict access to only authorized personnel.
 - 1. Open access doors only during periods authorized work inside air-handling units is required.
 - 2. Coordinate and monitor work inside air-handling units on a shift basis. Lock access doors once work is complete or at the end of each shift.
 - 3. Immediately report unauthorized access and any observed damage to Owner.

3.04 DUCT CONNECTIONS

- A. Connect ducts and plenums to air-handling unit connections. Comply with requirements in Section 233113 "Metal Ducts."
- B. Connect ducts and plenums to air-handling unit connections with flexible connections. Comply with requirements in Section 233300 "Air Duct Accessories."
- C. Provide duct transitions required to make field connections to air-handling units.
- D. Arrange ducts and plenums to provide unobstructed access to inside of air-handling units.

3.05 PIPING CONNECTIONS

- A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Where installing piping adjacent to air-handling unit, provide unobstructed access to inside of air-handling units for service and maintenance.
- C. Connect piping to air-handling units with flexible connectors.
- D. Drain Pan Piping:
 - 1. Make connections to air-handling unit connections with flanges or unions.

2. Extend dedicated drain piping from each air-handling unit connection to nearest equipment or floor drain and arrange piping to maintain clear service aisle paths free of potential tripping hazards.
 3. Construct traps near air-handling unit connections to seal airflow from escaping within air-handling unit. Locate traps in a serviceable location that is away from access doors.
 4. Install threaded cleanouts at changes in direction.
 5. Secure drain piping to structure.
- E. Air-Handling Unit Floor Drains: Do not require installation of permanent drain piping.
- F. Refrigerant Coil Piping: Comply with applicable requirements in Section 232300 "Refrigerant Piping." Install shutoff valve at each supply and return connection.

3.06 ELECTRICAL CONNECTIONS

- A. Install field power to each air-handling unit electrical power connection. Coordinate with air-handling unit manufacturer and installers.
- B. Connect wiring in accordance with Division 26 specifications.
- C. Ground equipment in accordance with Division 26 specifications.
- 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.
 1. Nameplate shall be laminated acrylic or melamine plastic signs, as specified in Division 26 specifications.
 2. Nameplate shall be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least 1/2 inch (13 mm) high.

3.07 CONTROL CONNECTIONS

- A. Install control and electrical power wiring to field-mounted control devices.
- B. Connect control wiring in accordance with Division 26 specifications
- C. Install nameplate for each control connection, indicating field control panel designation and I/O control designation feeding connection.
 1. Nameplate shall be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."
 2. Nameplate shall be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least 1/2 inch (13 mm) high.

3.08 STARTUP SERVICE

- A. Engage an air-handling unit factory-authorized service representative to perform startup service.
 1. Complete installation and startup checks in accordance with manufacturer's written instructions.
- B. Starting procedures for air-handling units include the following:
 1. Energize motor; verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated rpm. Replace fan and motor pulleys as required to achieve design conditions.
 2. Measure and record motor electrical values for voltage and amperage.
 3. Manually operate dampers from fully closed to fully open position and record fan performance.

3.09 ADJUSTING

- A. Adjust damper linkages for proper damper operation.
- B. Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC" for air-handling system testing, adjusting, and balancing.
- C. Before turning equipment over to Owner for use, adjust air-handling unit components that require further adjustment for proper operation. Consult air-handling unit manufacturer for instruction.
- D. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.
- E. Seasonal Adjustments: Make seasonal visits during warranty period to inspect and review operation of equipment. Make necessary adjustments for components observed to require adjustments for proper operation. Prepare and submit a report to Owner documenting each visit, observations, and any adjustments made.

3.10 CLEANING

- A. Cleaning Schedule: After completing system installation and testing, adjusting, and balancing air-handling unit and air-distribution systems, and after completing startup service, and immediately before Owner use, clean air-handling units to remove foreign material and construction dirt and dust.
- B. Unit Interior: Clean air-handling units internally to factory clean condition. Remove foreign material and construction debris, dirt, and dust.
 - 1. Vacuum clean with HEPA-filtered vacuum and then wipe down with cleaning solution.
 - 2. Clean casing floors, roofs, wall surfaces, access doors, and panels.
 - 3. Clean all internal components, such as, coils, dampers, filter frames, fans, and motors.
 - 4. Clean light fixtures and control devices.
- C. Unit Exterior: Clean external surfaces of air-handling units to factory clean condition. Remove foreign material and construction debris, dirt and dust. Vacuum clean with HEPA-filtered vacuum and then wipe down all surfaces with cleaning solution.
- D. Cleaning Materials: Use cleaning materials and products recommended in writing by air-handling unit manufacturer.
- E. Acceptance: Following unit cleaning submit a written request for review and Owner acceptance. Acceptance for cleaning of air-handling units must pass a white glove test.

3.11 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Manufacturer's Field Service: Engage a factory service representative to test and inspect components, assemblies, and equipment installations, including connections.
- C. Perform the following tests and inspections with the assistance of a factory-authorized service representative.
 - 1. Charge refrigerant coils with refrigerant and test for leaks.
 - 2. Field-Assembly Supervision: Instruct Installer and supervise field installation of first air-handling unit(s) shipped in multiple pieces for field assembly.
 - 3. Roof-Mounted Field-Installation Supervision: Instruct Installer and supervise field installation of first roof-mounted air-handling unit(s).
 - 4. Fan Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 5. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

- D. Field Casing Leakage Test:
1. Perform leak testing of air-handling units that include field assembly of multiple sections. Air-handling units that are shipped and installed as a single piece do not require field testing.
 2. Leak test one air-handling unit(s) of each unique size and arrangement randomly selected by Commissioning Agent.
 3. Follow procedures complying with ASHRAE 111.
 4. Assembled air-handling units shall satisfy leakage criteria indicated. Modify air-handling units that fail to satisfy criteria and retest. For every air-handling unit that fails test, another air-handling unit shall be tested until all air-handling units tested pass leakage criteria on first attempt.
 5. Submit a test report for each test indicating test equipment, procedures, results, date and time, and full name of personnel performing tests and witnesses.
 6. Test report shall be in accordance with ASHRAE 111.
 7. Witness Testing:
 - a. Provide written notification at least 20 business days in advance of testing.
 - b. Testing shall be conducted in presence of testing and balancing agent.
 - c. Other parties such as Architect, Commissioning Agent, and Owner shall be invited to witness testing with attendance being optional.
- E. Field Fan Vibration Test:
1. Perform fan vibration testing for every one out of 10 air-handling unit fans randomly selected by Commissioning Agent or Owner.
 2. Test after air-handling unit installation is complete.
 3. Three vibration readings shall be taken for each bearing in horizontal, vertical, and axial directions. Record each reading including vibration amplitude versus frequency.
 4. Modify fans that fail to satisfy performance criteria and retest. For every fan that fails test, another fan shall be tested until all fans tested pass criteria on first attempt.
 5. Submit a report for each fan tested indicating air-handling unit designation, fan designation, test equipment, procedures, results, date and time, and full name of personnel performing tests and witnesses.
 6. Witness Testing:
 - a. Provide written notification at least 20 business days in advance of testing.
 - b. Testing shall be conducted in presence of testing and balancing agent.
 - c. Other parties such as Commissioning Agent, Architect, and Owner shall be invited to witness testing with attendance being optional.
- F. Air-handling unit or components will be considered defective if unit or components do not pass tests and inspections.
- G. Prepare test and inspection reports.

3.12 OPERATION DURING CONSTRUCTION

- A. Operation of air-handling units for temporary cooling, heating, and ventilation is not allowed without Owner authorization.
1. Submit written request for Owner approval by signature with detailed description of operating procedures to be followed including, but not limited to, the following:
 - a. Description of construction activities while units are operating.
 - b. Operation:
 - 1) Beginning and ending calendar dates.
 - 2) List each day during week.
 - 3) List start and stop time and hours for each day.
 - c. Startup procedures and shut-down procedures.
 - d. Provisions for routine monitoring of unit operation.

- e. Provisions to prevent and protect against damage to equipment due to adverse operation such as, low temperature, high temperature, over pressure, fire, smoke, electrical over- and undervoltage and current and electrical fault.
 - f. Provisions and safeguards for filtration to keep inside of units from getting dirty.
 - g. Record keeping.
 - 2. If approved by Owner, units used for temporary cooling, heating, and ventilation during and before interior finish work is complete shall include an unconditional complete unit labor and parts warranty to extend at least two years after the warranty indicated expires.
 - 3. Interior and exterior of air-handling units shall be cleaned to a factory-cleaned condition and clean condition must be accepted by Owner.
- B. Filtration During Temporary Use:
- 1. Protect air-handling system ducts (exhaust air, outdoor air, and return air) with temporary filters installed and supported to prevent filter media from collapse and bypass of unfiltered air. Temporary media shall be installed at each inlet and shall have a published filtration efficiency of MERV 16 in accordance with ASHRAE 52.2.
 - 2. Protect air-handling units with open inlets that are not ducted with temporary filters installed and supported to prevent filter media from collapse and by-pass of unfiltered air. Temporary media shall be installed at each inlet and shall have a published filtration efficiency of MERV 16 in accordance with ASHRAE 52.2.
 - 3. Do not operate air-handling units until both temporary and scheduled permanent air-handling unit particulate filters are in place. Temporary filters must be installed upstream of permanent filters while units are operating.
 - 4. Replace temporary and permanent filters used during construction when dirty. After end of temporary use, replace permanent filters with new, clean filters before beginning testing, adjusting and balancing.
- C. Comply with SMACNA 008, "IAQ Guidelines for Occupied Buildings under Construction," for procedures to protect HVAC system.

3.13 DEMONSTRATION

- A. Engage air-handling unit manufacturer employed training instructor or factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air-handling units.
- B. Training shall include, but not be limited to, procedures and schedules related to performance, safety, startup and shut down, troubleshooting, servicing, preventive maintenance, and how to obtain replacement parts.
 - 1. Access Doors: Adjustment, gasket removal and replacement, handle removal and replacement, and spare parts.
 - 2. Access Panels: Removal and replacement, adjustment, gasket removal and replacement, and spare parts.
 - 3. Coils: Cleaning, combing fins, draining, venting, removal, and replacement.
 - 4. Controls: Calibration, cleaning, operation, service, removal and replacement, and spare parts.
 - 5. Damper Assemblies: Cleaning, operation, service, removal and replacement, and spare parts.
 - 6. Drain Pans: Cleaning, removal, and replacement.
 - 7. Fan and Motor Assemblies: Cleaning, operation, removal and replacement, service, and spare parts.
 - 8. Filters: Operation, removal and replacement, frame gasket removal and replacement, clip removal and replacement, and spare parts.
 - 9. Lights, Receptacles and Switches: Cleaning, operation, service, removal and replacement, and spare parts.
- C. Instructor:

1. Instructor shall be factory trained and certified by air-handling unit manufacturer with current training on equipment installed.
 2. Instructor's credentials shall be submitted for review by Architect, Commissioning Agent, or Owner before scheduling training.
 3. Instructor(s) primary job responsibility shall be Owner training.
 4. Instructor(s) shall have not less than three years of training experience with air-handling unit manufacturer and past training experience on at least three projects of comparable size and complexity.
- D. Schedule and Duration:
1. Schedule training with Owner at least 20 business days before first training session.
 2. Training shall occur before Owner occupancy.
 3. Training shall be held at mutually agreed date and time during normal business hours.
 4. Each training day shall not exceed eight hours of training. Daily training schedule shall allow time for a one-hour lunch period and 15-minute break after every two hours of training.
 5. Perform not less than 16 hours of training.
- E. Location: Owner to provide a suitable on-site location to host classroom training.
- F. Training Attendees: Assume three people.
- G. Training Attendance Records: For record purposes, document training attendees at start of each new training session. Record date, time, brief description of training covered during the session, attendee's name, signature, phone number, and e-mail address. Submit scanned copy of sign-in sheet to Owner for each training session.
- H. Training Format: Individual training modules to include classroom training followed by hands-on field demonstration and training.
- I. Training Materials: Provide training materials in electronic format to each attendee.
1. Include instructional videos showing general operation and maintenance that are coordinated with operation and maintenance manuals.
- J. Training Video Recording: Video record each classroom training session and submit an electronic copy to Owner before requesting Owner acceptance of training.
- K. Written Acceptance: Obtain Owner written acceptance that training is complete and requirements indicated have been satisfied.

END OF SECTION

SECTION 23 81 26
SPLIT-SYSTEM AIR-CONDITIONERS

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes split-system air-conditioning and heat-pump units consisting of separate evaporator-fan and compressor-condenser components.

1.02 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Include performance data in terms of capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
 - 1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 2. Wiring Diagrams: For power, signal, and control wiring.

1.03 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.
- B. Warranty: Sample of special warranty.

1.04 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For split-system air-conditioning units to include in emergency, operation, and maintenance manuals.

1.05 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Filters: One set(s) for each fan coil unit.

1.06 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. ASHRAE Compliance:
 - 1. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Standard for Refrigeration Systems."
 - 2. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 4 - "Outdoor Air Quality," Section 5 - "Systems and Equipment," Section 6 - "Procedures," and Section 7 - "Construction and System Start-up."
- C. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1.

1.07 COORDINATION

- A. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

1.08 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of split-system air-conditioning units that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period:
 - a. For Compressor: Five year(s) from date of Substantial Completion.
 - b. For Parts: Five year(s) from date of Substantial Completion.
 - c. For Labor: Five year(s) from date of Substantial Completion.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Mitsubishi Electric & Electronics USA, Inc.; HVAC Advanced Products Division.
 - 2. Carrier.
 - 3. Daikin.
 - 4. LG.
- B. Basis of Design is Carrier. If contractor submits on listed alternates, he shall assume monetary and logistical responsibility for any and all necessary structural, electrical, plumbing, architectural and HVAC modifications. Contractor shall also compensate the Architect of Record (AOR) and Mechanical Engineer of Record (MEOR) for efforts related to reviewing submittals to establish acceptability and updating energy compliance calculations

2.02 INDOOR UNITS (5 TONS OR LESS)

- A. Wall-Mounted or Ceiling mounted, Evaporator-Fan Components:
 - 1. Cabinet: Enameled steel with removable panels on front and ends in color selected by Architect, and discharge drain pans with drain connection.
 - 2. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and thermal-expansion valve. Comply with ARI 210/240.
 - 3. Fan: Direct drive, centrifugal.
 - 4. Fan Motors:
 - a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
 - b. Multitapped, multispeed with internal thermal protection and permanent lubrication.
 - c. Enclosure Type: Motors shall be open drip proof, permanently lubricated ball bearing with inherent overload protection. Fan motors shall be 3-speed.
 - d. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.
 - e. Mount unit-mounted disconnect switches on exterior or interior of unit.
 - 5. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
 - 6. Condensate Drain Pans:
 - a. Provide external secondary drain pan.

- b. Fabricated with one percent slope in at least two planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and humidifiers, and to direct water toward drain connection.
 - c. Single-wall, stainless-steel sheet.
 - d. Drain Connection: Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on one end of pan.
 - 1) Minimum Connection Size: 3/4 inch.
7. Air Filtration Section:
- a. General Requirements for Air Filtration Section:
 - 1) Comply with NFPA 90A.
 - 2) Minimum Arrestance: According to ASHRAE 52.1 and MERV according to ASHRAE 52.2.
 - 3) Filter-Holding Frames: Arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side or lifted out from access plenum.
 - b. Disposable Panel Filters:
 - 1) Factory-fabricated, viscous-coated, flat-panel type.
 - 2) Thickness: 1 inch.
 - 3) Arrestance according to ASHRAE 52.1: 80.
 - 4) Merv according to ASHRAE 52.2: 8.
 - 5) Media: Interlaced glass fibers sprayed with non-flammable adhesive.
 - 6) Frame: Galvanized steel, with metal grid on outlet side, steel rod grid on inlet side, and hinged; with pull and retaining handles.

2.03 OUTDOOR UNITS (5 TONS OR LESS)

- A. Air-Cooled, Compressor-Condenser Components:
- 1. Casing: Unit cabinet shall be constructed of galvanized steel, bonderized and coated with a baked enamel finish on inside and outside. Access panels shall be removable with minimal screws and shall provide full access to the compressor, fan, and control components. Outdoor compartment shall be isolated and have an acoustic lining to ensure quiet operation.
 - 2. Compressor: Fully hermetic with oil system, operating oil charge, and motor. Internal overloads shall protect the compressor from over-temperature and over-current.
 - a. Compressor Type: Scroll.
 - b. Refrigerant Charge: R-454B.
 - c. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and liquid subcooler. Comply with ARI 210/240.
 - 3. Fan: Direct drive propeller type, horizontal discharge, blow through configuration. Blades shall be statically and dynamically balanced with a PVC coated metal protective grille.
 - 4. Motor: NEMA rated class F suitable for operation in a refrigerant atmosphere. Totally enclosed single phase motor with class B insulation and permanently lubricated bearings. Motor shall be protected by internal thermal overload protection.
 - 5. Low Ambient Kit: Permits operation down to 25 deg F (7 deg C).
 - 6. Mounting Base: Polyethylene.
 - 7. Outdoor coil: Coil shall be constructed of aluminum fins mechanically bonded to seamless copper tubes, which are cleaned, dehydrated, and sealed. Coils shall be coated for corrosion resistance. Cathodic epoxy type electro-disposition coating formulated for high edge build to plate fin and tube heat exchangers. Coating shall provide excellent resistance and durability to corrosive effects of alkalis, acids, alcohols, petroleum, seawater, salt air and corrosive environments.

2.04 ACCESSORIES

- A. Thermostat: Wired thermostat to control compressor and evaporator fan, with the following features:
 - 1. Compressor time delay.
 - 2. 24-hour time control of system stop and start.
 - 3. Liquid-crystal display indicating temperature, set-point temperature, time setting, operating mode, and fan speed.
 - 4. Fan-speed selection including auto setting.
 - 5. Wireless thermostats are not permitted.
- B. Automatic-reset timer to prevent rapid cycling of compressor.
- C. Refrigerant Line Kits: Soft-annealed copper suction and liquid lines factory cleaned, dried, pressurized, and sealed; factory-insulated suction line with flared fittings at both ends.
- D. Drain Hose: For condensate.
- E. Additional Monitoring:
 - 1. Monitor constant and variable motor loads.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install units' level and plumb.
- B. Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure.
- C. Install roof-mounted, compressor-condenser components on equipment supports detailed on the construction plans. Anchor units to supports per plans.
- D. Install seismic restraints.
- E. Install compressor-condenser components on restrained, spring isolators with a minimum static deflection of 1 inch (25 mm). See Section 230548 "Vibration and Seismic Controls for HVAC Piping and Equipment."
- F. Install and connect precharged refrigerant tubing to component's quick-connect fittings. Install tubing to allow access to unit.
- G. Provide a secondary drain pan for units located in data rooms, electrical rooms, or similar critical spaces.

3.02 CONNECTIONS

- A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Where piping is installed adjacent to unit, allow space for service and maintenance of unit.

3.03 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- B. Tests and Inspections:
 - 1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.

2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Remove and replace malfunctioning units and retest as specified above.
- D. Prepare test and inspection reports.

3.04 STARTUP SERVICE

- A. Perform startup service.
1. Complete installation and startup checks according to manufacturer's written instructions.

3.05 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain units.

END OF SECTION

SECTION 23 81 29
VARIABLE REFRIGERANT VOLUME SYSTEMS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and Division 01 Specification Sections apply to this Section.
- B. Related Sections include the following:
 - 1. Section 230513 - Common Motor Requirements for HVAC Equipment.
 - 2. Section 230553 - Identification for HVAC Piping and Equipment.

1.02 SUMMARY

- A. Section includes outdoor units-heat recovery, heat and cool, heat pumps, horizontal and vertical fan coils, ceiling cassettes and their accessories and controls, in the following configurations:
 - 1. Ducted rooftop fan coils units.
 - 2. Ducted horizontal fan coils concealed units.
- B. Line Test Pressure for Refrigerant R-410A:
 - 1. Suction Lines (VRV), (VRF) Applications: 535 psig (3689 kPa).
 - 2. Hot-Gas and Liquid Lines: 535 psig (3689 kPa).

1.03 SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, furnished specialties, electrical characteristics, and accessories.
- B. Shop Drawings: For packaged units, include plans, elevations, and sections, details for wall penetrations, seismic bracing, and attachments to other work.
 - 1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 2. Wiring Diagrams: For power, signal, and control wiring.
 - 3. Piping diagram with all detailed valving, traps and accessories.
- C. Color Samples: For unit cabinet, discharge grille, and exterior louver, and for each color and texture specified.
- D. Product Test Reports: Based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified testing agency, for packaged terminal air conditioners.
- E. Field quality-control reports.
- F. Operation and Maintenance Data include in emergency, operation, and maintenance manuals.
- G. Product Data: For each type of valve and refrigerant piping specialty indicated. Include pressure drop, based on manufacturer's test data, for the following:
 - 1. Thermostatic expansion valves.
 - 2. Solenoid valves.
 - 3. Hot-gas bypass valves.
 - 4. Filter dryers.
 - 5. Strainers.
 - 6. Pressure-regulating valves.

- H. Show layout of refrigerant piping and specialties, including pipe, tube, and fitting sizes, flow capacities, valve arrangements and locations, slopes of horizontal runs, oil traps, double risers, wall and floor penetrations, and equipment connection details. Show interface and spatial relationships between piping and equipment.
 - 1. Shop Drawing Scale: $\frac{1}{2}$ inch equals 1 foot (1:50).
 - 2. Refrigerant piping indicated on Drawings is schematic only. Size piping and design actual piping layout, including oil traps, double risers, specialties, and pipe and tube sizes to accommodate, as a minimum, equipment provided, elevation difference between compressor and evaporator, and length of piping to ensure proper operation and compliance with warranties of connected equipment.
- I. Welding certificates.
- J. Field quality-control test reports.
- K. Operation and Maintenance Data: For refrigerant valves and piping specialties to include in maintenance manuals.

1.04 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1-2004, Section 4 - "Outdoor Air Quality," Section 5 - "Systems and Equipment," Section 6 - "Ventilation Rate Procedures," and Section 7 - "Construction and Startup."
- C. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2004.
- D. Consulting engineer proposing this system must evaluate the economic and energy and maintenance compared to offer popular HVAC systems. The design consultant must demonstrate and prove prior to design the VRV/VRF for this particular project is energy efficient; the project shall have an annual energy consumption target (specified in BTU/ft²) of at least 15 percent below the 2008 Title 24 requirements. The energy consumption target shall consider the number (and season) of actual operating days of the specific facility project.
- E. The design team shall submit compliance documentation consisting of calculations, reports, and compliance forms as set forth in the Energy Efficiency Manual developed by the CEC, to show that the proposed building exceeds the energy standards. The ability of the proposed design to exceed the Title 24 energy standards shall be demonstrated by providing the compliance documentation necessary, as if the building was to be permitted by a private sector developer working through the city building department.
- F. Building mechanical plans shall carry a signature of conformance by a registered Mechanical Engineer, licensed or registered in California under the California Business and Professional Code, to the effect that the following standards have been satisfactorily met State Mechanical Code pertaining to Energy Conservation Standards for New Residential and Non-Residential Buildings. Efficiency requirements for space-conditioned equipment shall be in accordance with Title 24 California Energy Code.

1.05 COORDINATION

- A. Coordinate layout and installation of (VRV), (VRF) units with wall construction with other construction that penetrates walls or is supported by them.

1.06 PRODUCT STORAGE AND HANDLING

- A. Store piping in a clean and protected area with end caps in place to ensure that piping interior and exterior are clean when installed.

1.07 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of packaged units that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period for Sealed Refrigeration System: Manufacturer's standard, but not less than five years from date of Substantial Completion, including components and labor.
 - 2. Contractors interested in bidding to install the (VRV) or (VRF) system must be trained by the specified manufacturer and must be certified prior to his bid date.
 - 3. Manufacturers of (VRV), (VRF) must be approved by the state of California and filed by the Energy Pro, Title 24, and must be accepted to receive Savings by Design from SDG&E. Listing manufacturer below does not conclude their qualification. They must prove their qualification prior to bidding.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - 1. Mitsubishi.
 - 2. LG.
 - 3. Daikin
 - 4. Toshiba-Carrier.
- B. Basis of Design is Trane-Mitsubishi. If contractor submits on listed alternates, he shall assume monetary and logistical responsibility for any and all necessary structural, electrical, plumbing, architectural and HVAC modifications. Contractor shall also compensate the Architect of Record (AOR) and Mechanical Engineer of Record (MEOR) for efforts related to reviewing submittals to establish acceptability and updating energy compliance calculations

2.02 INDOOR MANUFACTURED UNITS

- A. Description: Factory-assembled and tested with direct expansion coil, valves and controls.

2.03 CHASSIS OF INDOOR UNITS

- A. Cabinet: 0.052-inch- (1.32-mm-) thick steel with removable front panel with concealed latches.
 - 1. Finish: Epoxy coating.
 - 2. Access Door: Hinged door in top of cabinet for access to controls.
 - 3. Cabinet Extension: Matching cabinet in construction and finish, allowing diversion of airflow.
 - 4. Finish of Interior Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2004.
 - 5. Subbase: Enameled steel with adjustable leveling feet and adjustable end plates with factory-installed and –wired, fused disconnect switch and receptacle sized for unit.
- B. Refrigeration System: Direct-expansion indoor coil with capillary restrictor; with vibration isolation and overload protection.
 - 1. Indoor Coils: Seamless copper tubes mechanically expanded into aluminum fins with capillary tube distributor on indoor coil.
 - 2. Accumulator.
 - 3. Constant-pressure expansion valve.
 - 4. Reversing valve.

5. Charge: R-410A, or R-454B if available for selected equipment.
- C. Indoor fan: Forward curved, centrifugal; with motor and positive-pressure ventilation damper with electric operator.
- D. Filters: Disposable.
- E. Condensate Drain: Drain pan and drain pump and piping to direct condensate to building waste and vent piping.
 1. Comply with ASHRAE 62.1-2004 for drain pan construction and connections.
- F. Condenser Outdoor fan: Propeller forward curved, centrifugal or propeller type with separate motor.
 1. Indoor and Outdoor Fan Motors: Variable speed; comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 - Common Motor Requirements for HVAC Equipment.
 - a. Fan Motors: Permanently lubricated split capacitor.
 - b. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

2.04 SYSTEM DESCRIPTION

- A. The variable capacity, heat pump air conditioning system shall be Variable Refrigerant Flow Zoning. The systems shall be cooling and heating split system heat pump and cool/heat split system heat pump.
- B. The system shall consist of an outdoor unit, multiple indoor units and Direct Digital Controls. Each indoor unit or group of indoor units shall be capable of operating in any mode independently of other indoor units or groups. Each indoor unit or group of all indoor air handlers shall range from 50 to 150 percent of outdoor rated capacity.
 1. The units shall be listed by Electrical Laboratories (ETL) and bear the ETL label.
 2. All wiring shall be in accordance with the National Electrical Code (N.E.C.).
 3. The units shall be manufactured in a facility registered to ISO 9001 and ISO 14001 which is a set of standards applying to environmental protection set by the International Standard Organization (ISO).
 4. A full charge of R-410A for the condensing unit only shall be provided in the condensing unit. Provide R-454B if available for selected equipment.

2.05 OUTDOOR UNIT

- A. The outdoor unit shall be used specifically with the same manufacturer components. The outdoor units shall be equipped with multiple circuit boards that interface to the controls system and shall perform all functions necessary for operation. Each outdoor unit module shall be completely factory assembled, piped and wired and run tested at the factory.
- B. Outdoor unit shall have a sound rating no higher than 60 dB (A) individually or 63 dB (A) twinned while in night mode operation. If an alternate manufacturer is selected, any additional material, cost, and labor to meet published sound levels shall be incurred by the contractor.
- C. Outdoor unit shall be able to connect to up to 50 indoor units depending upon model.
- D. The outdoor unit shall have a high-pressure safety switch, over-current protection, crankcase heater and DC bus protection.
- E. The outdoor unit shall be capable of operating in heating mode down to -4 deg F ambient temperature or cooling mode down to 23 deg F ambient temperature, without additional low ambient controls.
- F. The outdoor unit shall not cease operation in any mode based solely on outdoor ambient temperature.

- G. The outdoor unit shall have a high efficiency oil separator plus additional logic controls to ensure adequate oil volume in the compressor is maintained.
- H. Unit Cabinet:
 - 1. The casings shall be fabricated of galvanized steel, bonderized and finished. Units cabinets shall be able to withstand 960 hours per ASTM B117 criteria for seacoast protected models (-BS models).
- I. Fan:
 - 1. Each outdoor unit module shall be furnished with one direct drive, variable speed propeller type fan. The fan shall be factory set for operation under 0 in. WG external static pressure, but capable of normal operation under a maximum of 0.24 in. WG external static pressure via dipswitch.
 - 2. All fan motors shall have inherent protection, have permanently lubricated bearings, and be completely variable speed.
 - 3. All fan motors shall be mounted for quiet operation.
 - 4. All fans shall be provided with a raised guard to prevent contact with moving parts.
 - 5. The outdoor unit shall have vertical discharge airflow.
- J. Coil:
 - 1. The outdoor coil shall be or nonferrous construction with lanced or corrugated plate fins on copper tubing.
 - 2. The coil fins shall have a factory applied corrosion resistant blue-fin finish.
 - 3. The coil shall be protected with an integral metal guard.
 - 4. Refrigerant flow from the outdoor unit shall be controlled by means of an inverter driven compressor.
 - 5. The outdoor coil shall include 4 circuits with two position valves for each circuit, except for the last stage.
- K. Compressor:
 - 1. Each outdoor unit module shall be equipped with one inverter driven scroll hermetic compressor. Non inverter-driven compressors shall not be allowed.
 - 2. A crankcase heater(s) shall be factory mounted on the compressors.
 - 3. The outdoor unit compressor shall have an inverter to modulate capacity. The capacity shall be completely variable with a turndown of 19 to 8 percent of rated capacity, depending upon unit size.
 - 4. The compressor will be equipped with an internal thermal overload.
 - 5. The compressor shall be mounted to avoid the transmission of vibration.
- L. Electrical:
 - 1. The outdoor unit electrical power shall be as indicated on drawings.
 - 2. The outdoor unit shall be controlled by integral microprocessors.
 - 3. The control circuit between the indoor units, controller and the outdoor unit shall be 24VDC completed using a 2-conductor, twisted pair shielded cable to provide total integration of the system.
 - 4. System must be tested and approved to connect compatibly with SDUSD EMCS.

2.06 FAN COIL UNITS

- A. The indoor unit shall be a high-wall fan coil design with mixing box and filters and shall have a modulating linear expansion device. The unit shall support individual control using DDC Controllers.
- B. The indoor unit shall be factory assembled, wired and run tested. Contained within the unit shall be all factory wiring, piping electronic modulating linear expansion device, control circuit board and fan motor. The unit shall have a self-diagnostic function, 3-minute time delay

mechanism, and an auto restart function. Indoor unit and refrigerant pipes shall be charged with dehydrated air before shipment from the factory.

- C. Unit Cabinet:
 - 1. The unit shall be space saving, high wall.
- D. Fan:
 - 1. The indoor unit fan shall be an assembly with one fans direct driven by a single motor.
 - 2. The indoor fan shall be statically and dynamically balanced and run on a motor with permanently lubricated bearings.
- E. Filter:
 - 1. Return filter box (rear or bottom placement) with high-efficiency filter.
- F. Coil:
 - 1. The indoor coil shall be of nonferrous construction with smooth plate fins on copper tubing.
 - 2. The tubing shall have inner grooves for high efficiency heat exchange.
 - 3. All tube joints shall be brazed with phos-copper or silver alloy.
 - 4. The coils shall be pressure tested at the factory.
 - 5. A condensate shall be gravity drained from the fan coil.
 - 6. Both refrigerant lines to the indoor units shall be insulated.
 - 7. A condensate pan and drain shall be provided under coil.
- G. Controls:
 - 1. This unit shall use controls provided to perform functions necessary to operate the system.
 - 2. Controls must be capable of integrating with the District's LAN/WAN.

PART 3 EXECUTION

3.01 PIPING APPLICATIONS FOR REFRIGERANT R-410A

- A. Suction Lines NPS 4 (DN 100) and Smaller: Copper, Type K (A), drawn-temper tubing and wrought-copper fittings with brazed joints.
- B. Hot-Gas and Liquid Lines and Suction Lines for Heat-Pump Applications: Copper, Type K (A), annealed- or drawn-temper tubing and wrought-copper fittings with brazed joints.
- C. Hot-Gas and Liquid Lines and Suction Lines for Heat-Pump Applications: Copper, Type K (A), drawn-temper tubing and wrought-copper fittings with Alloy HB soldered joints.
- D. Safety-Relief-Valve Discharge Piping: Copper, Type K (A), annealed- or drawn-temper tubing and wrought-copper fittings with brazed joints.

3.02 VALVE AND SPECIALTY APPLICATIONS

- A. Install diaphragm packless valves in suction and discharge lines of compressor.
- B. Install service valves for gage taps at inlet and outlet of hot-gas bypass valves and strainers if they are not an integral part of valves and strainers.
- C. Install a check valve at the compressor discharge and a liquid accumulator at the compressor suction connection.
- D. Except as otherwise indicated, install diaphragm packless valves on inlet and outlet side of filter dryers.
- E. Install a full-sized, three-valve bypass around filter dryers.

- F. Install solenoid valves upstream from each expansion valve and hot-gas bypass valve. Install solenoid valves in horizontal lines with coil at top.
- G. Install thermostatic expansion valves as close as possible to distributors on evaporators.
 - 1. Install valve so diaphragm case is warmer than bulb.
 - 2. Secure bulb to clean, straight, horizontal section of suction line using two bulb straps. Do not mount bulb in a trap or at bottom of the line.
 - 3. If external equalizer lines are required, make connection where it will reflect suction-line pressure at bulb location.
- H. Install safety relief valves where required by ASME Boiler and Pressure Vessel Code. Pipe safety-relief-valve discharge line to outside according to AHSRAE 15.
- I. Install moisture/liquid indicators in liquid line at the inlet of the evaporator coil capillary tube.
- J. Install strainers upstream from and adjacent to the following unless they are furnished as an integral assembly for device being protected:
 - 1. Solenoid valves.
 - 2. Thermostatic expansion valves.
 - 3. Hot-gas bypass valves.
 - 4. Compressor.
- K. Install filter dryers at liquid line between compressor and thermostatic expansion valve and in the suction line at the compressor.
- L. Install receivers sized to accommodate pump-down charge.
- M. Install flexible connectors at compressors.

3.03 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports.
- B. Tests and Inspections:
 - 1. Comply with ASME B3.1.5, Chapter VI.
 - 2. Test refrigerant piping, specialties, and receivers. Isolate compressor, condenser, evaporator, and safety devices from test pressure if they are not rated above the test pressure.
 - 3. Test high- and low-pressure side piping of each system separately at not less than the pressures indicated in Part 1 "Performance Requirements" Article.
 - a. Fill system with nitrogen to the required test pressure.
 - 1) System shall maintain test pressure at the manifold gage throughout duration of test.
 - 2) Test joints and fittings with electronic leak detector or by brushing a small amount of soap and glycerin solution over joints.
 - 3) Remake leaking joints using new materials and retest until satisfactory results are achieved.

3.04 SYSTEM CHARGING

- A. Charge system using the following procedures:
 - 1. Install core in filter dryers after leak test but before evacuation.
 - 2. Evacuate entire refrigerant system with a vacuum pump to 500 micrometers (67 Pa). If vacuum holds for 12 hours, system is ready for charging.
 - 3. Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig (14 kPa).
 - 4. Charge system with a new filter-dryer core in charging line.

3.05 ADJUSTING

- A. Adjust thermostatic expansion valve to obtain proper evaporator superheat.
- B. Adjust high- and low-pressure switch settings to avoid short cycling in response to fluctuating suction pressure.
- C. Adjust set-point temperature of air-conditioning or chilled-water controllers to the system design temperature.
- D. Perform the following adjustments before operating the refrigeration system, according to manufacturer's written instructions.
 - 1. Open shutoff valves in condenser water circuit.
 - 2. Verify that compressor oil level is correct.
 - 3. Open compressor suction and discharge valves.
 - 4. Open refrigerant valves except bypass valves that are used for other purposes.
 - 5. Check open compressor-motor alignment and verify lubrication for motors and bearings.
- E. Replace core of replaceable filter dryer after system has been adjusted and after design flow rates and pressures are established.

3.06 EXAMINATION

- A. Examine areas to receive unit for compliance with requirements for installation tolerances and other conditions affecting performance.
- B. Examine roughing-in for piping and electrical connections to verify actual locations before unit installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.07 INSTALLATION

- A. Install wall boxes in finished wall assembly, seal and weatherproof. Joint-sealant materials and applications are specified in Section 079200 - Joint Sealants.
- B. Install all cabinet units to comply with NFPA 90A.
- C. Install unit's level and plumb.
- D. Suspend units from structure with elastomeric hangers and seismic restraints. Vibration isolators and seismic restraints are specified in Section 230548 - Vibration and Seismic Controls for HVAC Piping and Equipment.
- E. Suspend units from structure with all-thread hanger rods and elastomeric hangers. Hanger rods and attachments to structure are specified in Section 230529 - Hangers and Supports for HVAC Piping and Equipment." Vibration hangers are specified in Section 230548 - Vibration and Seismic Controls for HVAC Piping and Equipment.
- F. Install wall-mounting thermostats and switch controls in electrical outlet boxes at heights to match lighting controls. Verify location of thermostats and other exposed control sensors with drawings and room details before installation.
- G. Install new filters in each fan-coil unit within two weeks of Substantial Completion.

3.08 CONNECTIONS

- A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to machine to allow service and maintenance.
- C. Connect supply ducts to fan coil units outside air and return air economizer with flexible duct connectors specified in Section 233300 - Air Duct Accessories.

- D. Comply with safety requirements in UL 1995.
- E. Unless otherwise indicated, install union and gate or ball valve on unit's connection.
- F. Ground equipment according to Section 260526 - Grounding and Bonding for Electrical Systems.
- G. Connect wiring according to Division 26 specifications.

3.09 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test and adjust field-assembled components and equipment installation, including connections and to assist in field testing. Report results in writing.
- B. Perform the following field tests and inspections and prepare test reports:
- C. Remove and replace malfunctioning units and retest as specified above.

3.10 ADJUSTING

- A. Adjust initial temperature set points.
- B. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.11 DEMONSTRATION

- A. Engage a factory-authorized service representative to train District's maintenance personnel to adjust, operate, and maintain cabinet unit heaters. Refer to Section 017900 - Demonstration and Training.

END OF SECTION

**SECTION 26 00 00
GENERAL ELECTRICAL SPECIFICATIONS**

PART 1 GENERAL

1.01 WORK INCLUDED

- A. This specification shall apply to all phases of Work hereinafter specified, shown on Drawings, or as required to provide a complete installation of electrical systems for this Project. Work required under this specification is not limited to just the Electrical Drawings - refer to Architectural, Structural, Landscape, and Mechanical/Plumbing Drawings, as well as all other drawings applicable to this project, which designate the scope of work to be accomplished. The intent of the Drawings and Specifications is to provide a complete and operable electrical system that includes all documents that are a part of the Contract.
 - 1. Work Included: Furnish labor, material, services and skilled supervision necessary for the construction, erection, installation, connections, testing, and adjustment of all circuits and electrical equipment specified herein, or shown or noted on Drawings, and its delivery to the Owner complete in all respects ready for use.
 - 2. The electrical Work includes installation or connection of certain materials and equipment furnished by others. Verify installation details, installation and rough-in locations from the actual equipment or from the equipment shop drawings.
- B. Electrical Drawings: Electrical Drawings are diagrammatic, and are intended to convey the scope of work, indicating intended general arrangement of equipment, conduit and outlets. Follow Drawings in laying out Work and verify spaces for installation of materials and equipment based on actual dimensions of equipment furnished.

1.02 QUALITY ASSURANCE

- A. Design, manufacture, testing and method of installation of all apparatus and materials furnished under requirements of these specifications shall conform to latest publications or standard rules of the following:
 - 1. Institute of Electrical and Electronic Engineers - IEEE
 - 2. National Electrical Manufacturers' Association - NEMA
 - 3. Underwriters' Laboratories, Inc. - UL
 - 4. National Fire Protection Association - NFPA
 - 5. Federal Specifications - Fed. Spec.
 - 6. American Society for Testing and Materials - ASTM
 - 7. American National Standards Institute - ANSI
 - 8. National Electrical Code - NEC
 - 9. National Electrical Safety Code - NESC
 - 10. Insulated Cable Engineers Association - ICEA
 - 11. American Institute of Steel Construction - AISC
 - 12. State and Municipal Codes In Force In The Specific Project Area
 - 13. Occupational Safety and Health Administration (OSHA)
 - 14. Electronics Industries Association/Telecommunications Industry Association (EIA/TIA)
 - 15. California Electrical Code (where adopted)
 - 16. Local Authority Having Jurisdiction (AHJ) Published Electrical Standards and Codes
- B. Perform Work in accordance with the National Electrical Code, applicable building ordinances, and other applicable codes, hereinafter referred to as the "Code." The Contractor shall comply with the Code including local amendments and interpretations without added cost to the Owner. Where Contract Documents exceed minimum requirements, the Contract Documents take

precedence. Where code conflicts occur, the most stringent shall apply unless variance is approved.

1. Comply with all requirements for permits, licenses, fees and codes. The Contractor, at Contractor's expense, shall obtain all permits, licenses, fees, special service costs, inspections and arrangements required for Work under this contract, unless otherwise specified.
2. Comply with requirements of the applicable utility companies serving this Project. Make all arrangements with utility companies for proper coordination of Work.

1.03 GENERAL REQUIREMENTS

- A. Guarantee: Furnish a written guarantee for a period of (1) one-year from date of acceptance.
- B. Wherever a discrepancy in quantity or size of conduit, wire, equipment, devices, circuit breakers, etc., (all materials), arises on the Drawing and/or Specifications, the Contractor shall be responsible for providing and installing all material and services required by the strictest condition noted on Drawings and/or in Specifications to ensure complete and operable systems as required by the Owner and Engineer.
- C. All Core Cutting, Drilling, and Patching:
 1. For the installation of work under this Section, the aforementioned shall be performed under this Section of the Specifications and the Concrete section of the Specifications.
 2. No holes will be allowed in any structural members without the written approval of the Project's Structural Engineer.
 3. For penetrations of concrete slabs or concrete footings, the work shall be as directed in the Concrete Section of Specifications.
 4. The Contractor shall be responsible for patching and repairing surfaces where he is required to penetrate for work under this contract.
 5. Penetrations shall be sealed to meet the rated integrity of the surface required to be patched and repaired. The patched surface shall be painted or finished to match the existing surface.
- D. Verifying Drawings and Job Conditions:
 1. The Contractor shall examine all Drawings and Specifications in a manner to be fully cognizant of all work required under this Section.
 2. The Contractor shall visit the site and verify existing conditions. Where existing conditions differ from Drawings, adjustment(s) shall be made and allowances included for all necessary equipment to complete all parts of the Drawings and Specifications.

1.04 WORK IN COOPERATION WITH OTHER TRADES

- A. Examine the Drawings and Specifications and determine the work to be performed by the electrical, mechanical and other trades. Provide the type and amount of electrical materials and equipment necessary to place this work in proper operation, completely wired, tested and ready for use. This shall include all conduit, wire, disconnects, relays, and other devices for the required operation sequence of all electrical, mechanical and other systems or equipment.
- B. Provide a conduit-only system for low voltage wiring required for control of mechanical and plumbing equipment described in this or other parts of the Contract Documents. Install all control housings, conduits, and backboxes required for installing conductors to the controls.
- C. Install separate conduits between each heating, ventilating and air conditioning sensing device and its control panel and/or control motor. Before installing any conduit for heating, ventilating and air conditioning control wiring, verify the exact requirements from the control diagrams provided with the equipment manufacturer's shop drawings.

1.05 TESTING AND ADJUSTMENT

- A. Upon completion of all electrical work, the Contractor shall test all circuits, switches, light fixtures, lighting control and dimming systems including distributed systems, UPSs, generators, SPDs, lighting inverters, transfer switches, motors, circuit breakers, motor starters and their auxiliary circuits and any other electrical items to ensure perfect operation of all electrical equipment.
- B. Equipment and parts in need of correction and discovered during such testing, shall be immediately repaired or replaced with all new equipment and that part of the system shall then be retested. All such replacement or repair shall be done at no additional cost to the Owner.
- C. All circuit(s) shall be tested for continuity and circuit integrity. Adjustments shall be made for circuits not complying with testing criteria.
- D. All test reports, including copies of any required Energy Code Acceptance Forms (e.g. CA Title 24 Acceptance for Code Compliance Forms) should be submitted to the Engineer at completion of project.

1.06 IDENTIFICATION

- A. Nameplates shall be provided for unit substations, switchgear, switchboards, distribution boards, distribution panels, panel boards, motor control centers, transformers, transfer switches, contactors, starters, disconnect switches, enclosed circuit breakers/switches, inverters, UPSs, PDUs, RDCs, SPDs, lighting control panels, dimming panels, door releasing system panels, fire alarm/central monitoring terminal cabinets/power supplies/control panels, and all low voltage system terminal and control cabinets.
 - 1. Nameplate inscriptions shall be identical to the equipment designations indicated in plans and specifications. Nameplates shall be engraved with the device designation/identification on the top line, source identification for the device on the 2nd line per NEC, or CEC where adopted, Art 408.4 and load designation for the device on the bottom line. Where load designation consists of a branch circuit, omit bottom line. Where device designation is not indicated on plans/specifications, Contractor shall submit a written clarification request to the Engineer.

Example: Transformer 1TA
Source Disconnecting Location: Switchboard MSA located in Rm 110
Load: Panels 1LA and 1 LB
 - 2. All circuit breakers/fuses in switchgear, switchboards, distribution boards, distribution panels, UPS output circuit breakers, PDU sub-feed circuit breakers and motor control centers shall have individual nameplates located immediately adjacent to the respective device. Nameplate inscription shall identify the downstream equipment or device served by the circuit breaker or fuse.
- B. Identification nameplates, UON, shall be laminated/extruded modified acrylic that is 3/32" thick, UV-stabilized, matte finish, suitable for use in 180 deg. F ambient, with beveled edges and engraved white letters 3/8" high, minimum, on 1-1/2" high black background (utility/normal and optional standby power systems) for single line of text. Where two lines of text are required, provide minimum 2" high nameplate. Where three lines of text are required, provide minimum 2.5" high nameplate. Provide white letters on red background for all NEC, or CEC where adopted, Article 517 essential power systems, Article 700 Emergency Systems, Article 701 Legally required standby systems and Article 708 COPS.
- C. Identification nameplates for new switchgear, switchboards, distribution boards, distribution panels, panel boards and motor control centers shall be attached with switchgear manufacturer-provided screws via switchgear manufacturer factory pre-drilled holes. A factory option to rivet identification nameplates to the equipment is only acceptable if screw-fastened nameplates are not an available option from the switchgear manufacturer. Field drilling or other

mechanical attachment methods that change/void the NEMA or NTRL rating of the enclosure are strictly forbidden.

- D. Identification nameplates for transformers, transfer switches, disconnect switches, enclosed circuit breakers/switches, inverters, UPSs, PDUs, RDCs, SPDs, lighting control panels, dimming panels, door releasing system panels, terminal cabinets and all circuit breakers/fuses in switchgear, switchboards, distribution boards, distribution panels, UPS output circuit breakers, PDUs, PDU sub-feed circuit breakers, and motor control centers shall be attached to the equipment by self-adhesive backing integral to the nameplates. When equipment is located outdoors, provide nameplates without self-adhesive backing and attach to equipment using weather-rated, UV-resistant epoxy. In all cases, clean surfaces before applying identification nameplates parallel to equipment lines.
- E. Warning Placards, as required by General Single Line Diagram Notes for multiple power sources, or instruction placards, as required for all lock-key interlock schemes, all UPS bypass procedures or as required elsewhere in the plans/specifications shall be engraved 1/2" high white lettering on a red background using the same material specified for identification nameplates with a self-adhesive backing. Warning/instruction placards shall be attached to the face of the equipment directly related to the placards. Provide a formal placard submittal for review by the Engineer prior to ordering any warning/instruction placards. In all cases, clean surfaces before applying warning/instruction placards parallel to equipment lines.
- F. Receptacles that are part of a UL-listed under floor computer room whip assembly, ceiling and/or cable/ladder tray-mounted receptacles used in lab, manufacturing, commercial kitchen environments or that are serving telecom/data/AV racks and cabinets shall have identification nameplates located on the wiring device plate cover. Nameplates shall be self-adhesive, 3/32" thick Micarta with beveled edges, engraved 1/4" high white lettering on black background with serving power source, circuit identification and NEMA/IEC receptacle type. Use of two (2) separate nameplates per device plate cover is acceptable. Affix nameplates to be visible when plugs are occupying receptacles.
- G. See wiring device section of this specification for wiring device plate cover labeling requirements.
- H. See drawings for panel board schedule directory installation requirements.
- I. See conduit installation section of this specification for conduit labeling requirements.

1.07 FINAL INSPECTION AND ACCEPTANCE

- A. After all requirements of the Specifications and/or the Drawings have been fully completed; representatives of the Owner will inspect the work. Contractor shall provide competent personnel to demonstrate the operation of any item or system to the full satisfaction of each representative.
- B. Final acceptance of the work will be made by the Owner after receipt of approval and recommendation of acceptance from each representative.

1.08 RECORD DRAWINGS

- A. Drawings of Record: The Contractor shall provide and keep up-to-date, a complete record set of drawings. These shall be corrected daily and show every change from the original Drawings. This set of prints shall be kept on the job site and shall be used only as a record set. This shall not be construed as authorization for the Contractor to make changes in the layout without definite instruction in each case. Upon completion of the work, a set of reproducible Contract Drawings shall be obtained from the General Contractor and all changes as noted on the record set of prints shall be incorporated thereon with black ink in a neat, legible, understandable and professional manner. Refer to the Supplementary General Conditions for complete requirements.

1.09 APPROVALS, EQUALS, SUBSTITUTIONS, ALTERNATIVES, NO KNOW EQUAL

- A. Approvals: Where the words (or similar terms) “approved”, “approval”, “acceptable”, and “acceptance” are used, it shall be understood that acceptance by the Owner, Architect and Engineer are required.
- B. Equal: Where the words (or similar terms) “equal”, “approved equal”, “equal to”, “or equal by”, “or equal” and “equivalent” are used, it shall be understood that these words are followed by the expression “in the opinion of the Owner, Architect, and Engineer.” For the purposes of specifying products, the above words shall indicate the same size, made of the same construction materials, manufactured with equivalent life expectancy, having the same aesthetic appearance/style (includes craftsmanship, physical attributes, color and finish), and the same performance.
- C. Substitution: For the purposes of specifying products, “substitution” shall refer to the submittal of a product not explicitly approved by the construction documents/ specifications.
 - 1. Substitutions of specified equipment shall be submitted and received by the Engineer ten (10) days prior to the bid date for review and written approval. Regulatory Agency approval for all substitutions will be the sole responsibility of the Contractor. To receive consideration, requests for substitutions must be accompanied by documentary proof of its equality with the specified material. Documentary proof shall be in letterform and identify the specified values/materials alongside proposed equal values/materials. In addition, catalog brochures and samples, if requested, must be included in the submittal. ONLY PRE-BID APPROVED PRODUCTS, ISSUED VIA A FORMAL BID ADDENDUM TO ALL BIDDERS, WILL BE ALLOWED ON THE PROJECT. REGARDLESS OF THE APPROVAL ON ANY SUBSTITUTION, ALL BIDS SHALL BE BASED ON THE PRODUCTS EXACTLY AS SPECIFIED. PRICING FOR EACH APPROVED SUBSTITUTION SHALL BE INCLUDED IN THE BID SUBMITTAL AS A SEPARATE LINE ITEM.
 - 2. In the event that written authorization is given for a substitution, after award of contract, the Contractor shall submit to the Engineer quotations from suppliers/distributors of both the specified and proposed equal material for price comparison, as well as a verification of delivery dates that conform to the project schedule.
 - 3. In the event of cost reduction, the Owner will be credited with 100 percent of the reduction, arranged by Change Order.
 - 4. The Contractor warrants that substitutions proposed for specified items will fully perform the functions required.
- D. Alternates/Alternatives: For the purposes of specifying products, “alternatives/alternates” may be established to enable the Owner/Architect/Engineer to compare costs where alternative materials or methods might be used. An alternate price shall be submitted in addition to the base bid for consideration. If the alternate is deemed acceptable, written authorization will be issued.
- E. No Known Equal: For the purposes of specifying products, “No Known Equal” shall mean that the Owner/Architect/Engineer is not aware of an equivalent product. The Contractor will need to submit a “Substitution” item, per the requirements listed above, if a different product is proposed to be utilized.

1.10 SHOP DRAWINGS/SUBMITTALS

- A. Shop Drawings/Submittals, unless required otherwise by general project specifications or instructions to bidders, shall be submitted in electronic format (PDF) to include a Letter of Transmittal (PDF), which shall give a list of the drawings submitted with dates and/or system(s) components contained within the submittal. Drawings and material cut sheets shall be complete in every respect and edited/marked to indicate specific items being provided. Printed/Hard copies are not acceptable.

- B. The Shop Drawings/Submittals shall be marked with the name of the project, numbered consecutively, and bear the approval of the Contractor as evidence that the Contractor has checked the Drawings. Any Drawings submitted without this approval will be returned to the Contractor for resubmission.
- C. If the shop drawings show variations from the requirements of the Contract because of standard shop practice or other reasons, the Contractor shall make specific mention of such variations in the Contractor's letter of transmittal. If the substitution is accepted, the Contractor shall be responsible for proper adjustment that may be caused by the substitution. Samples shall be submitted when requested.
- D. Only products listed as "Equal" within the contract documents, along with formally approved "Substitutions" will be reviewed. Products not conforming to these items will not be reviewed and will be returned to the Contractor for re-submittal.
- E. Review comments used in response to shop drawings/submittals are:
 - 1. "No Exception Taken" - Product approved as submitted.
 - 2. "Furnish as Corrected" - Re-submittal not required, although the Contractor shall provide the submitted product with corrections as noted.
 - 3. "Revise and Resubmit" - Re-submittal required with corrections as noted.
 - 4. "Rejected" - Re-submittal required based upon the originally specified product.
- F. Shop drawings shall be submitted on the following but not limited to:
 - 1. Lighting Fixtures, Lamps, and Ballasts.
 - 2. Switchgear, Switchboards, Distribution Boards, Motor Control Centers, Panel boards, and Bus Ducts; complete with overcurrent device information.
 - 3. Transformers.
 - 4. Fire Alarm System/Central Monitoring System.
 - 5. Wiring Devices.
 - 6. Lighting Control System/Dimming System Products.
 - 7. Pullboxes and Underground Vaults.
 - 8. Terminal Cabinets
 - 9. Lighting Inverters, UPSs, RDCs, PDUs, Generators, Transfer Switches, SPD Systems.
 - 10. Cable Tray, Flexible Cable Tray and Cable Runway.
 - 11. Power Poles and Floor Boxes.
 - 12. Arc Flash, Short-Circuit and Coordination studies.
 - 13. All other products called out on drawings that call for shop drawing submittal.

1.11 MAINTENANCE, SERVICING, INSTRUCTION MANUALS AND WIRING DIAGRAMS

- A. Prior to final acceptance of the job, the Electrical Contractor shall furnish to the Owner at least four (4) copies of operating, maintenance, and servicing instructions, as well as four (4) complete wiring diagrams for the following, but not limited to, items or equipment:
 - 1. Lighting Control System/Dimming Systems.
 - 2. Fire Alarm System.
 - 3. Transformers.
 - 4. Switchgear, Switchboards, Distribution Boards, Motor Control Centers, Panel boards, and Bus Ducts; complete with overcurrent device information
 - 5. Lighting Inverters, UPS's, PDUs, Generators, Transfer Switches, SPD Systems
- B. All wiring diagrams shall specifically cover the system supplied. Typical drawings will not be accepted. Four (4) copies shall be presented to the Owner.

1.12 INTERRUPTION OF SERVICE/SERVICE SHUTDOWN

- A. Any interruption of electrical services, electrical circuits, electrical feeders, signal systems, communication systems, fire alarm systems, etc. required to perform work, shall meet the specific prior-approval requirements of the Owner. Such work shall be scheduled with the Owner to be performed at the Owner's convenience.
- B. Interruptions/outages of any of the Owner's systems and services mentioned above shall be scheduled to occur during other than the Owner's normal business hours. Any overtime costs shall be borne by the Contractor.
- C. See drawings for any additional requirements regarding outages, interruption and any temporary services required.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Materials and Equipment: All electrical materials and equipment, including custom-made equipment, shall be new and shall be listed by Underwriter's Laboratories (UL) and bear their label or be listed and certified by a Nationally Recognized Testing Lab (NRTL) that is also recognized by the local Authority-Having-Jurisdiction (AHJ)
- B. Switchgear/Switchboards/Distribution Boards/Motor Control Centers:
 - 1. See general single line notes on single line drawing for more information.
- C. Panel boards – Branch Circuit:
 - 1. See drawings for panel board schedules and specifications.
- D. Transformers:
 - 1. See drawings for transformer schedules and specifications.
- E. Lighting Fixtures:
 - 1. See drawings for lighting fixture and lamp schedules and additional specifications. Furnish, install and connect a lighting fixture at each outlet where a lighting fixture type symbol (designated on plans) is shown as being installed. Each fixture shall be complete with all required accessories including sockets, glassware, boxes, spacers, mounting devices, fire rating enclosure and lamps.
 - 2. Ballasts: See lighting fixture schedule notes. All noisy ballasts shall be replaced at no cost to the Owner.
 - 3. Lamps: See lamp/fixture schedule and lamp/lighting fixture schedule notes.
- A. Wiring Devices:
 - 4. Provide wiring devices indicated per plan. Devices shall be specification grade. Acceptable manufacturers are Leviton, Pass and Seymour and Hubbell. Provide all similar devices of same manufacturer, unless indicated otherwise. All device colors shall be from the full range of manufacturer standard color options as selected by the Architect. This selection will be made during the shop drawing review process
 - a. Wiring Devices (Decora)
 - 1) Convenience Receptacle #16252- ???
 - 2) Dedicated Receptacle #16352-???
 - 3) Convenience I.G. Receptacle #16262-IG-???
 - 4) Dedicated I.G. Receptacle #16362-IG-???
 - 5) Convenience G.F.C.I. Receptacle #GFT1-???
 - 6) Dedicated G.F.C.I. Receptacle #GFNT2-???
 - 7) Tamper Resistant Convenience Receptacle#TDR15-???
 - 8) Tamper Resistant Dedicated Receptacle #TDR20-???
 - 9) Tamper Resistant GFCI Receptacle#GFTR2-???

- 10) Weather/Tamper Resistant GFCI Receptacle #GFWT2-???
- 11) Convenience Simplex Receptacle #16251-???
- 12) Dedicated Simplex Receptacle #16351-???
- 13) Recessed Clock Receptacle#5361-CH-???(Non-Decora)
- 14) Single Pole Switch #5621-2-???
- 15) Double Pole Switch #5622-2-???
- 16) Three Way Switch #5623-2-???
- 17) Four Way Switch #5624-2-???
- 18) Pilot Light Switch "On" #5628-2-???
- 19) Pilot Light Switch "Off" #5631-2-???
- 20) Projection Screen Switch #5657-2-???
- 21) Low Voltage Momentary Switch #5657-2-???
- 22) Keyed Switch #1221-2L-???(Non-Decora)
- 23) Door Jam Switch #1865-???
- b. Use of dedicated receptacles is required where plans depict a branch circuit supplying only a single simplex or duplex receptacle. Use of controlled receptacles is required where depicted on plans - see controlled receptacle specifications for additional information.
5. I.G. (isolated ground) receptacle bodies shall be of a basic color specified above with an orange triangle to symbolize isolated ground.
6. When shown circuited with an I.G. conductor, receptacles shall be of an I.G. type. As an example, a NEMA L6-30R denoted on the plans and shown circuited with an I.G. conductor shall be an I.G. version of that receptacle.
7. Wiring devices located in wood finished areas shall generally be black unless otherwise indicated by the Architect.
8. Wiring devices located in mirrors shall generally be white with stainless steel cover plates unless otherwise indicated by the Architect.
9. In addition to other device requirements listed elsewhere in this specification and NEC, or CEC where adopted, Articles 406.12 & 517.18, all 125V & 250V, 15A and 20A, non-locking receptacles shall be Tamper-Resistant when located in the following locations:
 - a. In dwelling units per NEC, or CEC where adopted, Article 210.52.
 - b. In guest rooms and guest suites of hotels and motels.
 - c. In child care or daycare facilities.
 - d. In preschool and elementary education facilities.
 - e. In business offices, corridors, waiting rooms, and the like in clinics, medical and dental offices and outpatient facilities.
 - f. In a subset of Assembly Areas outlined in NEC, or CEC where adopted, Article 518.2 including transportation waiting areas, gymnasiums, skating rinks, and auditoriums.
 - g. In dormitories.
 - h. In pediatric care areas per NEC, or CEC where adopted, Article 517.18(C).
10. Wiring device cover plates located on recessed boxes shall be commercial grade nylon. Plate color shall match wiring device color UON on plans. Cover plates utilized on surface mounted boxes shall be metal. Plastic cover plates are unacceptable.
11. Except as otherwise noted, all wiring device plates on the project shall be labeled with panel and circuit number(s) utilizing a Brother P-Touch labeling system with 1/2" tape (yellow on black) or equal by Herman-Tellerman or Panduit. Locate label on the concealed side of the wiring device plate. Handwritten labels are unacceptable.
12. The Contractor shall provide duplex receptacle outlets in the appropriate configurations necessary to comply with applicable energy code requirements for controlled receptacles and as shown on plans. All wiring devices indicated to be controlled receptacles shall be NEMA-approved, electrical code-compliant with factory markings on the face of the receptacle(s) with the word "Controlled" or utilize further markings and symbols to indicate

which receptacles on each outlet is/are controlled. Stickers, field-applied markings or other non-permanent markings are not acceptable. Where a GFCI receptacle outlet is required to be controlled, provide an adjacent controlled duplex receptacle outlet connected on the load side of the GFCI outlet. Generally, one receptacle in a duplex receptacle outlet is required to be controlled. It may be the lower receptacle or upper receptacle based on manufacturer offering. However, the controlled receptacle location within a controlled receptacle outlet shall remain consistent throughout the project. Where an existing duplex receptacle outlet is required to be controlled, provide a new wiring device with the appropriate control configuration necessary to comply with plans. All controlled receptacles shall be connected to a branch circuit controlled by an occupancy sensor-based or relay panel lighting control system. Acceptable manufacturers are Leviton, Pass and Seymour and Hubbell.

13. The following wiring device plates shall have custom engraving:

- a. Key operated switches, switches with pilot lights, and switches for the control of motors, heaters and ventilators. Engraving shall be black and occur on the exposed side of the plate indicating the motor, heater, or ventilator controlled.
- b. Receptacles on optional standby generator and/or UPS power shall have custom engraved plates with the words "Generator" or "UPS" in black letters. In addition, where located in telecommunications closets, IDFs, server rooms, data centers, labs (wet, dry or electronic) indicate panel board and circuit number.
- c. For Health Care Facilities, provide custom engraved device cover plates, for all devices, indicating panel board and circuit number. Devices served by normal/utility power circuits shall have black lettering. Devices served by essential electrical system power circuits shall have red lettering.
- d. All stainless steel and nylon device plates shall be engraved using a rotary engraving process except for black lettering on stainless steel device plates which may be accomplished via laser etching process. All lettering shall be 3/16" high. Provide a dimensioned submittal drawing detailing a typical device faceplate with engraving.

F. Weatherproof Outlet Covers/Assemblies: All Receptacles identified as weatherproof on the drawings shall be weather-resistant, tamper-resistant, GFCI type and equipped as follows:

1. Type WP-A: Recessed wall box with a hinged, lockable, cast aluminum, self-closing, gasket-equipped door that is wet location-listed rain tight while "in use". Unit shall comply with NEC, or CEC where adopted, Article 406.9(A) and (B). UON on drawings, provide a minimum of 2 separate compartments suitable for installation of power receptacles, AV or communications outlets. Additionally, unless otherwise noted on drawings, provide the following:
 - a. A 20A weather-resistant, tamper-resistant, GFCI duplex receptacle in the first compartment. Provide branch circuiting per plans.
 - b. A blank metal plate suitable for field installation of power, AV or communications devices in the second compartment.
 - c. Where indicated on plans as requiring data, AV, or other low voltage service outlet, provide minimum 3/4" C.O. with pull string routed from the second compartment to nearest low voltage pull box. Where shown mounted in a building wall, any blank/unused compartment shall be equipped min. 3/4" C.O. with pull string routed to the nearest accessible ceiling space.
 - d. See wiring device section of this specification for additional wiring device plate cover labeling requirements.
 - e. 1 key minimum per device (minimum of 2 per project) to the Owner's project manager upon completion of project.
 - f. Custom color powder coat finish as selected by Architect - Include all costs in base bid for same.
 - g. In locations with sufficient wall depth, provide 6" wide x 6" tall x 5-1/2" deep recessed wall box (C.W. Cole #TL310-WCS-K1-CUSTOM COLOR).

- h. In locations utilizing shallow stud walls construction or other walls of insufficient depth, provide 10-3/4" wide x 7-3/8" tall x 3-7/8" deep recessed wall box (C.W. Cole #TL310-WCS-SH-K1 -CUSTOM COLOR).
 - i. See drawings for additional details.
 - 2. Type/Subscript WP-B: Wet location-listed raintight while "in use" cast copper-free aluminum, extra-duty, lockable cover with baked aluminum lacquer finish and one gang, weather-resistant, tamper-resistant GFCI receptacle. Hubbell WP26E series. Polycarbonate covers are unacceptable. Unit shall comply with NEC, or CEC where adopted, Article 406.9(A) and (B). Contractor shall powder coat cover assembly to a custom color where receptacle locations are deemed by the Architect to be in aesthetically sensitive or public spaces. Custom color as selected by Architect.
 - 3. Type WP-C: (C.W. Cole #TL310-WCS-PED-ADA-K1-CUSTOM COLOR or #TL310-WCS-PED-K1-CUSTOM COLOR) pedestal device box with a hinged, lockable, cast aluminum, self-closing, gasket-equipped door that is wet location-listed raintight while "in use". Unit shall comply with NEC, or CEC where adopted, Article 406.9(A) and (B). UON on drawings, provide a minimum of 2 separate compartments suitable for installation power receptacles, AV or communications outlets. Additionally, unless otherwise noted on drawings, provide the following:
 - a. A 20A weather-resistant, tamper-resistant, GFCI duplex receptacle in the first compartment. Provide branch circuiting per plans.
 - b. A blank metal plate suitable for field installation of power, AV or communications devices in the second compartment.
 - c. Where indicated on plans as requiring data, AV, or other low voltage service outlet, provide minimum 3/4" C.O. with pull string routed from the second compartment to nearest low voltage pull box.
 - d. See wiring device section of this specification for additional wiring device plate cover labeling requirements.
 - e. 1 key minimum per device (minimum of 2 per project) to the Owner's project manager upon completion of project.
 - f. Include all costs in base bid for ADA version (22.5" tall) of pedestal box. Prior to ordering material, contractor shall coordinate with Architect and/or AHJ to determine which pedestal box locations do not require ADA compliance and may be changed to the standard (11.5" tall) version of the pedestal box.
 - g. Custom color powder coat finish as selected by Architect. Include all costs in base bid for same.
 - h. See drawings for additional details.
 - 4. Type/Subscript WP-D: Damp location-listed (not-Raintite-in-use) cast copper-free, pad lockable, die-cast aluminum cover with baked aluminum lacquer finish and one gang GFCI receptacle. Hubbell/Rayco 502?/503? Series. Polycarbonate covers are unacceptable. Unit shall comply with NEC, or CEC where adopted, article 406.9(A) and (B). Custom color powder coat finish as selected by Architect. Include all costs in base bid for same.
 - G. Motor Controllers/Starters: See drawings for motorized equipment schedules and specifications.
 - H. Circuit Breakers:
 - 1. Service entrance circuit breakers smaller than 400A (Amp) frame shall be thermal-magnetic trip with inverse time current characteristics unless otherwise indicated below. Service entrance main circuit breakers and main circuit breakers, 400A frame and larger, shall be 100% rated, solid-state type as outlined in this specification. All other service entrance circuit breakers, 400A frame and larger, shall be 100% rated, solid-state type as outlined in this specification.
 - 2. All non-service entrance circuit breakers 225A and larger shall be thermal magnetic type and have continuously adjustable instantaneous pick-ups of approximately 5 to 10 times trip rating. Breakers shall have either tamper-resistant rating dials or 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. Additionally, all non-service entrance circuit breakers, 600A frame and larger, located in 480V, 3-phase, 3-wire or 277/480V, 3-phase, 4-wire switchgear, distribution boards, panel boards or busway plugs shall be solid state, 100% rated. Breaker shall have built-in test points for testing long delay, short delay and instantaneous, and ground fault (where shown) functions of the breaker by means of a 120V operated test kit. Contractor shall utilize a test kit capable of testing all breakers 400A and above - at the Engineer's request.

3. All non-service entrance circuit breakers less than 225A shall be molded plastic case, air circuit breakers conforming to UL 489. Provide breakers with thermal magnetic trip units, and a common trip bar for two- or three-pole breakers, connected internally to each pole so tripping of one pole will automatically trip all poles of each breaker. Provide breakers of trip-free and trip-indicating bolt-on type, with quick-make, quick-break contacts. Provide single two- or three-pole breaker interchangeability. Provide padlocking device for circuit breakers as shown on the Drawings.
4. Where a Current Limiting Circuit Breaker (CLCB) is indicated on drawings or as required elsewhere in this specification, provide a UL listed current limiting thermal magnetic circuit breaker(s) UON. An independently operating limiter section within a molded case is not allowed. Coordinate CLCB ratings as required to protect electrical system components on the load side of the CLCB to include, but not limited to, protecting automatic transfer switches, panel boards and lighting control panels.
5. Where a solid-state circuit breaker is indicated on drawings or as required elsewhere in this specification, provide a solid-state circuit breaker with minimum five function complete with built-in current transformers. The five functions shall be independently adjustable and consist of Overload/Long Time Amp Rating, Long Time Delay, Short Time Delay, Short Circuit/Instantaneous Pickup, but may also include Shunt Trip and/or Ground Fault if so indicated on the Drawings. Rating plugs shall be interlocked so they are not interchangeable between frames. Breaker shall have built-in test points for testing long delay and instantaneous, and ground fault (where shown) functions of the breaker by means of a 120V operated test kit. Contractor shall utilize a test kit capable of testing all breakers 400A and above, at the Engineer's request.
6. Circuit breakers, 1200A Frame or larger, or circuit breakers with sensors or adjustable trip settings, 1200A or larger, shall be equipped with an Energy Reducing Maintenance Switch that complies with NEC, or CEC where adopted, 240.87 (B) (3) unless specified elsewhere with an alternate arc energy reduction method allowed by this same code section.
7. Ground Fault Interrupting Breakers: Provide with molded plastic case, air circuit breakers, similar to above with ground fault circuit interrupt capability, conforming to UL Class A, Group 1.
8. Arc Fault Interrupting Breakers: Provide with molded plastic case, air circuit breakers, similar to above with arc fault circuit interrupt capability, conforming to UL 1699. Provide on all dwelling-unit circuits supplying bedrooms, sleeping quarters etc. as required to comply with NEC, or CEC where adopted, Article 210.12.
9. Tandem or half-sized circuit breakers are not permitted.
10. Series-Rated Breakers: UL listed series-rated combinations of breakers can be used to obtain panelboard-interrupting ratings shown on Drawings. If series-rated breakers are used, switchboards, distribution boards, and panel boards shall be appropriately labeled to indicate the use of series-rated breakers. Shop drawing submittal shall include chart of UL listed devices, which coordinate to provide series rating.
11. Circuit breakers shall be standard interrupting construction. Panelboard shall accept standard circuit breakers up to 100A.
12. Circuit breaker handle accessories shall provide provisions for locking handle in the on or off position.
13. Shunt-trip equipped circuit breakers shall be provided on all elevator feeders.

14. Temperature compensating circuit breaker(s) shall be provided when located in outdoor enclosure(s) or when located in an enclosure subject to high ambient heat due to nearby industrial processes, etc.
 15. Provide 75 degree Celsius-rated conductor lugs/lug kits as required on all circuit breakers to accept conductor quantities and sizes shown on drawings.
 16. All circuit breaker terminations shall be suitable for use with 75-degree Celsius ampacity conductors. Listed, dual-rated pin terminals, straight or offset, are acceptable for use to in accommodating oversized or parallel conductor installations.
 17. Circuit breakers serving Fire Alarm or Central Monitoring panels and power supplies shall be red in color and lockable in the "ON" position.
- I. Disconnect Switches:
1. Non-fusible or fusible, heavy-duty, externally-operated horsepower-rated, 600V A.C: Provide NEMA 3R, lockable enclosures for all switches located on rooftops, in wet or damp areas and in any area exposed to the elements.
 2. Fusible switches shall be Class "R" when 600A or less or Class "L" when greater than 600A.
 3. Amperage, Horsepower, Voltage and number of poles per drawings: All shall be clearly marked on the switch nameplate.
 4. Provide the Owner's project manager with one (1) spare set of fuses and two (2) sets of fuse clips/fuses for every set of fuses on the project.
- J. Fuses:
1. Provide fuses at all locations shown on the Drawings and as required for supplemental protection:
 - a. Fuses shall be manufactured by Bussman, Shawmut, or equal.
 - b. All fuses shall be the product of a single manufacturer.
 2. Main and Feeder Protection:
 - a. Protective devices rated greater than 600A: Provide Bussman Hi-Cap fuses, Class L, current limiting, having an interrupting rating of 200,000A RMS.
 - b. Protective devices rated 600A or less: Provide Bussman Class R fuses, Class RK series current limiting fuses, having an interrupting rating of 200,000A RMS.
 3. Motor Protection:
 - a. Where rating of protective device is greater than 600A, provide Bussman Hi-Cap fuses, Class L, current limiting, having an interrupting rating of 200,000A RMS.
 - b. Where rating of protective device is 600A or less, provide Bussman Class RK series current limiting fuses, having an interrupting rating of 200,000A RMS.
 - c. Where fuses feeding motors are indicated, but not sized, it shall be the responsibility of the Contractor to coordinate the fuse size with the motor to provide proper motor running protection.
 - d. When rejection type fuses are specified (Class RK series) the fuse holder of all switches (specified in other Sections) shall be suitable for the fuses provided.
- K. Cable Tray, Flexible Cable Tray and/or Cable Runway:
1. See drawings for Cable Tray, Flexible Cable Tray and/or Cable Runway specifications.
- L. Lighting Control/Dimming Systems:
1. See drawings for Lighting Control and/or Dimming Systems schedules and specifications.
 2. Wall box dimmers shall be rocker-type as manufactured by Lutron (no known equal except as noted below). Dimmers and dimmer faceplates shall match the color of adjacent switches and faceplates. Dimmers and dimmer faceplates in wood finished areas shall generally be black unless otherwise indicated by the Architect. The Contractor shall obtain written approval of the Architect regarding final dimmer and dimmer faceplate color selection prior to ordering material. Multiple dimmers/switches shall be ganged together with a common cover plate. Provide dimmers as follows:

- a. Incandescent: Lutron DIVA DV-10P or DV-103P (3-way) (1000-Watt max.).
 - b. Electronic Low Voltage: Lutron DIVA DVELV-300P or DVELV-303P- (3-way) (300 Watt).
 - c. Magnetic Low Voltage: Lutron DIVA DVLV-10P or DVLV103p (3-way) (800-Watt max.).
 - d. Fluorescent (3-Wire): Lutron DIVA DVF-103P (single/3way, 8A @ 120V) or DVF-103P-277 (single/3way, 6A @ 277V).
 - e. Fluorescent (0-10V): Lutron DIVA DVTV with PP-???H Power Pack.
 - f. Fluorescent (Lutron Tu-Wire): Lutron DIVA DVFTU-5A3P with Lutron H.P. module where required.
 - g. LED (0 - 10V): Lutron DIVA DVTV with PP-???H Power Pack.
 - h. Screw Base CFL/LED: Lutron DIVA DVCL-153P.
 - i. Fan Control: Lutron DIVA DVFSQ-F (1.5A @ 120V max, 3 speed, single pole, 3-way).
3. Contractor shall verify if dimmer(s) requires derating when ganged. Contractor shall provide, and provide connections to, additional Lutron Power Modules, Lutron Power Packs, and / or Lutron Interface Modules where required to accommodate loads higher than dimmers standard or derated load-carrying capacity. Note - contractor may to provide a Lutron recommended dimmer type (typically a #DVF-103P unit) to control the necessary power modules or interface devices.
- M. Fire Alarm System/Central Monitoring System:
1. See drawings for Fire Alarm System or Central Monitoring System specifications.
- N. Surge Protective Device (SPD):
1. See drawings for SPD specifications.
- O. Conduit:
1. Galvanized Rigid Conduit (GRC) shall be full weight threaded type steel. Steel conduit shall be protected by overall zinc coating to inside and outside surfaces, applied by the hot dip, metalizing, or sherardizing process.
 2. Intermediate Metal Conduit (IMC), shall be hot-dipped galvanized in accordance with UL 1242, and meet Federal Specification WWC-581 (latest revision).
 3. Electrical Metallic Tubing (EMT) shall be zinc-coated steel with baked enamel or plastic finish on inside surfaces. EMT shall be dipped in a chromic acid bath to chemically form a corrosion-resistant protective coating of zinc chromate over galvanized surface.
 4. Flexible metal conduit shall be constructed of aluminum or hot-dipped galvanized steel strips wound spirally with interlocking edges to provide greatest flexibility with maximum strength. Interior surfaces shall be smooth and offer minimum drag to pulling in conductors. Use only as directed in writing by the Engineer with the exception of 400 Hz feeders and 400 Hz branch circuits which shall be run in flexible aluminum conduit.
 5. Liquid-tight conduit (Seal-Tite) shall be galvanized steel flexible conduit as above except with moisture and oil-proof jacket, pre-cut lengths and factory-installed fittings. For outdoor installations and motor connections only unless otherwise noted on drawings.
 6. Factory assembled, or off-site assembled wiring systems (such as Metal Clad (MC) Cable, Type AC Cable, Type NM Cable, Type BX Cable, etc.) shall not be used unless otherwise indicated in the Allowed Specification Deviations Section or Deductive/Additive Alternate Pricing Section generally located on the symbols list drawing.
 7. When approved for use in the Allowed Specification Deviations Section, generally located on the symbols list drawing, MC cables shall be allowed for lighting branch circuits (homeruns shall be EMT), receptacle branch circuits (homeruns shall be EMT) and poke-thru fed systems furniture homeruns. MC shall not be used where exposed, except for a maximum 6' length for final connections to light fixtures, or terminate in electrical panelboards or distribution boards. Equipment ground conductor shall be green. Isolated ground conductor shall be green with yellow stripe. Provide 600V rated aluminum or

lightweight steel interlocking armor Metal Clad (MC) cable with copper conductors, THHN (90-degree C) insulation, and integral equipment grounding conductor and isolated grounding conductor as required. Type AC cable listed for use in patient care areas for non-essential electrical system branch circuits per NEC or CEC where adopted, Article 517.13 shall be required in such areas in lieu of MC cable. Type AC and MC cable shall not be used for essential electrical system branch circuits. MC cable shall be manufactured to Underwriter Laboratory Standard 1569. See PART 3 - EXECUTION section of this specification for additional installation requirements.

8. Nonmetallic Flexible Tubing (ENT) shall not be used unless otherwise indicated in the Allowed Specification Deviations Section or Deductive/Additive Alternate Pricing Section generally located on the symbols list drawing. Use of ENT, if allowed, is strictly limited to use in CMU walls and parking structures decks or as directed in writing by the Engineer. See PART 3 - EXECUTION section in this specification for additional installation requirements.
9. Non-Metallic Conduit:
 - a. Polyvinyl chloride (PVC) rigid conduit, Schedule 40, Type II for underground installation only with solvent welded joints, conforming to Underwriters Laboratories, Inc. (UL) requirements, listed for exposed and direct burial application.
 - b. Conduit and fittings shall be produced by the same manufacturer.
10. Fire-rated MC Cable:
 - a. 2-hour fire-rated, polymer insulated 600V MC cable listed and conforming to Underwriters Laboratories, Inc. (UL) 2196 and UL 1569 requirements for installation as an Electrical Circuit Protective System for use in complying with NEC, or CEC where adopted, Articles 695 and 700. Where adopted, cable sheath shall be suitable for use as a NEC or CEC equipment grounding conductor, and shall be listed for use in wet locations to 90 degrees C (Raychem or equal).
 - b. Cable connectors shall be brass MC connectors.
- P. Fittings:
 1. Condulet type fittings shall be smooth inside and out, taper threaded with integral insulating bushing and of the shapes, sizes and types required to facilitate installation or removal of wires and cables from the conduit and tubing system. These fittings shall be of metal, smooth inside and out, thoroughly galvanized, and sherardized cadmium plated.
 2. Metallic condulet covers shall have the same finish as the fitting and shall be provided for the opening of each fitting where conductors do not pass through the cover.
 3. Connector, coupling, locknut, bushings and caps used with rigid conduit shall be steel, threaded and thoroughly galvanized. Bushings shall be insulated.
 4. UON all EMT fittings, connectors and couplings installed in concealed locations, areas not considered to be wet or damp locations by the AHJ, or areas not subject to physical damage, shall be steel, zinc or cadmium plated, threadless, compression, steel locking ring type with insulated throat. Where suitable for use, steel set screw fittings are allowed for trades sizes of 2" and smaller. Insulated throat is not required for fittings, connectors and couplings 1" and smaller.
 5. All interior and exterior EMT fittings, connectors and couplings, 2" and smaller, installed in exposed or concealed locations that are considered by the AHJ to be wet or damp locations, shall be Raintite-listed, steel, zinc or cadmium plated, threadless, compression, steel locking ring type with insulated throat. If Raintite-listed, EMT fittings, connectors and couplings are unavailable for a given trade size or if conduit is installed in an area subject to damage – provide rigid metallic or intermediate metallic conduits, fittings, connectors and couplings as required.
 6. Flexible steel conduit connectors shall be a malleable iron clamp or squeeze type or steel twist-in type with insulated throat. The finish shall be zinc or cadmium plating.
 7. Conduit unions shall be "Erickson" couplings, or approved equal. The use of running threads will not be permitted.

Q. 600 Volt Conductors - Wire and Cable:

1. All conductors shall be copper. Provide stranded conductor for #10 AWG and larger or when making flexible connections to vibrating machinery. Use compression "fork" type connectors or transition to solid conductors when connecting to switches, receptacles, etc.
2. Type THHN/THWN-2 thermoplastic, 600 volt, UL approved, dry and wet locations rated at 90 degrees Celsius, for conductors of all sizes from #12 AWG up to and including 1000 kcmil. RHH/RHW insulation is allowed only to provide an Electrical Circuit Protective System to comply with NEC, or CEC where adopted, Articles 695 and 700.
3. Wire and cable shall be new, manufactured not more than six (6) months prior to installation, shall have size, type of insulation, voltage rating and manufacturer's name permanently marked on outer covering at regular intervals.
4. Wire and cable shall be factory color-coded by integral pigmentation with a separate color for each phase and neutral. Each system shall be color-coded and it shall be maintained throughout.
5. Systems Conductor Color Coding:
 - a. Power 208/120V, 3PH, 4W:
 - 1) Phase A = Black
 - 2) Phase B = Red
 - 3) Phase C = Blue
 - 4) Neutral = White or White with Phase Color Tracer
 - 5) Switch legs = Purple (Switch legs shall also be identified separately by numerical tags).
 - 6) Travelers = Purple with Black stripe or Pink.
 6. Power 480/277V, 3PH, 4W:
 - 1) Phase A = Brown
 - 2) Phase B = Orange
 - 3) Phase C = Yellow
 - 4) Neutral = Grey or Grey with Phase Color Tracer
 - 5) Switch legs = Purple (Switch legs shall also be identified separately by numerical tags).
 - 6) Travelers = Purple with black stripe or Pink..
 - (a) Ground Conductors: Green
 - (b) Isolated Ground Conductors: Green with continuous yellow stripe.
 - (c) Fire Alarm System: As recommended by the manufacturer.
7. All color-coding for #12 through #6 AWG conductor shall be as identified above. Conductors #4 AWG and larger shall be identified with utilizing phase tape at each termination.
8. No conductors carrying 120V or more shall be smaller than #12 AWG.
9. Aluminum conductors shall not be used.
10. Wire-pulling compounds used as lubricants in installing conductors in raceways shall only be "Polywater J". No oil, grease, graphite, or similar substances may be used. Pulling of #1/0 or larger conductors shall be done with an approved cable pull machine. Other methods; e.g. using vehicles and block and tackle to install conductors are not acceptable.

R. Junction and Pullboxes:

1. For interior dry locations, boxes shall be NEMA 1 galvanized one-piece drawn steel, knockout type, with removable, machine screw secured covers.
2. For outside, damp or surface locations, boxes shall be NEMA 3R heavy cast aluminum or cast iron with removable, gasketed, non-ferrous machine screw secured covers.
3. For in-grade applications, junction and pull boxes shall be pre-cast concrete or molded fiberglass manufactured by Christy, Brooks-Jensen, or Utility Vault Co. Fiberglass boxes shall:

- a. Be used only in landscape planter areas that are not subject to damage from lawnmowers, tractors and other machinery.
 - b. Not be used in lawn or turf areas.
 - c. Not exceed 11" W x 17" L in size unless required to be larger to meet code requirements.
4. All boxes shall be sized for the number and sizes of conductors and conduits entering the box and equipped with plaster rings where required.
5. All boxes located in traffic areas shall be traffic rated.
- S. Outlet Boxes:
 1. For fixtures, boxes shall be galvanized, one-piece drawn steel, knockout type equipped with 3/8" fixture studs and plaster rings where required.
 2. For convenience outlets, wall switches, or other devices, outlet boxes shall be galvanized one-piece drawn steel, knockout type 4" x 4"x 2-1/8" minimum size with plaster rings as required.
 3. For locations where standard boxes are not suitable due to number and size of conduit to be terminated, special boxes shall be designed to fit space or meet other requirements, and submitted for approval.
 4. For exposure to weather, damp locations, or surface mounting, outlet boxes shall be heavy cast aluminum or cast iron with threaded hubs; covers shall be watertight with gaskets and non-ferrous screws.
 5. Outlet boxes used for support of ceiling fans shall be galvanized, one-piece drawn steel, knockout type equipped with bracing bars and plaster rings where required and listed for ceiling fan support use. Such boxes shall be labeled and capable of supporting ceiling fan weights up to 70 pounds.
 6. See drawings for floor box installation notes and specifications.
- T. Plywood Backboards: Where indicated for telephone or communications system terminals or other equipment assemblies, provide backboards of size indicated. Use 3/4" thick x 8' all (length per plans), Douglas Fir, void-free, kiln-dried, fire-rated plywood finished on one side and prime coat painted on all surfaces with finish coat of enamel paint, color by Architect. Leave one (1) fire-rating stamp/sheet exposed for inspection.
- U. Terminal Cabinets:
 1. Terminal cabinets shall be fabricated of hot dipped galvanized code gauge sheet metal for flush or surface mounting, complete with barriered sections, a door for each vertically barriered section and sizes as indicated on plan. Doors shall be hinged and lockable. Locks shall be keyed to match the branch circuit panelboards. Terminal cabinet trims shall match the branch circuit panels.
 2. Provide each terminal cabinet with a full size mounting backplate.
 3. Terminal cabinets shall be installed complete with full-length skirts of the same construction and finish as the terminal cabinet.
 4. Where mounted outdoors, terminal cabinets shall be NEMA 3R, weatherproof complete with gaskets and required sealant to prevent moisture from entering the terminal cabinet.
 5. All terminal cabinets and terminal cabinet barriered sections shall be labeled by the cabinet or cabinet section use (i.e. CATV, Security, etc.). Labels shall be Micarta type as specified elsewhere in these specifications. Unless otherwise noted, all termination blocks and cables shall be labeled per ANSI/EIA 606 standard.
- V. Painting: Terminal cabinets, panels, junction boxes, pull boxes, etc., and conduit installed in public view shall be painted with colors selected by the Architect to match the subject surfaces. Refer to painting section of the specifications for additional requirements.
- W. Seismic Design, Certification and Anchoring of Electrical Equipment:
 1. Contractor shall include all costs in the base bid for labor, materials, all special inspections and structural engineering design necessary to meet the Seismic Design Requirements

for Non-structural Components (Chapter 13, ASCE 7-16 Minimum Design loads for Buildings and Other Structures) as required by CBC where adopted, Section 1708A and as related to the installation all electrical equipment furnished under this contract. See Specific Project Site Seismic Criteria on architectural and/or structural plans which include Building Occupancy Category, Seismic Design Category, Design Spectral Response Acceleration (S_{DS}), Height factor ratio (z/h) and Site Class. Non-structural Component Importance Factor (I_P) for a particular component shall be determined based on the following criteria:

- a. $I_P = 1.0$: Non-life safety, Non-structural Components in an Occupancy Category IV Facility not required for continued operations of the facility or in any other Occupancy Category Facility where component failure will not impair continued operation of the facility.
 - b. $I_P = 1.5$: Designated Seismic Systems are those non-structural components in any Occupancy Category IV facility (except as noted above) or that are a part of any code-defined Critical, Life Safety, Emergency and Legally Required Standby Electrical System. Additionally, those non-structural components containing hazardous materials shall be classified as Designated Seismic Systems. While Designated Seismic Systems are generally identified on the plans, they may include items such as generators, automatic transfer switches, UPS units and all associated electrical distribution equipment and components necessary for the designated seismic system to form a complete and operable system. The Contractor shall ultimately be responsible for identifying Designated Seismic Systems. For any electrical component either identified on the plans or determined by the contractor to be a Designated Seismic System, all line and load side electrical distribution systems supporting that Designated Seismic System (including, but not limited to, feeders, panel boards switchboards, transformers, all related component supports and attachments etc.) shall be considered a part of the designated seismic system for the purposes of code-compliance and seismic certification.
 - c. z/h - Height factor ratio: See plans for respective equipment locations.
2. Provide a delegated-design submittal for each of the following seismic-restraint systems to be used as required:
- a. Restraint Channel Bracings consisting of MFMA-4, shop-or field-fabricated bracing assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end, with other matching components, and with corrosion-resistant coating; rated in tension, compression, and torsion forces.
 - b. Restraint Cables consisting of ASTM A 603 galvanized-steel cables. End connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for restraining cable service, with a minimum of two clamping bolts for cable engagement.
 - c. Seismic-Restraint Accessories consisting of hanger rod/hanger rod stiffener assemblies, multifunctional steel connectors for attaching hangers to rigid channel bracings and/or restraint cables, bushings for floor and wall-mounted equipment anchor bolts and resilient isolation washers and bushings.
 - d. Mechanical Anchor Bolts consisting of drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.
 - e. Adhesive Anchor Bolts consisting of drilled-in and capsule anchor system containing resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide specific LEED-compatible environmentally-friendly resins and adhesives on all LEED projects. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

3. Submittal shall include design calculations and details for selecting seismic restraints complying with performance requirements, design criteria, and analysis data signed and sealed by the contractor's structural engineer responsible for their preparation. Calculations shall include, but not be limited to, static and dynamic loading caused by equipment weight, operation, and seismic and, if applicable, wind forces required to select seismic and, if applicable, wind restraints and for designing vibration isolation bases. Provide seismic and wind-restraint detailing to support system selection, arrangement of restraints, attachment locations, methods, and spacings with all components identified to include their strengths, directions and values of forces transmitted to the structure during seismic events and association with vibration isolation devices. Sizes of components shall be selected so strength will be adequate to carry present static and seismic loads to accommodate 25% spare future capacity within specified loading limits.
 4. Any pre-approval and evaluation documentation shall have a California Office of Statewide Health Planning and Development (OSHPD) Special Seismic Certification Preapproval (OSP) demonstrating horizontal and vertical load testing and analysis showing maximum seismic-restraint ratings, by ICC-ES or another agency acceptable to authorities having jurisdiction. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are not available, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) that support seismic-restraint designs must be signed and sealed by a qualified professional engineer.
 5. Coordinate the location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified elsewhere in the project specifications.
 6. Install flexible connections in runs of raceways, cables, wireways, cable trays, and busways where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where connection is terminated to equipment that is anchored to a different structural element from the one supporting them as they approach equipment. Flexible connection limitations of the CEC where adopted, shall apply.
 7. Install seismic-restraint devices using methods approved by OSHPD or an agency acceptable to authorities having jurisdiction providing required submittals for component.
 8. Multiple Raceways or Cables: Secure raceways and cables to trapeze member with clamps approved for application by OSHPD or an agency acceptable to authorities having jurisdiction.
 9. The contractor shall engage a qualified testing agency to perform tests and inspections as listed in other Project Specifications, but as a minimum shall include at least four of each type and size of installed anchors and fasteners selected by Architect. Schedule tests with Owner, through Architect, before connecting anchorage device to restrained component (unless post connection testing has been approved), and with at least seven days' advance notice. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members as required. Test to 90 percent of rated proof load of device. Prepare and submit test and inspections reports.
- X. Trenching and Backfilling: Contractor shall be responsible for trenching and backfilling. Refer to Trenching and Backfilling section of the specifications for complete requirements.

PART 3 EXECUTION

3.01 PREPARATION AND INSTALLATION

- A. Installation of Conduit and Outlet Boxes:

1. All conduit installed in the dry walls or ceilings of a building shall be steel tube (EMT), aluminum tube (EMT), or Intermediate Metal Conduit (IMC). Flexible conduit shall not be used in lieu of EMT, IMC or rigid conduit except as noted herein.
2. Galvanized rigid conduit (GRC) or intermediate metal conduit (IMC) shall be used as follows:
 - a. When noted on the drawings.
 - b. When considered exposed to damage by the local AHJ.
 - c. When installed in wet or damp locations and of a trade size where listed-Raintite fittings, connectors, couplings etc. are unavailable.
 - d. When required by CEC Article 517.13.
 - e. When installed in concrete and masonry. The use of ENT in CMU walls and parking structures may be allowed only as directed in writing by the Engineer. Request for ENT substitution must be made prior to bid and in accordance with pre-bid substitution requests requirements of these specifications.
3. Intermediate metal conduit (IMC), is approved for use in all locations as approved for GRC or steel-tube EMT and in accordance with CEC where adopted, Article 342.
4. Flexible steel conduit shall only be permitted to be used at light fixture outlets and connections to vibrating electrical equipment. Except when concealed in walls or other structural elements, all flexible steel conduit runs shall be less than 6'-0". All outdoor installation shall be made using liquid-tight flex with approved fittings. Include a separate insulated green ground conductor sized per CEC in each conduit. Other uses of flexible conduit shall be allowed only as approved in writing by the Engineer.
5. Flexible liquidtight conduit shall be installed in lieu of the flexible steel; where required by the CEC where adopted, in damp and wet location, where exposed to weather, in refrigerated area (65°F or less), and/or between seismic joints. All rotating electrical equipment shall be supplied with flexible, liquid-tight conduit with appropriate slack and shall not exceed thirty-six (36) inches. Include a separate insulated green ground conductor sized per CEC in each conduit. Other uses of liquidtight flexible conduit shall be allowed as approved in writing by the Engineer on a case by case basis.
6. Rigid metallic conduit installed underground or embedded in concrete shall be 1" trade size minimum and shall be wrapped with 20 mil. Polyvinylchloride plastic tape, PVC conduit installed underground or embedded in concrete shall be 3/4" minimum trade size.
7. Where required for providing an electrical circuit protective system to comply with CEC where adopted, Articles 695 and 700 utilize UL Listed 2-hour fire-rated, MC cable or UL Listed 2-hour fire-rated RHH/RHW conductors in conduit.
8. Conduit shall be run so as not to interfere with other piping fixtures or equipment.
9. The ends of all conduit shall be cut square, carefully reamed out to full size and shall be shouldered in fitting.
10. No running threads will be permitted in locations exposed to the weather, in concrete or underground. Special union fittings shall be used in these locations.
11. Where conduit is underground, under slabs or grade, exposed to the weather, or in wet locations, make joints liquid tight and gas tight.
12. All metal conduit in masonry and concrete and where concealed under floor slabs shall have joints painted with thread compound prior to makeup.
13. PVC conduit shall not be run in walls except where approved by the Engineer prior to bid in limited instances that may include concrete or CMU walls used in site retaining, parking structures, or exterior equipment yard or enclosure walls, etc.
14. Where conductors enter a raceway or a raceway in a cabinet, pull box, junction box, or auxiliary gutter, the conductors shall be protected by a plastic bushing type fitting providing a smoothly rounded insulating surface.
15. Where conduit extends through roof to equipment on roof area, the Contractor shall provide flashing material compatible with the roofing system as required by the roofing specifications or as required by the Owner's roof warranty. This flashing shall be

delivered to the roofing Contractor for installation. The actual location of all such roof penetrations and outlets shall be verified by the Architect/Owner. Contractor to verify type of flashing prior to bid and include all costs.

16. All conduit shall be supported at intervals not less than 6'-0" and within 12" from any outlet and at each side of bends and elbows. Conduit supports shall be galvanized, heavy stamped, two-hole conduit clamp properly secured.
17. Where conduit racks are used the rack shall consist of two-piece conduit clamps attached to galvanized steel slotted channels, properly secured via threaded rods attached directly to the building structure.
18. Nail-in conduit supports, one-piece set screw type conduit clamps or perforated iron for supporting conduit shall not be used.
19. Seismic Conduit Support:

- a. All conduit shall be supported in such a manner that it is securely attached to the structure of the building. Attachment is to be capable of supporting the tributary weight of conduit and contents in any direction. Maximum spacing of support and braces are to be as follows:

<u>CONDUIT SIZE</u>	<u>MAXIMUM SPACING</u>
1/2" to 3"	6'-0"
3-1/2" to 4"	8'-0"

20. All conduit runs shall be installed parallel or perpendicular to walls, structural members, or intersection of vertical planes and ceilings. Field made bends and offset shall be avoided where possible. Crushed or deformed raceway shall not be installed.
21. Open knockouts in outlet boxes only where required for inserting conduit.
22. Locate wall outlet of the same type at same level in all rooms, except where otherwise noted.
23. Outlet boxes on metal studs shall be attached to metal hangers, tack welded or screwed to studs; on wood studs attachment shall be with wood screws, nails are not acceptable.
24. Recessed boxes shall not be mounted back-to-back in any wall; minimum offset shall be 24 inches.
25. Junction Boxes that do not contain any device(s) shall be located in storage rooms, electrical closets, or above accessible ceilings, not in hard lid ceilings or other forms of inaccessible ceilings. Place boxes which must be exposed to public view in a location approved by the Owner's Project Manager. Provide covers or plates to match adjacent surfaces as approved by the Owner's Project manager.
26. Surface mounted pull boxes, terminal cabinets, junction boxes, panel boards etc., shall be attached to walls using appropriate screws, fasteners, backing plates, stud blocking etc., as detailed on architectural and/or structural drawings. If architectural and/or structural drawings are not provided on the project, Contractor shall provide all necessary mounting hardware and backing support to comply with local building code requirements and any additional requirements imposed by the local Authority-Having-Jurisdiction.
27. Sleeves shall be installed where conduit passes through masonry or concrete walls and shall be 24-gauge galvanized steel no more than 1/2" greater in diameter than the outside diameter of the conduit. When located in non-rated structures, caulk conduit sleeve with stone wool and waterproof below grade. When located in fire rated structures, provide UL listed fire stopping system. See fire stopping section of this specification for additional requirements.
28. All boxes shall be covered with outlet box protector, Appleton SB-CK, or similar device/method to keep dirt/debris from entering box, conduit or panels. If dirt/debris does get in, it shall be removed prior to pulling wires.
29. All boxes installed outdoors shall be suitable for outdoor installations, gasketed, screw cover, and painted as directed by the Architect with weatherproof paint to match building.
30. All conduit entries to outdoor mounted panels, cabinets, boxes, etc., shall be made using Myers "SCRU-TITE" hubs Series ST.

31. Provide nylon or a 1/8-inch O.D. polyethylene rope, rated at 250 pounds tensile strength, in all conduits more than 5 feet in length left empty for future use. Not less than 5 feet of rope shall be left at each end of the conduit. Tag all lines with a plastic tag at each end indicating the termination/stub location of the opposite end of the conduit.
32. All multiple conduit runs within suspended ceilings shall be suspended from building structure by means of unistrut hangers/racks, Conduit shall not be allowed to lay on ceiling or be supported from ceiling suspension wires or other suspension system. Support conduit to structure above suspended ceilings 8" minimum above ceiling to allow removal of ceiling tile. Maintain two-inch clearance above recessed light fixtures
33. All exposed conduits and support hardware shall be painted to match the finish of the wall or ceiling to which it is supported.
34. Where conduits or wireways cross seismic joints, provide approved flexible conduit connection or approved expansion/deflection fitting to allow for displacement of conduit in all three axes. Connection shall allow for movement in accordance with design of seismic joint. Non-flexible raceways crossing expansion joints or other areas of possible structural movement shall make provision for 3-way movement at such points by means of expansion/deflection fittings. Fittings shall be installed in the center of their axes of movement and shall not be deflected to make part of a conduit bend, or compressed or extended to compensate for incorrect conduit expansion/deflection fittings(s) complete with ground jumpers. Where necessary, provide approved expansion joints to allow for thermal expansion and contraction of conduit(s). Install expansion joints complete with ground jumpers.
35. Seal all conduits where termination is subject to moisture or where conduit penetrates exterior wall, floor or roof, in refrigerated areas, classified (hazardous areas) and as indicated on the drawings.
36. Except as otherwise indicated on the Drawings or elsewhere in these specifications, bends in feeder and branch circuit conduit 2 inches or larger shall have a radius or curvature of the inner edge, equal to not less than ten (10) times the internal diameter of the conduit. Except where sweeping vertically into a building, and where sweep radius equals ten (10) times conduit diameter, underground communications and building interconnect conduits 3 inches or larger shall have a minimum 12'-6" radius or curvature of the inner edge. For the serving utilities, radius bends shall be made per their respective specifications.
37. Tag all empty conduits at each accessible end with a permanent tag identifying the purpose of the conduit, footage end-to-end, and the location of the other end. In wet, corrosive outdoor or underground locations, use brass, bronze, or copper 16-gauge tags secured to conduit ends with #16 or larger galvanized wire. Inscribe on the tags, with steel punch dies, clear and complete identifying information.
38. The following additional requirements shall apply to underground conduits:
 - a. Underground conduit shall be Schedule 40 PVC (polyvinyl chloride) unless otherwise indicated elsewhere in these specifications or as required per CEC where adopted Article 517.13.
 - b. For all communications conduits 2" and larger and feeders 100A or greater, provide with a minimum 3" inch, (2,000 LB) concrete envelope, 2-inch minimum separation between conduits, installed at depth of not less than 24" below grade. (Provide concrete encasement and/or greater minimum conduit depth as required by the Utility Companies.) Conduit separation within a duct bank shall be maintained using plastic spacers located at 5'-0" intervals. Where power and communication conduits are run in a common trench, a 12-inch minimum separation shall be maintained between power and communication conduits or as required by Utility Companies. Where concrete encasement is not required by serving utilities for a utility-only duct bank, provide free draining sand bedding suitable to achieve 95% relative compaction based on ASTM D1557 using 6" lifts or directed by Utility Company Standards.

- c. In all cases, where any conduit(s) pass under a building slab or footing, the electrical Contractor will provide a Bentonite clay or concrete barrier that conforms to the height and width of the trench excavation extending a minimum of 24" on either side of the foundation. In all cases, where conduit(s) pass through a sleeve in a footing or other foundation element, the electrical Contractor will provide a Bentonite clay or concrete barrier between the sleeve and the conduit(s) surrounding the conduit(s) for the entire depth of the sleeve. The barrier is required to prevent passage of moisture under or through the slab or footing via the trench or sleeve.
 - d. Where underground conduit passes under a building slab, concrete encasement may not be required, except as required above, contact the Engineer for written direction prior to omitting any encasement.
 - e. Underground conduits, which terminate inside building(s) below grade, such as in a basement level, or which slope so that water might flow into interior building spaces, shall be sealed at the point of penetration with a modular conduit seal (Link-Seal or equal by Rox Systems). Conduit/conduit sealing system penetrations of waterproofing membranes/systems on existing structures shall be completely restored as required to maintain membrane/system manufacturer and installer warranty for the installation. All conduits shall be provided with a 4% slope away from buildings. All conduits shall be installed such that the water cannot accumulate in the conduit and such that water drains into the nearest manhole, pull box or vault – not into the facility. In instances where grade changes or elevation differences prevent sloping of conduit away from a building into the nearest manhole, pull box or vault or where accumulation of water in a manhole, pull box or vault may result in water traveling into the facility, conduits shall be sealed internally at each end of each conduit using conduit sealing bushing, sized as required for the conductors contained within the conduit (O-Z Gedney #CSBG 100psig withstand or equal). In all cases, install plugs or caps in spare (empty) conduits at both ends of each conduit (Jackmoon or equal) preventing both water and gas from entering the facility via the conduits.
 - f. Include a separate insulated green ground conductor sized per CEC where adopted, in each underground electrical feeder/branch circuit.
 - g. All underground conduits with circuits rated at 40As or greater and all underground communications conduits shall be provided with a metallic marker tape located 12 inches below the finished grade.
 - h. Where underground conduits sweep into/through slabs, utilize PVC 90 degree sweeps that transition, via female PVC adapter to GRC coupling mounted flush in slab. GRC couplings shall be 1/2 lap taped with 20-mil tape. If the distance of the conduit run between a sweep and the next connecting sweep, pullbox, vault or manhole exceeds 150 ft then the sweep shall be concrete encased. Exceptions:
 - 1) Communications conduits shown terminating at a finished floor shall have an additional 4" high GRC nipple equipped with a bushing, removable conduit plug, labeling tag and pull rope. Tie off pull rope to conduit plug.
 - 2) Utility conduit sweeps shall be installed per the requirements of the respective utility company.
 - i. All PVC conduit shall be glued for a water and gas tight installation. The Contractor shall use appropriate solvent on all joints prior to gluing conduit and fittings together.
 - j. All underground conduit work shall conform to the Federal, State and Local Safety Orders or Rules regarding excavations, trenches and related earthwork. For projects in California, refer to the California Code of Regulations, Title 8, Construction Code Sections 1540 and 1541 for additional requirements.
39. Installation of Metal Clad (MC) Cable (when use is permitted in the Allowed Specification Deviations Section or Deductive/Additive Alternate Pricing Section, generally located on the symbols list drawing).

- a. Provide J-box above accessible ceiling prior to running MC cable within partitions or walls. J-box shall be permanently labeled with panel identification and circuit numbers contained within.
 - b. Overhead MC cable runs shall generally follow building lines to provide a neat and workmanlike installation.
 - c. Provide code-sized J-boxes to accommodate MC cable splicing in general. For systems furniture poke-through feeds utilizing MC cable, transition from MC cables to conduit and wire near the panelboard in the TI accessible ceiling space on the floor below the panel board via code-sized gutter(s). Utilize UL listed, insulated barrier strips with recessed screw heads (Ideal #89-6?? Series or equal) fastened within the gutter(s), terminate MC conductors on one side of the strips(s) and individual conductors in conduit from the panelboard(s) on the other side of the strip(s). Label each terminal strip(s) with panel designation. Label each phase conductor with circuit number using wire markers (Ideal or equal). Wire nuts are not an acceptable alternative to the terminal strips in these underfloor transition locations. Provide (1) spare 3/4" conduit from each gutter to its respective panelboard.
 - d. MC cable shall not run directly into panelboards, distribution boards or electrical rooms.
 - e. MC cabling shall be provided with its own code-approved ceiling support wires, cable hangers, individual spring steel support clips, steel trapeze hangers, threaded rods or dedicated #10 AWG drop wire. Cable supports shall be fastened to concrete slabs, beams, joists or other structural members of the building. In no case shall MC cable rest on ceilings, suspended ceilings or structures. Do not support MC cable using ceiling support wires. The use of nylon cable ties to support MC cable is not allowed.
 - f. Use lock or spring nut MC cable fittings.
 - g. Cable runs shall be continuous from wiring device to wiring device – no intermediate splicing J-boxes allowed.
 - h. When terminating or splicing at a junction, outlet, or switch box, cut the cable with an armored cable rotary cutter such that 6-inches of free conductors remain for connections or splices. Use screw-in or spring lock connector and ensure a proper bonding by firmly tightening the connector to both the box and cable. Insert an anti-short bushing at cable ends to protect conductors from abrasion and use insulated connectors.
 - i. MC cable bend radius shall not be less than seven (7) times the external diameter of the cable.
 - j. MC cables passing through fire-rated walls or floors shall be firestopped as required with a UL listed system. See firestopping requirements outlined elsewhere in this specification for additional requirements.
 - k. Installation shall not exceed code requirements for total current carrying conductors in multiple MC Cable runs bundled together into a single MC cable hanger or strap, unless support device is specifically listed for such purpose. Neutrals shall be counted as current carrying conductors.
 - l. Maintain MC Cable clearance of at least 6 inches from hot water and any other high temperature pipes. Maintain at least 12-inches clearance between MC cable(s) and telecommunication conduits and cables. MC cable shall cross telecommunication cables and conduits at right angles.
 - m. MC cabling shall not be run through exposed ceilings, where open grid conditions exist, exposed on walls, or exposed to view. See Power Plan and Lighting Plan General Notes for additional requirements.
40. Installation of Electrical Nonmetallic Tubing (ENT) Cable (when use is permitted in the Allowed Specification Deviations Section or Deductive/Additive Alternate Pricing Section generally located on the symbols list drawing).

- a. When approved for use in the Allowed Specification Deviations Section or Deductive/Additive Alternate Pricing Section, generally located on the symbols list drawing, 1/2" and 3/4" trade size ENT shall be allowed for concealed lighting branch circuits, receptacle branch circuits and miscellaneous signal system circuits within concrete floors, walls and columns within parking structures.
- b. ENT conduit shall meet the requirements of Underwriters Laboratories Standards 1479 and 1655, NEMA TC-13, and be UL-listed.
- c. All ENT conduit, ENT fittings, ENT boxes and ENT accessories shall be UL listed and manufactured by the same manufacturer so as to form a complete ENT system. ENT systems shall only be used if they are listed for use in fire resistance rated concrete floors and ceilings with resistance ratings as indicated elsewhere in the project plans. ENT system shall comply with CEC where adopted, Article 362.
- d. All ENT fittings and ENT boxes shall be concrete-tight listed without the use of tape. Additionally, ENT fittings shall be constructed of high impact PVC and able to resist ENT conduit pull out forces of a minimum of 175 lbs. ENT fittings with fewer than 6 locking tabs for ENT connection shall utilize manufacturer approved glue as additional protection from fitting/conduit separation. ENT conduit to rigid conduit transition fittings shall be equipped with set screw fittings on the rigid conduit side of the fitting. ENT to metal box fittings shall be equipped with a threaded end and lock washer.
- e. Where tubing enters a box, fitting, or other enclosure provide a bushing or adapter to protect conductors from abrasion unless the box, fitting, or enclosure design provides equivalent protection.
- f. ENT junction boxes shall have brass screw inserts and shall be rated to support lighting fixtures weighing less than 50 lbs.
- g. Concrete tight metal boxes shall be used to support pendant hung fixtures or fixtures over 50 lbs.
- h. ENT shall be provided in continuous lengths between junction boxes without use of in-line splices or connectors and shall be clearly marked/labeled at least every 10 feet.
- i. All ENT conduit containing electrical branch circuits shall contain a code-sized equipment ground conductor.
- j. ENT shall transition to EMT, IMC, RMC, or rigid PVC, as appropriate or as called out elsewhere in this specification, for all exposed conduits within/on/under a parking structure.
- k. ENT shall transition to appropriately sized PVC expansion joint(s) at all structure expansion or seismic joints.
- l. ENT shall be securely fastened and supported every 2 – 3 ft. and within 1 ft. of every junction box and fitting to prevent movement and sag.
- m. ENT shall be routed straight without sags, or excessive bending. Where bends are required, comply with Table 362.24 of the CEC for minimum radius of bends. Number of bends shall not exceed quantity allowed by code where used for power and lighting branch circuit and/or feeder conductors. Where utilized for communications system conductors (phones, data cabling, etc.) number of bends shall not exceed the equivalent of (2) 90-degree bends with conduit length no more than 100 feet without installation of a TIA 569-compliant pull box.
- n. Separation of ENT from fittings, excessive sags, or deflections in ENT runs that prevent pulling of wire and other ENT system product or system installation failures/errors shall be corrected by saw cutting and patching as necessary at no additional cost to the Owner. Use of surface mounted conduits and junction boxes as a repair method is unacceptable.
- o. Empty ENT runs shall be provided with a nylon pull string.

- p. Coordinate installation of raceway with structural steel and other structural members. Do not cut, notch or otherwise alter structural members without obtaining approval in writing from the Structural Engineer of record.
 - q. No more than (2) 3/4" ENT conduits may cross each other within a horizontal concrete slab without obtaining approval in writing from the Structural Engineer of record.
- B. Installation of 600-Volt Conductors:
- 1. All electrical wire, including signal circuits, shall be installed in conduit.
 - 2. All circuits and feeder wires for all systems shall be continuous from over current protective device or switch to terminal or farthest outlet. No joints shall be made except in pull, junction or outlet boxes, or in panel or switchboard gutters.
 - a. Utilize preinsulated "winged" spring type connectors, 3M Company "Performance Plus" #O/B or #R/Y or equal as required for splices and taps in conductors #6 AWG and smaller. When a spring connector is used in an underground environment or when subject to moisture, utilize a 3M Company Scotchcast 3507G epoxy resin connector sealing pack to seal the spring connector. THE USE OF PUSH-WIRE CONNECTORS (e.g. "WAGO" OR EQUIVALENT) IS STRICTLY PROHIBITED.
 - b. Wires #4 AWG and larger AWG shall be joined together as follows:
 - 1) When located in an underground environment or when subject to moisture, the splice shall be made with compression connector and sealed by a 3M, or equal, PST cold shrink connector insulator.
 - 2) When located in an interior environment, the splice shall be made with an IlSCO or equal dual rated, insulated splice-reducer connector or multi-tap connector-listed for use with 75/90-degree Celsius rated conductors.
 - c. Connections to busbar shall be made with dual-rated copper/aluminum one-piece compression lugs. Paralleled conductor connections shall be by mechanical lugs.
 - 3. Thoroughly clean all conduit and wire-ways and see that all parts are perfectly dry before pulling any wires.
 - 4. Install UL approved fixture wire from all lighting fixture lamp sockets into fixture outlet or junction box.
 - 5. For 20A branch circuit wiring, increase #12 conductors to #10 for 120-volt circuits longer than 100 feet and for 277V circuits longer than 150 feet.
 - 6. Conductor Support: Provide conductor supports as required by codes and recommended by cable manufacturer. Where required, provide cable supports in vertical conduits and provide lower end of conduit with a ventilator.
- C. Grounding/Bonding:
- 1. Provide grounding and bonding for entire electric installation as shown on plans, as listed herein, and as required by applicable codes. Included, but not limited to, are items that require grounding/bonding:
 - a. Conduit, Raceways and Cable Trays.
 - b. Neutral or identified conductors of interior wiring system.
 - c. Panel boards, Distribution Boards, Switchgear and Switchboards.
 - d. Non-current carrying metal parts of fixed equipment.
 - e. Telephone distribution equipment.
 - f. Transformers, Inverters, UPS, PDU, RDC, Transfer Switch and Generator Systems.
 - g. Raised Flooring.
 - h. Exposed metal in maintenance holes, hand holes.
 - i. Lightning Protection Systems and Antennas.
 - j. Metal piping installed in or attached to a building/structure.
 - k. Metallically isolated structural steel.
 - l. Metallically isolated underground metal water piping.
 - m. Elevator hydraulic piston/lift case.

2. In multi-occupancy buildings, Contractor shall bond metal water piping systems installed in, under or attached to a building and/or structure serving individual occupancies where the piping system(s) are metallically isolated from each other. Per CEC where adopted ART. 250.104(A)(2) and (4), the bonding conductor shall be sized per Table 250.122 and connected to the switchboard/panel board serving that suite/occupancy.
3. Use of Ground Rods: Furnish and install required number of 3/4" x 10' copper clad ground rods to meet specified resistance, all required grounding wires, conduit and clamps. The size of the grounding conductors shall be not less than that set forth in the latest edition of the California Code of Regulations, Title 24, State of California and (CEC, where adopted), unless otherwise indicated. Rods shall be installed such that at least 10 feet of length is in contact with the soil. Where rock bottom is encountered, the electrode shall be driven at an oblique angle not to exceed 45 degrees from vertical or shall be buried in a trench that is at least 30 inches deep. The upper end of the electrode shall be flush with or below ground level unless the above ground end and the grounding electrode conductor attachments are protected against physical damage. Unless otherwise noted, connection to the grounding electrode conductor may be by compression type or exothermic process connector. Mechanical connectors shall not be used.
4. Grounding System Connection:
 - a. Compression connectors shall be unplated copper, manufactured by Burndy, or approved equal, designed specifically for the intended connection.
 - b. Exothermic weld-type connectors shall be 'Cadweld' manufactured by Erico Products, or approved equal, designed specifically for the intended connection.
 - c. Mechanical connectors shall not be used.
5. Isolated Ground Receptacles shall have an insulated ground wire connected between the receptacle and the panelboard isolated ground bus. Unless otherwise noted, this ground wire shall not be grounded at any other point, and shall be distinguished from other ground wires by a continuous yellow stripe.
6. Provide separate green equipment ground conductor in all electrical raceways to effectively ground all fixtures, panels, controls, motors, disconnect switches, exterior lighting standards, and noncurrent carrying metallic enclosures. Use bonding jumpers, grounding bushings, lugs, busses, etc., for this purpose. Connect the equipment ground to the building system ground. Use the same size equipment ground conductors as phase conductors, up through #10 AWG. Use CEC where adopted, Table 250.122 for conductor size with phase conductors #8 and larger, if not shown on the Drawings.
7. Clean the contact surfaces of all ground connections prior to making connections.
8. Ductwork: Provide a flexible ground strap, No. 6 AWG equivalent, at each flexible duct connection at each air handler, exhaust fan, and supply fan, and install to preclude vibration.
9. Motors: Connect the ground conductor to the conduit with an approved grounding bushing, and to the metal frame with a bolted solderless lug. Bolts, screws and washers shall be bronze or cadmium plated steel.
10. Building grounding system resistance to ground shall not exceed 25 ohms unless otherwise noted and should be confirmed by testing.
- B. Line Voltage and Low Voltage Power Supplies to all Mechanical Equipment Including Plumbing, Heating and Air Conditioning Units:
 11. An electric power supply, including conduit, any necessary junction and/or outlet boxes and conductors and connection shall be furnished and installed by the Contractor for each item or mechanical equipment.

12. Power supplies to individual items of equipment shall be terminated in a suitable outlet or junction box adjacent to the respective item of equipment, or a junction box provided by the manufacturer or the equipment and directed by the Mechanical Contractor. Allow sufficient lengths of conductor at each location to permit connection to the individual equipment without breaking the wire run.
 13. The location of all conduit terminations to the equipment is approximate. The exact location of these conduit terminations shall be located and installed as directed by the Mechanical and Plumbing Contractor.
 14. Provide power supplies to all plumbing and mechanical equipment, including but not limited to, equipment furnished and installed by Owner or Contractor such as heating and air conditioning equipment, pumps, boilers, auto valves, water coolers, trap primers etc. The installation shall produce a complete and operable system.
 15. Unless otherwise noted, the Contractor shall furnish and install all conduit, boxes, wires, etc., for line voltage wiring and low voltage wiring.
 16. It is the Contractor's responsibility to verify with the drawings of other trades regarding the extent of his responsibility for mechanical equipment. The bid must include a sum sufficient to cover the cost of the installation.
 17. The location of all power supply connection and/or terminations to the mechanical equipment is approximate. The exact locations of these terminations shall be verified with other trades during construction.
- C. Prefabricated Equipment: Installation of all prefabricated items and equipment shall conform to the requirements of the manufacturer's specifications and installation instruction pamphlets. Where code requirements affect installation of materials and equipment, the more stringent requirements, code or manufacturer's instructions and/or specifications, shall govern the work.
- D. Firestopping:
18. The Contractor shall be responsible for furnishing all material, labor, equipment, and services in conjunction with the selection and installation of a complete, fully functioning, code compliant, UL-listed, fire stop assembly/system(s) as required by project conditions.
 19. Each fire stop assembly/system shall have an "F" and/or "T" rating as required by each condition requiring fire stopping. Each fire stop assembly/system shall have a current UL listing, as indicated in the latest edition of the UL Fire Resistance Directory. Contractor shall verify acceptability of all fire stopping methods and system selections with the authority having jurisdiction prior to installation. The Contractor shall install each fire stop assembly/system in accordance with the manufacturer's printed instructions.
 20. Each fire stop assembly/system shall be labeled with fire stop manufacturer-furnished label on each side of the fire stopping systems depicting UL # etc.
- E. Housekeeping Pads
21. Provide a minimum 3" high housekeeping pad above finished floor/finished grade for all floor-mounted switchgear, switchboards, distribution boards, transformers, motor control centers, etc., flush with the face of the equipment. Located in mechanical central plant(s), other mechanical spaces, and located outdoors, pads shall be flush with the face of the equipment. Confirm pad dimensions with local inspector prior to forming pad to ensure any local code interpretations/conditions are met regarding housekeeping pads.
 22. Unless otherwise noted above, provide a minimum 1-1/2" high housekeeping pad above finished floor/finished grade for all interior floor-mounted switchgear, switchboards, distribution boards, transformers, motor control centers, transfer switches etc., flush with the face of the equipment. All housekeeping pad heights are as measured from finished floor or grade. Confirm pad dimensions with local inspector prior to forming pad to ensure any local code interpretations/conditions are met regarding housekeeping pads.
 23. Provide a 1-1/2" high housekeeping pad above finished floor/finished for service equipment. Prior to pad rough-in, Contractor shall verify serving utility company's

maximum meter height requirements and, if necessary, adjust height of housekeeping pad to comply with those requirements. In indoor applications, the pad shall be flush with the face of the switchgear. In outdoor applications, the housekeeping pad shall extend a minimum of 4 feet from the front of switchgear/switchboard's weatherproof enclosure. Confirm pad dimensions with local inspector prior to forming pad to ensure any local code interpretations/conditions are met regarding housekeeping pads.

24. All housekeeping pads located in, on or attached to a building shall be seismically braced/connected to the building structure.

END OF SECTION

SECTION 27 10 00 STRUCTURED CABLING SYSTEM

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. The work under this section includes all final design, material, equipment, supplies, labor, testing, and accessories required to furnish and install a complete Structured Cabling System (SCS) as indicated on the drawings and as specified herein. These systems shall be defined as all cables, equipment, products, and etcetera, as indicated on the drawings and mentioned in these specifications.
- B. It is the intent of the Drawings and Specifications, which are presented in a "design-build" format, for the Contractor to design, provide and install a complete, fully operational, and tested system.
- C. All miscellaneous system components including, but not limited to, cables, cable supports, termination equipment, punch blocks, patch panels, patch cords, device outlets, ladder runway, backboards, equipment racks, equipment cabinets, enclosures, terminal cabinets, equipment grounding, and any other related items shall be furnished and installed complete under this section, such that the system shall perform all functions listed herein in compliance with all of the specified requirements.
- D. Schedule is paramount to the project's success. With this, the Contractor will have to be a team player, continually working with the team to facilitate expeditious design, procurement, and construction processes.
- E. This project will be performed in a phased construction format. Each phase of construction will be completely installed, labeled, and tested, to the greatest extent physically possible, before moving to the next phase.
- F. It is a mandatory requirement that a single Contractor perform the work described in the following specification sections:
 - 1. Section 27 10 00 Structured Cabling System

1.02 RELATED WORK, STANDARDS, DOCUMENTS AND PUBLICATIONS

- A. Each agency's relative codes, standards, and recommended practices apply to the voice/data cabling systems and their components as specified herein:
 - 1. Building Industry Consulting Service International (BICSI)
 - a. Telecommunications Distribution Methods Manual (TDMM) – latest edition.
 - b. Customer-Owned Outside Plant Design Manual (CO-OSP) – latest edition.
 - 2. Federal Communications Commission (FCC)
 - a. FCC Part 68 Rule
 - 3. American Society for Testing and Materials (ASTM)
 - a. E814-02 Standard Test Method for Fire Tests of Through-Penetration Fire Stops
 - 4. International Electrotechnical Commission (IEC)
 - a. IEC 61935-01 Generic Cabling Systems - Specification for the testing of balanced communication cabling in accordance with ISO/IEC 11801 Part 1: Installed Cabling
 - b. IEC 61935-02 Generic Cabling Systems - Specification for the testing of balanced communication cabling in accordance with ISO/IEC 11801 Part 2: Patch Cords and Work Area Cords
 - 5. Institute of Electrical and Electronics Engineers (IEEE)
 - a. IEEE 802 Specification for Local Area Networks, latest edition.

- b. IEEE 802.3an Specification for 10GBASE-T Ethernet, latest edition.
- c. ANSI/IEEE C62.41 – Guide on the Surge Environment in Low-Voltage (1000V or less) AC Power Circuits, latest edition.
- 6. International Organization for Standardization (ISO)
 - a. ISO/IEC 11801 Information Technology – Generic Cabling for Customer Premises, latest edition.
- 7. National Fire Protection Association (NFPA)
 - a. ANSI/NFPA-70 National Electric Code – Current version as adopted by AHJ(NEC), California Electric Code.
 - b. ANSI/NFPA-75 Standard for the protection of information technology equipment
- 8. National Electrical Manufacturers Association (NEMA)
- 9. Occupational Safety and Health Administration (OSHA)
- 10. Telecommunications Industry Association (TIA)
 - a. Optical Fibers Suitable for Manufacturing OM4 Cabled Optical Fiber.
 - b. TIA-526-7 Optical Power Loss of Installed Single-Mode Fiber Cable Plant.
 - c. TIA-526-14-B Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant; IEC 61280-4-1 Edition 2, Fiber-Optic Communications Subsystem Test Procedure- Part 4-1: Installed Cable Plant- Multimode Attenuation Measurement.
 - d. TIA-568-E.0 Telecommunications Cabling for Customer Premises, latest edition.
 - e. TIA-568-E.1 Commercial Building Telecommunications Cabling Standard
 - f. TIA-568-E.2 Twisted-Pair Telecommunications Cabling and Components Standard, latest edition.
 - g. TIA-568-E.3 Optical Fiber Cabling Components Standard, latest edition.
 - h. TIA-568-E.4 Broadband Coaxial Cabling and Components Standard
 - i. TIA-569-E Telecommunications Pathways and Spaces, latest edition.
 - j. TIA-598-E Optical Fiber Cable Color Coding.
 - k. TIA-606-D Administration Standard for Commercial Telecommunications Infrastructure, latest edition.
 - l. TIA-607-E Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications, latest edition.
 - m. TIA-758-B Customer-Owned Outside Plant Telecommunications Infrastructure Standard, latest edition.
 - n. TIA-862-C Building Automation Systems Cabling Standard, latest edition.
 - o. TIA-942-C Telecommunications Infrastructure Standard for Data Centers
 - p. TIA-1152 Requirements for Field Test Instruments and Measurements for Balanced Twisted-Pair Cabling, latest edition.
- 11. Underwriters Laboratories Standards (UL)
 - a. UL 5 Surface Metal Raceways and Fittings, latest edition.
 - b. UL 5A Nonmetallic Surface Raceways and Fittings, latest edition.
 - c. UL 5B Strut-Type Channel Raceways and Fittings, latest edition.
 - d. UL 5C Surface Raceways and Fittings for Use with Data, Signal, and Control Circuits, latest edition.
 - e. UL 514A Metallic Outlet Boxes, latest edition.
 - f. UL 514B Conduit, Tubing, and Cable Fittings, latest edition.
 - g. UL 514C Nonmetallic Outlet Boxes, Flush-Device Boxes, Covers, latest edition.
 - h. UL 514D Cover Plates for Flush-Mounted Wiring Devices, latest edition.
 - i. UL 1685 Vertical-Tray Fire-Propagation and Smoke-Release Test for Electrical and Optical-Fiber Cables, latest edition.
 - j. UL 1863 Communications-Circuit Accessories, latest edition.
- 12. Intertek Testing Services ETL SEMKO (ETL)

- B. The Contractor shall be responsible for obtaining and utilizing the latest Structured Cabling, Architectural, Security and Electrical plans.

1.03 GENERAL REQUIREMENTS

- A. Manufacturer: The term "manufacturer" shall be defined as the company, or group of companies, that produces the products meeting the requirements of Section 2 of this document. The manufacturer shall have a minimum of seven (7) years' experience in manufacturing products of this type and shall be ISO 9001 Certified. The products, summarized in this specification, shall be supplied by a single manufacturer, except for:
- 1.Data racks and other hardware that is not defined as part of the copper cable channel test configuration by TIA-568-E.
 - 2.Fiber Optic Cable and Outside plant (OSP) fiber optic cable.
 - 3.Channel solutions consisting of cabling and connectivity hardware independently tested as by UL or ETL and that are listed Section 2 of this document.
 - 4.Cables manufactured by another manufacturer specifically called out on the drawings.
- B. Contractor: The term "Contractor" shall be defined as the company, or group of companies, that provides the products per Section 2 and installs the products per Section 3 of this document. The Contractor selected to provide the installation of this system shall be certified by the manufacturer in all aspects of design, installation and testing of the products described herein.
- 1.The Contractor shall hold a valid State of California C-7 Low-Voltage license, shall have completed at least ten (10) projects of equal scope, shall have been in business of furnishing and installing systems of this scope and magnitude for at least the past five (5) consecutive years, and capable of being bonded to assure the Owner's Project Manager of performance and satisfactory service during the guarantee period.
 - 2.The Contractor shall have a minimum of one (1) Registered Communications Distribution Designer (BICSI RCDD) and a minimum of one (1) BICSI Technician level installer on staff as full-time employees.
 - 3.All work shall be performed under the supervision of a company accredited and trained by the manufacturer and such accreditation must be presented with the bid submittal. Contractor must be accredited a minimum of 180 days prior to bid submittal date.
 - 4.The Contractor shall be a manufacturer's Authorized Installer and Warranty Station for the equipment offered and shall maintain a fully equipped service organization capable of furnishing adequate repair service to the equipment.
 - 5.All personnel performing work on this project must have successfully completed the manufacturer's training course prior to performance of any work on this project. Accreditation will consist of individual employee certifications issued by the manufacturer. All personnel engaged in the testing of fiber optic and category-6A metallic premise horizontal and distribution systems must have successfully completed the test equipment manufacturer's training. Certification of such training must be presented with the bid submittal.
 - 6.The Contractor shall own and maintain tools and equipment necessary for successful installation and testing of single mode and multimode fiber optic cable, Categories 6 and 6A metallic premise horizontal and distribution systems and have personnel who are manufacturer- trained in the use of such testing tools and equipment.
 - 7.The Contractor shall hold all other licenses required by the legally constituted authorities having jurisdiction (AHJ) over the work.
 - 8.The Contractor shall maintain and provide appropriate liability and worker's compensation insurance coverage.
 - 9.The Contractor selected for this Project shall adhere to the engineering, installation and testing procedures and utilize the authorized manufacturer components and distribution channels in provisioning this Project.
 10. For additional Contractor requirements, see Section 1.06 of this document in its entirety.

1.04 QUALITY ASSURANCE

- A. It is the intent of these specifications to establish an installation standard of quality for labor and materials.
- B. Products specified by a particular Manufacturer's name and followed by the words "no equal" shall be provided by the Contractor and no substitution will be accepted. These products shall be provided to match other products already in use on this site, in accordance with Public Contract Code 3400 (b)(2).
- C. For any proposed product substitution, or when the Contractor intends to include a "Substitution / Or-Equal" product in the bid pricing, the Contractor shall provide a "Substitution / Or-Equal Request" submittal to the Owner's Project Manager for review no later than ten (10) calendar days prior to Bid submittal. This report shall include *all* the following items:
 - 1. Description of how the proposed product(s) will impact meeting the project completion date, indicate all item(s) with lead times and expected delivery date(s).
 - 2. Itemized cost comparisons between the proposed product(s) and the listed product(s).
 - 3. Detailed technical analysis of the electrical and mechanical specification differences between the proposed product(s) and the listed product(s).
 - 4. Provide either ETL "Verified" or UL "Verified" test lab documentation for the proposed product(s) and assemblies proposed.
 - 5. Proposed product identification, manufacturer literature (specifications and cut sheets).
 - 6. Name, address, and contact information of several (minimum of two) similar projects where the substituted product(s) have been used.
 - 7. Name, address, and contact information of the proposed product(s) manufacturer's local representative.
 - 8. Sample proposed product(s) manufacturer's component and application extended warranty. Detailed warranty requirements are described in Section 1.10 General System Product Warranty of this document.
- D. Failure to provide *all* items listed in Section 1.4.A.1 through 8 for review by the Owner's Design Team shall result in rejection of the substitution/or-equal request.
- E. The Contractor's bid shall include pricing for all specified products called out in the bid documents. The Contractor's bid shall also include alternate pricing for any proposed Substitution/Or-Equal products.
- F. The Owner's Design Team/Project Manager must approve any proposed product(s) substitution/or-equal item in writing. The Owner's Design Team/Project Manager reserves the right to require a complete sample of any proposed product(s) and may request a sample tested by an independent testing consultant to prove equality. The decision of the Owner's Design Team/Project Manager regarding equality of proposed product(s) items will be final.
- G. If a proposed product(s) is given final acceptance by the Owner's Project Manager, the Contractor shall reimburse the Owner's Design Team/Project Manager for the costs to review the proposed product(s) substitution(s), and for any additional engineering charges, and shall pay all charges of other trades resulting from this product's use, at no cost to the Owner.

1.05 GENERAL SUBMITTAL REQUIREMENT

- A. Submittals shall be presented and formatted per the guidelines in the Division 1 section of this bid package.
- B. All cut sheets shall represent the latest version, part number, and revision of the product. Where multiple products or part numbers appear on a page, a bold arrow or circle shall indicate which product or part numbers are to be used as part of the installation. The submittal shall include all descriptive pages associated with the product, not just the page showing the part number.

Contractor submittal shall include a materials list. Cut sheets shall be numbered by and match page numbers of each item included on the material list.

1.06 PRE-INSTALLATION SUBMITTAL REQUIREMENTS

A. Within fifteen (15) calendar days after the date of award of the Contract, the Contractor shall submit the following:

1. Submittal Binder: Submit one (1) hard copy and one (1) electronic copy of the complete Submittal Binder to the Project Engineer for review. The binder shall consist of five (5) major sections with each section separated by Index Tabs. Each page in the binder shall be numbered sequentially and shall be summarized in the Index.
 - a. The FIRST section shall include the following items:
 - 1) The TITLE SHEET which shall include the Submittal Date, Project Title and Address, Contractor's Name and contact information, and name of the Owner.
 - 2) The INDEX sheet which shall list each item included in the binder along with the page number where it may be found.
 - b. The SECOND section shall include the following items:
 - 1) CONTRACTOR'S LICENSE: A copy of the low voltage Contractor's valid State of California C-7 Low-Voltage license.
 - 2) PROOF OF EXPERIENCE: Proof (written documentation) that the low voltage Contractor has been regularly engaged in the business of low voltage contracting consisting of, but not limited to, engineering, fabrication, installation, and servicing of communication systems of the type specified herein for at least the past five (5) consecutive years.
 - 3) PENDING LITIGATION: Provide a statement summarizing any pending litigation involving any officer or principal of/or the company, the nature of the litigation and what effect the litigation may carry as it relates to this work in the worst-case scenario. Non-disclosure of this item, if later discovered, may result, at the Owner's discretion, in the Contractor bearing all costs and any cost related to the associated delays in the progress of the work.
 - 4) INSURANCE CERTIFICATES: Copy of low voltage Contractor's current liability insurance, workers compensation, and state industrial insurance certificates in conformance with the contract documents.
 - 5) PROJECT LIST: A List containing at least ten (10) California installations completed within the last five (5) years by the low voltage Contractor that are comparable in scope and nature to that specified in the contract document. Provide up to date contact information for each project listed including contact name, title, email address and phone number.
 - 6) SERVICE CAPABILITY: Documentation indicating in detail that the low voltage Contractor has competent engineering, installation, service personnel and facilities with reasonable stock of service parts within 75 air miles of the job site. Do not submit a sales brochure as documentation.
 - 7) AUTHORIZATION LETTERS: Letters from the low voltage equipment manufacturer stating that the low voltage bidding Contractor is a Factory Authorized Distributor/Installer and is trained and certified for the equipment he proposes to use on this project and is licensed to purchase and install software required to provide the specified functions.
 - 8) CERTIFICATION: Copy of the following current BICSI certifications. Provide proof that the certificate holders are full time employees of the low voltage Contractor's local facility servicing this project and will be actively involved on site for the duration of this project.
 - (a) BICSI RCDD, minimum of (1). Mandatory requirement: Shall be on site a minimum of one (1) day per workweek.

- (b) BICSI TECHNICIAN, minimum of (1). Mandatory requirement: Shall be on site a minimum of five (5) full 8-hour days per workweek.
- 9) **PROOF OF TRAINED PERSONNEL:** Documentation that the Contractor has full time on-staff personnel, manufacturer trained and BICSI certified, for the equipment proposed for this project, and on-staff manufacturer trained and certified by the Test Equipment manufacturer in the proper use of the test equipment required on this project. Provide copies of all manufacturers' training/certification documentation, and Test Equipment manufacturer's training/certification documentation. Provide a statement that personnel meeting these qualifications are in the local facility and will be maintained at that facility throughout the project and the warranty period.
- c. The **THIRD** section shall contain a detailed bill of materials including the quantity, product Manufacturer, product part number, product description, and corresponding specification section number or drawing sheet number where that product is referenced. Also listed in the Contractor's bill of materials shall be each item of test equipment to be used to test the optical fiber, copper, and coax components. Include all patch cords and other specialized components. See example format below:

Description	Part #	Quantity	UoM	Spec	Test Equip.
CAT6A Station cable	Brand X #12345	100 boxes	1000ft/box	2.03	Fluke DTX- 1800

This information may be used by the Owner to evaluate the Contractor's general understanding of the project scope during the bid evaluation. Errors or omissions from this bill of material do not relieve the Contractor from providing all material, components, labor, and etcetera, as outlined in this specification and on the drawings to provide a complete and useable structured cabling system.

- d. The **FOURTH** section shall contain original manufacturer cut sheets for all the materials that meet the requirements listed in Section 2 of this specification and all materials described on the construction drawings. Also include manufacturer's cut sheets for all testing equipment to be used for completion of the project. All pages shall be numbered sequentially corresponding to the bill of materials. On each cut-sheet, provide an indicating arrow next to each part number of proposed material.
- e. The **FIFTH** section shall contain a designation schedule for each system component location and complete full size 30" x 42" (unless otherwise specified) bond drawings (shop drawings), showing system wiring plans. The professionally drafted drawings shall be generated on AutoDesk AutoCAD 2018 (or later) computer design software. These drawings shall also include:
- 1) **MDF and IDF Diagrams** - Including:
 - (a) Cable routing
 - (b) Position of all devices, components, and apparatus
 - (c) Detailed elevation layout of the wall field(s)
 - (d) Labeling plan (see Owner labeling requirements)
 - 2) **Site Plan** – Including:
 - (a) Conduit routing of all site conduits including size and quantity
 - (b) Building designations
 - (c) MDF and IDF locations
 - (d) Campus cabling (if applicable) and conduit between MDF and IDF racks including cable type and quantity
 - 3) **Work Area Floor Plans** - Including:

- (a) Detailed cable routes including cable type and quantity
 - (b) Device locations and quantities with labeling
 - (c) Work area labeling plan (see Owner labeling requirements)
 - 4) Cross Connect Documentation - Including:
 - (a) Cross-connect records for all voice and data devices
 - (b) Cross-connect records may be in either Excel or Word format
 - 5) Riser Distribution Plan
 - 6) Rack elevations of all MDF and IDF equipment
 - 7) 1/4-inch scale floor plans of all data rooms (MDF, IDF, MPOE, etcetera)
 - (a) Identify all equipment racks, cabinets, terminals, cross connect locations, ground bus bar, and all other components in room(s).
 - 8) Cable Tray, Conduit, and Raceway Plans (if applicable)
 - (a) Provide 1/4-inch scale ladder runway plan for all data rooms.
 - (b) Provide scaled plans for all in-building conduit and raceway.
- B. Failure to comply with any of the requirements listed above may result in the rejection of the entire submittal package.

1.07 PROJECT DIRECTION

- A. Single Point of Contact: Contractor shall provide an English-proficient, single point of contact, i.e., Project Manager, to speak for the Contractor and shall provide the following functions:
- 1. Initiate and coordinate tasks with Owner's Project Manager, and others as specified by Owner's Project Manager.
 - 2. Provide day-to-day direction and on-site supervision of Contractor personnel.
 - 3. Shall be readily available to the Owner/Owner's Project Manager 24 hours a day, 7 days a week, throughout the duration of the Project.
 - 4. Shall have full-time cellular phone capability, and the ability to send/receive email correspondence, accessible by the Owner's Project Manager.
 - 5. Ensure conformance with all Contract provisions.
 - 6. Participate in weekly site project meetings and construction meetings.
 - 7. Provide detailed and written weekly status reports to Owner's Project Manager. The content shall be substantive enough to bring about a full understanding of all situations current and situations future. Weekly reports shall include but are not limited to detailed progress report, RFI status log (Request for Information), Change Order Log (pending and approved), Project Addendum log, and a two-week look ahead work calendar. Each of the above must show assigned responsibilities and event history. Weekly reports shall include milestone information, resource updates (staff and materials), and any conditions or incidents that may impact the Project Schedule.
 - 8. This individual shall remain as Project Manager for the duration of the project. The Contractor may change Project Managers only with the Owner's Project Manager's written approval.

1.08 PLANNING

- A. Planning meetings and schedule: Within fifteen (15) calendar days after the date of award of the Contract, an initial planning meeting will be held with the successful bidder to clarify all requirements (systems, services, distribution methods, etc.), identify responsibilities, and schedule the events that will transpire during the implementation of the project. Within seven (7) calendar days of this initial meeting, the Contractor shall provide a written report and project schedule to clearly document the events and responsibilities associated with the project. Contractor's project schedule shall conform to the overall Project Construction Schedule issued by the Construction Management Company or the Owner. Contractor is required to attend all

planning and other construction meetings as requested by the Owner, Architect, or Engineer of Record.

1.09 POST INSTALLATION SUBMITTAL REQUIREMENTS

A. Within fifteen (15) calendar days after the completion of work, the Contractor shall submit the following to the Owner's representative for review:

1. Record Documentation:

- a. Final Test Results – Test results for each cable indicating tests performed, results obtained, and values measured. Test results shall be provided in electronic format (CD or USB drive) with the associated application (if required) for viewing. Contractor shall provide individual test results for each cable tested, and a summary sheet listing all cables, test summary, lengths, and the total cable count. Provide test reports for all copper cables and fiber optic cables. Testing shall be conducted in accordance with Section 3.06 of this document.
- b. As-Built Records – Contractor shall create and provide all backgrounds and floor plans in AutoCAD or Revit file format. As-builts shall be professionally drafted. Sheets with hand-written field markups shall be rejected. Sheet borders shall be either provided by, or approved by, the Architect. Contractor's as-built records shall include all items described and listed in section 1.6.A.1.e of this document.

B. After as-built submittal is approved by Owner, the Contractor shall provide two (2) sets of CDs and/or two (2) sets of USB drives containing all post-installation submittals and close out documentation in AutoCAD (or Revit) format; and in PDF, Word, or Excel formats as required elsewhere in this document.

C. Warranty Documentation

1. Contractor shall apply for all Manufacturers' Extended Warranties on behalf of the Owner. Contractor shall present to Owner all product Warranty documents per General System Product Warranty Section of this document. Warranty shall commence after final acceptance of System and Project Close Out by the Owner.

1.10 GENERAL SYSTEM PRODUCT WARRANTY

A. The horizontal communications cabling system installed shall be eligible for coverage by minimum twenty 20-year Manufacturer's Warranty to the Owner.

1. Horizontal copper channels shall be completed with Manufacturer's factory-terminated copper patch cords. Horizontal fiber optic channels shall be completed with Manufacturer's factory-terminated fiber optic patch cords.

2. Approved product shall be listed on the most recent version of the applicable data sheets for each solution.

B. Certified, manufacturer-trained Contractors shall provide labor, materials, and documentation in accordance with SCS manufacturer's requirements necessary to ensure that the Owner will be furnished with all Manufacturer's Warranties.

C. The installed structured cabling system shall provide a warranty guaranteeing installed channel performance above the ANSI/TIA 568-E requirements for Category 6 and Category 6A cabling systems or ISO 11801 requirements for Class E, and/or Class Ea. Standards-compliant channel performance tests shall be performed in the field with a SCS manufacturer approved certification tester in the appropriate Channel Test configuration.

D. Necessary documentation for warranty registration shall be provided to the manufacturer by the Contractor (within 10 days) following 100 percent testing of cables. Contractor shall submit test results to the SCS solution Manufacturer's warranty department, in the certification test analyzer's original software files. Contractor shall ensure that the warranty registration is properly submitted, with all required documentation within ten (10) days of project completion.

Contractor must adhere to the terms and conditions of the respective manufacturer's warranty programs.

- E. Contractor shall ensure that the Owner receives the manufacturer issued project warranty certificate within thirty (30) calendar days of warranty registration.
- F. The warranty period shall commence upon the Owner's written Acceptance of Work Product (AWP).
- G. Cable Manufacturer "site certifications" are prohibited.

1.11 GENERAL ENGINEERING AND DESIGN GUIDELINES

A. Cabling System Installation Practices

1. Plastic cable tie (tie wrap) devices shall not be utilized at any time. Only Plenum-rated Velcro-type hook-and-loop strap devices are permitted. In the MDF and IDF rooms, all vertically run cables and conductors shall be secured with Velcro at a maximum interval of eighteen (18) inches, and all horizontally run cables and conductors shall be secured with Velcro at a maximum interval of eighteen (18) inches.
2. In the MDF and IDF rooms, all vertically run innerduct shall be secured with Velcro at a maximum interval of eighteen (18) inch intervals. Innerduct installed on ladder runway shall be supported horizontally and vertically at a maximum of eighteen (18) inch intervals.
3. All horizontally run innerduct shall be secured with Velcro at a maximum interval of forty-eight (48) inches when installed horizontal above accessible ceiling spaces or open ceiling spaces.
4. All cables installed above accessible ceiling spaces shall be independently supported from other systems.
5. A pull rope is to be installed and/or replaced in all below-grade pathways for future use.
6. All intra-building cabling shall be routed either parallel or at right angles to the building structure and/or walls.
7. No cabling shall be pulled through electrical conduit bodies (Condulets) devices. If conduit body devices are pre-existing and it is determined, at the review of the Owner's representative, that sufficient space in the conduit is available and the Owner provides written approval to utilize the Condulet, the Contractor shall remove the Condulet cap, pull the cable to and beyond the cap, then carefully reinstall the cap.
8. Communications cabling shall never be tied or attached to the exterior of electrical conduits, power cables or devices, lighting systems, or co-exist inside any pathway with power or lighting conductors.
9. Any visible damage to a cable such as kinks or bends in violation of the minimum bend radius shall render the cable segment defective and shall be removed and replaced by the Contractor at no additional cost to the Owner.
10. All materials shall be new, unused, and delivered to job site in original manufacturer or distributor cartons or packages. No previously installed material shall be used at any time.
11. Reference Part 3 of this document for additional installation guidelines and requirements.

PART 2 PRODUCTS

2.01 STRUCTURED CABLING SYSTEM

A. Acceptable Manufacturers - all equipment listed herein shall be by:

1. SCS components (faceplates, jacks, patch panels): Panduit, Leviton, or approved equal.
2. Copper Category 6A Cable: Superior Essex, Leviton, General, or approved equal.
3. Fiber Optic Cable: Corning, OCC, Leviton, or approved equal.
4. Fiber Optic Enclosures/Panels: Panduit, Leviton, or approved equal.

5. Fiber Optic Connectors: Panduit, Leviton, or approved equal.
 6. Riser and OSP Copper Cable: Superior Essex, General, or approved equal.
 7. Ladder Runway: Chatsworth, or approved equal.
 8. Equipment Racks, Cabinets: Chatsworth, B-Line, or approved equal.
 9. Protectors: Circa, Emerson, or approved equal.
- B. It is the responsibility of the bidder to ensure that the proposed product meets or exceeds every standard set forth in these specifications and the equipment's technical data sheets.
- C. The functions and features specified are vital to the operation of this facility; therefore, inclusion of a component's manufacturer in the list of acceptable manufacturers does not release the Contractor from strict compliance with the requirements of this specification.

2.02 OUTLETS

- A. Telecommunications equipment outlets (TO) shall consist of one- or two-gang utility outlet boxes equipped with 8-pin modular (RJ-45) jacks utilizing the T568B wiring scheme and a faceplate. All outlet cabling shall terminate on patch panels at their associated Main Distribution Frame (MDF) room, Intermediate Distribution Frame (IDF) Rooms, or as otherwise indicated on the drawings.
- B. Faceplates
1. All Faceplates shall be available in duplex, quad, or six-plex configuration in a single-gang form factor.
 2. Surface mount boxes shall be available in dual, quad, and six-plex configuration.
 3. Modular furniture faceplates shall be available in dual and quad configuration for the Owner's modular existing and/or new modular furniture. Faceplates shall be flush-mounted in the modular furniture. Surface mounted boxes/faceplates are unacceptable. The Contractor is responsible for coordinating with the Owner's modular furniture Contractor to determine faceplate requirements. The Contractor shall provide and install all parts/fittings necessary to meet the requirements of this section.
 4. Wall mounted phone jack faceplates shall be single gang configuration, constructed of stainless steel and have two standard phone mounting posts located above and below the jack opening. Wall mounted phone faceplates will consist of 8p8c modular (RJ-45) jacks.
 5. Faceplates shall have two (2) designation windows, one located at top, and one located at bottom. Designation windows shall be equipped with clear plastic covers to house machine-generated labels.
 6. Color of faceplates shall match adjacent electrical plates unless otherwise noted. Contractor shall verify final faceplate color with Owner prior to ordering materials.
 7. Provide blank faceplate inserts for all unused outlet locations within the faceplate.
- C. Category 6A, 10-Gigabit jacks
1. All category 6A jacks shall be 8-position/8-conductor (8p8c) modular RJ-45 jacks incorporating 110-style rear termination lugs for termination of Category 6A cable, T568B wiring type, with a connector body made of high-impact fire-retardant plastic.
 2. Category-6A jacks shall be Channel-rated.
 3. All Category 6A jacks shall meet or exceed TIA-568-E.2 component Cat 6A requirements for connecting hardware from 1MHz to 650MHz, 10 GB/s.
 4. Category 6A jacks shall include a pair separation tower to facilitate required conductor separation.
 5. Category 6A jack color shall be Blue unless otherwise noted on the plan drawings.

2.03 STATION CABLE

- A. Station cables shall extend between the station equipment outlet (TO) and its associated MDF or IDF room.
- B. Category 6A, 10-Gigabit station cable
 - 1. The Category 6A 10-Gigabit cable shall consist of unbonded 4-pair, 23-AWG bare copper twisted pairs with a UTP design.
 - 2. The Cat-6A cable jacket shall be CMP 'plenum' rated with 0.265" overall diameter or smaller.
 - 3. Outdoor and underground Cat-6A cable shall be Indoor/Outdoor/Plenum-rated.
 - 4. Category 6A cable shall be ETL verified to TIA-568-E.2-10 Category 6A, and support 10GBASE-T IEEE 802.3an standard of 10 GB/s up to 650MHz.
 - 5. Color of Cat-6A cable shall be Blue unless otherwise noted on the plan drawings.

2.04 MODULAR PATCH PANEL SYSTEM – CATEGORY 6A

- A. The termination block shall support the appropriate emerging high-bandwidth applications, including 1 Gbps Ethernet, potentially 1.2 Gbps ATM and 2.4 Gbps ATM, Multi-Tasked Split Screen Computing, Virtual Holographic Video Conferencing, Instant Access Telemedicine, 3D CAD/CAM Engineering, and Internet-Intranet Communications/ Commerce, as well as all 77 channels (550 MHz) of analog broad band video, including 1000 Mbps Ethernet and potentially 1.2 Gbps ATM, and facilitate cross connection and inter connection using modular patch cords.
- B. All modular patch panels shall have a flat form factor, preloaded with Cat-6A RJ45 connectors, and utilize 110 rear terminations wired to the T568B wiring scheme.
- C. Patch panels shall be 24-port 1RU height or 48-port 2RU height (3"), flat, and Black in color.
- D. Contractor shall provide Category 6A modular patch panels in sufficient quantities to terminate all Category 6A cables.
- E. All patch panels shall have two (2) cable strain relief/management bars installed at the rear of the panel to support the terminated horizontal cabling.
- F. Unless otherwise indicated on the bid documents and plan drawings, Contractor shall provide and install a 2RU horizontal wire manager immediately below each 2RU patch panel. A 1RU space shall be left open immediately below the horizontal wire manager before mounting the next patch panel. This space is reserved for installation of a 1RU network switch to service all ports on the patch panel immediately above the horizontal wire manager. Contractor shall verify final required rack equipment layout with Owner prior to cable termination.

2.05 PATCH CORDS / STATION CORDS - CATEGORY 6A

- A. Patch cords shall be equipped with an 8-pin 8-conductor modular connector on each end and shall conform to the length(s) specified. All cords shall be wired to T568B wiring scheme. All cords shall be factory-built by the cable manufacturer. Fabrication of cords in the field is prohibited.
- B. All Category 6A patch cords shall exceed ANSI/TIA/EIA and ISO/IEC Category 6A specifications.
- C. At the MDF and each IDF floor mounted rack/cabinet, provide one (1) 5-foot cat-6A patch cord for each cat-6A cable terminated in the cat-6A patch panels, unless otherwise noted.
- D. At wall-mounted IDF cabinets, provide one (1) 4-foot cat-6A patch cord for each cat-6A cable terminated in the cat-6A patch panels.
- E. At each TO and other devices (waps, cameras, etc.), provide one (1) Cat-6A patch cord for each cat-6A cable terminated at the TO and other devices. Refer to plan drawings for additional patch cord requirements.
- F. Contractor shall verify all patch cord color and length requirements with Owner prior to ordering materials. Include all costs in base bid.
- G. Provide two (2) Category 6A modular patch cords for each cat-6A cable installed on this project.

2.06 FIBER OPTIC CABLING

- A. 12-strand, OS2, 8.3 - 9 micron, single-mode fibers.
- B. 12-strand, OM4, multimode, graded index, laser optimized fibers with 50/125 micron core/cladding.
- C. Fiber optic cable shall meet or exceed ANSI/EIA/TIA-492 specifications and ISO/IEC 11801 standards.
- D. Single mode fiber shall have maximum attenuation 0.40 dB/km @ 1310 nm, 0.30 dB/km @ 1550 nm.
- E. Multimode fiber shall
 - a. Have dual wavelength capability, transmitting at 850 and 1300 nm ranges.
 - b. Support 10Gb/s applications up to 550 meters at 850 nm
 - c. Have maximum attenuation 3.00 dB/km @ 850 nm, 1.00 dB/km @ 1300 nm.
 - d. Have EMB bandwidth: 4700 MHz-km @ 850 nm, and OFL bandwidth 500 MHz-km @ 1300 nm.
- F. All fibers shall be color coded to facilitate individual fiber identification per TIA/EIA 569-B.
- G. All fiber optic cable installed inside buildings shall be installed within Contractor-provided innerduct. Innerduct shall be rated for the environment in which it is installed. Innerduct shall be ORANGE in color, unless otherwise noted in the bid documents/plan drawings.
- H. Outdoor-rated and installed cables shall be tight buffered construction, and gel free.
- I. Cable shall be "indoor-outdoor-plenum-rated" cable.
- J. Provide fiber optic cable when shown on the plan drawings.

2.07 FIBER OPTIC PATCH CORDS

- A. Fiber patch Cords shall be available in duplex single-mode and duplex multimode.
- B. Construction shall be either 3.0 mm cordage or 1.6 mm cordage.
- C. Connectors shall be Duplex LC. Verify with Owner prior to ordering materials.
- D. The single-mode and multimode fiber optic solution shall utilize factory-made patch cords.
- E. At the MDF and at each IDF room, provide a minimum of one (1) 1-meter LC to LC duplex single-mode and (1) 1-meter LC to LC duplex multimode fiber optic patch cord for every 6-strands of single-mode and multimode fiber installed. Verify patch cord lengths and connector types with Owner in field prior to ordering product.

2.08 FIBER PATCH PANEL/ENCLOSURE

- A. Fiber Patch Panels/Enclosures: A rack mount or wall mount enclosure that terminates, provides cross connection, interconnection, and splicing and fiber identification up to 72 fiber strands in a 1U form factor. The shelf will provide protection from mechanical stress on the cable and fibers and from macro-bending losses.
 - 1. The shelf shall be wall or rack mountable depending on the location requirement. The units must fit into a 19" wide frame arrangement and have an integrated jumper routing trough.
 - 2. When wall mounted, the shelf shall consist of a modular enclosure with front and side access and can be fully administered from the front. Wall mount enclosure shall include adjustable fiber management rings, and be constructed of 16-gauge steel, power coated black.
 - 3. The unit shall have integrated sliding tray to allow bulkhead to glide forward or backward after installation.
 - 4. The rack mounted enclosure shall have a hinged front cover with door lock included.

5. Rack mount enclosures shall be available in 1U, 2U and 4U sizes for 19"-wide racks and made of 16-gauge steel power coated black.
6. The adapter/connector plates shall snap into the front of the enclosure and accommodate LC connectors as required. Adapter plates shall utilize zirconia ceramic sleeves.
7. Provide (1) 6-port LC duplex Green colored adapter panel for every 12 strands of single mode fiber optic cable installed.
8. Provide (1) 6-port LC duplex Aqua colored adapter panel for every 12 strands of multimode fiber optic cable installed.
9. Fiber patch panel/shelf shall be labeled according to the Owner's specific requirements.
10. Provide quantity of enclosures and adapter panels as required to terminate all strands.
11. Provide blank molded plates to cover all unused panel openings.
12. Include all buffer tube fan-out kits as required.

2.09 FIBER OPTIC CONNECTORS

- A. Fiber Optic Connectors: Provide a field installable single mode or multimode type connectors to terminate fiber optic cables from cable-to-cable, cable-to-equipment, or equipment-to-equipment, and to make jumpers.

1. The connector must:
 - a. Be pre-polished and field installable.
 - b. Ferrule shall be made of zirconia ceramic.
 - c. Be capable of mounting on either 250 um or 900 um buffered fiber.
 - d. Single mode shall be rated OS2. Multimode shall be rated for OM4.
 - e. Average connector insertion loss: Single mode 0.2dB, multimode 0.1dB.
 - f. Maximum insertion loss: Single-mode 0.5dB, multimode 0.5dB.
 - g. Be available in LC style, Blue color for single-mode, Aqua for multimode.
 - h. Have a locking feature to the coupler and assure non-optical disconnect.

2.10 COPPER CABLING

- A. Outside Plant Multipair Copper Cables

1. All outside plant multipair copper cables shall support analog voice circuits (fire alarm, intrusion alarm, elevator phone, etcetera) and building energy management systems.
2. All copper cable placed in the outside environment shall be 24 AWG, solid annealed copper, twisted pair, and multi-conductor. Refer to section 1.12.A of this document for additional requirements.
3. Quantity of twisted pairs shall be 25 pairs.
4. The outside plant cable shall have PET Tape core wrap.
5. The outside plant cable shall have a low smoke zero halogen, Indoor/Outdoor grade jacket.
6. All outside plant cable shall be installed in conduit. Direct burying of cable is prohibited.
7. Multi-pair voice grade copper cables installed in underground conduit shall be minimum Category-5E rated.
8. Provide outside plant cabling when shown on the plan drawings.

- B. Indoor Multipair Copper (Riser) Cables: In multi-story buildings, shielded or unshielded 24 AWG multi-pair copper cables shall be used as vertical riser cables between floors. The inner-building cable shall support analog voice circuits (fire alarm, intrusion alarm, elevator phone, etc.) and building energy management systems. The bending radius and pulling strength requirements of all backbone cables shall be observed during handling and installation. The multi-pair copper cables shall be in plenum or riser rated form and placed in conduit as required by code, or as noted on the bid documents/plan drawings.

1. Shielded: The shielded cable, 25 pair or more, shall consist of solid-copper conductors insulated with expanded polyethylene covered by a PVC skin, be conformance tested to

meet ANSI/TIA/EIA 568-C for Category 5E cables, be UL and Listed as CMR. The core shall be overlaid with a corrugated aluminum sheath, which is adhesively bonded to an outer jacket of PVC plastic to form an ALVYN sheath.

a. The cable shall be available in 25, 50, 100 through 1800 pair counts.

2.Non-shielded: The non-shielded non-plenum cable shall consist of 24-AWG solid-copper conductors insulated with color coded PVC, UL Verified to ANSI/TIA/EIA 568-C for Category 5E. The non-shielded cable shall be available in 25, 50, 75 and 100 pairs.

2.11 INDOOR MULTI-PAIR RISER CABLE TERMINATIONS

- A. The multipair riser cable wiring block shall be 66M-split-type and support Category 5E and 6 applications and facilitate cross connection and interconnection using either cross connect wire or the appropriate category patch cords. The wiring blocks shall support analog voice circuits (fire alarm, intrusion alarm, elevator phone, etc.) and building energy management circuits.
- 1.The wiring blocks shall be fire retardant, molded plastic 4 columns of metal contacts. The blocks will have 100 contacts which are divided into 50 pairs. This will allow the termination of 25 individual cable pairs on the left and right side of the wiring block, for a total of 50 cable pairs per block.
 - 2.The wiring blocks shall have a series of fanning strips shall be located on each side of the block for dressing the cable pairs terminated on the adjacent contacts.
 - 3.Plastic hinged covers shall be provided on each block and shall not interfere with running, tracing, or removing jumper wire. Labels shall be color-coded, and machine labeled/numbered according to Owner's requirements.
 - 4.The wiring blocks shall be able to mount directly on wall surfaces utilizing a standoff bracket, either with or without metal backboards. The standoff bracket shall be 10" high by 3.40" wide by 1.50" deep.
 - 5.The wiring blocks shall be able to accommodate over 500 repeated insertions without incurring permanent deformation and it shall pass the reliability test of no more than one contact failure in 10,000 connections.
- B. MPOE-MDF-IDF Rooms, or as otherwise indicated on drawings, shall be equipped with 66M-type termination blocks for termination of analog station cables. All blocks shall be securely fastened to the room backboards or equipment racks – refer to bid documents/plan drawings. Provide all required D-rings or other approved cable guides as required to provide a neat installation. All cables shall terminate in numerical sequence. Refer to subsection above for description of termination blocks.

2.12 PROTECTORS

- A. All outside plant underground backbone multi-pair copper cables shall be provided with transient voltage protection between each building with a building entrance-cable protector panel(s). All building-to-building multipair copper cables shall be routed through this protector(s). The protector(s) shall be connected with a #6 AWG copper bonding conductor between the protector's ground lug and the MDF or IDF telecommunications ground busbar (TMGB/TBG).
- B. Plug in Surge Protection Modules shall be provided for each pair terminated on the protector chassis. Protector module shall be solid-state type unless otherwise noted.
- 1.240VDC/300VDC solid-state protector modules shall provide transient and power fault protection for standard telephone line applications. The modules shall be fast acting, self-resetting current limiters to protect against sneak current type faults. These modules shall be UL Listed with integrated test points and Black in color.
 - 2.30VDC/75VDC solid-state protector modules shall provide transient and power fault protection for digital and data line applications. The modules shall be fast acting, self-resetting current limiters to protect against sneak current type faults. These modules shall be UL Listed with integrated test points and Red in color.

3. In the event that protector modules are not called out in the drawings, Contractor shall include all costs in base bid to provide the 75v solid-state modules w/sneak current protection. Confirm module color with Owner's Engineer prior to ordering. In all cases, the Contractor is responsible to coordinate appropriate module with Owner prior to ordering material.

C. Product Specification: Circa, Emerson or Marconi.

2.13 GROUNDING SYSTEM AND CONDUCTORS

- A. The Contractor shall utilize a Telecommunications Bonding Backbone (TBB) as provided by the Electrical Contractor. The Contractor shall terminate TBB cable(s) on Contractor-provided ground bus bars located at each MDF/IDF Room, or as otherwise indicated on the drawings. Ground bus bars shall be ANSI-J-STD-607-E compliant, and UL Listed. MDF telecom main ground bus bar (TMGB) shall be Chatsworth #40153-020. IDF telecom ground bus bars (TGB) shall be Chatsworth # 40153-012, or as noted on the drawings. Wall mounted cabinets require a horizontal rack bus bar (Chatsworth #10610-XXX) (equal by Harger). All communication system bonding and grounding shall be in accordance with the ANSI-J-STD-607-A (current edition), the NEC/CEC, and NFPA.
- B. Horizontal cables shall be grounded in compliance with ANSI/NFPA 70 and local requirements and practices.
- C. Horizontal equipment including cross connect frames, patch panels, cable trays, equipment racks, ladder trays, conduits, active telecommunication equipment, test apparatus and equipment shall be bonded to the ground bus bars utilizing a #6-AWG solid copper green insulated conductor and 2-hole crimp type grounding lugs. All connections shall be bare metal to bare metal using appropriate antioxidant compound. Burndy mechanical-type grounding lugs and terminals are prohibited. Minimize the length and number of bends of the grounding conductors to the busbar. Attachment to every rack and cabinet shall be made by one of the following methods:
 1. Wall mounted IDF cabinets- Attach ground conductor's 2-hole compression lug to the rear rail's bottom holes of the rack, using either two (2) tri-lobular thread-forming screws (not self-tapping or sheet metal screws) or by using two (2) standard bolts with two (2) "Type B" internal-external tooth lock washers per bolt. If thread-forming screws are not used, remove paint at the connection point and use an approved anti-oxidant prior to attaching the ground conductor.
 2. Floor Mounted Cabinet/Racks - Install a dedicated copper horizontal ground busbar strip at the top of the rear rail of each rack and cabinet. Attach ground conductor's 2-hole compression lug to this ground strip using either tri-lobular thread-forming screws (not self-tapping or sheet metal screws) or by using two (2) standard bolts with two (2) "Type B" internal-external tooth lock washers per bolt.
- D. The Contractor shall be responsible for providing an approved ground at all newly installed distribution frames, and/or insuring proper bonding to any existing facilities. The Contractor shall also be responsible for ensuring ground continuity by properly bonding all appropriate cabling, cable sheaths, circuit protectors, closures, cabinets, service boxes, and framework.
- E. Contractor shall label both ends of each grounding conductor as close as practical to the point of termination in a readable position. Ground tag must indicate the location of both ends of the ground conductor (e.g., Rack#1 to TMGB) and tag must include the warning "If this connector or cable is loose or must be removed, please call the Owner's Telecommunications Manager at xxx-xxx-xxxx (Contractor shall include the proper phone number on this label)".

2.14 OPEN EQUIPMENT RACKS

- A. When shown on drawings, communication closets shall be equipped with floor mounted, open equipment racks provided by the Contractor to house shelves, patch panels, power strips, LAN electronics, UPS, etcetera. The racks shall be made of aluminum and include mounting hardware for mounting specified termination equipment to the frame.
- B. Open 2-post rack dimensions shall be 7' H x 19" W x 3" D.
- C. Racks shall be UL-Listed, and rated for heavy-duty, high-capacity installations. The 2-post racks shall be rated up to 1500 pounds, and 4-post racks rated to 2000 pounds.
- D. Equipment racks and rack mount accessories shall be Black in color.
- E. Floor mounted open racks shall be secured from the base to the structural floor to prevent movement and secured to ladder tray sections installed above. Contractor shall provide and install a minimum of four (4) fasteners/anchors per floor mounted rack. Fasteners installed to the structural floor shall be torqued to the "fastener manufacturer's" recommendation.
- F. Racks mounted on raised floors shall be seismically braced to the structural floor below the raised floor to the satisfaction of DSA, and all local, state, and federal requirements.
- G. Floor-mounted open racks shall be secured to the overhead ladder runway.
- H. All racks shall be individually grounded to the dedicated telecommunications ground busbar (TMGB, TGB) within the equipment room. Refer to grounding section 2.13 of this document. "Daisy-chaining" a ground conductor between racks or to other components is not allowed.
- I. All racks shall be equipped with vertical cable managers on each side, and horizontal cable managers. Refer to cable manager section in this document for more information.
- J. Refer to plan drawings for quantity and locations of all open equipment racks.
- K. Product Specification: B-Line 2-post rack #SB556084XU, or Chatsworth, 2-post rack #48353-703, 4-post rack #15218-703

2.15 EQUIPMENT CABINETS

- A. When shown on drawings, cabinets shall be provided by the Contractor to house shelves, patch panels, power strips, LAN electronics, UPS, etcetera. The cabinets shall be UL Listed and include mounting hardware for mounting specified termination equipment to the frame. In addition, the mounting hardware must provide vertical and horizontal wire managers for patch cords and equipment cords.
- B. Wall mount cabinet dimensions shall be 24"H x 24"W x 30"D, 36"H x 24"W x 30"D, and 48" H x 24" W x 30" D. Refer to plan drawings for specific quantity and sizes required.
- C. Wall mount Low-Profile cabinets shall be Panduit PanZone TrueEdge 42"H x 28"W x 14"D.
- D. Contractor shall provide vertical and horizontal wire managers for patch and equipment cords.
- E. Cabinets and accessories shall be Black in color. Low profile cabinets shall be Gray in color.
- F. Wall mounted cabinets, when indicated on the plan drawings, shall be secured to plywood backboard at locations indicated on the plan drawings. Contractor shall provide and install fasteners and anchors that are designed and rated for the determined mounting surface and building construction type. Contractor shall provide and install fasteners and anchors that are designed and rated for the combined weight of the equipment support cabinet and its contents. Contractor shall be responsible for determining correct cabinet mounting and anchoring methods that will safely support the combined weight of the cabinet and its contents. Contractor shall install cabinet in such a manner that a minimum of six (6) fasteners and/or anchors are attached directly into wall framing studs, or if applicable, masonry or concrete wall. Anchoring methods shall comply with DSA requirements and all local, state, and federal safety codes.
- G. Cabinets shall be configured per the Owner's Project Manager's direction.
- H. All floor and wall mounted cabinets shall be individually grounded to the isolated ground busbar (TMGB, TGB) within the equipment room per section 2.13 of this document. Daisy chaining of

ground wire between cabinets or to other components is not allowed. Wall mounted Low Profile Cabinets shall be grounded to the nearest electrical panel's ground busbar using a 2-hole compression lug and #6 jacketed green cable.

- I. Cabinets mounted on raised floors shall be seismically braced to the structural floor below the raised floor to the satisfaction of DSA and all local, state, and federal requirements.
- J. Cabinets shall come equipped with a locking Plexiglas front door.
- K. Product Specification: Chatsworth Cube-IT #12419-724, #12419-736, #12419-748, Hubbell Low Profile #RE4X

2.16 HORIZONTAL AND VERTICAL CABLE MANAGERS

- A. Horizontal cable managers shall be available in 1RU and 2RU sizes and fit in 19"-wide racks and cabinets. Horizontal managers shall be single-sided unless otherwise noted. Manager shall be a flat for factor and have 5 rings.
- B. Vertical managers shall be 7-foot high, 6-inch wide, double sided, with full length hinged door on the front and open cable rings on the rear. Provide 10-inch wide instead of 6-inch-wide vertical managers when specifically noted on the plan drawings.
- C. In each MDF and IDF rack, provide one (1) 1RU horizontal cable manager below each rack mounted fiber enclosure, and below each 24-port patch panel, unless otherwise noted. Provide one (1) 2RU horizontal cable manager below each 48-port patch panel, unless otherwise noted.
- D. Product Specification: Chatsworth Vertical Manager #40095-703, Chatsworth 1RU horizontal manager #30139-719, Leviton 1RU horizontal manager #49253-6PM, Leviton 2RU horizontal manager #49253-2CM.

2.17 BACKBOARDS

- A. Where indicated on plan drawings, provide new plywood terminal backboards. Use Douglas Fir plywood, A/C grade, finished A-side facing out, with prime coat painted on all surfaces (front, back and sides), and two (2) finished coats of white enamel paint on the front. On each plywood sheet leave one (1) Fire Marshal Stamp unpainted for inspection. Unless otherwise indicated, use 8'-0" high x 3/4" thick plywood x length as shown on the plan drawings.

2.18 UNSPECIFIED EQUIPMENT AND MATERIAL

- A. Any item of equipment or material not specifically addressed on the drawings or in this document and required to provide a complete and functional SCS installation shall be provided in a level of quality consistent with other specified items.

2.19 FIRE RATED PATHWAY

- A. The firewall through-penetration shall be a manufactured, UL Classified, firestop device/ system designed to allow cables to penetrate fire-rated walls with a built-in fire sealing system that automatically adjusts to the amount of cables installed.
- B. The firestopping device shall be capable of installation in new construction or retrofit in existing structures.
- C. The device shall be UL Tested and Classified in accordance with ASTM E814 (UL 1479) and with ratings up to and including 2 hours.
- D. Contractor shall be responsible to provide firestopping devices for all SCS cables that penetrate a fire-rated assembly (wall, floor, ceiling).
- E. Manufacturer: Specified Technologies Inc., EZ-Path (#EZDP33FW) or equal by Wiremold.

PART 3 EXECUTION

3.01 GENERAL INSTALLATION REQUIREMENTS

- A. The wiring of the system shall be executed in accordance with the drawings and the equipment manufacturer's wiring diagrams. Should any variations in these requirements occur, the Contractor shall notify the Owner's Project Manager before making any changes. It shall be the responsibility of the manufacturer-authorized distributor of the approved equipment to install the equipment and guarantee the system to operate as per plans and specifications.
- B. Furnish all conductors, equipment plugs, terminal strips, etcetera, and labor to install a complete and operable system.
- C. The cables within the rack or cabinets shall be numbered for identification using machine generated labels wrapped around the cable jacket within 6 inches of termination point. Refer to Labeling Requirements section of this document for additional requirements. Handwritten labels are prohibited.
- D. Splicing of any cable is prohibited unless specifically noted on the plan drawings.
- E. The labor employed by the Contractor shall be regularly employed in the installation and repair of communication systems and shall be acceptable to the Owner's Project Manager to engage in the installation and service of this system.
- F. The system must meet all local and other prevailing codes.
- G. All cabling installations shall be performed by qualified and manufacturer-trained technicians.
- H. Cable lubricants (e.g., Polywater) shall be used to reduce the cable pull tension stated by the cable manufacturer during cable installation in conduits and innerduct. SCS Contractor shall verify the acceptability of the lubricant to be used with the cable manufacturer, prior to using such a lubricant. Lubricants that harden after installation are not allowed. Submit all proposed lubricants for approval PRIOR to use on low voltage, A/V, coax, fiber, and data cable installation. Cable lubricants shall be allowed to dry a minimum of 15 days before performing cable certification tests.
- I. Indoor rated cables may be run exposed above accessible ceilings, provided the cabling is supported independent of other utilities such as conduits, pipes, and the ceiling support systems. The Contractor shall include all costs in base bid for any additional supports/seismic bracing required by the Local Authority having Jurisdiction. The cables shall not be laid directly on the ceiling panels.
- J. The cable jacket composition must meet local and all other prevailing fire and safety codes.
- K. All firewalls penetrated by structured cabling shall be sealed by use of a non-permanent fire blanket or other method in compliance with the current edition of NFPA and the CEC or other prevailing code and must be a system listed by UL. The SCS Contractor must not use concrete or other non-removable substance for fire stopping on cable trays, wireways or conduits. Contractors who use this method will be required to replace all cables affected and provide the original specified access to each effected area. This requirement also applies to maintaining fire ratings of all floors penetrated by conduits or devices designated for use by voice and data cabling.
- L. All equipment racks and cabinets shall be bolted to the structural floor by the SCS Contractor in the location shown on drawings. Wall mounted relay rack and wall mounted cabinet kits shall be fastened to structural studs, not drywall or backboard only.
- M. Any cable damaged or exceeding recommended installation parameters during installation shall be replaced by the Contractor before final acceptance at no cost to the Owner.
- N. The cable manufacturer's minimum bend radius and maximum pulling tension shall not be exceeded.

- O. Cable raceways, when required, shall not be filled greater than the NEC maximum fill for the particular raceway type. At no point shall any conduit fill exceed 40 percent.
- P. SCS Contractor shall provide and install all conduit sleeve penetrations through all sound and fire rated assemblies (wall, floor, ceiling) whether or not the sleeves are shown on the plan drawings. Include all costs in base bid. All low voltage cables that penetrate a wall, floor or ceiling shall be enclosed in a conduit sleeve. Penetrations through fire-rated assemblies shall be properly fire stopped to the original fire rating of the assembly by the Contractor.
- Q. Roof penetrations are prohibited, unless specifically noted on the plan drawings. No conduit shall be installed on roofs or route horizontally on exterior walls.

3.02 SPECIFIC SYSTEM INSTALLATION REQUIREMENTS

- A. All cabling used throughout this project shall comply with the requirements as outlined in the NEC Articles 725, 760, 770, and 800 (or related CEC Articles), and the appropriate local codes. All copper cabling shall bear UL listed type CMP (Plenum Rated). All fiber optic cabling shall be Indoor/Outdoor/Plenum rated.
- B. All warranties begin when an Acceptance of Work Product (AWP) is signed by the Owner.
- C. Contractor shall perform, at its own cost and expense and without reimbursement from the Owner, any work necessary to correct errors or omissions which are identified by the Owner and communicated in writing.
- D. All projects are complete turn-key and the responsibility of the Contractor until an AWP is signed by the Owner. The Contractor shall be responsible for bring product(s) to site, placing, installing, securing, and configuring Contractor provided equipment at no additional charge.
- E. Owner by written notice to Contractor may in its sole discretion suspend or terminate any or all activities, in whole or part, under the Contract or purchase order, at any time, when in the best interest of the Owner to do so.
- F. Service Loops – Contractor shall provide cable service loops (slack loops) as follows: 10-foot service loop for all cables in the MDF and IDF; 3-foot service loop for all end point or equipment outlets. MDF and IDF room service loops may be located on the backboard or ladder rack system if dressed and secured in a neat, workmanlike fashion. End point/equipment outlet service loops shall be neatly installed and secured above accessible ceiling.
- G. Cable Pathways:
 - 1. In suspended ceilings and accessible ceiling areas where duct, cable trays or conduit are not available, the Contractor shall bundle cable, in bundles of 48 or less. Cable bundles shall be supported via "J" hooks attached to the existing building structure and framework at a maximum of five (5) foot intervals. The SCS Contractor shall adhere to the manufacturers' requirements for bending radius and cable pulling tension.
 - 2. Cables or J-hooks shall not be attached to lift-out ceiling grid supports or laid directly on the ceiling grid.
 - 3. Cables or J-hooks shall not be attached to or supported by fire sprinkler heads, HVAC ducts, or delivery systems, or any environmental sensor located in the ceiling air space.
 - 4. Where additional conduit(s)/sleeve(s) are required, but not provided by the electrical Contractor, the cabling Contractor shall be responsible to provide such conduit(s)/sleeve(s). Conduit(s) and sleeve(s) shall be of suitable material, sized, installed, fire-stopped, and grounded as may be required by the NEC, ANSI/TIA/EIA standards and all other applicable codes and standards. Any conduit(s) and sleeve(s) added by the Contractor shall be approved by the Owner's Project Manager prior to rough-in. Conduit sleeves 10 feet in length or less do not require grounding.
 - 5. All J-hooks shall be rated and designed for Category 6A cabling.
 - 6. Contractor shall provide and install machine generated labeling of all conduit and innerduct pathways on both ends.

H. Sealing of openings between floors, into or through rated fire and smoke walls, existing or created by the Contractor for placement of new or removal of old cable into or through shall be the responsibility of the SCS Contractor. Sealing material (Approved UL listed system) and application of this material shall be accomplished in such a manner that is acceptable to the local fire and building authorities having jurisdiction over this work. Creation of such openings as are necessary for cable passage between locations as shown on the drawings shall be the responsibility of the Contractor's work. Any openings created by or for the SCS Contractor and left unused shall also be sealed as part of this work.

1. Fire stopping work shall be performed by a single Contractor to maintain consistency and accountability on the project.
2. The Contractor shall install penetration firestop seal materials in accordance with design requirements, and manufacturer's instructions.
3. The Contractor's installer shall be certified, licensed, or otherwise qualified by the firestopping manufacturer as having been provided the necessary training to install manufacturer's products per specified requirements.
4. All installed through penetration firestops shall be identified via label, or stencil. Label shall state that the fill material around the penetrating item is a firestop, and that it shall not be disturbed unless by an authorized Contractor. The label shall include the firestop brand name, and the classified system number for which it was installed.

a. Sample Label:

MANUFACTURER'S NAME:

ATTENTION

Fire Rated Assembly

For Any Changes To This System, Please Refer To UL System Listed Below

PRODUCT:

HOUR RATING:

UL SYSTEM:

INSTALLATION DATE:

INSTALLED BY: (Contractor's Company name)

CONTRACTOR LICENSE NUMBER:

BUSINESS PHONE:

EMAIL ADDRESS:

- I. The Contractor shall be responsible for damage to any surfaces or work disrupted because of his work. Repair of surfaces, including painting, shall be included as necessary.
- J. Cable bundles within the MDF and IDF shall be dressed into bundles of no more than twenty-four (24) cables.
- K. The Contractor shall install all patch cords per direction of the Owner's project manager in a neat and systematic fashion. Patch cord color shall match the terminated cable and jack unless otherwise noted by the Owner. Prior to installing all patch cords, the Contractor shall install patch cords in a single rack to demonstrate work practices to the Owner's project manager. Only after any corrections/modification to the installation as directed by the Owner's project manager, may the Contractor continue installing the patch cords in the remaining racks.
- L. Rack/cabinet-mounted electronic equipment shall be grounded via the equipment chassis, in accordance with manufacturer's instructions. The equipment chassis shall be bonded to the rack/cabinet using one of the following methods:
 1. If the equipment has a separate grounding hole or stud, use a #10-AWG ground wire from the chassis ground hole/stud to the rack grounding bus.
 2. If the manufacturer suggests grounding via the chassis mounting flanges, use tri-lobular thread-forming screws (not self-tapping or sheet metal screws) to attach the equipment to the rack/cabinet rails. If the equipment mounting flanges are painted, remove the paint and apply an anti-oxidant, or use tri-lobular thread-forming screws and two (2) "Type B" internal-external tooth lock washers to safely ground equipment to the rack.

M. Bonding of ladder tray sections- Attach bonding straps to each ladder tray section by utilizing either two (2) tri-lobular thread-forming screws (not self-tapping or sheet metal screws) or by using two (2) standard bolts with two (2) "Type B" internal-external tooth lock washers per bolt. If thread-forming screws are not used, remove paint at each connection point and use an approved anti-oxidant prior to attaching the bonding strap.

N. All installation shall be done in conformance with TIA/EIA 568-E standards, BICSI TDMM guidelines and manufacturer's installation guidelines. The Contractor shall ensure that the maximum pulling tensions of the specified distribution cables are not exceeded and cable bends maintain the proper radius during the placement of the facilities. Failure to follow the appropriate guidelines will require the Contractor to provide, in a timely fashion, any additional material and labor necessary to properly rectify the situation to the satisfaction and written approval of the Owner's Project Manager. This shall also apply to all damages sustained to the cables by the Contractor during the implementation.

1. Bonding and Grounding: All cable sheaths and splice cases shall be grounded to a Telecommunications Ground Bus. All grounding must be in accordance with the NEC, CEC, NFPA, ANSI-J-STD-607-E and all local codes and practices. The Electrical Contractor shall be responsible for providing a properly sized grounding conductor from the main electrical ground to the telecommunications ground bus in each MDF/IDF room. The SCS Contractor shall be responsible to provide the telecommunications busbar (TMGB, TGB), attach the Electrical Contractor-provided ground conductor, and bond all required equipment and components within each MDF/IDF to the busbar.

2. Power Separation: The Contractor shall not place any distribution cabling alongside power lines, or share the same conduit, channel, or sleeve with electrical apparatus. Maintain a minimum of 12-inch separation from light fixtures. Equipment racks and cabinets shall maintain a minimum of 48-inch separation from electrical transformers.

3. Miscellaneous Equipment: The Contractor shall provide any necessary screws, anchors, clamps, hook & loop ties, distribution rings, wire molding (MDF & IDF locations), miscellaneous grounding and support hardware, etcetera, necessary to facilitate the installation of the System.

4. Special Equipment and Tools: It shall be the responsibility of the Contractor to furnish any special installation equipment or tools necessary to properly complete the System. This may include, but is not limited to, tools for terminating cables, testing, and splicing equipment for copper/fiber cables, communication devices, jack stands for cable reels, or cable winches.

5. Labeling: The Contractor shall be responsible for printed labels for all pull boxes, conduits, cables, protectors, racks, cabinets, patch panels, connector panels, cords, distribution frames, and outlet locations, according to the specifications. Handwritten labels are prohibited. See LABELING REQUIREMENTS Section 3.9 of this document for more information.

6. Cable Storage: The Contractor shall not roll or store cable reels without an appropriate underlay and the prior written approval of Owner's Project Manager.

7. Cable Records: The Contractor shall maintain conductor polarity (tip and ring) identification at the main equipment room (switch room), risers, and station connecting blocks in accordance with industry practices, but only in locations authorized by the Owner's Project Manager. Contractor to provide spread sheet for all outdoor backbone and indoor riser backbone cables tested.

3.03 STRUCTURED CABLING GENERAL INSTALLATION DESCRIPTION

A. The structured cabling system shall consist of the following subsystems:

1. Work Area Subsystem
2. Horizontal Subsystem
3. Administration Subsystem

4.Backbone Subsystem

5.Equipment Subsystem

B. Work Area Subsystem: The Work Area Subsystem provides the connection between the telecommunications outlet (TO) and the station equipment in the work area. It consists of patch cords, adapters, and other transmission electronics.

1.Contractor shall supply the wiring or patch cords that connect terminal devices to telecommunications outlets. This includes mounting cords and connectors.

C. Horizontal Subsystem: The Horizontal Subsystem provides connections from the horizontal cross connect to the telecommunications outlets in the work areas. It consists of the horizontal transmission media (copper, fiber, etc.), the associated connecting hardware terminating this media and outlets in the work area. Each floor of a building is served by its own Horizontal Subsystem(s) unless otherwise noted on the plan drawings.

1.Horizontal Cabling

- a. Contractor shall supply horizontal cables to connect each telecommunications outlet to the backbone subsystem as shown on the drawings.
- b. Unless otherwise noted on the floor plans or within this document, the type of horizontal cables used for each work location shall be 4-pair unshielded twisted pair (UTP).
- c. The 4-pair UTP cables shall be run using a star topology format from the administration subsystem to every individual telecommunications outlet. All cable routes, other than those dictated on the drawings, are to be approved by Owner's Project Manager prior to installation.
- d. The length of each individual run of horizontal cable from the administration subsystem to the telecommunications outlet shall not exceed 295-ft (90 m).
- e. Contractor shall observe the bending radius and pulling strength requirements of the 4-pair UTP cable during handling and installation.
- f. Each run of cable between the termination block and the telecommunications outlet shall be continuous without any joints or splices.
- g. All station cable shall be placed in the interior of walls unless otherwise noted in the bid documents/plan drawings.
- h. In the event Contractor is required to remove ceiling tiles, such Work shall not break or disturb the ceiling grid. Removal of the ceiling grid must be coordinated with the Owner's Project Manager. All insulation shall be replaced in its original location. Contractor shall be responsible to replace any ceiling tiles that they damage during the course of their work, at no additional cost to the Owner.
- i. Avoid electromagnetic interference (EMI) by maintaining adequate physical separation between telecommunications cabling and possible sources such as, but not limited to, electric motors, electric erasers, electric pencil sharpeners, transformers, fluorescent lighting that share distribution space with telecommunications cabling, copiers that share work area space with line cords and terminals, large fax machines and power cords that supports such equipment. Minimum separation shall be six (6) inches.
- j. Contractor shall provide Owner's Project Manager with detailed cable run diagrams for cable runs within raised floors (if shown on plans) detailing exact locations of cable for review and written approval by Owner's Project Manager.
- k. Conduit runs installed above grade by the Contractor should not exceed 100 feet or contain more than two 90 degree bends without utilizing appropriately sized pull box. Pull boxes are not to be used in lieu of a bend.
- l. Station cables and riser cables installed within ceiling spaces shall be routed through these spaces at right angles to electrical power circuits.
- m. Cable service slack loop shall be located within 15' of the MDF/IDF rack/cabinet as required to maintain a neat and "workmanship like" installation.

- D. Administration Subsystem: The Administration Subsystem links all the subsystems together. It consists of labeling hardware for providing circuit identification and patch cords or jumper wire used for creating circuit connections at the cross connects. All wall field layouts must be approved by Owner's Project Manager prior to rough-in and installation.
1. Separate termination fields shall be created for voice/data, wireless access points, paging, surveillance cameras, clocks, and building energy management system applications.
 2. Termination blocks that require rotation after connection of horizontal/vertical wiring will not be allowed.
 3. Contractor shall supply cross-connect wire, patch cords and fiber patch cords for cross-connection and inter-connection of termination blocks and lightguide interconnection units.
- E. Backbone Subsystem:
1. The main cable route between two or more buildings is called the Backbone Subsystem. It links the main distribution frame (MDF) in the equipment room to each intermediate distribution frame (IDF). It consists of the backbone transmission media between these locations and the associated connecting hardware terminating this media. It is normally installed in a star topology, with first-level backbone cables beginning at the main cross connect. If needed, second-level backbone cables begin at intermediate cross connects.
 2. The backbone subsystem shall include vertical runs (riser) of in-building cable between floors of a multi-story building, if applicable.
 3. All backbone fiber optic cable(s) will be run in innerduct and terminated in the MDF/IDF Rooms, or as otherwise indicated on the plan drawings, with connectors, type as specified elsewhere, in rack mounted or wall mounted fiber patch panels equipped with sufficient panels, couplers and jumper storage shelves to terminate and secure all fibers. All innerduct (Carlson or equal) shall be corrugated and a minimum of 3/4" in diameter unless otherwise indicated on plans. Innerduct shall be plenum, riser or general rated as required by the environment in which it is to be installed. Innerduct capacity shall not exceed 40 percent fill.
 4. All backbone multipair copper cable(s) will be terminated in the MDF/MPOE/IDF rooms, or as otherwise indicated on the plan drawings. Backbone multipair cable shall be terminated on building entrance fused protectors as specified elsewhere in this document. The minimum pair count for multipair copper cable between buildings shall be 25-pairs. Refer to bid documents/plan drawings for any additional required pairs.
 5. In multi-story buildings, Contractor shall supply multi-pair copper cables and optical cables as the riser cables between floors. Reference this document and plan drawings for quantities. Contractor shall observe the bending radius and pulling strength requirements of all backbone cables during handling and installation.
- F. Equipment Room Subsystem: The Equipment Subsystem consists of shared (common) electronic communications equipment in the equipment room or telecommunications closet and the transmission media required to terminate this equipment on distribution hardware.

3.04 DAMAGES

- A. The Contractor will be held responsible for all damages to portions of the building caused by it, its employees, or sub-Contractors; including but not limited to:
1. Damage to any portion of the building caused by the movement of tools, materials, or equipment.
 2. Damage to any component of the construction of spaces.
 3. Damage to the electrical distribution system.
 4. Damage to the electrical, mechanical and/or life safety or other systems caused by inappropriate operation or connections made by the Contractor or other actions of Contractor.

5. Damage to the materials, tools and/or equipment of the Owner, its consultants, agents, and tenants.

3.05 PENETRATIONS OF WALLS FLOORS AND CEILINGS

- A. Unless specifically shown on the drawings, the Contractor shall make no penetration of floors, walls, or ceiling without the prior written approval of the Owner's Project Manager.
- B. Any penetrations through acoustical walls or other walls for cable pathways/cables shall be sealed by the Contractor in compliance with applicable code requirements and as directed by Owner's Project Manager.
- C. Any penetrations through fire-rated walls for cable pathways/cables shall be sealed by the Contractor as required by code and as directed by Owner's Project Manager. The Contractor shall be required to work together with the General Contractor and the Electrical Contractor to coordinate and develop all fire stopping methods prior to any cable installation. The Contractor shall also, prior to the commencement of on-site activities, submit to Owner's Project Manager, details of any special systems to be used.
- D. Roof penetrations are prohibited. No conduit shall be installed on roofs or run horizontally on exterior walls.

3.06 TESTING AND WARRANTY

A. Structured Cabling System

- 1. The Contractor shall provide competent, test equipment manufacturer-trained engineers and/or technicians, authorized by the manufacturer of the cabling system, to technically supervise and participate during all tests for the systems.
- 2. All cables and termination hardware shall be 100% tested for defects in installation and to verify cable performance under installed conditions. All conductors of each installed cable shall be verified usable by the Contractor before system acceptance. Any defect in the cable system installation including but not limited to cable, connectors, feed-through couplers, patch panels, splices, and connector blocks shall be repaired or replaced to ensure 100% useable conductors in all cables installed.
- 3. Each cable shall be tested for continuity on all pairs and/or conductors. Twisted-pair voice cables shall be tested for length, continuity, pair reversals, opens, shorts, transpositions, presence of AC and DC voltages and opens. Twisted-pair horizontal cables shall be tested per the above requirements, plus tests that indicate installed cable performance. Category-6A cables shall be tested using a TIA-568-E.2-1 Category 6A Level III/IEC 61935 Level III or better, ETL certified cable tester/analyzer.
- 4. Shielded/screened cables shall be tested with a device that verifies shield continuity in addition to the above stated tests.
- 5. The test shall be recorded as pass/fail as indicated by the test set in accordance with the manufacturers recommended procedures and referenced to the appropriate cable identification number and circuit or pair number. Any faults in the wiring shall be corrected and the cable re-tested before final acceptance.
- 6. Each installed cable shall be tested for installed length using a Time Domain Reflectometer (TDR) type device. The cables shall be tested from patch panel to patch panel, block to block, patch panel to outlet or block to outlet as appropriate. The cable length shall conform to the maximum distances set forth in the TIA-568-E Standard. Cable lengths shall be recorded, referencing the cable identification number and circuit or pair number.
- 7. Multi-pair cables, record the following tests on every cable pair in each multipair cable using a TDR type device: record the shortest pair length, continuity, pair reversals, shorts, opens, transpositions, presence of AC and DC voltage.

8. Category 6A data cable shall be performance verified using an automated test set. This test set shall be capable of testing for the continuity and length parameters defined above, and provide results for the following tests:
 - a. Attenuation (Insertion Loss).
 - b. Return Loss (RL).
 - c. Near End Crosstalk (NEXT) – measured at both ends of each cable pair.
 - d. Attenuation to Crosstalk Ratio (ACR).
 - e. Power Sum Near End Crosstalk (PSNEXT).
 - f. Power Sum Attenuation to Crosstalk Ratio (PSACR).
 - g. Far End Crosstalk (FEXT).
 - h. Equal Level Far End Crosstalk (ELFEXT).
 - i. Power Sum Equal Level Far End Crosstalk (PSELFEXT).
9. Test results shall be automatically evaluated by the equipment, using the most up-to-date criteria from the ANSI/TIA/EIA Standard, and the result shown as pass/fail. Test results shall be printed directly from the test unit or from a download file using an application from the test equipment manufacturer. The printed test results shall include all tests performed, the expected test result, and the actual test result achieved.
10. Optical Fiber Cable Testing: All fiber testing shall be performed on all fibers in the completed end to end system by test equipment manufacturer-trained engineers and/or technicians. There shall be no splices unless clearly defined in Section 3 of this specification or on the plan drawings. Testing shall consist of a bi-directional end to end OTDR trace performed per ANSI/TIA/EIA 455-61 & ANSI/TIA/EIA 526 and a bi-directional end to end power meter test performed per ANSI/TIA/EIA 455-53A. The system loss measurements shall be provided at 850 and 1300 nanometers for multimode fibers and 1310 and 1550 for single mode fibers.
 - a. Pre-installation cable testing: The Contractor shall test all fiber optic cable prior to the installation of the cable. The Contractor shall assume all liability for the replacement of the cable should it be found defective during the warranty period.
 - b. Loss Budget: Fiber links shall have a maximum loss of: (allowable cable loss per km) x (km of fiber in link) + (.4dB) x (number of connectors) = maximum allowable loss.
 - c. Any link not meeting the requirements of the standard shall be brought into compliance by the Contractor, at no additional charge to Owner.
11. The SCS Contractor shall provide test documentation to the Owner's Project Manager in CD format and / or USB thumb drive within three weeks after the completion of a specific project. These shall be clearly marked on the outside front cover with the words "Test Results", the project name, and the date of completion (month and year). The documentation shall be divided by test type. A paper copy of the test results shall be provided that lists all the links that have been tested, and include link name, overall pass/fail evaluation, date and time of test, cable type and NVP value. Detailed test results shall be provided for each link tested and shall include length, propagation delay, delay skew, insertion loss, return loss, NEXT, ELFEXT, ACR, PSNEXT, PSELFEXT, and PSACR. Detailed test results for each link will also include customer site name, name of standard selected to execute the tests, date and time test results were saved in memory of test unit, brand name model and serial number of tester and revision of the tester software and test standards database in the tester. Individual test data within each section shall be presented in the sequence listed in the test summary records. Unless a more frequent calibration cycle is specified by the manufacturer, an annual calibration cycle is anticipated on all test equipment used for this installation.
12. When repairs and re-tests are performed, the problem found and corrective action taken shall be noted, and both the failed and passed test data shall be collocated in the document.
13. The entire SCS system shall be warranted free of mechanical or electrical defects by the Contractor for a period of one (1) year after final acceptance of the installation.

14. Any equipment that is not installed per the manufacturer's recommendation shall be replaced promptly and at no cost to the Owner.
15. Any material showing mechanical or electrical defects shall be replaced promptly at no expense to the Owner.
16. Provide all labor and material warranties for each system, as described elsewhere in this document.
17. At the Owner's direction, the Contractor shall perform additional random testing which shall consist of a random sample of up to 10% of each installation distribution system. The Contractor shall assume responsibility for providing the proper test equipment and staff to conduct tests. The Owner's representative shall witness the tests.
18. Should the initial 10% test not be 100% successful (all drops testing over CAT6A up to 500MHz), the Contractor shall assume responsibility to repair/replace non-passing links, at the direction of the Owner, and the links to re-verify and resubmitted. A 20% random sample shall then be conducted to ensure proper performance of the system.
19. Should there be failure in this re-test, the Contractor shall be responsible to repeat the re-test procedure until such time as all cabling is verified.

3.07 COMPLETION OF WORK:

- A. At the completion of the Systems, the SCS Contractor shall restore to its former condition, all aspects of the project site, and daily shall remove all waste and excess materials, rubbish debris, tools and equipment resulting from or used in the services provided under this Contract. All clean up, restoration, and removal noted above will be by the Contractor and at no cost to Owner. If the Contractor fails in its duties under this paragraph, Owner may upon notice to the Contractor perform the necessary clean up and deduct the costs thereof from any amounts due or to become due to the Contractor. It shall be the Contractor's responsibility to remove trash from the areas it is working in and bring trash and debris to the Contractor provided dumpster.

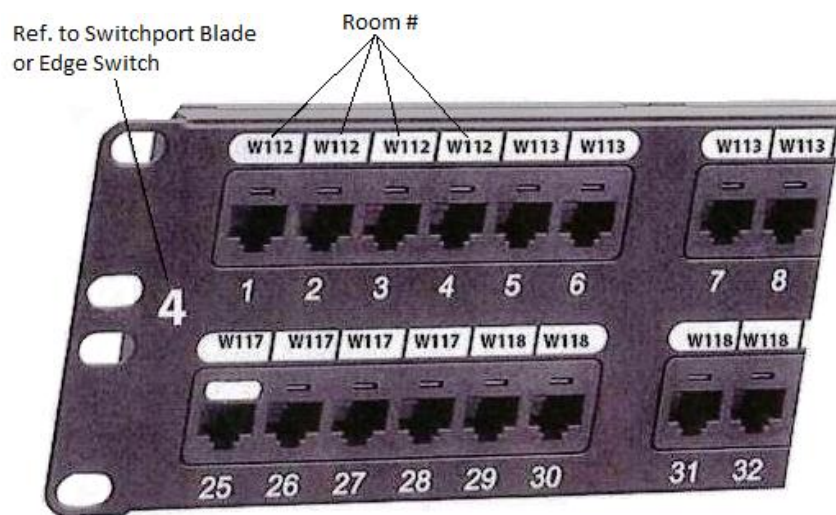
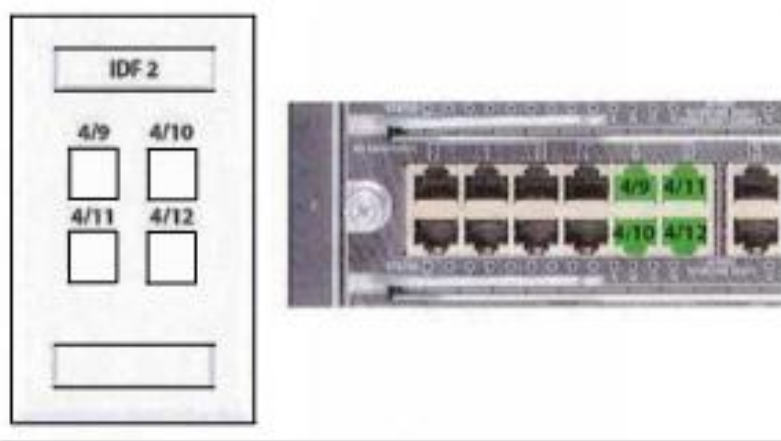
3.08 INSPECTION

- A. On-going inspections shall be performed during construction by the Owner's representative. All work shall be performed in a high-quality manner and the overall appearance shall be clean, neat, and orderly. Any work that does not meet the Owner's representative's approval shall be removed and reinstalled by the Contractor at no additional cost to the Owner.

3.09 LABELING REQUIREMENTS

- A. Owner shall supply Contractor with all label information in Microsoft Excel format or an asset tag, as needed. Contractor shall coordinate with Owner in the field by issuing an RFI for clarification prior to Contractor creating any labels. The Contractor shall provide and install labels per this document. If the Owner doesn't provide label information, the Contractor shall create labels in the format as outlined in this document.
- B. Numbers must be assigned to each outlet location using a logical designation convention. Blueprints with the outlet placement and configuration information have been furnished to the Contractor. Contractor will provide the equipment as necessary to generate Panduit PAN-CODE (or Equal) laser printer generated self-laminating labels using the numbering convention shown below and as specified herein. Before any permanent labels are installed on blocks, face plates or cables, Contractor shall submit a sample label of each various type listed below to Owner's Project Manager for written approval to ensure compliance with the labeling scheme, legibility, etcetera. Contractor is responsible to provide the labeling scheme as described herein.
- C. Station Faceplate (telecommunications equipment outlet) Labeling. The following is illustrative of the number convention to be used:

- 1.Top Window: IDF-2. This identifies the IDF location where cable originates within the building (i.e., IDF room “#2”).
- 2.Bottom Window: blank. For future use.
- 3.Faceplate jacks shall be numbered sequentially from top to bottom and left to right. Individual jack labels shall indicate Patch Panel number / port number. (i.e., 4/9 represents patch panel #4, patch panel port #9).



- D. Network Switch Labeling. All rack mounted Ethernet edge switches shall be sequentially numbered. Number shall be printed and attached to the left edge and centered. Numbers shall be minimum 1/2" high and printed white on a black background.
- E. Patch Panel Labeling. All copper category 6A rack mounted patch panels shall be sequentially numbered, beginning with the uppermost panel in the rack. Patch panel number shall be printed and attached to both left and right edges and centered. Numbers shall be minimum 1/2" high and printed white on a black background. Patch panel ports shall be labeled with the corresponding room number where the cable's faceplate is located. Cables shall be terminated sequentially by room number and faceplate order.
- F. Station Cable Jacket Labeling. All cables shall be labeled between three and six inches of each termination end (e.g., at Both Ends, the outlet end and MDF/IDF end) using machine-generated, "P-Touch" type, self-laminating cable markers.
- 1.Example: IDF2-4/9

- 2.IDF location where cable originates (e.g., IDF room “#2”).
 - 3.Patch panel and port numbers where cable terminates (e.g., patch panel #4, port #9)
- G. Backbone and Riser Multipair Cable Labeling. All backbone and riser cables (copper, fiber, coax, etc.) will be labeled to reflect the origin and destination abbreviation for the cable and pair counts on large font (16 pitch) self-laminating labels, which shall be located within 18 inches of each end of the cable. Labels shall be placed on the cable to be visible without relocating surrounding cables.
- 1.Example #1: IDF2/IDF3/CP100/01
 - 2.IDF2: Cable Origination
 - 3.IDF3: Cable Destination
 - 4.CP100: Cable Type & Pair or Strand Count (e.g., 100 – pair Copper Cable. Other possibilities include CX for coax, HB for hybrid fiber cable, MM for multimode cable, and SM for single mode cable.)
 - 5.01: Cable identification number (e.g., cable 01). There may be more than one backbone or riser cable with the same origin, destination, and pair count.
- H. Multipair Cable Termination Block Labels. All multipair cables will be labeled using appropriate terminal-block label strip with label holders. Termination blocks shall be labeled in such a manner to indicate Termination Block number (e.g., W1, W2, etc.) and type of cables (e.g., Fire Alarm-FA, Security Alarm-SE, Paging-PA, FAX machine, etcetera).
- 1.Termination Block Label:
 - 2.Example: W1 – Alarm Cables 1st Floor
 - 3.W1: Wall Field 100-pair 110-block #1
 - 4.Individual cable numbers on label strip:
 - 5.Example: 001
 - 6.Station #1
- I. Multipair Cable Termination Block Labels. All multipair riser blocks shall be labeled using appropriate terminal-block label strip with label holders and shall follow the labeling scheme outlined above. Building interconnect cable termination block labels shall be per ANSI/TIA/EIA-606-B. Final label scheme shall be determined by the Owner’s decision.
- J. Fiber Enclosure Labels. All fiber enclosures and panels will be labeled using self-laminating laser label markers. Fiber labels shall include all information as specified by the Owner. Contractor is responsible to provide a labeling scheme that meets with the Owner’s satisfaction. At a minimum, the fiber enclosure label card shall indicate: destination of connected cables, slash (/), origination of connected cables, slash (/), and the fiber enclosure number and port number.
- 1.Example: MDF/IDF2/1-1
 - 2.MDF: Destination Patch Panel Location Designation
 - 3.IDF2: Origination Patch Panel Location Designation
 - 4.1-1 Indicates fiber enclosure number and fiber port number on both origin and destination fiber enclosures.
- K. Equipment Rack/Cabinet Labeling: All equipment racks/cabinets shall be labeled according to their room identifier and a two-digit number. The labels will be engraved plastic plates, with 1”-high white letters on black background. The labels will be attached to the cross member at the top front of each frame or rack with appropriately sized sheet metal screws. Self-adhesive strips, glues, etcetera are unacceptable. Racks and cabinets within the same room shall be numbered sequentially from left to right, when facing the front of the racks/cabinets.
- 1.Example: MDF-01
 - 2.MDF. Room Designation
 - 3.01. Rack Identifier
- L. Innerduct and Fiber Cable Warning Labeling. The Contractor shall provide and install tags of stamped plastic for tube cable and innerduct. The labeling convention described above within Paragraph E shall apply. Additionally, the Contractor will also install fiber optic warning tags

(Panduit #PST-FO) every 12 feet on all exposed fiber optic cable and on innerduct containing fiber optic cable installed within the building, also on innerduct and cable visible in each pull box, manhole, and vault.

- M. MDF/IDF Floor Plan Mounting Frame: Provide wall mountable floor plan mounting frame with removable Plexiglas front cover in each MDF/BDF/IDF. Frame and cover shall be sized to house 30"x42" floor plan drawing. Coordinate location of frame with Owner's Project Manager prior to installation.
- N. Telecommunications Main Grounding Busbars (TMGB, TGB): All telecom grounding busbars shall be labeled using large font (16 pitch) self-laminating labels. Labels shall indicate "TMGB" or "TGB". If more than 1 busbar is in the room, include a numerical indication (e.g., TMGB-1).

3.10 MISCELLANEOUS PROJECT REQUIREMENTS

- A. Site Cleaning: The Contractor shall keep the working area free from debris of all types. Daily the Contractor shall remove from the premises all rubbish resulting from any work done by Contractor. The work site shall be in order at all times when work is not actually being performed and shall be maintained in a reasonably clean condition at all times.
- B. Conduits: All backbone cabling will run through dedicated conduits. All new conduits will be supplied with a pull string. SCS Contractor shall supply pull string and pull rope for the installation of all cables in existing conduits. For all conduits with available capacity, SCS Contractor shall replace pull strings with 1/4-inch pull rope during his work. Contractor must seal all underground low voltage conduits within manholes, underground vaults/pull boxes, and underground conduits that enter a facility, with an approved mechanical water/gas/airtight plug (Jack Moon plug, or equal). Unused conduits shall be sealed with a blank plug. Expanding foam type sealant is prohibited. All exposed exterior conduits installed on this project shall be painted to match surrounding surfaces.
- C. Seismic Requirements: SCS Contractor will install all equipment racks, equipment cabinet enclosures, cable runways, etcetera, according to DSA and local, state and/or federal code. Contractor will notify Owner's Project Manager of such requirements and shall provide such bracing as required at no additional increase to the base bid. Contractor to coordinate all installation with the structural Engineer of Record.
- D. Safety Requirements: SCS Contractor will utilize appropriate personnel and display warning signs, signals, flags and/or barricades at the work site to ensure adherence to safety regulations and as prudence requires.
- E. Specification/Drawing Status: All specifications and drawings related to this project will be "frozen" after shop drawing approval. The Owner reserves the right to negotiate any future changes with the Contractor at any time.

3.11 MISCELLANEOUS SUPPORT REQUIREMENTS

- A. Upon approval of shop drawings, SCS Contractor shall immediately place orders for all required materials, components, and supplies. In addition, Contractor shall secure and forward written confirmations (including orders and shipping dates) direct from each manufacturer/vendor to the Owner's Project Manager.
- B. SCS Contractor shall expedite shipment of all materials, components, and supplies, as necessary to ensure the successful completion of the Project by the date required. All costs for expediting shall be included within Contractor's base bid.
- C. All equipment and supplies required for work shall be stored off-site by Contractor and delivered just in time for installation (within 15 days of install). No claim for allowances of time, storage, or money will be accepted.

- D. Minimum standards for maintenance purposes shall include optional access to service on a 24 hour-a-day, 365 day-a-year basis. In addition, Contractor shall, upon notification, respond as follows:
1. Emergency Response: Contractor must respond by utilizing remote diagnostics capabilities (as applicable) within thirty minutes of notification. If necessary, Contractor must dispatch at least one certified technician for arrival on-site within two hours of notification.
 2. Non-Emergency Response: Contractor shall respond by utilizing remote diagnostics capabilities and or cause dispatch of at least one certified technician for arrival on-site within one business day of notification.
 3. Definition of "Emergency": For maintenance purposes, "emergency" shall be defined as one or more of the following conditions:
 - a. Defects of any riser pairs and/or components involving at least ten percent (10%) of any riser cable's capacity.
 - b. Defects of station cable pairs and/or components involving at least ten percent (10%) of any department or group of voice and/or data stations.
 - c. Defects significantly impairing any single attendant console.
 - d. Defects of any fiber optic cable and/or components involving at least ten percent (10%) of any department or group's fiber-based systems and/or stations.
 - e. Any pre-defined failure as submitted by Owner and agreed to be Contractor.

3.12 TRAINING

- A. The Contractor shall provide training for at least five (5) Owner representatives with a minimum allotment of two (2) two-hour sessions. All training shall include written and/or video materials that shall remain the property of Owner. If materials are written, they shall be provided in quantities sufficient for each person trained; if materials are video, one (1) copy of each will be required. The administration/maintenance training shall include, but not be limited to, the following:
1. Review of all deliverables including as-built documentation, drawings, test results.
 2. Review of all warranty information.
 3. Site inspection of MDF and IDF room rack and cabinet equipment layouts

3.13 FINAL ACCEPTANCE

- A. The Owner or Owner's representative may visit the site during the installation of the system to ensure that correct installation practices are being followed.
- B. The Owner or Owner's representative will conduct a final job review once the Contractor has finished the job. Review will take place within one (1) week after the Contractor notifies Owner.
- C. Two (2) copies of all certification data and drawings for all identifications shall be provided to the Owner before the Owner's review.
- D. The Owner or Owner's representative will review the installation and certification data prior to the system acceptance.
- E. The Owner or Owner's representative may test some of the systems features to ensure that the certification data is correct. If a substantial discrepancy is found, the Owner reserves the right to have an independent consultant perform a certification of the entire system. If such a procedure is undertaken, the cost of the testing will be billed back to the Contractor.
- F. If repairs or adjustments are necessary, the Contractor shall make these repairs at his own expense. All repairs shall be completed within ten (10) days from the time they are discovered.
- G. The Contractor shall provide two (2) copies of an "operating and servicing manual" for the system within fourteen (14) calendar days of Owner's final acceptance of the system. The manuals shall be bound in flexible binders. All data shall be printed material or typewritten. Each manual

will include the following: instructions necessary for proper operation and servicing of the system; complete as-built installation drawings of the system (11"x17"); equipment specification cut sheets, complete performance test data, complete warrantee information and replacement parts list with current prices listed, contact information for repair and warranty work requests.

1. The Contractor shall hand to the Owner a copy of any applicable installation specific software configurations including all log-in passwords on CD or USB drive in .docx format.

END OF SECTION

SECTION 27 5123
PUBLIC ADDRESS INTERCOMMUNICATIONS SYSTEM

PART 1 GENERAL

1.01 INCLUSION OF GENERAL CONDITIONS

- A. The applicable provisions of Division 1 and the General Conditions, Supplementary Conditions, and General Requirements are a part of these specifications.

1.02 SCOPE OF WORK

- A. Modify, expand, and revise the existing system and provide additional materials, labor, equipment, testing, and documentation for a complete public address (PA), clock, and intercom system including, but not limited, to the following:
 - 1. Connection to existing public address, intercom, clock main console.
 - 2. Modifications to main control console (existing)
 - 3. Room speakers.
 - 4. Exterior speakers.
 - 5. Cabling, terminations, and connections.
 - 6. Telephone stations and handsets.
 - 7. Room clocks
- B. Provide testing, final commissioning and Owner training.

1.03 RELATED WORK

- 1. Section 26 00 00: Common Work Results for Electrical
- 2. Section 27 10 00: Structured Cabling System

1.04 QUALITY ASSURANCE

- A. The equipment, devices, and systems to be supplied by a single Contractor.
- B. The Contractor shall hold the necessary valid C-10 California State Electrical Contractors License.

1.05 SUBMITTALS

- A. Provide submittals for the following:
 - 1. Amplifiers and expansion modules
 - 2. Intercom handsets
 - 3. Clocks
 - 4. Room Speakers
 - 5. Outside paging speakers
 - 6. Backboxes and specialty rough-in items
 - 7. Wire, cable, jacks, and termination fields.
- B. Point-to-point wiring diagrams
 - 1. Plan drawing
 - 2. Show all devices, interconnections, and wire type
 - 3. Identify devices according to name, function and manufacturer's catalog numbers, and indicate their locations on the drawings.
 - 4. Show connections to existing Main console
 - 5. Scale: 1/8" = 1'-0"

- C. Riser diagram:
 - 1. Show all devices on riser diagram
 - 2. Diagram to represent system topology
- D. The record drawings shall include a functional block diagram and a point-by-point diagram of components, devices, and interconnections.

1.06 WARRANTY

- A. Warranty the complete fully functional PA/Intercom system
 - 1. Wiring, equipment, and connections shall be free from defects in workmanship and materials.
 - 2. The warranty shall be effective for a period of one (1) year and shall commence at the date of acceptance of the system.
 - 3. All labor and material costs to be included.
- B. The Contractor shall make available, and maintain, a radio dispatched mobile service department capable of furnishing equipment inspection and timely service at the Owner's location.
- C. The Contractor to offer a service contract for the maintenance of the system beyond the warranty period.

1.07 PERFORMANCE AND FUNCTIONS

- A. The communications system shall provide a comprehensive microprocessor controlled, multiple talkback network between telephone stations and intercom speakers.
 - 1. There shall be one 12-Watt talkback amplifier and one 20-Watt paging amplifier for every 24 speaker stations in the system.
 - 2. Provide remote booster amplifiers where required.
- B. The speaker control central processor and switching unit shall be of the modular plug-in printed circuit board type, using HMOS microprocessor and TTL logic with HCMOS memory and sensing.
 - 1. CMOS circuitry shall be protected with transient suppression devices on all inputs and outputs.
 - 2. Non-volatile EPROM shall store field programmable memory.
- C. The system shall provide no less than the following features and functions:
 - 1. Complete DTMF signaling, dial tone and busy signals to the telephone control microprocessor.
 - 2. Amplified-voice communication with loudspeakers from any system telephone with automatic VOX switching. The system shall provide up to 8 simultaneous amplified-voice intercom communications over staff loudspeakers.
 - 3. The system shall be expandable to over 200 total stations.
 - 4. Provide system-wide emergency all-call feature. The emergency all-call shall be accessed at designated staff or administrative phones or by Emergency handset or by the activation of contact closure (which shall also give program input #3 emergency status). The emergency call-call shall capture complete system priority, shall be transmitted over all speakers, and shall activate an external relay for control of external functions.
 - 5. Provide four (4) built-in alarm tones, each accessed by dialing a three-digit number from designated administrative telephones.
 - 6. Provide four (4) external driver outputs, for activation of television system switching and other external control functions as specified, accessible by dialing a pre-determined number from designated administrative telephones or automatically programmed in software, to be determined by the Owner.

7. Provide integral program material interface which shall accept up to 3 program /control modules. This shall contain input modules for program sources and digital announcement messages as specified herein and shall allow for input matching and level control of program into the system speakers. Program distribution control shall be made available to authorized system telephones as allowed by programming.
8. The system shall provide for field-programmable three or four-digit architectural speaker station numbers, to match the building architectural numbers.
9. An architectural-number/station-number cross-reference shall be field-accessible to facilitate service.
10. There shall be an automatic level control for return speech during amplified-voice communications.
11. Each station loudspeaker shall be assigned to any of eight paging zones, plus all call. It shall be possible via programming to exclude a station from all-call paging.
12. Each station loudspeaker shall be assigned to any of eight time-signaling zones. These zones shall be independent of paging zones.
13. There shall be 8 time-signaling schedules with a total of 1048 user-programmable events. Each event shall sound one of 8 user-selectable tones. It shall be possible to assign each schedule to a day of the week, or manually change schedules from a designated administrative telephone. It shall also be possible to assign relay control to the time events.
14. An internal program clock (with battery back-up) shall be included in the system. It shall be possible to synchronize the program clock with an external master clock.
15. There shall be a pre-announce tone signal at any loud-speaker selected for amplified-voice communication. The pre-announced tone shall be disabled by programming.
16. There shall be a periodic privacy tone signal at any loud-speaker selected for amplified-voice communication. The privacy tone shall be disabled by programming.
17. There shall be an automatic disconnect to prevent tying up communications channels. When a telephone is lifted from its cradle and does not initiate a call within ten (10) seconds, the station shall receive a busy signal.
18. The entire system shall include diagnostic / programming software for system testing and for full remote maintenance.
1. The system will also provide, via field programming, for the disconnect of the speaker when its associated telephone is lifted from the cradle. The system shall allow individual paging of a single classroom speaker from a classroom phone by simply dialing "*" and the 3 digit room number. Systems which do not offer such selective paging shall not be acceptable.
19. The telephone will be capable of generating an emergency call by flashing the hook button three times. Emergency calls can be programmed to ring a single administrative phone.
20. Any classroom telephone will also be allowed to access any one of the three program sources and turn on and off the program sources to that related speaker.
21. It shall be possible to configure the system with non-dial handsets, call switches, administrative display phones and speakers. It shall be possible to program each station location as a staff station (handset or speaker and call-in switch), or administrative station (keypad dialing DTMF telephone and alphanumeric display panel).
22. The staff stations may be programmed to ring one administrative telephone during day hours and one administrative telephone during night hours. Day and night hours shall be user programmable.

PART 2 PRODUCTS

2.01 RACEWAYS, PATHWAYS, AND BOXES

- B. Provide required conduit, wireway, junction boxes, pull boxes.

2.02 MAIN CONSOLE

- C. Existing Bogen Multi-Comm 2000 (Contractor shall verify if system has been upgraded to Quantum. If so, Contractor shall provide all components as needed to integrate with the Quantum system.)
- A. Provide modifications to accommodate new speakers and clocks.
- B. Provide new amplifiers for remote buildings to maintain signal level within nominally acceptable values.

2.03 TELEPHONES

- A. Wall or desk mounted as required
- B. DTMF dialing with 12- pushbutton keypad
- C. Housing molded high impact ABS plastic
- D. Color: beige
- E. Dynamic receiver and carbon transmitter
- F. Coil cord
- G. Manufacturer: Bogen MCWESS and MCESS

2.04 SPEAKERS

- A. Interior speakers:
 - 1. 8" cone type loudspeaker
 - 2. 6 oz Ceramic magnet
 - 3. Frequency response: 50 Hz to 12 KHz
 - 4. Power rating: 7 Watts
 - 5. Axial sensitivity: 95 dB
 - 6. Impedance matching transformer: matches 8 Ohm speaker to 25 or 70 Volt line with power taps of 4, 2, 1, 1/2, 1/4 and 1/8 Watts.
 - 7. Grille: steel type sized for 8" cone type speaker. Diameter 13". White semi-gloss enamel finish.
 - 8. Tile bridge: load bearing T-bar support to sustain weight of 8" speaker and enclosure.
 - 9. Manufacturer: Bogen
 - a. S86 speaker
 - b. S86T725 transformer
 - c. PG8W grille
 - d. TB8 tile bridge.
- B. Exterior Weatherproof Speakers:
 - 1. Double re-entrant type with compression driver mounted within waterproof housing.
 - 2. Surface mount
 - 3. Power rating: 20 Watts equalized
 - 4. Frequency response: 475 Hz to 14KHz
 - 5. SPL: 121 dB (4 foot on axis, 15 Watt input)
 - 6. Dispersion: 160 degrees
 - 7. Impedance: 8 Ohms
 - 8. Transformer with power taps at 15, 7.5, 3.8, 2, and 1
 - 9. Heavy duty construction, grey baked epoxy finish
 - 10. Baffle: recessed vandal resistant, heavy duty security grille 1/4" thick cast aluminum.

11. Enclosure: recessed enclosure fabricated of -.036 CRS undercoated to eliminate acoustical and mechanical resonance. Conduit knockouts; adjustable to final tile or plaster finish.
12. Manufacturer:
 - a. Atlas, Soundolier APF-15T speaker
 - b. Lowell SQLK-8-APF recessed baffle (with special tools)
 - c. Lowell P875X-6 enclosure.

2.05 CLOCKS

- A. Synchronous wired, analog type, semi-flush wall clock
- B. Dial dimensions: 12.12" diameter
- C. Overall projection from the wall: 1.62"
- D. Classroom clocks shall be Lathem model SS12RFAB 24 Volt A/C. Clock back box shall be Lathem model SAM0756.
- E. Synchronous motor and brass movement for local timekeeping and a correction coil for synch with a master control unit.
- F. Manufacturer: Lathem

2.06 COMBINATION CLOCK SPEAKER ENCLOSURES

- A. Recessed enclosure for common clock/speaker applications
- B. Heavy gauge cold rolled steel construction
- C. Acoustically treated interior surface
- D. Knockouts: 1/2" and 3/4"
- E. Low voltage center barrier
- F. Rust retardant grey primer finish
- G. Hinged baffle
- H. Provide wire guard for gymnasium locations
- I. Manufacturer: Bogen PC-312 enclosure with MC-300 baffle

2.07 SYSTEM CABLING

- A. PA/Intercom cabling: cabling for classroom speakers and handsets shall consist of 1 twisted pair #22 solid copper under jacket and 1 twisted pair #22 under shield solid copper with overall PVC jacket, West-Penn #253.
- B. Horizontal telephone cable: Category 5e UTP cable: Unshielded, 4 twisted-pair, 24 AWG copper, Enhanced Category 5e, NEC Article 800 type CM rated, non-plenum type, extended performance, tested to 400MHz, Mohawk MegaLAN 400 #M55989.
- C. Paging speaker cabling: Cabling to separate paging speaker installed in hallways, corridors, and building exterior shall be single twisted pair, shielded, #20 AWG stranded copper, West-Penn #292.
- D. No splices are permitted except in approved junction boxes. All terminations shall be made on telephone type punch blocks or at specified devices. Display, speaker, and specialty cables shall be as required for best operation under manufacturer recommendations.

2.08 SYSTEM TERMINATIONS AND ORGANIZATION

- A. Jacks: All station device terminations (except speakers) shall be terminated on USOC standard modular jacks. Jacks for wall mounted telephones shall have lugs for securely attaching the instrument to the wall.
- B. Where instruments are to be wall-mounted, provide mounting studs on the faceplate. Faceplates are to be stainless steel AT&T #630B.
- C. Backboards: Provide 4' x 4' painted plywood backboards for mounting of system cross connect field. Mount as shown on the plans. Provide Modular Termination backboards with 110 type terminal blocks as required to terminate all cables. Provide Distribution and cross connect backboards equal to 66M Harris Series for all cross connect wiring.
- D. Terminal Cabinets: A terminal cabinet with a sufficient number of bushed openings shall be installed in the wall behind the Intercom Control Console equipment rack. Cabling between the equipment rack and the main junction box shall be provided with telephone type 50 pin connectors to allow ease in console connections, disconnection's and service. Satellite terminal junction boxes shall be provided as needed to allow for station terminations in each building.

2.09 SYSTEM ACCESSORIES

- A. The communications Contractor shall furnish all equipment, accessories and material required for the installation of a comprehensive clock/signal/telephone communications system. Include all material, devices, equipment, connections, and wiring not specified or described herein but necessary for the proper operation of the system.

PART 3 EXECUTION

3.01 WIRING

- A. Obtain the services of a California-licensed Sound Contractor to install the system, make connections, provide tuning and adjustments and make final tests.
- B. All systems shall be provided and installed by a Factory Authorized Dealer for the equipment.
 - 1. All systems shall be supplied and installed by one Contractor.
 - 2. Certificates of authorization showing that the submitting Contractor is qualified to install and maintain all of the types of equipment shall be included in the Contractor's submittal package.
- C. A comprehensive, documented communications wiring system is to be installed.
 - 1. Wiring is to be identified by room number, segregated, neatly laced, and terminated on telephone type punch blocks.
 - 2. Back boards and cross connect fields shall be neatly organized as to function, (i.e.: intercom, telephone stations, data network etc.).
 - 3. All termination points are to be labeled with function.
 - 4. Data cables shall be certified as usable and checked using the cable certification sheet.
 - 5. Data cables shall be labeled as per the data identification scheme.
- D. Splicing
 - 1. Make splices at punch-down blocks to be provided and mounted on backboards at the MDF and IDFs.
 - 2. Splices are not permitted in underground pull boxes.
 - 3. Provide machine generated labels at all termination

3.02 TESTING

- A. Prior to connection of any terminal equipment, all cables shall be tested as per REA spec. PC-4. Cables shall be tested for Opens, Splits, Crossed Pairs, Shorts to Ground and Shield Continuity.
 - 1. All defective cabling is to be replaced prior to device hook-up.
- B. Upon completion of the installation:
 - 1. Test each room station speaker, handset or call switch for proper operation.
 - 2. All telephones, programming and functions are to be tested for proper operation.
 - 3. All emergency and program functions are to be tested.
 - 4. Any malfunction shall be corrected prior to final acceptance.

3.03 TRAINING

- A. The Contractor shall instruct personnel designated by the Owner in the proper use, basic care, and maintenance of the equipment.
- B. Such training shall be provided as an integral component of the system.
- C. These training sessions will be on both the general operation and basic programming of these systems.
- D. The Contractor will also provide the Owner with limited programming access to the system. This programming will be executed utilizing plain English menus, from any authorized administrative phone, to assist the Owner with all necessary changes.
- E. The main programming for the system shall be PC/Windows based for ease of operation. Systems that do not use plain English menus and Windows based PC programming and are only programmable from a laptop PC will not be accepted as equal.

3.04 SYSTEM PROGRAMMING

- A. Provide complete programming of the existing system to accommodate new devices.
- B. Program clocks to suit district time schedule.
- C. Program system for new telephone handset use.
- D. Program system operational zones.

3.05 SPEAKER TRANSFORMER TAPS

- A. Set transformer taps on all speakers
- B. Indicate final tap setting on as-built drawings
- C. Test each tap for adequate sound level dB over normal space ambient.

END OF SECTION

**SECTION 281600
INTRUSION ALARM SYSTEM**

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. The work under this section includes all final design, all labor, material, equipment, supplies, labor, testing, and accessories required to expand the existing campus Intrusion Alarm System as indicated on the drawings and as specified herein.
- B. It is the intent of the Drawings and Specifications, which are presented in a "design-build" format, for the Contractor to design, provide and install a complete, fully operational, and tested system.
- C. All miscellaneous system components including, but not limited to, cables, termination equipment, punch blocks, patch panels, backboards, and any other related items shall be furnished and installed complete under this section, such that the system shall perform all functions listed herein in compliance with all of the specified requirements.
- D. The Intrusion Alarm System shall include, but not limited to, the following subsystems / products:
 - 1. See Products Section.

1.02 RELATED WORK

- A. Documents affecting work of this section include, but are not necessarily limited to, General Conditions, Supplementary Conditions and sections of Divisions 1 and 16 of these specifications.
- B. All applicable portions of Sections 260000 and 271000 shall apply to this section as though written herein completely.

1.03 GENERAL REQUIREMENTS

- A. The contractor shall hold a valid State of California C-7 Low-Voltage, and a valid Department of Consumer Affairs Bureau of Security and Investigative Services (BSIS) "Alarm Company Operator's" License, shall have completed at least 20 projects of equal scope, shall have been in business of furnishing and installing systems of this scope and magnitude for at least five (5) years, and capable of being bonded to assure the owner of performance and satisfactory service during the guarantee period.
- B. The contractor shall hold all other licenses required by the legally constituted authorities having jurisdiction over the work.
- C. All work shall be performed under the supervision of a company accredited by the basic equipment manufacturer and such accreditation must be presented with the contractor's bid submittal.
- D. The installing contractor shall be a factory authorized distributor and warrantee station for the brand of equipment offered and shall maintain a fully equipped service organization capable of furnishing adequate repair service to the equipment. The installing contractor shall maintain a spare set of all major parts for the system at all times. All circuit boards, amplifiers and control sub systems shall be 100% backed up with stock at contractor's shop.
- E. All of the equipment in this specification shall be furnished and installed by the Authorized Factory Distributor of the equipment. The Contractor shall furnish a letter from the manufacturer of all major equipment, which certifies that the installing contractor is the Authorized Distributor and that the equipment has been installed according to factory intended practices. The

Contractor shall also furnish a written guarantee from the manufacturer that they will have a service representative assigned to this area for the life of the equipment.

- F. All system equipment/systems supplied shall be listed by Underwriter's Laboratories under UL Standard 1459. A copy of the UL listing card for the proposed system shall be included with the contractor's submittal.
- G. All of the equipment in this specification shall be furnished and installed by the Authorized Factory Distributor of the equipment with the most current software package available at the time of installation. At the time of Owner Acceptance of the installation, all equipment shall include any and all updated software revisions. In addition, when the software is available in disk format, a backup copy of the most up to date revision, in disk format, shall be handed to the Owner at the completion of the project.
- H. The Contractor shall pay all charges (including travel, lodging, meals, etc.) required to provide factory certification, equal to that of a Factory Authorized Distributor of the substituted item, for two (2) selected Owner's representatives. This training shall occur at the primary factory of the substituted item in question and shall allow the selected Owners representatives to provide any and all Factory / Manufacturer Approved repairs, services, software upgrades, etc... without affecting any available or applicable Manufacturer Warranties.

1.04 QUALITY ASSURANCE

- A. In order to maintain a high degree of quality assurance, the contractor shall, without exception, use the parts and supplies as specified in this specification.
- B. All new products and components installed on this project must match existing manufacturer brand on site. Substitutions shall not be accepted.

1.05 SUBMITTAL AND MANUAL

- A. Comply with all requirements of the General Conditions, Supplementary Conditions and applicable sections of Divisions 1 and 16 of these specifications.
- B. Additional requirements of this section are:
 - 1. Within thirty-five (35) calendar days after the date of award of the Contract, the Contractor shall submit eight copies of the complete submission to the Architect for review. Electronic submittals (PDF) are acceptable in lieu of printed copies.
 - 2. The submission shall consist of five (5) major sections with each section separated with index tabs. Each page in the submission shall be numbered chronologically and shall be summarized in the index.
 - 3. The first section shall be the "index" which shall include the project title and address, name of the firm submitting the proposal and name of the Architect.
 - 4. The second section shall include a copy of the Contractor's valid C-7 California State Contractors license, a list of twenty (20) projects of equal or greater scope, and a list of proposed instrumentation to be used by the contractor. In addition, provide a written notice guarantying the provision of the requested warranty.
 - 5. The third section shall contain the comparative specification listing, including a complete listing of the characteristics of the equipment to be furnished next to all of the specified equipment's features and functions as stated in the specifications and data sheets.
 - 6. The fourth section shall contain an original factory data sheet for every component in the specifications.
 - 7. The fifth section shall contain a designation schedule for each Structured Cabling System location and complete 1/8" = 1'-0" scale drawing showing system wiring plans.
- C. Failure to comply with all of the requirements listed above will result in the rejection of the entire submittal package.

- D. The Contractor shall provide two copies of an "Operating and Servicing Manual" for the system. The manuals shall be bound in flexible binders. All data shall be printed material or typewritten. Each manual shall include the following: Instructions necessary for the proper operation and servicing of the system; complete as-built installation drawings of the system; a wiring destination schedule for each circuit leaving for each piece of equipment; a schematic diagram of major components with all transistor and IC complements and replacement number.

1.06 GENERAL SYSTEM PRODUCT, INSTALLATION AND OVERALL SYSTEM WARRANTY

- A. Prior to Owner acceptance, the contractor shall provide to Owner, a manufacturer's product and performance warranty. This will require a submittal of the required pre-job certification registration forms as well as the required project closing information. The Owner will only acknowledge acceptance upon submittal of a valid manufacturer's warranty.
- B. The warranty shall commence from the date of final written acceptance by the Owner.
- C. All conditions for obtaining the manufacturer's warranty shall be the sole responsibility of the contractor.
- D. The contractor shall maintain a competent service organization and shall, if requested, submit a service maintenance agreement to the owner after the end of the guarantee period.
- E. typewritten notice shall be posted at the equipment rack that shall indicate the firm, address and telephone number to call when service is necessary. The notice shall be mounted in a neatly finished metal frame with a clear plastic window and securely attached to the inside of the door.

1.07 SPECIFIC SYSTEM PRODUCT, INSTALLATION AND OVERALL SYSTEM WARRANTY

- A. The entire system shall be warranted free of mechanical or electrical defects for a period of one (1) year after final acceptance of the installation. Any material showing mechanical or electrical defects shall be replaced promptly at no expense to the Owner.

1.08 APPLICABLE CODES AND STANDARDS

- A. 2001 Building Standards Administrative Code, Part 1, Title 24 C.C.R.
- B. 2001 California Building Code (CBC), Part 2, Title 24 C.C.R.;
- C. (1997 Uniform Building Code vols. 1-3 & 2001 California Amendments).
- D. 2014 California Electrical Code (CEC), Part 3, Title 24 C.C.R.;
- E. (2014 National Electrical Code and 2001 California Amendments)
- F. 2001 California Fire Code (CFC), Part 9, Title 24, C.C.R.;
- G. (1997 Uniform Fire Code and 2001 California Amendments)
- H. 2001 California Referenced Standards Code, Part 12, Title 24, C.C.R.
- I. 1990 Title 19 C.C.R., Public Safety, State Fire Marshall Regulations.

PART 2 SYSTEM EQUIPMENT SPECIFICATION

2.01 ACCEPTABLE MANUFACTURERS

- A. All equipment listed herein will be by DMP to match existing system on campus. No substitutions shall be accepted.
- B. It is the responsibility of the bidder to ensure that the proposed product meets or exceeds every standard set forth in these specifications and the equipment's technical data sheets.

- C. The functions and features specified are vital to the operation of this facility. Therefore, inclusion of a component's manufacturer in the list of acceptable manufacturers does not release the contractor from strict compliance with the requirements of this specification.
- D. All basic electronic equipment (not including cable) specified herein shall be produced by a single manufacturer of established reputation and experience who shall have produced similar apparatus for at least three (3) or more years and who shall be able to refer to similar installations rendering satisfactory service.

2.02 SYSTEM FUNCTIONS AND CAPABILITIES:

- A. The system shall consist of dual technology motion detection devices connected to detect intrusion into the covered areas. The system shall be zoned per device. Zone numbering and device naming shall be provided by the district.
- B. The system shall be capable of interior / perimeter partitioning.
- C. The system shall be capable of master and associate operation.
- D. The system shall be capable, via the District's WAN to a remote computer, of off-site programming and diagnostic functions by the Owner, distributor or manufacturer personnel. It shall also be possible to facilitate remote software changes. Contractor to provide, install, and program a copy of the Remote Account Manager software to accomplish this task.

2.03 PRODUCTS:

- A. Existing DMP XR550 control panel. Contractor shall provide additional zone expanders and/or control panels, relay output module, batteries and power supplies as required to accommodate all devices on the campus. Contractor shall field verify existing system prior to bid. Include all costs in base bid. If an additional control panel is required, provide with a minimum of 24 Amp hours of battery backup.
- B. Motion sensor shall be tri-technology, ceiling mounted, Bosch #DS9370, or as directed by district. Color shall be white.
- C. Motion sensor cable shall be per motion sensor manufacturer's requirements.
- D. Communication bus cable shall be 4-conductor, wet location rated, West Penn #AQ245 or equal. If cable length exceeds 500 feet, provide #18 AWG gauge conductors.
- E. Independent Zone Control (KeyPad) shall be DMP ThinLine Series #7063N-W. Color white. Locate per District's instruction and where indicated on plan drawings. Provide power supply as required when cable length exceeds 500 feet from keypad to system control panel.
- F. When keypad cable length exceeds 500 feet from keypad to system control panel, use #18 AWG conductors, minimum.
- G. Power supply for motion sensor shall be as required by the motion sensor manufacturer, with automatic switchover to battery on AC fail. Locate in contractor provided terminal cabinet.
- H. Transformer for motion sensor power supply shall be plug in type, class 2, 120 VAC 60 Hz input, 15 VAC output, or as required by motion sensor manufacturer's recommendation.
- I. Back up battery for motion sensor power supply shall be provided by the contractor and housed in a terminal cabinet.
- J. Door Contacts - Exterior Steel Door – Recessed, Dual Pole Dual Throw, DMP 1076D.
- K. Protect any roof hatches in each building with magnetic contacts, Armored Amseco #ODC-59A series, with mounting as necessary to adapt to doors.

PART 3 EXECUTION

3.01 GENERAL INSTALLATION REQUIREMENTS

- A. The wiring of the system shall be executed in accordance with the drawings and the equipment manufacturer's wiring diagrams. Should any variations in these requirements occur, the contractor shall notify the architect before making any changes. It shall be the responsibility of the factory-authorized distributor of the approved equipment to install the equipment and guarantee the system to operate as per plans and specifications.
- B. Furnish all conduit, junction boxes, conductors, equipment plugs, terminal strips, etc., and labor to install a complete and operable system.
- C. The cables within the rack or cabinets shall be carefully cabled and secured with Velcro-type fasteners. All cables shall be numbered for identification.
- D. Splices of conductors in underground pull boxes are not permitted.
- E. The labor employed by the contractor shall be regularly employed in the installation and repair of intrusion alarm/communication systems and shall be acceptable to the owner and architect to engage in the installation and service of this system.
- F. The contractor shall thoroughly clean all equipment and materials. All exposed parts of the equipment, cabinets, and other equipment shall be left in a clean condition, unblemished and free of all dirt, dust, smudges, spots, fingerprints, etc. Daily, the contractor shall remove all debris and rubbish occasioned by the electronic systems work from the site. Daily, the contractor shall thoroughly clean all buildings of any dirt, debris, rubbish, marks, etc., caused by the performance of this work.
- G. The system must meet all local and other prevailing codes.
- H. All cabling installations shall be performed by qualified technicians.
- I. All cabling shall be splice free.
- J. Cable lubricant to aid in the installation of cables in conduits, shall be manufactured specifically for communications and security cables. The use of "Yellow 77" lubricant is prohibited. Contractor shall verify the acceptability of any cable lubricant to be used with the cable manufacturer, prior to using such a lubricant.
- K. Plenum rated cable may be run exposed above accessible ceilings, provided the cabling is supported independent of other utilities such as conduits, pipes, and the ceiling support systems. The cables shall not be laid directly on the ceiling panels. Cables shall be independently supported by dedicated j-hooks spaced no further than five (5) feet apart. The use of tie-wraps to secure cables above the ceiling space is prohibited. The cable jacket composition must meet local and all other prevailing fire and safety codes.
- L. All firewalls penetrated by structured cabling shall be sealed by use a non-permanent fire blanket or other method in compliance with the current edition of National Fire Protection Association (NFPA) and the California Electric Code (CEC) or other prevailing code. The contractor must not use concrete or other non-removable substance for fire stopping on cable trays, wireways or conduits. Contractors who use this method will be required to replace all cables affected and provide the original specified access to each effected area.
- M. All equipment racks shall be bolted to the floor by the contractor once the Owner determines the exact location for each rack. The earthquake mounting brackets that come with each relay rack kit shall be screwed to studs, not drywall. All equipment shall be serviceable in the racks final location – the need to unbolt racking equipment to access or service equipment is not acceptable. All equipment cabinets shall be screwed to the structural walls with a minimum of four (4) fasteners to the wall studs or plywood backboard, not drywall. The use of drywall screws is prohibited.
- N. Low voltage systems shall be independently suspended. Do not combine low voltage systems on the same hangers.

3.02 SPECIFIC SYSTEM INSTALLATION REQUIREMENTS

- A. The installer shall, upon completion of the system installation, adjust all controls, etc., to provide a system operating at maximum capability.
- B. Submit block diagram and shop drawings of all equipment associated with system installation in accordance with the submittal requirements of Division 1 and 16.
- C. The system shall be programmed by the District to annunciate, in alpha-numeric format, the device type and device location (in room name format) for all alarm, trouble, service, and faulted conditions.

3.03 GENERAL TESTING REQUIREMENTS

- A. Provide all instruments for testing and demonstrating in the presence of the Owner's inspector that the frequency response is as stated in the factory data sheets. Check all circuits and wiring to verify they are free of shorts and grounds.

3.04 SPECIFIC SYSTEM TESTING REQUIREMENTS

- A. System shall detect the entry through a door, switched door and/or the motion of a body taking not more than four steps in an area secured with motion detection equipment where entry doors or windows are possible access. System shall be complete and properly operating prior to calling for the test. The Inspector, Contractor and Engineer shall walk test system at District's option and Contractor shall make minor satisfactory adjustments to the system in the presence of the inspector. Contractor shall coordinate the time of test with the District inspector. This test shall be performed during a time when there are no other persons on the site.
- B. Test equipment: Provide two portable radio transceivers to be used when walk testing the security detection system. The transceivers shall be capable of communication throughout the entire site.

PART 4 FINAL ACCEPTANCE

- A. The Owner or Owner's representative may visit the site during the installation of the system to ensure that correct installation practices are being followed.
- B. The Owner or Owner's representative will conduct a final job review once the Contractor has finished the job. This review will take place within one (1) week after the Contractor notifies the Owner.
- C. Two (2) copies of all certification data and drawings for all identifications shall be provided to the Owner before the Owner's review.
- D. The Owner or Owner's representative will review the installation and certification data prior to the system acceptance.
- E. The Owner or Owner's representative may test some of the systems features to ensure that the certification data is correct. If a substantial discrepancy is found, the Owner reserves the right to have an independent consultant perform a certification of the entire system. If such a procedure is undertaken, the cost of the testing will be billed back to the Contractor.
- F. In the event that repairs or adjustments are necessary, the Contractor shall make these repairs at his own expense. All repairs shall be completed within ten (10) days from the time they are discovered.
- G. The Contractor shall provide not less than eight (8) hours for site instruction of personnel in the operation and maintenance of the installed systems. This instruction time shall be divided as directed by the Owner.

- H. The Contractor shall hand to the owner a copy of any applicable installation specific software configurations in disk format.

END OF SECTION

SECTION 28 31 00
FIRE DETECTION AND ALARM SYSTEM

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. The work under this section includes all final design, all labor, material, equipment, supplies, labor, testing, and accessories required to furnish and install a complete Fire Alarm System as indicated on the drawings and as specified herein.
- B. All miscellaneous system components including, but not limited to, cables, termination equipment, punch blocks, patch panels, backboards, and any other related items shall be furnished and installed complete under this section, such that the system shall perform all functions listed herein in compliance with all of the specified requirements.
- C. The Fire Alarm System shall include, but not limited to, the following subsystems / products:
 - 1. All equipment listed herein will be by Silent Knight/Farenhyt Series by Honeywell to match existing currently on campus. No substitutions allowed. The Fire Alarm Control Panel (FACP) or panels shall be microprocessor-based and network capable. The Fire Alarm System shall be integrated with the existing Facility Wide Silent Knight Farenhyt Fire Alarm Network. The FACP shall be compliant with UL 864, 9th edition.
 - a. The fire alarm system shall be furnished and installed by a Honeywell/Silent Knight Farenhyt Factory Authorized Distributor. Systems furnished and/or installed by contractors who are not Factory Authorized Distributors of Farenhyt products shall be considered in non-compliance with this specification and subject to replacement at the expense of the Prime Contractor.
 - 1) The Honeywell Farenhyt Series Factory Authorized Distributor shall furnish all labor, materials, appliances, cabling, tools, equipment, facilities, transportation and services necessary for and incidental to the performance of all operations in connection with furnishing, delivery and installation of all equipment, wiring, programming, configuration, testing and training required by this Section, complete as indicated in the applicable Contract Drawings and/or specified herein.
 - (a) This specification provides the requirements for the installation, programming, configuration, testing and maintenance of a complete analog addressable fire alarm system. This system shall include, but shall not be limited to:
 - (1) Control panel
 - (2) System cabinet
 - (3) Power supply
 - (4) Voice Command Module
 - (5) Microphone
 - (6) Network Interface Module
 - (7) Digital Signaling Line Circuits (SLC)
 - (8) Notification Appliance Circuits (NAC)
 - (9) RS-485 Serial Communication Bus (S-bus)
 - (10) Annunciators both integral and remote
 - (11) Batteries
 - (12) Wiring
 - (13) Conduit
 - (14) Associated peripheral devices

- (15) Other relevant components and accessories required to furnish and install a complete and operational fully automatic, addressable reporting Life Safety System.
 2. The fire alarm system shall be capable of providing, at a minimum, the following:
 - a. Fire Alarm Control Panel (FACP)
 - b. Built in dual line, IP and optional cellular digital communicator, UL listed for Remote Station, Proprietary and Central Station fire alarm systems.
 - c. Analog addressable initiation devices
 - d. Analog addressable monitor and/or control modules
 - e. Notification appliances
 - 1) Compatible with combination horn/strobe two-wire synchronized circuit.
 - f. Notification Appliance Circuit (NAC) remote power supply
 - 1) Combination horn/strobe two-wire circuit.
 - g. Built-in synchronization capabilities
 - h. Voice Evacuation capability
 - i. Firefighter Telephone capability
 3. Any material and/or equipment necessary for the proper operation of the system, which is not specified or described herein, shall be deemed part of this Specification.
 4. The Analog Addressable Fire Alarm System specified herein shall be connected to a UL Listed Central Station Monitoring Company.
 - a. Contractor shall coordinate with the Owner or his representative to obtain two telephone lines for code required offsite monitoring.
 5. Contractor shall offer code required fire alarm system inspection and maintenance contract.
- D. All work shall be in compliance with CBC/CFC Chapter 9 and NFPA 72.

1.02 RELATED WORK

- A. Documents affecting work of this section include, but are not necessarily limited to, General Conditions, Supplementary Conditions and sections of Divisions 1 and 26 of these specifications.
- B. All applicable portions of Section 26 00 00 shall apply to this section as though written herein completely.

1.03 QUALIFICATIONS

- A. Equipment
 1. This specification is based on the equipment of manufacturer(s) who have been approved by the Owner and the Manufacturer(s) herein named shall be considered as meeting the requirements of this specification.
 2. The equipment manufacturer shall be a United States manufacturer, who has been regularly engaged in the manufacture of fire alarm systems for at least twenty-five (25) years.
 3. The Facility Standard for Fire Alarm Systems is Honeywell/Silent Knight Farenhyt Series.
 - a. Equipment provided for this project shall be the product of Farenhyt Series by Honeywell. No substitutions shall be approved.
 - b. Contact Honeywell/Silent Knight for a list of Factory Authorized Distributors of the products specified herein.
 4. It is the Contractor's responsibility to meet the entire intent of these specifications. Deviations from the specified items shall be at the risk of the Contractor until the date of final acceptance by the Architect, Engineer and the Owner's representative. All costs for

removal, relocation or replacement of a substituted item shall be at the risk of the Prime Contractor.

5. All equipment shall conform to currently adopt applicable codes and ordinances.
6. All equipment shall be California State Fire Marshal (CSFM) listed.
7. All equipment shall bear the label of a Nationally Recognized Testing Laboratory (NRTL) such as Intertek Testing Services NA, Inc. (ITSNA - formerly ETL) or Underwriters Laboratories Inc. (UL) and be listed by their re-examination service.

B. System Supplier/Installer

1. The system shall be furnished and installed by a Honeywell/Silent Knight Farenhyt Select Factory Authorized Distributor who is trained and certified by the Manufacturer in the proper installation, programming, configuration, testing, service and maintenance of the systems specified herein.
2. Subsequent to a successful bid and upon request of the Owner the System Supplier/Installer shall submit a qualification documentation package which shall include the following:
 - a. Evidence of current status as a Honeywell/Silent Knight Farenhyt Factory Authorized Distributor.
 - b. Certificates indicating that a minimum of four (4) technicians have attended and completed all requirements and received certification from the manufacturer's installation and service school.
 - c. A list of twenty (20) completed projects of equal scope, with associated Owners Representative contact names and telephone numbers.
 - d. Evidence of current State of California Contractor's License, C-10.
 - e. Evidence of current State of California Alarm Company Operator License, ACO.
 - f. Per California law all individuals involved in the installation of the fire alarm system shall hold a valid State of California, Division of Apprenticeship Standards (DAS), Fire/Life Safety Technician Certification.
 - 1) Evidence of DAS certification shall be provided immediately upon request at the project site.
 - g. The System Supplier/Installer shall show satisfactory evidence, upon request, that he maintains a fully equipped service organization capable of furnishing adequate inspection, service and maintenance of the system.
 - h. The System Supplier/Installer shall maintain at his facility the necessary spare parts in the proper proportion as recommended by the manufacturer to maintain and service the equipment being supplied.
 - i. The System Supplier/Installer shall be prepared to offer a service contract for the maintenance of the system beyond the warranty period.
 - j. The System Supplier/Installer shall provide proof that they maintain a complete service and maintenance center within 50 miles of the project address. A complete service center shall include replacement parts in stock in the quantities deemed sufficient by the owner or its representatives.

1.04 QUALITY ASSURANCE

- A. In order to maintain a high degree of quality assurance, the contractor shall, without exception, use the parts and supplies as specified in this specification.
- B. The equipment shall be as manufactured by Farenhyt Series by Honeywell.

1.05 1SUBMITTAL AND MANUAL

- A. Comply with all requirements of the General Conditions, Supplementary Conditions and applicable sections of Divisions 1 and 26 of these specifications.
- B. Additional requirements of this section are:

1. Within thirty-five (35) calendar days after the date of award of the Contract, the Contractor shall submit eight copies of the complete submission to the Architect for review.
2. The submission shall consist of five major sections with each section separated with index tabs. Each page in the submission shall be numbered chronologically and shall be summarized in the index.
3. The first section shall be the "index" which shall include the project title and address, name of the firm submitting the proposal and name of the Architect.
4. The second section shall include the following items:
 - a. Contractor's License: A copy of the electronics contractor's valid State of California License.
 - b. Proof of Experience: Proof that the fire alarm contractor has been regularly engaged in the business of fire alarm contracting consisting of, but not limited to, engineering, fabrication, installation, and servicing of fire alarm systems of the type specified herein for at least the past ten (10) consecutive years. Provide a statement summarizing any pending litigation involving any officer or principal of/or the company, the nature of the litigation and what effect the litigation may carry as it relates to this work in the worst case scenario. Non-disclosure of this item, if later discovered, may result, at the owner's discretion, in the contractor bearing all costs and any cost related to associate delays in the progress of the work.
 - c. Insurance Certificates: Copy of fire alarm contractor's current liability insurance and state industrial insurance certificates in conformance with the contract documents.
 - d. Project List: A List containing at least ten (10) California installations completed within the last five (5) years by the fire alarm contractor that are comparable in scope and nature to that specified in the contract document.
 - e. Service Capability: Documentation indicating in detail that the fire alarm contractor has competent engineering, installation, service personnel and facilities with reasonable stock of service parts within 100 air miles of the job site.
 - f. Authorization Letters: Letters from the fire alarm equipment manufacturer stating that the fire alarm contractor is the Factory Authorized Distributor, and is trained and certified for the equipment the proposes to use on this project, and is licensed to purchase and install that software required to provide the specified functions.
 - g. Certification:
 - 1) Proof that the fire alarm contractor is Underwriters Laboratories, Inc. (UL) listed under the classification of "PROTECTIVE SIGNALING SERVICES-LOCAL, AUXILIARY, REMOTE STATION AND PROPRIETARY (UUJS).
 - 2) Apprenticeship Certified – Blue Card for Life Safety System for all personal.
 - 3) Copy of the following (NICET) Certificates. Proof that the certificate holders are a part of the fire alarm contractor's local facility servicing this project and will be actively involved in this project.
 - (a) a) Technician Level 2 minimum of (5).
 - (b) b) Technician Level 4 minimum of (1)
 - h. Proof of Trained Personnel:
 - 1) Documentation that the fire alarm contractor has on staff personnel factory-trained and certified for the equipment proposed for this project. Also, a statement that personnel meeting these qualifications are in the local facility, and will be maintained at that facility throughout the project and the warranty period.
5. The third section shall contain the comparative specification listing, including a complete listing of the characteristics of the equipment to be furnished next to all of the specified equipment's features and functions as stated in the specifications and data sheets. Include CSFM listing sheet for each component.
6. The fourth section shall contain an original factory data sheet for every component in the specifications.

7. The fifth section shall contain complete 1/8" = 1'-0" scale drawing showing system wiring plans.
 - a. Riser Diagram.
 - b. Typical Device Wiring Diagram.
 - c. Wire Legend.
 - d. Battery Calculation for each control panel, power supply, field power supply and network annunciator.
 - e. Voltage drop for each circuit type per building.
 - f. Floor Plans showing all conduits, sizes, quantity of conductors.
 - g. Mounting Height of each devices and back box requirement.
 - h. Zoning and address description legend.
- C. Failure to comply with all of the requirements listed above will result in the rejection of the entire submittal package.
- D. The Contractor shall provide two copies of an "Operating and Servicing Manual" for the system. The manuals shall be bound in flexible binders. All data shall be printed material or typewritten. Each manual shall include the following: Instructions necessary for the proper operation and servicing of the system; complete as-built installation drawings of the system; a wiring destination schedule for each circuit leaving for each piece of equipment; a schematic diagram of major components with all transistor and IC complements and replacement number.

1.06 1GENERAL SYSTEM PRODUCT, INSTALLATION AND OVERALL SYSTEM WARRANTY

- A. Prior to Owner acceptance, the contractor shall provide to Owner, a manufacturers product and performance warranty. This will require a submittal of the required pre-job certification registration forms as well as the required project closing information. The Owner will only acknowledge acceptance upon submittal of a valid manufacturer's warranty.
- B. The warranty shall commence from the date of final written acceptance by the Owner.
- C. All conditions for obtaining the manufacturer's warranty shall be the sole responsibility of the contractor.
- D. The contractor shall maintain a competent service organization and shall, if requested, submit a service maintenance agreement to the owner after the end of the guarantee period.
- E. A typewritten notice shall be posted at the equipment rack that shall indicate the firm, address and telephone number to call when service is necessary. The notice shall be mounted in a neatly finished metal frame with a clear plastic window and securely attached to the inside of the door.

1.07 SPECIFIC SYSTEM PRODUCT, INSTALLATION AND OVERALL SYSTEM WARRANTY

- A. The entire system shall be warranted free of mechanical or electrical defects for a period of one (1) year after final acceptance of the installation. Any material showing mechanical or electrical defects shall be replaced promptly at no expense to the Owner.

PART 2 SYSTEM EQUIPMENT SPECIFICATION

2.01 ACCEPTABLE MANUFACTURERS

- A. All equipment listed herein will be by Silent Knight/Farenhyt Series by Honeywell to match existing currently on campus. No substitutions allowed.

- B. It is the responsibility of the bidder to insure that the proposed product meets or exceeds every standard set forth in these specifications and the equipment's technical data sheets.
- C. The functions and features specified are vital to the operation of this facility. Therefore, inclusion of a component's manufacturer in the list of acceptable manufacturers does not release the contractor from strict compliance with the requirements of this specification.
- D. All basic electronic equipment (not including cable) specified herein shall be produced by a single manufacturer of established reputation and experience who shall have produced similar apparatus for at least three or more years and who shall be able to refer to similar installations rendering satisfactory service.

2.02 SYSTEM REQUIREMENTS

- A. Basic Performance and Capabilities
 - 1. System shall be fully programmable and configurable on site to accommodate system expansions and facilitate changes in operation.
 - 2. All software programs shall be stored in non-volatile programmable memory within the FACP.
 - a. Loss of primary and secondary power shall not erase the instructions stored in the memory.
 - b. System programming shall be password protected.
 - 3. Alarm, supervisory and trouble signals from analog addressable devices shall be encoded onto NFPA Style 4 (Class B) signaling line circuits (SLC).
 - 4. Initiation device circuits (IDC) shall be wired NFPA Style B (Class B)
 - 5. Notification appliance circuits shall be wired NFPA Style Y (Class B).
 - 6. A single ground or open on any system SLC, IDC or NAC shall not cause a system malfunction, loss of operating power or the ability to report an alarm.
 - 7. Alarm signals arriving at the main FACP shall not be lost due to a power failure.
 - 8. The system shall be provided with sufficient battery capacity to operate the entire system upon loss of 120 VAC power in a normal supervisory mode for a period of twenty four (24) hours with five (5) minutes of alarm indication at the end of this period.
 - a. Systems that include voice evacuation shall provide sufficient battery capacity for twenty-four (24) hours with fifteen (15) minutes of alarm in lieu of the five (5) noted above.
 - 9. The system shall automatically transfer to the standby batteries upon power failure. All battery charging and recharging operations shall be automatic. Batteries, once discharged, shall recharge at a rate to provide a minimum of 70% capacity in twelve (12) hours
- B. SYSTEM FUNCTIONAL OPERATION
 - 1. The actuation of any approved alarm initiating device shall automatically initiate the following functions:
 - a. Alarm LED on the FACP shall flash.
 - b. Local audible piezo electronic signal in the FACP shall sound.
 - c. The alarm condition description, including the type of point and the location within the protected premises, shall be displayed on the LCD display at the FACP and any remote annunciator(s).
 - d. System shall transmit the condition to a UL Listed Central Station Monitoring Facility. Supervising station shall be approved per CFC.
 - e. Printing and history storage equipment shall log the information associated with the condition, including the time and date of the alarm occurrence.
 - f. System output programs configured via control-by-event (CBE) programming to be activated by the particular point in alarm shall be executed, and the associated

- system output (alarm notification appliances and relays) shall be activated on either local outputs or points located on other network nodes.
2. The actuation of any approved supervisory alarm initiating device shall automatically initiate the following functions:
 - a. Supervisory LED on the FACP shall flash.
 - b. Local audible piezo electronic signal in the FACP shall sound.
 - c. The supervisory condition description, including the type of point and the location within the protected premises, shall be displayed on the LCD display at the FACP and any remote annunciator(s).
 - d. System shall transmit the condition to a UL Listed Central Station Monitoring Facility. Supervising station shall be approved per CFC.
 - e. Printing and history storage equipment shall log the information associated with the condition, including the time and date of the alarm occurrence.
 - f. System output programs configured via control-by-event (CBE) programming to be activated by the particular point in alarm shall be executed, and the associated system output (alarm notification appliances and relays) shall be activated on either local outputs or points located on other network nodes.
 3. Whenever a trouble condition is detected and reported the FACP shall automatically initiate the following functions:
 - a. Trouble LED on the FACP shall flash.
 - b. Local audible piezo electronic signal in the FACP shall sound.
 - c. The trouble condition description, including the type of point and the location within the protected premises, shall be displayed on the LCD display at the FACP and any remote annunciator(s).
 - d. System shall transmit the condition to a UL Listed Central Station Monitoring Facility. Supervising station shall be approved per CFC.
 - e. Printing and history storage equipment shall log the information associated with the condition, including the time and date of the alarm occurrence.
 - f. System output programs configured via control-by-event (CBE) programming to be activated by the particular point in alarm shall be executed, and the associated system output (alarm notification appliances and relays) shall be activated on either local outputs or points located on other network nodes.

C. TEST FUNCTIONS

1. A "Lamp Test" or "Indicator Test mode shall be a standard feature of the FACP and shall test all LED's and the LCD display on the main FACP and remote annunciators.
2. A "Walk Test" mode shall be a standard feature of the FACP.
 - a. The Walk Test feature shall function so that each alarm input tested shall operate the associated notification appliance for two seconds. The FACP will then automatically reset and confirm normal device operation.
 - b. The event memory shall contain the information on the point tested, the zone tripped, the zone restore and the individual point's return to normal.
3. A "Fire Drill mode shall allow the manual testing of the Fire Alarm System notification circuits. The Fire Drill shall be capable of being initiated at the main annunciator, remote annunciators and via a remote contact input.
4. "Bypass Mode" shall allow for any point or NAC circuit to be bypassed without affecting the operation of the total Fire Alarm System.

D. Remote Monitoring Connection

1. The fire alarm system shall be connected via Digital Alarm Communicator Transmitter (DACT) and an NFPA 72, Chapter 26 compliant transmission channel(s) to a UL Listed Central Station Monitoring Company.
 - a. The fire alarm control panel shall provide an integral Digital Alarm Communicator Transmitter (DACT) for signaling to a UL Listed Central Station Monitoring Company.

- 1) The fire alarm system shall transmit alarm, supervisory alarm and trouble signals with the alarms having priority over the trouble signal.

2.03 SYSTEM COMPONENTS

- A. Fire Alarm Control Panel with integral Emergency Voice/Alarm Communication System.
 1. The existing Voice Evacuation Control Panel shall be Honeywell Farenhyt Series IFP-2100ECS.
 - a. The IFP-2100ECS shall be the FACP on all systems where Networking is not required (Small elementary schools and middle schools) for compliance with CFC required Emergency Voice/Alarm Communication in K -12 schools.
 - b. Remote Voice Evacuation Amplifiers shall be:
 - 1) Honeywell Farenhyt Series ECS-50W
- B. NETWORK NODES
 1. Network Nodes, if required, shall be Honeywell Farenhyt Series IFP-2100ECS.
 - a. All Network systems shall have at least one (1) IFP-2100ECS node for compliance with CFC required Emergency Voice/Alarm Communication in K -12 schools.
 - b. All Network Nodes shall have the capability of being connected with either copper cable or fiber optic cable.
- C. REMOTE ANNUNCIATOR
 1. The remote annunciator shall be Honeywell Farenhyt Series ECS-LOC.
 - a. The remote annunciator shall have 160 character LCD display and 5 LED's for general alarm, supervisory, systems trouble, system silence and system power.
 - b. The remote annunciator shall have the same control and display layout as the integrated annunciator at the FACP.
 - c. The remote annunciator shall have the same functionality and operation as the integrated annunciator at the FACP.
 - d. The remote annunciator shall have twenty (20) levels of user codes to limit access to the system to authorized individuals.
 - e. The remote annunciators shall be capable of operating at a maximum wiring distance of 6,000 feet from the control unit on unshielded, non-twisted cable.
 - f. The system shall support a maximum of eight (8) remote annunciators.
- D. SERIAL/PARALLEL INTERFACE GATEWAY MODULE
 1. The fire system shall be capable of supporting up to two serial/parallel interfaces that are capable of driving standard computer style printers. The interface shall be programmable for the serial and parallel ports and allow printing of events as they occur.
- E. DISTRIBUTED POWER MODULES
 1. The Intelligent Remote Power Supply shall be Honeywell Farenhyt Series 5895XL, compatible with the IFP-2100ECS fire alarm control panel.
 - a. The existing Intelligent Remote Power Supply shall be connected to the FACP via S-bus.
 - 1) The 5895XL shall have the capability of accommodating all IFP-2100ECS add-on modules including the 5815XL SLC Expander.
 - 2) The 5895XL shall have 6 amps of output power, six Flexput circuits rated at 3 amps each and two form C relay circuits rated at 2.5 amps at 24VDC.
 - 3) The 5895XL shall have 6 amps of output power, 4 output circuits that may be programmed as NAC or Auxiliary Power.
 - b. The Intelligent Remote Power Supply shall act as a bus repeater allowing connection of additional S-bus devices to a maximum wiring distance of 6,000 feet from the power supply.

- c. The Intelligent Remote Power Supply shall have on-board synchronization for System Sensor NAC devices.
- F. Signaling Line Circuit (SLC) Devices:
 - 1. Each SLC shall be capable to accommodating 159 addressable detectors and 159 addressable modules.
 - 2. Provide SLC devices as indicated on the construction drawings. All devices shall be listed for compatibility with the IFP-2100ECS FACP.
- G. Notification Appliance Circuit (NAC) Devices:
 - 1. NAC devices shall be the product of Gentex. All devices shall be listed for compatibility with the IFP-2100ECS FACP.
- H. System/Wire Cable
 - 1. All Fire Alarm System Wire and Cable shall be installed in conduit, unless noted otherwise.
 - a. Interior
 - 1) SLC cable shall be #16AWG, 2-conductor, unshielded, FPL, red jacket.
 - b. SLC cable shall be California State Fire Marshal (CSFM) listed.
 - 1) NAC Wire shall be #12 AWG THHN/THWN, stranded color red and black.
 - 2) S-bus cable shall be #16AWG, 4-conductor, unshielded, FPL, red or black jacket.
 - (a) S-Bus cable shall be California State Fire Marshal (CSFM) listed.
 - 3) Speaker cable shall be #16AWG, 2-conductor, shielded, FPL, red jacket.
 - (a) Speaker cable shall be California State Fire Marshal (CSFM) listed.
 - 4) Network Fiber Optic Cable shall be 6-strand 62.5/125 micron multimode loose tube Indoor/Outdoor AMP 1-1664234-5 or equal.
 - c. Exterior
 - 1) SLC cable shall be #16AWG, 2-conductor, unshielded, FPL, water-blocked, black jacket.
 - (a) SLC cable shall be California State Fire Marshal (CSFM) listed.
 - 2) NAC Wire shall be #12 AWG THHN/THWN, stranded color red and black.
 - 3) S-bus cable shall be #16AWG, 4-conductor, unshielded, FPL, water-blocked, black jacket.
 - (a) S-Bus cable shall be California State Fire Marshal (CSFM) listed.
 - 4) Speaker cable shall be #16AWG, 2-conductor, shielded, FPL, water-blocked, black jacket.
 - (a) Speaker cable shall be California State Fire Marshal (CSFM) listed.
 - 5) Network Fiber Optic Cable shall be 6-strand 62.5/125 micron multimode loose tube OSP Belden #B9B510T or equal with ST connectors.
- I. CONDUIT AND SURFACE RACEWAY
 - 1. All conduit, surface raceways, outlet boxes, junction boxes, pull boxes, terminal cabinets, and similar devices required in this section of the work shall be provided under Division 26 00 00 and as shown on drawings.
 - 2. Conduit and surface raceways shall comply with the requirements of Section 26 00 00.
 - 3. Conduit shall not enter the Fire Alarm Control Panel, or any other remotely mounted Control Panel equipment or backbox, except where conduit entry is specified by the FACP manufacturer.
 - 4. All fire alarm related conduits shall be clearly marked as "Fire Alarm System" and painted red in color to indicate such system.
- J. TERMINAL CABINETS AND JUNCTION BOXES:
 - 1. All boxes and cabinets shall be UL listed for their use and purpose.

2. Terminal cabinets shall comply with the requirements of Section 26 00 00 Terminal Cabinets.
3. Provide terminal blocks for all conductors entering and/or exiting each terminal cabinet.
4. Provide (2) 1" conduit only from each terminal cabinet stubbed into an adjacent ceiling space and (2) 1" conduit only stubbed outside the building into an 11" x 17" flush-in-grade concrete pullbox.

PART 3 EXECUTION

3.01 GENERAL INSTALLATION REQUIREMENTS

- A. The wiring of the system shall be executed in accordance with the drawings and the equipment manufacturer's wiring diagrams. If any variations in these requirements occur, the contractor shall notify the architect before making any changes. It shall be the responsibility of the factory-authorized distributor of the approved equipment to install the equipment and guarantee the system to operate as per plans and specifications.
- B. Furnish all conduit, junction boxes, conductors, equipment plugs, terminal strips, etc., and labor to install a complete and operable system.
- C. The cables within the rack or cabinets shall be carefully cabled and laced with no. 12 Cord waxed linen lacing twine or ty-raps. All cables shall be numbered for identification.
- D. Splices of conductors in underground pull boxes is not permitted.
- E. The labor employed by the contractor shall be regularly employed in the installation and repair of communication systems and shall be acceptable to the owner and architect to engage in the installation and service of this system.
- F. The contractor shall thoroughly clean all equipment and materials. All exposed parts of the equipment, cabinets, and other equipment shall be left in a clean condition, unblemished and free of all dirt, dust, smudges, spots, fingerprints, etc., the contractor shall remove all debris and rubbish occasioned by the electronic systems work from the site. The contractor shall thoroughly clean all buildings of any dirt, debris, rubbish, marks, etc., Caused by the performance of this work.
- G. The system must meet all local and other prevailing codes.
- H. All cabling installations shall be performed by qualified technicians.
- I. All cabling shall be splice free.
- J. In order to ensure the least amount of cable untwisting, it is required that all cables shall be stripped using a special tool.
- K. The use of lubricants (i.e. Yellow 77) to facilitate the installation of cables in conduits is highly discouraged. If such a lubricant must be used, the contractor shall verify the acceptability of the lubricant to be used with the cable manufacturer, prior to using such a lubricant.
- L. Under no circumstance are "channel locks" or other pliers to be used.
- M. All firewalls penetrated by structured cabling shall be sealed by use a non-permanent fire blanket or other method in compliance with the 2022 edition of National Fire Protection Association (NFPA) and the 2022 California Electric Code (CEC) or other prevailing code. The contractor must not use concrete or other non-removable substance for fire stopping on cable trays, wireways or conduits. Contractors who use this method will be required to replace all cables affected and provide the original specified access to each effected area.
- N. Provide p-touch label of approximately 1 inch wide with red lettering for each initiating device that is hidden from view. Tags shall indicate the name and type of device: Heat Detector, or Duct Smoke Detector. Tags shall be permanently attached on access panel or t-bar grid which is used to access a hidden device.

3.02 SPECIFIC SYSTEM INSTALLATION REQUIREMENTS

- A. The entire system shall be installed in a workmanlike manner in accordance with approved manufacturers manuals and wiring diagrams. The contractor shall furnish all wiring, conduit, outlet boxes, junction boxes, terminal cabinets and similar devices necessary for the completed installation..
- B. Installation off conduit, outlet boxes, junction boxes, terminal cabinets, special back boxes and similar devices shall comply with the requirements of Section 26 00 00 Basic Electrical Materials.
- C. All conduit, junction boxes, conduit supports and hangers shall be concealed in finished areas and may be exposed in unfinished areas. Smoke detector heads shall not be installed prior to the system programming and test period. If construction is ongoing during this period, measures shall be taken to protect smoke detectors from contamination and physical damage.
- D. All fire detection and alarm system devices, control panels and remote annunciators shall be flush mounted when located in finished areas and may be surface mounted when located in unfinished areas. Verify with the Project Architect prior to any surface mounted installations.
- E. All penetrations of floor slabs and fire walls, shall be fire stopped in accordance with the electrical specifications.
- F. Duct mounted Smoke Detectors shall be furnished and wired by this Contractor and installed by the Mechanical Contractor. All shutdown and interface wiring shall be performed by the Electrical Contractor. All air pressure differential testing shall be performed by the Mechanical/Air Balance Contractor.
- G. The sprinkler flow and tamper switches shall be furnished, installed and adjusted by the Sprinkler Contractor, wired and tested by this Contractor.

3.03 SYSTEM START-UP

- A. All start-up programming and system commissioning shall be performed by a manufacturer's trained and certified technician currently employed by the System Supplier/Installer.

3.04 SYSTEM VERIFICATION

- A. Subsequent to system start-up the system installer shall perform a 100% system pre-test to verify that the following features are functioning properly.
 - 1. All notification appliances.
 - 2. All initiation devices.
 - 3. All control modules.
 - 4. All monitor modules.
 - 5. Communication link to monitoring service.

3.05 ACCEPTANCE TESTING

- A. The system installer shall, in the present of the Inspector of Record (IOR), perform 100% testing as noted in System Verification above.

3.06 IN SERVICE TRAINING

- A. The Contractor shall instruct personnel designated by the District/Owner in the proper use, basic care and maintenance of the system beyond the warranty period. Contractor shall provide up to 8 hours of in-service training with this system.

3.07 FACTORY TRAINING & CERTIFICATION

- A. Not required under this Contract.

3.08 CONTRACT CLOSE-OUT DOCUMENTATION

- A. Contractor shall provide the following:
 - 1. One reproducible hard copy of project record drawings.
 - 2. One hard copy of manufacturer's maintenance and operation manuals.
 - 3. One CD containing manufacturer's maintenance and operation manuals in PDF format.
 - 4. One copy of system warranty.

3.09 WARRANTY

- A. The Contractor shall warrant the equipment to be new and free from defects in material and workmanship, and will, within one year from the date of installation, repair or replace any equipment found to be defective. This warranty shall not apply to any equipment that has been subject to misuse, abuse, negligence or unauthorized modification.
- B. Provide the NFPA certificate to the Owner, Local Fire Official, Architect and DSA.

END OF SECTION

SECTION 321123
AGGREGATE BASE COURSES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Aggregate base course.
- B. Permeable Aggregate base for Synthetic Turf (Non-athletic)

1.02 RELATED REQUIREMENTS

- A. Section 321216 - Asphalt Paving: Finish and binder asphalt courses.
- B. Section 321313 - Concrete Paving: Finish concrete surface course.
- C. Project Geotechnical Report.

1.03 REFERENCE STANDARDS

- A. AASHTO M 147 - Standard Specification for Materials for Aggregate and Soil–Aggregate Subbase, Base, and Surface Courses; 2017 (Reapproved 2021).
- B. AASHTO T 180 - Standard Method of Test for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop; 2022, with Errata .
- C. ASTM C136/C136M - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates; 2019.
- D. ASTM D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m³)); 2012 (Reapproved 2021).
- E. ASTM D1556/D1556M - Standard Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method; 2024.
- F. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³ (2,700 kN-m/m³)); 2012 (Reapproved 2021).
- G. ASTM D2167 - Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method; 2015.
- H. ASTM D2487 - Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System); 2017, with Editorial Revision (2020).
- I. ASTM D6938 - Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth); 2023.
- J. Standard Specifications for Public Works Construction (Greenbook); current edition.
- K. California State Department of Transportation Standard Specifications (Caltrans); current edition.
- L. Project Geotechnical Report.

1.04 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Materials Sources: Submit name of imported materials source, location, and gradation of the material.

- C. Aggregate Composition Test Reports: Results of laboratory tests on proposed and actual materials used.
- D. Compaction Density Test Reports.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Aggregate Storage, General:
 - 1. Separate differing materials with dividers or stockpile separately to prevent intermixing.
 - 2. Prevent contamination.
 - 3. Protect stockpiles from erosion and deterioration of materials.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Aggregate Base: Crushed aggregate base, conforming to Greenbook, Section 200-2.2.
- B. Permeable Aggregate Base for Synthetic Turf (Non-athletic)
 - 1. Uniformly mixed processed stone.
 - 2. Aggregate shall be durable and not exceed 12% loss of materials.
 - 3. Permeability requirements: 20 inches / hour.
 - 4. Permeable Base Gradation

Sieve	Percent Passing by Weight Base Aggregate Layer
1 inch	100%
0.75 inch	90-100%
0.50 inch	80-100%
0.375 inch	70-100%
No. 4	50-85%
No. 8	30-65%
No. 16	10-50%
No. 30	0-35%
No. 60	0-15%
No. 100	0-8%
No. 200	0-2%

- C. Herbicide: Commercial chemical for weed control, registered by the EPA.

2.02 SOURCE QUALITY CONTROL

- A. See Section 014000 - Quality Requirements for general requirements for testing and analysis of aggregate materials.
- B. Where aggregate materials are specified using ASTM D2487 classification, testing of samples for compliance will be provided before delivery to site.
- C. If tests indicate materials do not meet specified requirements, change material and retest.
- D. Provide materials of each type from same source throughout the work.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that survey bench marks and intended elevations for the work are as indicated.
- B. Verify substrate has been inspected, gradients and elevations are correct, and is dry.

3.02 PREPARATION

- A. Correct irregularities in substrate gradient and elevation by scarifying, reshaping, and re-compacting.
- B. Do not place aggregate on soft, muddy, or frozen surfaces.

3.03 INSTALLATION

- A. Spread aggregate over prepared substrate to a total compacted thickness as indicated on plans.
- B. Place aggregate in maximum 4 inch layers and roller compact to specified density.
- C. Level and contour surfaces to elevations and gradients indicated.
- D. Add small quantities of fine aggregate to coarse aggregate as appropriate to assist compaction.
- E. Add water to assist compaction. If excess water is apparent, remove aggregate and aerate to reduce moisture content.
- F. Use mechanical tamping equipment in areas inaccessible to compaction equipment.
- G. Permeable Aggregate Base for Synthetic Turf
 - 1. Contractor shall apply water to the aggregate on site to attain and maintain 90% to 100% of the optimum moisture content.
 - 2. Prior to placement, remove any excess of contaminated backfill from any existing drainage trenches.
 - 3. Should any separation of the materials occur during any stage of the spreading or stockpiling, the Contractor must immediately remove and dispose of segregated material and correct or change handling procedures to prevent further separation. Double handling of materials should be avoided.
 - 4. Contractor shall utilize laser-controlled equipment for the grading of the permeable aggregate to ensure accuracy in grading tolerances.
 - 5. Each layer must be spread uniformly with equipment that will not cause perceptible separation in gradation (segregation of the Permeable aggregate base), preferably a self-propelled paving machine, or a small grader or low ground pressure (LPG) dozer.
 - 6. Contractor shall grade the surface of the processed stone acceptable to receive the final synthetic turf surface system.
 - 7. The permeable aggregate base shall be compacted to a minimum compaction of 90% and maximum compaction of 93%. (ASTM D698)
 - 8. The area should be compacted at 2 inch increments to ensure uniform compaction throughout the entire area.
 - 9. Permeable Aggregate Base Testing
 - a. Test samples shall be taken (at minimum of) one sample per every 10,000 square feet or as otherwise directed by the Owner's Representative. Final in-place aggregate shall have a percolation rate of not less than 20 inches per hour.
 - 1) ASTM F2898 (Overflow)
 - b. If at any time the permeable base does not meet specifications, it shall be the Contractor's responsibility to restore the processed stone based to the required grade and density.

- c. When the Contractor has independently confirmed that the site is in compliance with all above listed requirements, he shall schedule a final inspection by the qualified FieldTurf installer. Any deficiencies uncovered during this inspection must be remedied to the satisfaction of the installer before the base system will be considered acceptable.
- H. Apply herbicide per manufacturer requirements.

3.04 TOLERANCES

- A. Flatness: Maximum variation of 1/4 inch measured with 10 foot straight edge.
- B. Scheduled Compacted Thickness: Within 1/4 inch.
- C. Variation From Design Elevation: Within 1/2 inch.

3.05 FIELD QUALITY CONTROL

- A. See Section 014000 - Quality Requirements for general requirements for field inspection and testing.
- B. Compaction density testing will be performed on compacted aggregate base course in accordance with ASTM D1556, ASTM D2167, or ASTM D6938.
- C. Results will be evaluated in relation to compaction curve determined by testing uncompacted material in accordance with AASHTO T 180, ASTM D698 ("standard Proctor"), or ASTM D1557 ("modified Proctor").
- D. If tests indicate work does not meet specified requirements, remove work, replace and retest.
- E. Proof roll compacted aggregate at surfaces that will be under slabs-on-grade.

3.06 CLEANING

- A. Remove unused stockpiled materials, leave area in a clean and neat condition. Grade stockpile area to prevent standing surface water.
- B. Leave borrow areas in a clean and neat condition. Grade to prevent standing surface water.

END OF SECTION

**SECTION 321216
ASPHALT PAVING**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Single course bituminous concrete paving.
- B. Double course bituminous concrete paving.
- C. Surface sealer.

1.02 RELATED REQUIREMENTS

- A. Section 321123 - Aggregate Base Courses: Aggregate base course.
- B. Section 321313 - Concrete Paving: Concrete substrate.
- C. Section 321313 - Concrete Paving: Concrete curbs.
- D. Section 321723 - Pavement Markings
- E. Project Geotechnical Report.

1.03 REFERENCE STANDARDS

- A. AI MS-2 - Asphalt Mix Design Methods; 2015.
- B. AI MS-19 - Basic Asphalt Emulsion Manual; 2008.
- C. ASTM D946 - Standard Specification for Penetration-Graded Asphalt Cement for Use in Pavement Construction; 2009a.
- D. ASTM D3549 Standard Test Method for Thickness of Height of Compacted Asphalt Mixture Specimens (2018).
- E. ASTM D2950 Standard Test Method of Density of Bituminous Concrete in Place by Nuclear Methods (2020).
- F. Standard Specifications for Public Works Construction (SSPWC, Greenbook); current edition.

1.04 QUALITY ASSURANCE

- A. Perform Work in accordance with Standard Specifications for Public Works Construction (SSPWC) and the California Department of Transportation (Caltrans), latest editions and supplements for asphalt paving work.
- B. Obtain materials from same source throughout.

1.05 SUBMITTALS

- A. Product Data: For each type of product indicated. Include technical data and tested physical and performance properties.

1.06 FIELD CONDITIONS

- A. Do not place asphalt when ambient air or base surface temperature is less than 50 degrees Fahrenheit and rising, or surface is wet or frozen.

- B. Place bitumen mixture when temperature is not more than 15 F degrees below bitumen supplier's bill of lading and not more than maximum specified temperature.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Asphalt Concrete: Greenbook, Section 203-6.
- B. Aggregate Base Course: Section 321123.
- C. Seal Coat per Greenbook, Section 203-9.

2.02 ASPHALT PAVING MIXES AND MIX DESIGN

- A. Parking lots including drive aisles and parking spaces:
 - 1. Wearing course: III-C3 PG 64-10 per SPPWC Section 203-6.5.
 - 2. Base course: III-B3 PG 64-10 per SPPWC Section 203-6.5.
- B. Playgrounds/Hardcourts/Playcourts.
 - 1. Wearing course: III-D PG 64-10 per SPPWC Section 203-6.5.
 - 2. Base course: III-B2 PG 64-10 per SPPWC Section 203-6.5.
- C. Submit proposed mix design of each class of mix for review prior to beginning of work.

2.03 SOURCE QUALITY CONTROL

- A. Test mix design and samples in accordance with AI MS-2.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that compacted subgrade is dry and ready to support paving and imposed loads.
- B. Verify gradients and elevations of base are correct.

3.02 AGGREGATE BASE COURSE

- A. See Section 321123.

3.03 PREPARATION - TACK COAT

- A. Apply tack coat in accordance with SPPWC (Greenbook), Section 302-5.4.
- B. Apply tack coat to existing pavement including planed surfaces, between hot mix asphalt layers, and to vertical surfaces of curbs, gutters, construction joints and milled pavements.

3.04 PLACING ASPHALT PAVEMENT - SINGLE COURSE

- A. Install work in accordance with SPPWC (Greenbook) 302-5.
- B. Place asphalt within 24 hours of applying primer or tack coat.
- C. Place to a maximum thickness per SSPWC 302-5.
- D. Compact pavement by rolling to specified density. Do not displace or extrude pavement from position. Hand compact in areas inaccessible to rolling equipment.
- E. Perform rolling with consecutive passes to achieve even and smooth finish without roller marks.

3.05 PLACING ASPHALT PAVEMENT - DOUBLE COURSE

- A. Install work in accordance with SPPWC (Greenbook) 302-5.
- B. Place asphalt base course within 24 hours of applying primer or tack coat.
- C. No pavement course shall be less than 1 1/2 inches in compacted thickness. If finish pavement thickness is 3 inches or less it shall be laid as single course.
- D. No pavement course shall be more than 4 inches in compacted thickness.
- E. Compact pavement by rolling to specified density. Do not displace or extrude pavement from position. Hand compact in areas inaccessible to rolling equipment.
- F. Perform rolling with consecutive passes to achieve even and smooth finish, without roller marks.

3.06 SEAL COAT

- A. Apply seal coat to asphalt surface course and asphalt curbs in accordance with SPPWC (Greenbook) 203-9.

3.07 TOLERANCES

- A. Flatness: Maximum variation of 1/4 inch measured with 10 foot straight edge.
- B. Compacted Thickness: Within 1/4 inch of specified or indicated thickness.
- C. Variation from True Elevation: Within 1/2 inch.

3.08 FIELD QUALITY CONTROL

- A. See Section 014000 - Quality Requirements, for general requirements for quality control.
- B. Provide final surfaces of uniform texture, conforming to required grades and cross sections.
 - 1. Test in-place asphalt concrete courses for compliance with requirement for density, thickness, and surface smoothness.
 - a. Density:
 - 1) Field test density of compacted asphalt surface course shall be determined by a properly calibrated nuclear test gage in accordance with ASTM D2950.
 - b. Thickness:
 - 1) Thickness of compacted paving shall conform to ASTM D3549 based on core test.
 - 2) In-place compacted thickness shall conform to the dimensions indicated on the contract drawings. Variation from indicated thicknesses shall not exceed plus-or-minus 1/4-inch.
- C. Flood Testing
 - 1. Flood Test: Before acceptance, all pavements in the presence of the project inspector shall be water tested to ensure proper drainage. The contractor shall provide water for this purpose. The flooding shall be conducted with a water tank truck. Depressions where the water ponds to a depth of more than 1/8-inch shall be filled or the slope corrected to provide proper drainage. The edges of the fill shall be feathered and smoothed so that the joint between the fill and the original surface is invisible. No standing water shall remain 1-hour after test.

3.09 PROTECTION

- A. Immediately after placement, protect pavement from mechanical injury for 2 days or until surface temperature is less than 140 degrees F.

END OF SECTION

**SECTION 321313
CONCRETE PAVING**

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Driveways.
- B. Curbs and gutters.
- C. Walks.
- D. Detectable warnings.

1.02 RELATED REQUIREMENTS

- A. Division 00 Section Available Project Information (Geotechnical Report)
- B. Division 03 Section Cast-in-Place Concrete
- C. Division 05 Section Pipe and Tube Railings.
- D. Division 32 Section Architectural Site Concrete
- E. Division 32 Section Concrete Paving Joint Sealants

1.03 DEFINITIONS

- A. Cementitious Materials: Portland cement alone or in combination with one or more of the following: Fly ash and other pozzolans, and ground granulated blast-furnace slag, subject to compliance with requirements.

1.04 PREINSTALLATION CONFERENCE

- A. Conduct conference at Project site two weeks prior to start of work of this section. Required attendance of all affected installers.
 - 1. Review methods and procedures related to concrete paving, including but not limited to, the following:
 - 2. Concrete mixture design
 - 3. Testing and inspection procedures.
 - 4. Concrete finishes and finishing.
 - 5. Cold- and hot-weather concreting procedures.
 - 6. Curing procedures.
 - 7. Construction joints.
 - 8. Forms and form-removal limitations.
 - 9. Reinforcement accessory installation.
 - 10. Concrete repair procedures.
 - 11. Protection of cast-in-place architectural site concrete.
 - 12. Review special testing and inspection procedures.
 - 13. Placement sequence and schedule.
 - 14. Require representatives of each entity directly concerned with concrete paving to attend, including the following:
 - a. Contractor's superintendent.
 - b. Ready-mix concrete manufacturer.

- c. Concrete paving subcontractor.
- d. District's or Client's Representative
- e. Architect's Representative
- f. Inspector of Record
- g. Provide meeting minutes for pre-installation conference

1.05 SUBMITTALS

- A. Product Data: For each type of product indicated.
 - 1. Proprietary admixtures, pigments, curing compounds, hardeners, sealers, form-release agents, etc.: Indicate compatibility with other materials used.
 - 2. Stenciling material
- B. Design Mixtures: Submit proposed mix designs and test data for each class of concrete and for each method of placement.
 - 1. Prepare mix designs on the basis of field experience (preferred) and/or trial mixes, in compliance with California Building Code (CBC), Chapter 1903A.
 - 2. Mix designs shall be prepared, stamped and signed by a structural or civil engineer registered in the State of California.
 - a. Mix designs shall be reviewed by the Architect (AOR) and Structural Engineer of Record (SEOR).
 - 3. Identify for each mix design submitted the method by which proportions have been selected.
 - a. For mix designs based on trial mixtures, include trial mix proportions, test results, graphical analysis and show required average compressive strength f'_c results. Provide gross weight and yield per cubic yard of trial mixes.
 - b. Indicate quantity of each ingredient per cubic yard of concrete and percentages.
 - c. Indicate type and quantity of admixtures proposed or required.
 - d. Indicate water to cement ratio by weight.
 - e. Measured slump.
 - f. Measured air content.
 - g. Provide shrinkage test results.
 - 4. Multiple mix designs or multiple manufacturers shall not be permitted for the same application.
- C. Provide maximum 5% fly ash; ground granulated blast-furnace slag, and/or silica fume content as Portland cement replacement in all concrete.
- D. Submit proposed alternate design mixtures for review by the Architect and SEOR when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.
- E. Steel Reinforcement Shop Drawings: Placing drawings that detail fabrication, bending, and placement. Include bar sizes, lengths, material, grade, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, splices and laps, mechanical connections, tie spacing, hoop spacing, and supports for concrete reinforcement. Shop drawings should include details such as reveals, recessed lights, handrails, or other elements requiring steel coordination.
 - 1. Coordinate with and identify the details of the Contract Drawings on the shop drawings.
 - 2. Comply with ACI 315, part B and CRSI requirements.
- F. Construction Joint Layout: Indicate proposed construction joints required to construct the structure. Submit dimensioned drawing indicating layout of construction joints, contraction (control) joints, dowelled joints, decorative scoring and placement sequence of concrete if different than layout indicated on plans.
 - 1. Location of construction joints are subject to approval of the Architect.
 - 2. All form seams are to align with construction joints or reveals.

- G. Placement Schedule: Submit concrete placement schedule before start of placement operations. Include locations of all joints including construction joints.
- H. Pavement-Marking Shop Drawings: Indicate pavement markings, lane separations, and defined parking spaces. Indicate, with international symbol of accessibility, spaces allocated for people with disabilities.
- I. Qualification Data: For qualified ready-mix concrete manufacturer (batch plant) and installer of detectable warnings.
- J. Welding Certificates: Submit certifications signed by AWS Certified Welding Inspector of prequalified welding procedures, qualifications of welding procedures unless prequalified, qualifications of welding operators and qualifications of welders.
- K. Material Certificates: For the following, submit manufacturer data, test results, and technical information for aggregate, sand and cement, submit ½ cubic foot physical sample. For sealant submit manufacturer color standard and custom palette together with physical samples:
 - 1. Cementitious materials.
 - 2. Aggregates and sand.
 - 3. Steel reinforcement and reinforcement accessories.
 - 4. Admixtures.
 - 5. Curing compounds.
 - 6. Applied finish materials.
 - 7. Bonding agent and epoxy adhesives.
 - 8. Joint fillers.
 - 9. Sealer
 - 10. Sealant.
- L. Material Test Reports: For each of the following:
 - 1. Aggregates. Include service-record data indicating absence of deleterious expansion of concrete due to alkali-aggregate reactivity.
- M. Detectable Warning Device Warranty: Submit copies of manufacture's five year warranty for each of these products and manufacturer custom and standard color palette.
- N. Field quality-control reports.
 - 1. Submit copies of delivery tickets complying with ASTM C 94 for each load of concrete delivered to the site. Tickets shall include all information required by the referenced standard.
- O. Minutes of pre-installation conference.

1.06 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with CBC Chapter 19A.
 - 1. Chemical products field-applied to concrete shall comply with the air quality requirements of authorities having jurisdiction.
 - 2. Comply with requirements of local, State and other authorities having jurisdiction for work performed within public right-of ways.
- B. Chemical products field-applied to concrete shall comply with the air quality requirements of authorities having jurisdiction.
- C. Comply with requirements of local, State and other authorities having jurisdiction for work performed within public right-of ways.
- D. Industry Standards: Comply with the following unless modified by requirements in the Contract Documents.(Plans and specifications)
 - 1. ACI 301, "Specifications for Structural Concrete".
 - 2. ACI 117, "Specifications for Tolerances for Concrete Construction and Materials".

3. ACI 302.1R, "Guide for Concrete Floor and Slab Construction".
 4. ACI 304R, "Guide for Measuring, Mixing, Transporting, and Placing Concrete".
 5. ACI 305R, "Hot Weather Concreting".
 6. ACI 306.1, "Standard Specification for Cold Weather Concreting".
 7. ACI 318, "Building Code Requirements for Structural Concrete".
 8. ACI 347, "Guide to Formwork for Concrete".
 9. ACI SP-66, "ACI Detailing Manual".
 10. CRSI, "Manual of Standard Practice".
 11. CRSI, "Placing Reinforcing Bars".
- E. Detectable Warning Installer Qualifications: An employer of workers trained and approved by manufacturer of cast-in-place, surface-applied unit-paver-type detectable truncated dome products.
- F. Ready-Mix-Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.
1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities" (Quality Control Manual - Section 3, "Plant Certification Checklist").
- G. Source Limitations for Concrete Paving: Obtain each color, size, type, and variety of concrete material and concrete mixture from single manufacturer with resources to provide concrete of consistent quality in appearance and physical properties. Secure all material required for the duration of the project as needed to ensure consistent quality in appearance.
- H. Welding Qualifications: Comply with CBC Chapter 17A.
1. Qualify welding procedures and welding personnel according to AWS D1.4/D 1.4M, "Structural Welding Code - Reinforcing Steel" prior to performing any welding.
 2. Qualify welding inspection personnel according to AWS QC1, "Standard for AWS Certification of Welding Inspectors."
- I. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-1 or an equivalent certification program.
- J. Concrete Testing Service: Engage a qualified testing agency to perform material evaluation tests and to design concrete mixtures.
- K. ACI Publications: Comply with ACI 301 unless otherwise indicated.
- L. Mockups: Before casting concrete paving, build mockups to verify selections made under Sample submittals and to fully demonstrate typical joints (including expansion and saw cut joints), surface finish, texture, color tolerances, standard of workmanship and completed product. Build mockups to comply with the following requirements, using materials indicated for the completed Work:
1. Build mockups in the location and of the size indicated or, if not indicated, as directed by Architect.
 - a. Paving Modules: Construct at least one 4 ft. x 4 ft. mockup of each color, finish, and mix design of special paving module, including stenciled areas, banding and curbs
 - b. Truncated Domes: minimum 3'X6' long set in concrete with concrete base and grout.
 2. Build mockups full-size, matching site concrete components indicated on the Drawings. Mock-ups shall be complete in every detail, including joints, reveals, edges, chamfers, etc. Include complex joinery conditions where necessary to integrate to other Project components as indicated including multiple pour conditions. Mockups should be provided for each finish, color, joint and detail specified.
 3. Maintain accurate records of variables associated with each mockup to facilitate the matching of accepted mockups during actual construction.
 4. Demonstrate curing, cleaning, and protecting of cast-in-place concrete paving, finishes, and contraction and expansion joints, as applicable.

5. Mockup Acceptance: Obtain Architect's approval of mockups before casting architectural site concrete and paving.
 - a. The Architect may reject mockups that, in the Architect's sole judgment, do not demonstrate an acceptable completed product, including, but not limited to, color, joint work, surface finish, texture, tolerances, and standard of workmanship
 - b. The Architect may require modifications to mockups to obtain acceptable results.
 - c. The Architect may require modifications to mockup repairs to obtain acceptable results.
 - d. The Architect may require removal and reconstruction of mockups to obtain acceptable results. Multiple mock ups maybe required.
 - e. Contractor shall provide additional mockups as required to obtain results acceptable to the Architect at no additional cost to the Owner.
6. Mockup Disposition: Accepted mockups shall not become part of the completed Project. Maintain mockup onsite for the duration of construction and until all work has been accepted. Remove and legally dispose mockups after acceptance of final installed work. prior to Project Completion. If sufficient permanent concrete paving work has been completed, Contractor may submit a written request to Architect to transfer quality control for concrete paving from the accepted mockups to one or more designated portions of the permanent work.
7. Provide written meeting minutes for each mock up review indicating items reviewed, approvals, rejections, connections, or other action items.

1.07 PROJECT CONDITIONS

- A. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.
- B. Pavement-Marking Paint: Proceed with pavement marking only on clean, dry surfaces and at a minimum ambient or surface temperature of 55 deg F for water-based materials, and not exceeding 95 deg F.

1.08 DELIVERY, STORAGE, AND HANDLING

- A. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending, damage, and rust.
 1. Label bundles with durable identification tags. Maintain reinforcement identification after bundles are broken.
 2. Store reinforcement to avoid excessive rusting or fouling with grease, oil, dirt or other bond-weakening contaminants.
 3. Avoid damaging applied coatings, if any, on steel reinforcement.

PART 2 - PRODUCTS

2.01 FORMS

- A. Formwork: / Form Materials: Plywood, metal, metal-framed plywood, or other approved panel-type materials to provide full-depth, continuous, straight, and smooth surfaces.

1. Set forms to alignment, grade and required dimensions. Formwork shall not deviate more than 1/4 inch from required vertical positions and 1/4 inch from required horizontal positions. Exposed Surfaces: Provide faced plywood panels complying with, or equivalent to, DOC PS 1, Structural I. Provide minimum 7-ply plywood and provide balance sheets for panels coated one-side only. Furnish in largest practicable sizes to minimize number of joints. Provide Medium-Density Overlay (MDO) panels or high density overlay (HDO) panels, with mill-applied release agent and edge sealant. Provide one of the following panels, or comparable substituted product:
 - a. Olympic Panel Products, "B-Matte 333 MDO Concrete Form." Overlay Color: Brown.
 - b. Pacific Laminate Products, "ProFace MDO." Overlay Color: Black.
 - c. Sylvan Products, LLC, "Armor Ply MDO" Overlay Color: Brown.
 2. Hold forms rigidly in place by stakes, clamps, spreaders, and braces at 3 feet on centers, and where required to ensure rigidity.
 3. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and that will not impair subsequent treatments of concrete surfaces.
 4. Place joint filler or backer rod on vertical surfaces in contact with concrete paving.
 5. Benders or thin plank forms may be used on curves, grade changes, or curb returns. Back forms for curb returns may be made of 1/2-inch thick benders cleated together for full depth of the curb.
 6. Keep forms in place until concrete is sufficiently hard to prevent damage to concrete.
 7. Reuse of Forms:
 - a. Do not reuse forms if there is any evidence of surface wear or defect which would impair quality of surface or edge.
 - b. Thoroughly clean and properly coat forms before reuse.
 - c. Do not use forms from previous projects.
 8. Provide new forms specifically purchased for this project. Reuse of forms from past projects or contractors stock will not be accepted.
- B. Curved Work: Kerf back of plywood form-facing panels, or use accepted flexible or curved forms for curved work with a radius of 100 feet or less.
- C. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and that will not impair subsequent treatments of concrete surfaces.
1. Obtain written acceptance of form release agent from integral colored concrete pigment manufacturer.
 2. Form-release agents shall be non-staining and can cause no visual effect to the finish.
 3. Formulate form-release agent with rust inhibitor for steel form-facing materials.

2.02 STEEL REINFORCEMENT

- A. Reinforcing Bars: ASTM A 615/A 615M, Grade 60; deformed.
- B. Joint Dowel Bars: ASTM A 615/A 615M, Grade 60 plain-steel bars. Cut bars true to length with ends square and free of burrs.
 1. Provide two-component "Speed Dowel System" manufactured by Greenstreak.
- C. Tie Bars: ASTM A 615/A 615M, Grade 60, deformed.
- D. Hook Bolts: ASTM A 307, Grade A, internally and externally threaded. Design hook-bolt joint assembly to hold coupling against paving form and in position during concreting operations, and to permit removal without damage to concrete or hook bolt.

- E. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars, welded wire reinforcement, and dowels in place. Manufacture bar supports according to CRSI's "Manual of Standard Practice" from steel wire, plastic, or precast concrete of greater compressive strength than concrete specified, and as follows:
 - 1. Equip wire bar supports with sand plates or horizontal runners where base material will not support chair legs.
- F. Zinc Repair Material: ASTM A 780.

2.03 CONCRETE MATERIALS

- A. Cementitious Material: Use the following cementitious materials, of same type, brand, and source throughout Project:
 - 1. Portland Cement: ASTM C 150, Type II/V, Type I/II or Type IV, gray, unless white cement is required to achieve colors indicated.
 - a. Fly Ash: none accepted.
- B. Normal-Weight Aggregates: ASTM C 33, complying with building code. Provide aggregates from a single source. All aggregates shall be free of materials with deleterious reactivity to alkali in cement when tested in accordance with ASTM C 289.
 - 1. Comply with CBC section 1903A.
 - 2. Maximum Coarse-Aggregate Size: 3/4 inch nominal.
 - a. Hard rock mix; no pea gravel will be accepted.
 - 3. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.
- C. Water: Potable and complying with ASTM C 94/C 94M.
- D. Shrinkage-Reducing Admixture: Commercially formulated, shrinkage inhibitor capable of reducing initial shrinkage by 80% and long-term shrinkage by 50%. Provide product suitable for use with either air-entrained or non-air-entrained concrete as appropriate to structural member and project location.
 - 1. Products: Subject to compliance with requirements, provide the following(as required):
 - a. Meet ASTM C494 requirements
 - 1) Euclid Chemical Company (The), an RPM company; EUCON SRA, SRA+.
 - 2) Grace Construction Products, W. R. Grace & Co.; Eclipse Floor, Eclipse Plus.
 - 3) Sika Corporation; Control 40.

2.04 CURING MATERIALS

- A. Absorptive Cover: AASHTO M 182, Class 3, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. (305 g/sq. m) dry or cotton mats.
- B. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.
- C. Water: Potable.
- D. Evaporation Retarder: Waterborne, monomolecular, film forming, manufactured for application to fresh concrete. Provide products with not more than 100g/L volatile organic content.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. BASF Construction Chemicals, LLC; Confirm.
 - b. Conspec by Dayton Superior; Aquafil.
 - c. Nox-Crete Products Group; MONOFILM.
- E. Clear, Waterborne, Membrane-Forming Curing Compound (Colored Concrete): Provide products that are acceptable to concrete color pigment manufacturer complying with ASTM C 309, Type 1, Class B, 18 to 25 percent solids, nondissipating, certified by curing compound manufacturer to not interfere with bonding of sealers with no glossy finish and compatible with specified sealer. Provide products with not more than 100g/L volatile organic content.
 - 1. Products: Subject to compliance with requirements, provide one of the following:

- a. Sinak Corporation; The Cure WCE or Lithium Cure 1000.
 - b. L. M. Scofield; Cureseal-W.
 - c. Butterfield Color; Clear Guard H2O.
- F. All curing materials should be dissipating without leaving a shiny, cloudy, or glossy finish. Curing material does not substitute requirement of a sealer.

2.05 HARDENERS AND SEALERS

- A. Penetrating Liquid Floor and Horizontal Surface Treatment (Sealer): Clear, chemically reactive, waterborne solution of inorganic silicate or silicate water-based lithium quartz materials and proprietary components; odorless; that penetrates, hardens, and densifies concrete surfaces. Materials shall be compatible with concrete admixtures and shall be recommended by manufacturer for intended use. Provide product with 0g/L volatile organic content.
- 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Sinak Corporation; Concrete Sealer HLQ 125.
 - b. L. M. Scofield; Cureseal-W.
 - c. L&M Construction Chemicals, Inc.; Seal Hard.

2.06 RELATED MATERIALS

- A. Joint Fillers:
- 1. Ceramar by W.R. Meadows. A closed cell isomeric polymer synthetic foam ASTM D 5249, Type 2.
 - 2. Deck-O-Foam polyethylene by W.R. Meadows. A closed cell expansion joint filler ASTM D 4819
 - 3. 1/4" thickness.
- B. Bonding Agent: ASTM C 1059, Type II, non-re-emulsifiable. Provide proprietary products composed of latex polymers.
- 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. W. R. Meadows, Inc.; "Acry-Lok".
 - b. Grace Construction Products, W. R. Grace & Co.; "Daraweld C".
 - c. Larsen Products Corp., "Weld-Crete".
- C. Epoxy Bonding Adhesive: ASTM C 881/C 881M, two-component epoxy resin capable of humid curing and bonding to damp surfaces; of class suitable for application temperature, of grade complying with requirements, and of the following types:
- 1. Types IV and V, load bearing, for bonding hardened or freshly mixed concrete to hardened concrete, and for anchoring dowels to hardened concrete.

2.07 DETECTABLE WARNING MATERIALS

- A. General: All detectable warning systems shall comply with Americans with Disabilities Act (28 CFR Part 36 ADA Standards for Accessible Design, Appendix A, Section 4.29.2 Detectable Warnings on Walking Surfaces), and CBC requirements (Section 11B-24, 11B-705 and others). All detectable warning materials shall have raised truncated domes with a base diameter of nominal 0.90 inch (22.9 mm), tapering to a top diameter of 0.45 inch (11.4 mm), a height of nominal 0.20 inch (5.08 mm), and a center-to-center spacing of 2.35 inches (59.7 mm) nominal. The orientation of the dome pattern for all panels shall be parallel with the panel edges. Detectable warning materials shall visually contrast with surrounding areas.

1. California Compliance Warranty: All detectable warning systems shall be approved by DSA-AC. If not approved, DSA will accept a written five (5) year product warranty provided by the manufacturer of detectable warning products and directional surfaces. Such warranty shall indicate compliance with architectural standards as published in the current edition of the California Building Standards Code, and also include durability criteria which indicate that the shape, color fastness, confirmation, sound-on-cane acoustic quality, resilience, and attachment will not degrade significantly for at least five (5) years after initial installation. As defined by the State, "not degrade significantly" means that the product maintains at least 90 percent of its approved design characteristics, as determined by the enforcing agency.
- B. Concrete Paver Detectable Dome Warning System: Provide standard size precast architectural concrete paving units for installation in sand or mortar beds.
 1. Basis-of Design Product: Provide the following, or comparable substitute product:
 - a. Wausau - ADA-2 Truncated dome pavers.
 - 1) 12 inches by 12 inches, with 2 3/8 inches thickness.
 - 2) Color A-40 Yellow (Federal Yellow No. 33538)

2.08 CONCRETE MIXTURES

- A. Prepare design mixtures, proportioned according to ACI 301 (ACI 301M), for each type and strength of normal-weight concrete, and as determined by either laboratory trial mixtures or field experience.
 1. Use a qualified independent testing agency for preparing and reporting proposed concrete design mixtures for the trial batch method.
 2. Proportioning:
 - a. The proportioning of ingredients shall be such that the concrete can be readily worked into forms and around reinforcement under the conditions of placement to be used, without segregation or excessive bleeding.
 - b. When proportioning by weight of loose, dry material, 94 pounds of cement shall be considered 1 cubic foot.
 - 1) Float/Broom Finish: Coarse aggregate 50 percent-50 percent fine aggregate.
 - c. Total water content shall not exceed 35 gallons per cubic yard of concrete.
 - d. Weighing equipment shall be accurate within 1 pound and shall be adjustable for varying aggregate moisture content.
 - e. A beam auxiliary shall register any part of the last 100 pounds of each aggregate. The aggregate hopper shall have a volume adjustment.
 3. Prepare compressive strength data for both 7-day and 28-day strengths.
 - a. The 7-day compressive strength shall be at least 60 percent of the required 28-day strength.
 - b. The 28-day compressive strength shall be as indicated.
 - c. Provide drying shrinkage test data at 28 days, from not less than 3 test specimens.
- B. Proportion mixtures to provide normal-weight concrete with the following properties:
 1. Typical Compressive Strength (28 Days): Provide the following minimum compressive strength (28 days) for concrete paving unless otherwise indicated: 3000 psi.
 2. Maximum Water-Cementitious Materials Ratio at Point of Placement: 0.50-0.60.
 3. Slump Limit: 4 inches, plus or minus 1 inch, unless indicated otherwise.
 - a. Slump Limit (High-Range Water-reducing Admixture): 8 inches for concrete with verified slump of 2 to 4 inches before adding high-range water-reducing admixture, plus or minus 1 inch, unless indicated otherwise.

- C. Air Content, Exterior Exposed Concrete: Add air-entraining admixture at manufacturer's prescribed rate to result in normal-weight concrete at point of placement having the following air entrainment for all exposed concrete with a weathering probability of severe or moderate per ACI-318-19, ACI 305R, and ACI 306R.
 - 1. Provide air entrainment of 6.0 percent, plus or minus 1.5 percent at point of delivery for 1-inch and 3/4-inch nominal maximum aggregate size, if required unless indicated otherwise.
- D. Limit "drying shrinkage" after 28 days of curing hardened concrete to 0.045 percent of the original concrete volume.
- E. Limit water-soluble, chloride-ion content in hardened concrete to 0.30 percent by weight of cement.
- F. Chemical Admixtures: Admixtures may only be used if they are incorporated into the accepted concrete mix designs. Use admixtures according to manufacturer's written instructions.
 - 1. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
 - 2. Use water-reducing admixture in pumped concrete, concrete for heavy-use industrial slabs and parking structure slabs, concrete required to be watertight, and concrete with a water-cementitious materials ratio below 0.50.
 - 3. Use corrosion-inhibiting admixture in concrete mixtures where indicated.

2.09 CONCRETE MIXING

- A. Ready-Mixed Concrete: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M [or ASTM C 1116/C 1116M when fiber reinforcement is used]. Furnish batch certificates for each batch discharged and used in the Work.
 - 1. When air temperature is between 85 and 90 deg. F (30 and 32 deg. C), reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg. F (32 deg. C), reduce mixing and delivery time to 60 minutes.
- B. Provide batch ticket for each batch discharged and used in the Work, indicating Project identification name and number, date, mixture type, mixing time, quantity, and amount of water added.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine exposed subgrades and subbase surfaces for compliance with requirements for dimensional, grading, and elevation tolerances.
- B. Proof-roll prepared subbase surface below concrete paving with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding.
 - 1. Completely proof-roll subbase in one direction and repeat in perpendicular direction. Limit vehicle speed to 3 mph.
- C. Proceed with concrete paving installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Remove loose material from compacted subbase surface immediately before placing concrete.

3.03 EDGE FORMS AND SCREED CONSTRUCTION

- A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides to required lines, grades, and elevations. Install forms to allow continuous progress of work and so forms can remain in place at least 24 hours after concrete placement.
- B. Clean forms after each use and coat with form-release agent to ensure separation from concrete without damage.
- C. Slope stair and step treads at not less than 1.0 percent and not more than 2.0 percent cross slope to drain.

3.04 STEEL REINFORCEMENT

- A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.
- B. Clean reinforcement of loose rust and mill scale, earth, ice, or other bond-reducing materials.
- C. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement. Maintain minimum cover to reinforcement.
- D. Install fabricated bar mats in lengths as long as practicable. Handle units to keep them flat and free of distortions. Straighten bends, kinks, and other irregularities, or replace units as required before placement. Set mats for a minimum 2-inch overlap of adjacent mats.

3.05 JOINTS

- A. General: Form construction, isolation or expansion joint, and saw cut / contraction joints and tool edges true to line, with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to centerline unless otherwise indicated.
 - 1. When joining existing paving, place transverse joints to align with previously placed joints unless otherwise indicated.
- B. Isolation (Expansion) Expansion Joints: Form isolation joints of preformed joint-filler strips abutting concrete curbs, catch basins, manholes, inlets, structures, other fixed objects, and where indicated.
 - 1. Locate expansion joints at intervals of 20 feet maximum unless otherwise indicated.
 - 2. Extend joint fillers full width and depth of joint and recess 1 inch from finish surface where no joint sealant is indicated.
 - 3. Terminate joint filler not less than 1/2 inch or more than 1 inch below finished surface if joint sealant is indicated.
 - 4. Furnish joint fillers in one-piece lengths. Where more than one length is required, lace or clip joint-filler sections together.
 - 5. Break steel at expansion joints.
 - 6. Dowels- provide prefabricated 'speed dowel' assemblies.
- C. Saw Cut (Control) Joints: Form weakened-plane saw cut joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth plus 1/4 inch of the concrete thickness, as follows, and to match jointing of existing adjacent concrete paving:
 - 1. Continue steel reinforcement across sawcut joints unless otherwise indicated.
- D. Edging: After initial floating, tool edges of paving, gutters, curbs, and joints in concrete with an edging tool to a 1/8-inch radius unless otherwise noted. Repeat tooling of edges after applying surface finishes. Eliminate edging-tool marks on concrete surfaces.

3.06 CONCRETE PLACEMENT

- A. Before placing concrete, inspect and complete formwork installation, steel reinforcement, and items to be embedded or cast-in. Notify other trades as necessary to permit installation of their work.
- B. Remove snow, ice, or frost from subbase surface and steel reinforcement before placing concrete. Do not place concrete on frozen surfaces.
- C. Moisten subbase to provide a uniform dampened condition at time concrete is placed. Do not place concrete around manholes or other structures until they are at required finish elevation and alignment.
- D. Comply with ACI 301 requirements for measuring, mixing, transporting, and placing concrete.
- E. Do not add water to concrete during delivery or at Project site. Do not add water to fresh concrete after testing.
- F. Deposit and spread concrete in a continuous operation between transverse joints. Do not push or drag concrete into place or use vibrators to move concrete into place.
- G. Consolidate concrete according to ACI 301 by mechanical vibrating equipment supplemented by hand spading, rodding, or tamping.
 - 1. Consolidate concrete along face of forms and adjacent to transverse joints with an internal vibrator. Keep vibrator away from joint assemblies, reinforcement, and side forms. Use only square-faced shovels for hand spreading and consolidation. Consolidate with care to prevent dislocating reinforcement, dowels and joint devices.
- H. Screed paving surface with a straightedge and strike off.
- I. Commence initial floating using bull floats or darbies to impart an open-textured and uniform surface plane before excess moisture or bleed water appears on the surface. Do not further disturb concrete surfaces before beginning finishing operations or spreading surface treatments.
- J. Curbs and Gutters: Produce curbs and gutters to required cross section, lines, grades, finish, and jointing.
- K. Compact subbase and prepare subgrade of sufficient width to prevent displacement of slip-form paving machine during operations.
- L. Cold-Weather Placement: Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing, or low temperatures. Comply with ACI 306.1 and the following:
 - 1. When air temperature has fallen to or is expected to fall below 40 deg. F (4.4 deg C), uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg. F (10 deg C) and not more than 80 deg. F (27 deg C) at point of placement.
 - 2. Do not use frozen materials or materials containing ice or snow.
 - 3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in design mixtures.
- M. Hot-Weather Placement: Comply with ACI 305R (ACI 305R M) and as follows when hot-weather conditions exist:
 - 1. Cool ingredients before mixing to maintain concrete temperature below 90 deg. F (32 deg C) at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated in total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
 - 2. Cover steel reinforcement with water-soaked burlap so steel temperature will not exceed ambient air temperature immediately before embedding in concrete.
 - 3. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.

- N. Provide sand and base materials as indicated.

3.07 FLOAT/BROOM FINISHING

- A. General: Do not add water to concrete surfaces during finishing operations.
- B. Float Finish: Begin the second floating operation when bleed-water sheen has disappeared and concrete surface has stiffened sufficiently to permit operations. Float surface with power-driven floats or by hand floating if area is small or inaccessible to power units. Finish surfaces to true planes. Cut down high spots and fill low spots. Refloat surface immediately to uniform granular texture.
 - 1. Burlap Finish: Drag a seamless strip of damp burlap across float-finished concrete, perpendicular to line of traffic, to provide a uniform, gritty texture.
 - 2. Medium-to-Fine-Textured Broom Finish: Draw a soft-bristle broom across float-finished concrete surface perpendicular to line of traffic to provide a uniform, fine-line texture. Required to meet slip coefficient requirement.
 - 3. Portland cement concrete paving shall be stable, firm, and slip resistant and shall comply with **CBC Sections 11B-302 and 11B-403.**

3.08 DETECTABLE WARNINGS

- A. Detectable Warnings, General: Install detectable warnings as part of the concrete paving placement sequence. Set true to line and elevation. Comply with maximum slope and cross-slope requirements for accessible walkways.
 - 1. Blockouts: Form blockouts in concrete and asphalt pavements for installation of detectable paving units.
 - a. Tolerance for Opening Size: Plus 1/4 inch, no minus.
- B. Detectable warnings surfaces shall comply with **CBC Section 11B-705.1.**
- C. Detectable warning surfaces shall be yellow conforming to **FS 33538 of Federal Standard 595C**, except for locations at curb ramps, islands, or cut through medians where color used shall contrast visually with that of adjacent walking surfaces, either light-on-dark or dark-on-light. **CBC Sections 11B-705.1.1.3 and 11B-705.1.1.5.**
- D. Detectable warning surfaces shall differ from adjoining surfaces in resiliency or sound-on-cane contact. **CBC Section 11B-705.1.1.4.**
- E. Provide 5 year minimum warranty per **DSA Bulletin 10/31/02, revised 04/09/08.**
- F. Precast Concrete Detectable Warning Tiles: Comply with approved plans and details along with manufacturer's written instructions.

3.09 CONCRETE PROTECTION, CURING AND SEALING:

- A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.
- B. Comply with ACI 306R for cold-weather protection.
- C. Evaporation Retarder: Apply evaporation retarder to concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete but before float finishing.
- D. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.
- E. Curing Methods: Cure concrete by moisture curing, moisture-retaining-cover curing, curing compound or a combination of these as follows:

1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:
 - a. Water.
 - b. Continuous water-fog spray.
 - c. Absorptive cover, water saturated and kept continuously wet. Cover concrete surfaces and edges with 12-inch lap over adjacent absorptive covers.
 2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover, placed in widest practicable width, with sides and ends lapped at least 12 inches and sealed by waterproof tape or adhesive. Immediately repair any holes or tears occurring during installation or curing period using cover material and waterproof tape.
 3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas that have been subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating, and repair damage during curing period.
- F. Seal Concrete: Apply specified sealer in accordance with manufacturer's recommendations.
1. Apply full strength in two coats with airless sprayer at the manufacturer's recommended rate.
 2. After the first coat is completely dry, apply second coat at right angles to the first coat.

3.10 PAVING TOLERANCES

- A. Comply with tolerances in ACI 117, the Americans with Disabilities Act, the CBC and as follows:
1. Elevation: 1/8 inch.
 2. Thickness: Plus 3/8 inch, minus 1/4 inch.
 3. Surface: Gap below 10-foot- long, unleveled straightedge not to exceed 1/8 inch. Surface must properly drain.
 4. Surface Discontinuities: Maximum 1/4 inch, subject to further limitations of accessible routes.
 5. Alignment of Tie-Bar End Relative to Line Perpendicular to Paving Edge: 1/2 inch per 12 inches of tie bar.
 6. Lateral Alignment and Spacing of Dowels: 1/4 inch.
 7. Vertical Alignment of Dowels: 1/8 inch.
 8. Alignment of Dowel-Bar End Relative to Line Perpendicular to Paving Edge: 1/8 inch per 12 inches of dowel.
 9. Joint Spacing: 3 inches, except joint position shall be within 1/4 inch of objects in alignment with joint such as benches, light poles, pull boxes, etc.
 10. Sawcut Joint Depth: Plus 1/4 inch, no minus.
 11. Joint Width: Plus 1/16 inch, no minus.

3.11 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Testing Services: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:
1. Testing Frequency: Obtain at least one composite sample for each 20 cu. Yd., or fraction thereof of each concrete mixture placed each day.
 - a. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
 2. Slump: ASTM C 143/C 143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.

3. Air Content: ASTM C 231, pressure method; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
4. Concrete Temperature: ASTM C 1064/C 1064M; one test hourly when air temperature is 40 deg. F and below and when it is 80 deg. F and above, and one test for each composite sample.
5. Compression Test Specimens: ASTM C 31/C 31M; cast and laboratory cure one set of three standard cylinder specimens for each composite sample.
6. Compressive-Strength Tests: ASTM C 39/C 39M; test one specimen at seven days and two specimens at 28 days.
 - a. A compressive-strength test shall be the average compressive strength from two specimens obtained from same composite sample and tested at 28 days.
- C. Strength of each concrete mixture will be satisfactory if average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.
- D. Test results shall be reported in writing to Owner, Architect, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.
- E. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Architect but will not be used as sole basis for approval or rejection of concrete.
- F. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect.
- G. Remove and replace concrete paving where test results indicate that it does not comply with specified requirements. Concrete paving will be considered defective if it does not pass tests and inspections.
- H. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
- I. Prepare test and inspection reports.

3.12 REPAIRS AND PROTECTION

- A. Remove and replace concrete paving that is broken, damaged, cracked, chipped, stained or defective or that does not comply with requirements in this Section as determined by Landscape Architect. Remove work in complete sections from joint to joint unless otherwise approved by Architect.
- B. Drill test cores, where directed by Architect, when necessary to determine magnitude of cracks or defective areas. Fill drilled core holes in satisfactory paving areas with Portland cement concrete bonded to paving with epoxy adhesive.
- C. Protect concrete paving from damage. Exclude all but pedestrian traffic from paving for at least 28 days after placement. When construction traffic is permitted, maintain paving as clean as possible by providing adequate surface protection and by removing surface stains and spillage of materials as they occur.
 1. Rubber tire marks are unacceptable in the completed construction.
- D. Maintain concrete paving free of stains, discoloration, dirt, and other foreign material. Sweep paving not more than two days before date scheduled for Project Completion inspections.
- E. Repair of damaged, defective or rejected concrete is not permitted. Remove all concrete from expansion joint to expansion joint or greater as required to provide a constant continuous finish.

3.13 FINAL CLEANING

- A. Remove all excess concrete, form materials, over pours, waste, etc., and legally dispose off-site.
- B. Provide a final acid and power wash for all concrete paving surfaces. Do not use any material that will affect the appearance of the concrete.
- C. All over pours in planting areas should be removed prior to landscape operations.
- D. Clean concrete paving to remove stains, markings, dust, and debris.

END OF SECTION

**SECTION 321373
PAVEMENT JOINT SEALERS**

PART 1 - GENERAL

1.01 SECTION INCLUDES: RELATED DOCUMENTS

- A. Exterior joint sealant for non-traffic surfaces.

1.02 RELATED REQUIREMENTS

- A. Division 32 Section Concrete Paving.

1.03 SUBMITTALS

- A. Product Data: For each joint-sealant product indicated.
- B. Samples for Verification: For each type and color of joint sealant required. Install joint-sealant samples in 1/2-inch- (13-mm-), and 1/4-inch (6.4-mm) wide joints formed between two 6-inch- (150-mm-) long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.
- C. Materials forming joint substrates and joint-sealant backings have been tested for compatibility and adhesion with joint sealants.
- D. Interpretation of test results and written recommendations for primers and substrate preparation needed for adhesion.
- E. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for sealants.

1.04 QUALITY ASSURANCE

- A. Source Limitations: Obtain each type of joint sealant through one source from a single manufacturer.
- B. Preconstruction Compatibility and Adhesion Testing: Submit to joint-sealant manufacturers, for testing indicated below, samples of materials that will contact or affect joint sealants.
- C. Use ASTM C 1087 to determine whether priming and other specific joint preparation techniques are required to obtain rapid, optimum adhesion of joint sealants to joint substrates.
- D. Submit not fewer than eight pieces of each type of material, including joint substrates, shims, joint-sealant backings, secondary seals, and miscellaneous materials.
- E. Schedule sufficient time for testing and analyzing results to prevent delaying the Work.
- F. For materials failing tests, obtain joint-sealant manufacturer's written instructions for corrective measures including use of specially formulated primers.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials to Project site in original unopened containers or bundles with labels indicating manufacturer, product name and designation, color, expiration date, pot life, curing time, and mixing instructions for multi-component materials.
- B. Store and handle materials to comply with manufacturer's written instructions to prevent their deterioration or damage due to moisture, high or low temperatures, contaminants, or other causes.

1.06 PROJECT CONDITIONS

- A. Do not proceed with installation of joint sealants under the following conditions:
- B. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer or are below 40 deg F (4.4 deg C).
- C. When joint substrates are wet or covered with frost.
- D. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
- E. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, products listed in other Part 2 articles.

2.02 MATERIALS, GENERAL

- A. Compatibility: Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by sealant manufacturer, based on testing and field experience.
- B. Colors of Exposed Joint Sealants: As selected by Landscape Architect from manufacturer's full range.

2.03 ELASTOMERIC JOINT SEALANTS

- A. Elastomeric Sealants: Comply with ASTM C 920 and other requirements indicated for each liquid-applied chemically curing sealant specified, including those referencing ASTM C 920 classifications for type, grade, class, and uses related to exposure and joint substrates.
- B. Stain-Test-Response Characteristics: Where elastomeric sealants are specified to be nonstaining to porous substrates, provide products that have undergone testing according to ASTM C 1248 and have not stained porous joint substrates indicated for Project.
- C. Multicomponent Pourable Urethane Sealant (Sealant #1):
 - 1. Available Products:
 - a. Pecora Corporation; Urexpan NR-200.
 - b. Sika Corporation, Inc.; Sikaflex - 2c SL.
 - 2. Type and Grade: M (multicomponent) and P (pourable).
 - 3. Class: 25.
 - 4. Use Related to Exposure: T (traffic).
 - 5. Uses Related to Joint Substrates: M, A, and, as applicable to joint substrates indicated, O.

2.04 JOINT-SEALANT BACKER MATERIALS

- A. General: Provide joint-sealant backer materials that are nonstaining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by joint-sealant manufacturer based on field experience and laboratory testing.
- B. Round Backer Rods for Cold- and Hot-Applied Sealants: ASTM D 5249, Type 1, of diameter and density required to control sealant depth and prevent bottom-side adhesion of sealant.

2.05 PRIMERS

- A. Primers: Product recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint-sealant performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions.
- B. Joint Priming: Prime joint substrates where indicated or where recommended in writing by joint-sealant manufacturer, based on preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.

3.03 INSTALLATION OF JOINT SEALANTS

- A. General: Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.
- B. Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.
- C. Install backer materials of type indicated to support 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 backer materials.
 - 2. Do not stretch, twist, puncture, or tear backer materials.
 - 3. Remove absorbent backer materials that have become wet before sealant application and replace them with dry materials.
- D. Install sealants using proven techniques that comply with the following and at the same time backings are installed:
 - 1. Place sealants so they directly contact and fully wet joint substrates.
 - 2. Completely fill recesses provided for each joint configuration.
 - 3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.
- E. Provide joint configuration to comply with joint-sealant manufacturer's written instructions, unless otherwise indicated.
- F. Provide recessed joint configuration for silicone sealants of recess depth and at locations indicated.

3.04 CLEANING

- A. Clean off excess sealants or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved by manufacturers of joint sealants and of products in which joints occur.

3.05 PROTECTION

- A. Protect joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately and replace with joint sealant so installations with repaired areas are indistinguishable from the original work.

3.06 SCHEDULE

- A. Horizontal Joints, less than 5 percent slope; Sealant No. 1.

END OF SECTION

SECTION 321413
PRECAST CONCRETE UNIT PAVING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Salvaged precast concrete unit pavers.
- B. Sand setting bed.
- C. Sand joint filler.
- D. Topsoil filler.
- E. Edge restraints.

1.02 RELATED REQUIREMENTS

- A. Section 321123 - Aggregate Base Courses: Aggregate subbase for pavers.

1.03 REFERENCE STANDARDS

- A. ASTM C33/C33M - Standard Specification for Concrete Aggregates; 2024a.
- B. ASTM C936/C936M - Standard Specification for Solid Concrete Interlocking Paving Units; 2023a.
- C. ASTM D5268 - Standard Specification for Topsoil Used for Landscaping and Construction Purposes; 2023.

1.04 QUALITY ASSUARANCE

- A. Source Limitations: Obtain each type of unit paver, joint material, and setting material from single source with resources to provide materials and products of consistent quality in appearance and physical properties.
- B. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
 - 1. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.
- C. Preinstallation Conference: Conduct conference at work site.

1.05 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Manufacturer's Installation Instructions: Indicate substrate requirements, _____, and installation methods.
- C. Maintenance Materials: Provide the following for Owner's use in maintenance of project.
 - 1. Extra Pavers: 10 of each type and size.

1.06 DELIVERY STORAGE, AND HANDLING

- A. Store pavers on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied.

- B. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Interlocking Concrete Pavers: The design is based on the following product: salvaged precast concrete unit pavers from the site. .

2.02 MATERIALS

- A. Salvaged precast concrete unit pavers.(Salvaged from site during demolition)
- B. Sand for Setting Bed: Clean washed natural sand or crushed stone, free from deleterious or foreign matter complying with gradation requirements of ASTM C33/C33M for fine aggregates.
1. Do not use mason sand or sand conforming to ASTM C 144 for the bedding sand.
 2. Bedding Sand at vehicular use areas:
 - a. Sieve according to ASTM C 136.
 - b. Requirements for bedding sand at vehicular use areas shall conform to the grading requirements of ASTM C 33 with the modifications shown in table below.

Sieve Size	Percent Passing
3/8 inch (9.5mm)	100
No. 4 (4.75 mm)	95 to 100
No. 8 (2.36 mm)	85 to 100
No. 16 (1.18 mm)	50 to 85
No. 30 (0.600 mm)	25 to 60
No. 50 (0.300 mm)	10 to 30
No. 100 (0.150 mm)	2 to 10
No. 200 (0.075 mm)	0 to 1

- C. Sand for Joints: Fine washed sand with 70 to 100 percent passing No. 16 sieve and not more than 5 percent passing No. 200 sieve. ASTM C 144 ASTM C 144.

Sieve Size	Percent Passing
No. 4 (4.75 mm)	100
No. 8 (2.36 mm)	95 to 100
No. 16 (1.18 mm)	70 to 100
No. 30 (0.600 mm)	40 to 75
No. 50 (0.300 mm)	10 to 35
No. 100 (0.150 mm)	2 to 15
No. 200 (0.075 mm)	0 to 5

- D. Aggregate base for subbase: If required to repair existing base conditions. Refer to specification section 321123 Aggregate Base Courses.

2.03 ACCESSORIES

- A. Sealers:
1. Surebond SB-1300

- B. Geotextile: Nonwoven needle-punched geotextile fabric, manufactured for subsurface drainage applications, made from polyolefins or polyesters; with elongation greater than 50 percent; complying with AASHTO M 288 and the following, measured per test methods referenced:
 - 1. Survivability: Class 2, AASHTO M 288.
 - 2. Apparent Opening Size: No. 40 (0.425-mm) sieve, maximum; ASTM D 4751.
 - 3. Permittivity: 0.5 per second, minimum; ASTM D 4491.
 - 4. UV Stability: 50 percent after 500 hours' exposure, ASTM D 4355.

PART 3 EXECUTION

3.01 EXAMINATION

- A. With the installer present, verify that substrate is level or to correct gradient, smooth, capable of supporting pavers and imposed loads, and ready to receive work of this Section.
- B. Verify gradients and elevations of substrate are correct.
- C. Proceed with installation only after unstatifactory conditions have been corrected.

3.02 PREPARATION

- A. Where aggregate subbase is required, proof roll subgrade to identify soft pockets and areas of excess yeilding. Proceed with precast concrete paver installation only after deficient subgrades have been corrected and ready to recieve subbase and base courses for concrete pavers.
- B. Treat leveling course to retard plant growth.

3.03 CLEANING

- A. Do not clean pavers until pavers and mortar are dry.
- B. Clean soiled surfaces using cleaning solution. Do not harm pavers, joint materials, or adjacent surfaces.
- C. Use non-metallic tools in cleaning operations.
- D. Rinse surfaces with clean water.
- E. Broom clean paving surfaces. Dispose of excess sand.

3.04 PROTECTION

- A. Do not permit traffic over unprotected paver surface.
- B. Protect paver surface with sheets of plywood.
- C. Do not permit traffic for 48 hours after pavement placement.

3.05 REPAIRING

- A. Remove and replace unit pavers that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Provide new units to match adjoining units and install in same manner as original units, with same joint treatment and with no evidence of replacement.

END OF SECTION

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**SECTION 321723
PAVEMENT MARKINGS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Parking lot markings, including parking bays, crosswalks, arrows, curb markings, and ISA symbols.

1.02 RELATED REQUIREMENTS

- A. Section 321216 - Asphalt Paving.
- B. Section 321313 - Concrete Paving.

1.03 REFERENCE STANDARDS

- A. AASHTO MP 24 - Standard Specification for Waterborne White and Yellow Traffic Paints; 2015 (Reapproved 2020).
- B. California MUTCD - Manual of Uniform Traffic Control Devices for Streets and Highways; State of California Department of Transportation (FHWA's MUTCD as amended for use in California); current edition.

1.04 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Product Data: Manufacturer's data sheets on each product to be used.
- C. Certificates: Submit for each batch stating compliance with specified requirements.
 - 1. Painted pavement markings.

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. Installer Qualifications: Company specializing in performing work of the type specified and with at least three years of documented experience and approved by manufacturer.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Deliver paint in containers of at least 5 gallons accompanied by batch certificate.
- B. Store products in manufacturer's unopened packaging until ready for installation.
- C. Store and dispose of solvent-based materials, and materials used with solvent-based materials, in accordance with requirements of local authorities having jurisdiction.

1.07 FIELD CONDITIONS

- A. Do not install products under environmental conditions outside manufacturer's absolute limits.
- B. Do not apply paint if temperature of surface to be painted or the atmosphere is less than 50 degrees F or more than 95 degrees F.

1.08 SEQUENCING

- A. Allow new pavement surfaces to cure for a period of not less than 14 days before application of markings.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Painted Pavement Markings:
 - 1. Dunn-Edwards Corporation; Vin-L-Stripe Specialty Interior/Exterior Flat Zone Marking Paint.
 - 2. Sherwin Williams: Setfast Acrylic Traffic Paint.
 - 3. Pervo Paint Company: Acrylic Traffic Paint.
 - 4. Vista Paint Corporation: Traffic Paint.
 - 5. Equal.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Identify existing markings for removal.
- B. Verification of Conditions: Verify that pavement is dry and ready for installation.
- C. Notify Architect of unsatisfactory conditions before proceeding.

3.02 PREPARATION

- A. Establish survey control points for locating and dimensioning of markings.
- B. Place barricades, warning signs, and flags as necessary to alert approaching traffic.
- C. Clean surfaces prior to installation.
 - 1. Remove dust, dirt, and other debris.
 - 2. Remove rubber deposits, existing paint markings, and other coatings.
- D. Temporary Markings: Apply as directed by Architect.
- E. Apply paint stencils by type and color at necessary intervals.

3.03 REQUIREMENTS

- A. Accessible parking spaces serving a particular building or facility shall be located, and dispersed if serving more than one accessible entrance, on the shortest accessible routes to an entrance or to multiple accessible entrances. CBC Section 11B-208.3.1.
- B. Accessible parking spaces in a parking facility not serving a particular building or facility shall be located on the shortest accessible route to an accessible pedestrian entrance of the parking facility. CBC Section 11B-208.3.1.
- C. Minimum number of required accessible parking spaces shall be provided in accordance with CBC Table 11B-208.2 for each parking facility provided.
- D. For every six or fraction of six accessible parking spaces, at least one shall be an accessible van parking space. CBC Section 11B-208.2.4.
- E. Accessible parking spaces and access aisles shall comply with CBC Section 11B-502 and shall be dimensioned to the centerline of the marked lines as follows:

1. Parking spaces and access aisles shall be marked according to CBC Section 11B-502.2, 11B-502.3, and 11B-502.3.3. Their surfaces shall comply with CBC Section 11B-302 and shall be at the same level with slopes not steeper than 1:48 in any direction. CBC Section 11B-502.4.
 2. Parking spaces shall be 9' x 18' minimum and van parking spaces shall be 12' x 18' minimum with an adjacent access aisle of 5' x 18' minimum. Access aisles shall be placed on either side of the parking spaces except be located on the passenger side for van parking spaces. Van parking spaces shall be permitted to be 9' x 18' minimum where the access aisle is 8' x 18' minimum.
 3. Access aisles shall be marked by a blue painted borderline around their perimeter. The area within the blue borderlines shall be marked with hatched lines a maximum of 36" on center in a color contrasting with that of the aisle surface, preferably blue or white. Access aisle markings may extend beyond the minimum required length. CBC Section 11B-502.3.3.
 4. Access aisles (parking spaces as well - similar application) shall not overlap the vehicular way. CBC Section 11B-502.3.4.
 5. A vertical clearance of 8'-2" minimum shall be provided for accessible parking spaces, access aisles, and vehicular routes serving them. CBC Section 11B-502.5.
- F. At least one passenger loading zone shall be provided in every continuous 100 linear feet of loading zone space, or fraction thereof, complying with CBC Section 11B-209 and 11B-503 as follows:
1. Vehicle pull-up spaces shall be 8' x 20' minimum. Access aisles shall be 5' x 20' minimum and shall be adjacent and parallel to the vehicular pull-up spaces. They shall be the same level with slopes not steeper than 1:48 in any direction. CBC Section 11B-503.4.
 2. Access aisles for passenger drop-off and loading zones shall be marked with a painted borderlines around their perimeter. The areas within the borderlines shall be marked with hatched lines a maximum of 36" on center in a color contrasting with that of the aisle surface. CBC Section 11B-503.3.
 3. A vertical clearance of 9'-6" minimum shall be provided for vehicle pull-up spaces, access aisles, and a vehicular route serving them connecting a vehicular entrance and a vehicular exit. CBC Section 11B-503.5.
- G. Bus loading zones and bus stops shall comply with CBC Sections 11B-209 and 11B-810.2 as follows:
1. Boarding and alighting areas shall be 8' x 5' minimum, with 8' measured perpendicular to the curb or vehicle roadway edge, and with 5' measured parallel to the vehicle roadway. Slopes in 8' direction shall be 1:48 maximum. Slopes in 5' direction shall be the same as that of the roadway, to the maximum extent practicable. CBC Figure 11B-810.2.2.
 2. Bus shelters shall provide a minimum 30" x 48" clear floor or ground space (36" x 48" or 36" x 60" as applicable in an alcove), with slopes not steeper than 1:48 in any direction, entirely within the shelter complying with CBC Section 11B-305.
 3. Bus shelters shall be connected by an accessible route complying with CBC Section 11B-402 to a boarding and alighting area complying with CBC Section 11B-810.2. CBC Figure 11B-810.3.
- H. Electric Vehicle Charging Stations:
1. Where electric charging stations are provided, they shall be provided in accordance with CBC Section 11B-228.3, Table 11B-228.3.2.1 and CBC Section 11B-812.
 2. Accessibility requirements for Public Use or Common Use EVCS facilities:
 - a. Vehicle spaces and access aisles serving them shall comply with CBC Section 11B-302. Access aisles shall be at the same level as the vehicle space they serve. Changes in level, slopes exceeding 1:48, and detectable warnings shall not be permitted in vehicle spaces and access aisles. CBC Section 11B-812.3.

- b. Vehicle spaces, access aisles serving them and vehicular routes serving them shall provide a vertical clearance of 8'-2" minimum. CBC 11B-812.4.
- c. Accessible routes between EVCS parking, equipment and the building or facility served shall be provided per CBC Section 11B-812.5.
- d. Vehicle spaces for van accessible, standard accessible, ambulatory, and drive-up EVCS shall meet minimum length and width requirements per CBC Section 11B-812.6.
- e. Accessible EVCS stalls shall be marked "EV Charging Only" per CBC Section 11B-812.9 and Figure 11B-812.9.
- f. Access aisles for van accessible and standard accessible EVCS shall meet minimum length and width requirements and be marked per CBC Section 11B-812.7 the color of the perimeter, hatch lines and "No Parking" letters shall contrast with the surface color (blue color required for use at non-EVCS accessible parking shall not be used). Effective July 1, 2021, where one parking space and one electric vehicle charging space share an access aisle, access aisle marking shall comply with Section 11B-502.3.3 and shall not be required to comply with Section 11B-812.7.2. Additionally, where four or fewer total EVCS are provided within a facility, the access aisle for non-angled van accessible spaces may be located on either the driver or passenger side of the vehicle space. See CBC 11B-812.7.1 exception and 11B-812.7.2 exception.
- g. Where four or fewer total EVCS are provided, identification with an International Symbol or Accessibility (ISA) shall not be required.
- h. Where five to twenty-five total EVCS are provided, one van-accessible EVCS shall be identified with an ISA complying with section CBC Section 11B-703.7.2.1. The required standard accessible EVCS shall not be required to be marked with an ISA.
- i. Where twenty-six or more EVCS are provided, all required van-accessible, and all required standard accessible EVCS shall be identified with an ISA.
- j. The required ISA identification sign shall be reflective with a minimum 70 square inches; shall be visible from the EVCS it serves. The sign shall be permanently posted either immediately adjacent to the vehicle space or within the projected vehicle space at the head end of the vehicle space. Signs identifying van accessible vehicle spaces shall contain the designation "Van Accessible". Signs shall be minimum 60" above the finish surface except that if the sign projects into a pedestrian circulation area, they shall be minimum 80" above finish surface per CBC Section 11B-812.8.
- k. Ambulatory EVCS complying with CBC Section 11B-812.6.3 shall be required where 26 or more EVCS are provided per CBC table 11B-228.3.2.

3.04 INSTALLATION

- A. General:
 - 1. Position pavement markings as indicated on drawings.
 - 2. Field location adjustments require approval of Architect.
- B. Painted Pavement Markings:
 - 1. Apply in accordance with manufacturer's instructions.
 - 2. Apply in accordance with California MUTCD manual for details not shown.
 - 3. Obliterating Paint: Apply as necessary to cover existing markings completely.
 - 4. Marking Paint: Apply uniformly, with sharp edges.
 - a. Applications: One coat.
 - b. Wet Film Thickness: 0.015 inch, minimum.
 - c. Stencils: Lay flat against pavement, align with striping, remove after application.
 - d. Length Tolerance: Plus or minus 3 inches.
 - e. Width Tolerance: Plus or minus 1/8 inch.

3.05 FIELD QUALITY CONTROL

- A. See Section 014000 - Quality Requirements for additional requirements.
- B. Perform field inspection for deviations from true alignment or material irregularities.
- C. If inspections indicate work does not meet specified requirements, rework and reinspect at no cost to Owner.
- D. Allow the pavement marking to set at least the minimum time recommended by manufacturer.

3.06 CLOSEOUT ACTIVITIES

- A. See Section 017800 - Closeout Submittals for additional requirements.
- B. Temporary Markings: Remove without damaging surfaces.

3.07 PROTECTION

- A. Prevent approaching traffic from crossing newly applied pavement markings.
- B. Replace damaged or removed markings at no additional cost to Owner.
- C. Preserve survey control points until pavement marking acceptance.

END OF SECTION

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SECTION 321723.13
PAINTED PAVEMENT MARKINGS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Parking lot markings, including parking bays, crosswalks, arrows, handicapped symbols, and curb markings.
- B. Roadway lane markings and crosswalk markings.
- C. "No Parking" curb painting.

1.02 RELATED REQUIREMENTS

- A. Section 321216 - Asphalt Paving.

1.03 REFERENCE STANDARDS

- A. MPI (APL) - Master Painters Institute Approved Products List; Master Painters and Decorators Association; Current Edition.
- B. California MUTCD - Manual on Uniform Traffic Control Devices for Streets and Highways; State of California Department of Transportation (FHWA's MUTCD as amended for use in California); current edition.

1.04 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. Installation methods.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Deliver paint in containers of at least 5 gallons accompanied by batch certificate.
- B. Deliver glass beads in containers suitable for handling and strong enough to prevent loss during shipment accompanied by batch certificate.
- C. Store products in manufacturer's unopened packaging until ready for installation.
- D. 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. Do not install products under environmental conditions outside manufacturer's absolute limits.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Line and Zone Marking Paint: MPI (APL) No. 97 Latex Traffic Marking Paint; color(s) as indicated.
 - 1. Parking Lots: Yellow.
 - 2. Handicapped Symbols: Blue.
- B. Temporary Marking Tape: Preformed, reflective, pressure sensitive adhesive tape in color(s) required; Contractor is responsible for selection of material of sufficient durability as to perform satisfactorily during period for which its use is required.

PART 3 EXECUTION

3.01 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.

3.02 PREPARATION

- A. Allow new pavement surfaces to cure for a period of not less than 14 days before application of marking materials.
- B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.
- C. Clean surfaces thoroughly prior to installation.
 - 1. Remove dust, dirt, and other granular surface deposits by sweeping, blowing with compressed air, rinsing with water, or a combination of these methods.
 - 2. Completely remove rubber deposits, existing paint markings, and other coatings adhering to the pavement, by scraping, wire brushing, sandblasting, mechanical abrasion, or approved chemicals.
- D. Where oil or grease are present, scrub affected areas with several applications of trisodium phosphate solution or other approved detergent or degreaser, and rinse thoroughly after each application; after cleaning, seal oil-soaked areas with cut shellac to prevent bleeding through the new paint.
- E. Establish survey control points to determine locations and dimensions of markings; provide templates to control paint application by type and color at necessary intervals.
- F. Temporary Pavement Markings: When required or directed by Architect, apply temporary markings of the color(s), width(s) and length(s) as indicated or directed.
 - 1. After temporary marking has served its purpose, remove temporary marking by carefully controlled sandblasting, approved grinding equipment, or other approved method so that surface to which the marking was applied will not be damaged.
 - 2. At Contractor's option, temporary marking tape may be used in lieu of temporary painted marking; remove unsatisfactory tape and replace with painted markings at no additional cost to Owner.

3.03 REQUIREMENTS

- A. Accessible parking spaces serving a particular building or facility shall be located, and dispersed if serving more than one accessible entrance, on the shortest accessible routes to an entrance or to multiple accessible entrances. **CBC Section 11B-208.3.1.**
- B. Accessible parking spaces in a parking facility not serving a particular building or facility shall be located on the shortest accessible route to an accessible pedestrian entrance of the parking facility. **CBC Section 11B-208.3.1.**
- C. Minimum number of required accessible parking spaces shall be provided in accordance with **CBC Table 11B-208.2** for each parking facility provided.
- D. For every six or fraction of six accessible parking spaces, at least one shall be an accessible van parking space. **CBC Section 11B-208.2.4.**
- E. Accessible parking spaces and access aisles shall comply with **CBC Section 11B-502** and shall be dimensioned to the centerline of the marked lines as follows:
 - 1. Parking spaces and access aisles shall be marked according to **CBC Section 11B-502.2, 11B-502.3, and 11B-502.3.3.** Their surfaces shall comply with **CBC Section 11B-302** and shall be at the same level with slopes not steeper than 1:48 in any direction. **CBC Section 11B-502.4.**
 - 2. Parking spaces shall be 9' x 18' minimum and van parking spaces shall be 12' x 18' minimum with an adjacent access aisle of 5' x 18' minimum. Access aisles shall be placed on either side of the parking spaces except be located on the passenger side for van parking spaces. Van parking spaces shall be permitted to be 9' x 18' minimum where the access aisle is 8' x 18' minimum.
 - 3. Access aisles shall be marked by a blue painted borderline around their perimeter. The area within the blue borderlines shall be marked with hatched lines a maximum of 36" on center in a color contrasting with that of the aisle surface, preferably blue or white. Access aisle markings may extend beyond the minimum required length. **CBC Section 11B-502.3.3.**
 - 4. Access aisles (parking spaces as well - similar application) shall not overlap the vehicular way. **CBC Section 11B-502.3.4.**
 - 5. A vertical clearance of 8'-2" minimum shall be provided for accessible parking spaces, access aisles, and vehicular routes serving them. **CBC Section 11B-502.5**
- F. At least one passenger loading zone shall be provided in every continuous 100 linear feet of loading zone space, or fraction thereof, complying with **CBC Section 11B-209 and 11B-503** as follows:
 - 1. Vehicle pull-up spaces shall be 8' x 20' minimum. Access aisles shall be 5' x 20' minimum and shall be adjacent and parallel to the vehicular pull-up spaces. They shall be the same level with slopes not steeper than 1:48 in any direction. **CBC Section 11B-503.4.**
 - 2. Access aisles for passenger drop-off and loading zones shall be marked with a painted borderlines around their perimeter. The areas within the borderlines shall be marked with hatched lines a maximum of 36" on center in a color contrasting with that of the aisle surface. **CBC Section 11B-503.3.**
 - 3. A vertical clearance of 9'-6" minimum shall be provided for vehicle pull-up spaces, access aisles, and a vehicular route serving them connecting a vehicular entrance and a vehicular exit. **CBC Section 11B-503.5.**
- G. Bus loading zones and bus stops shall comply with **CBC Sections 11B-209 and 11B-810.2** as follows:
 - 1. Boarding and alighting areas shall be 8' x 5' minimum, with 8' measured perpendicular to the curb or vehicle roadway edge, and with 5' measured parallel to the vehicle roadway. Slopes in 8' direction shall be 1:48 maximum. Slopes in 5' direction shall be the same as that of the roadway, to the maximum extent practicable. **CBC Figure 11B-810.2.2.**

2. Bus shelters shall provide a minimum 30" x 48" clear floor or ground space (36" x 48" or 36" x 60" as applicable in an alcove), with slopes not steeper than 1:48 in any direction, entirely within the shelter complying with **CBC Section 11B-305**.
3. Bus shelters shall be connected by an accessible route complying with **CBC Section 11B-402** to a boarding and alighting area complying with **CBC Section 11B-810.2. CBC Figure 11B-810.3**.

3.04 INSTALLATION

- A. Begin pavement marking as soon as practicable after surface has been cleaned and dried.
- B. Do not apply paint if temperature of surface to be painted or the atmosphere is less than ____ degrees F or more than 95 degrees F.
- C. Apply in accordance with manufacturer's instructions using an experienced technician that is thoroughly familiar with equipment, materials, and marking layouts.
- D. Comply with California MUTCD manual for details not shown.
- E. Apply markings in locations determined by measurement from survey control points; preserve control points until after markings have been accepted.
- F. Apply uniformly painted markings of color(s), lengths, and widths as indicated on drawings true, sharp edges and ends.
 1. Length Tolerance: Plus or minus 3 inches.
 2. Width Tolerance: Plus or minus 1/8 inch.
- G. Parking Lots: Apply parking space lines, entrance and exit arrows, painted curbs, and other markings indicated on drawings.
 1. Mark the "International Symbol of Accessibility" (ISA) at indicated parking spaces.
 2. Hand application by pneumatic spray is acceptable.
- H. Symbols: Use a suitable template that will provide a pavement marking with true, sharp edges and ends, of the design and size indicated.

3.05 DRYING, PROTECTION, AND REPLACEMENT

- A. Protect newly painted markings so that paint is not picked up by tires, smeared, or tracked.
- B. Provide barricades, warning signs, and flags as necessary to prevent traffic crossing newly painted markings.
- C. Allow paint to dry at least the minimum time specified by the applicable paint standard and not less than that recommended by the manufacturer.
- D. Remove and replace markings that are applied at less than minimum material rates; deviate from true alignment; exceed length and width tolerances; or show light spots, smears, or other deficiencies or irregularities.
- E. Remove markings in manner to avoid damage to the surface to which the marking was applied, using carefully controlled sand blasting, approved grinding equipment, or other approved method.
- F. Replace removed markings at no additional cost to Owner.

END OF SECTION

SECTION 323353
ARCHITECTURAL SITE CONCRETE

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Concrete site walls.
- B. Light pole bases.
- C. Other architectural site concrete as indicated.

1.02 RELATED REQUIREMENTS

- A. Division 00 Section - 003100 Available Project Information(Geotechnical Report)
- B. Division 09 Section - Permanent Non-Sacrificial Anti-Graffiti
- C. Division 32 Section - Concrete Paving
- D. Division 32 Section - Concrete Paving Joint Sealants

1.03 DEFINITIONS

- A. Cast-in-Place Architectural Site Concrete: Non-building formed concrete that is exposed to view in completed exterior work and that requires concrete materials, formwork, placement, or finishes to obtain specified architectural appearance.
- B. Cementitious Materials: Portland cement alone or in combination with one or more of the following: Fly ash and other pozzolans, ground granulated blast-furnace slag, and silica fume; subject to compliance with requirements.
- C. Design Reference Sample: Sample designated by Architect in the Contract Documents that reflects acceptable surface quality and appearance of cast-in-place architectural site concrete.
- D. Reveal: Projection of coarse aggregate from matrix or mortar after completion of exposure operations.

1.04 PREINSTALLATION MEETINGS

- A. Pre-installation Conference: Conduct conference at project site.
 - 1. Before submitting design mixtures, review concrete design mixture and examine procedures for ensuring quality of concrete materials. Require representatives of each entity directly concerned with cast-in-place architectural site concrete to attend, including the following:
 - a. Contractor's superintendent.
 - b. Independent testing agency responsible for concrete design mixtures.
 - c. District's Representative(s).
 - d. Architect's Representative(s)
 - e. Cast-in-place architectural site concrete subcontractor.
 - f. Inspector of Record (IOR).
 - g. Subcontractor for any adjacent work

2. Review testing and inspection procedures, concrete finishes and finishing, cold- and hot-weather concreting procedures, curing procedures, construction joints, forms and form-removal limitations, reinforcement accessory installation, concrete repair procedures, and protection of cast-in-place architectural site concrete.
3. Contractor to provide meeting minutes for pre-installation conference.

1.05 SUBMITTALS

- A. Product Data: For each type of product.
 1. Proprietary admixtures, pigments, curing compounds, hardeners, sealers, form-release agents, all accessory material, etc.: Indicate compatibility with other materials used.
- B. Design Mixtures: Submit proposed mix designs and test data for each class, color, application, and strength of concrete and for each method of placement.
 1. Prepare mix designs on the basis of field experience (preferred) and/or trial mixes, in compliance with California Building Code (CBC), Section 1905A.3.
 2. Mix designs shall be prepared and signed by a structural or civil engineer registered in the State of California.
 - a. Mix designs shall be reviewed by the Architect and Structural Engineer of Record (SEOR).
 3. Identify for each mix design submitted the method by which proportions have been selected.
 - a. For mix designs based on field experience, include individual strength test results, standard deviation, and required average compressive strength calculations.
 - b. For mix designs based on trial mixtures, include trial mix proportions, test results, graphical analysis and show required average compressive strength face results. Provide gross weight and yield per cubic yard of trial mixes.
 - c. Indicate quantity of each ingredient per cubic yard of concrete.
 - d. Indicate type and quantity of admixtures proposed or required.
 - e. Indicate water to cement ratio by weight.
 - f. Measured slump.
 - g. Measured air content.
 - h. Provide shrinkage test results.
 - i. Provide maximum [5%] fly ash; ground granulated blast-furnace slag, and/or silica fume content as Portland cement replacement in all concrete.
 4. Submit proposed alternate design mixtures for review by the Architect and SEOR (Structural Engineer of Record) when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.
 5. Mix designs for each application must be from a single source for the duration of the project. Multiple vendors or courses will not be permitted.
 6. All mix designs must be wet stamped by a licensed Engineer.
- C. Steel Reinforcement Shop Drawings: Placing drawings that detail fabrication, bending, and placement. Include bar sizes, lengths, material, grade, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, splices and laps, mechanical connections, tie spacing, hoop spacing, and supports for concrete reinforcement.
 1. Coordinate with and identify the details of the Contract Drawings on the shop drawings.
 2. Comply with ACI 315, part B and CRSI requirements.
- D. Formwork Shop Drawings: Show formwork construction including form-facing joints, rustications, construction and contraction joints, form joint-sealant details, form tie locations and patterns, inserts and embedments, cutouts, cleanout panels, and other items that visually affect cast-in-place architectural site concrete.

1. Engineering Responsibility: Formwork shop drawings shall be prepared by or under the supervision of a licensed professional engineer detailing fabrication, assembly, and support of formwork.
 2. Shoring and Reshoring: Indicate proposed schedule and sequence of stripping formwork, shoring removal, and reshoring installation and removal.
 3. Location of form ties and patterns are subject to approval of the Landscape Architect. For walls less than 18" high, ties to be located above and below wall face, whenever possible.
 4. Align all form joints with reveal locations indicated on plans. Provide custom size and cut form boards as required.
- E. Construction Joint Layout: Indicate proposed construction joints required to construct the structure. Submit dimensioned drawing indicating layout of construction joints, contraction (control) joints, dowelled joints, decorative scoring and placement sequence of concrete.
1. Location of construction joints are subject to approval of the Architect.
 2. Construction joints locations should align with reveal locations as located per drawings.
 3. Provide custom form boards as required for joint alignment noted per drawings.
 4. Align all form joints with reveal locations indicated on plans. Provide custom size and cut form boards as required.
- F. Placement Schedule: Submit concrete placement schedule before start of placement operations. Include locations of all joints including construction joints.
- G. Samples: For each of the following materials:
1. Form-facing panel.
 2. Form ties.
 3. Form liners.
 4. Coarse- and fine-aggregate gradations.
 5. Reveals
 6. One quart sample of sand and fine aggregate
 7. On quart sample of coarse aggregate
- H. Qualification Data: For manufacturer (batch plant).
- I. Welding Certificates: Submit certifications signed by AWS Certified Welding Inspector of prequalified welding procedures, qualifications of welding procedures unless prequalified, qualifications of welding operators and qualifications of welders.
- J. Material Certificates: For each of the following:
1. Cementations materials.
 2. Aggregates and sand.
 3. Admixtures.
 4. Form materials and form-release agents.
 5. Steel reinforcement and accessories.
 - a. Provide mill test certificates for all reinforcing steel, showing physical and chemical analyses. For steel that will be welded, include in the chemical analysis the percentages of carbon, manganese, copper, nickel, chromium, phosphorus and sulfur, and optionally, the percentages of molybdenum and vanadium.
 6. Curing compounds.
 7. Surface treatments.
 8. Bonding agents.
 9. Adhesives.
 10. Semi rigid joint filler.
 11. Joint-filler strips.
 12. Repair materials.
- K. Material Test Reports: For the following, by a qualified testing agency:

1. Aggregates. Include service record data indicating absence of deleterious expansion of concrete due to alkali-aggregate reactivity.
- L. Field Quality-control Reports. Submit reports of all compressive strength, slump, shrinkage and air content tests required by the authorities having jurisdiction and as indicated.
 1. Submit copies of delivery tickets complying with ASTM C 94 for each load of concrete delivered to the site. Tickets shall include all information required by the referenced standard.
- M. Minutes of pre-installation conference.

1.06 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with CBC Chapter 19A.
 1. Chemical products field-applied to concrete shall comply with the air quality requirements of authorities having jurisdiction.
- B. Industry Standards: Comply with the following unless modified by requirements in the Contract Documents.
 1. ACI 301, "Specifications for Structural Concrete".
 2. ACI 117, "Specifications for Tolerances for Concrete Construction and Materials".
 3. ACI 302.1R, "Guide for Concrete Floor and Slab Construction".
 4. ACI 303.1 "Specifications for Cast-in-Place Architectural Concrete".
 5. ACI 304R, "Guide for Measuring, Mixing, Transporting, and Placing Concrete".
 6. ACI 305R, "Hot Weather Concreting".
 7. ACI 306.1, "Standard Specification for Cold Weather Concreting".
 8. ACI 318, "Building Code Requirements for Structural Concrete".
 9. ACI 347, "Guide to Formwork for Concrete".
 10. ACI 318, "Building Code Requirements for Structural Concrete."
 11. ACI SP-66, "ACI Detailing Manual".
 12. CRSI, "Manual of Standard Practice".
 13. CRSI, "Placing Reinforcing Bars".
- C. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.
 1. Manufacturer certified according to NRMCA's "NRMCA Quality Control Manual - Section 3, Certification of Ready Mixed Concrete Production Facilities."
 2. Testing Agency Qualifications: Qualified according to ASTM C 1077 and ASTM E 329 for testing indicated, as documented according to ASTM E 548.
 3. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-01 or an equivalent certification program.
 4. Personnel performing laboratory tests shall be an ACI-certified Concrete Strength Testing Technician and Concrete Laboratory Testing Technician - Grade I. Testing Agency laboratory supervisor shall be an ACI-certified Concrete Laboratory Testing Technician - Grade II.
- D. Source Limitations for Cast-in-Place Architectural Site Concrete: Obtain each color, size, type, and variety of concrete material and concrete mixture from single manufacturer with resources to provide cast-in-place architectural site concrete of consistent quality in appearance and physical properties for the duration of the project.
- E. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:
 1. ACI 301, "Specification for Structural Concrete," Sections 1 through 5 and Section 6, "Architectural Concrete."
 2. ACI 303.1, "Specification for Cast-in-Place Architectural Concrete."

- F. Concrete Testing Service: Engage a qualified independent testing agency to perform material evaluation tests and to design concrete mixtures.
- G. Source Limitations for Concrete Paving: Obtain each color, size, type, and variety of concrete material and concrete mixture from single manufacturer with resources to provide concrete of consistent quality in appearance and physical properties. Secure all material required for the duration of the project as needed to ensure consistent quality in appearance
- H. Welding Qualifications: Comply with CBC Chapter 17A.
 - 1. Qualify welding procedures and welding personnel according to AWS D1.4/D 1.4M, "Structural Welding Code - Reinforcing Steel" prior to performing any welding.
 - 2. Qualify welding inspection personnel according to AWS QC1, "Standard for AWS Certification of Welding Inspectors."
- I. Mockups: Before casting architectural site concrete, build mockups to verify selections made under Sample submittals and to fully demonstrate typical joints, surface finish, texture, tolerances, reveals edges, bulkhead or cold joints, standard of workmanship and completed product. Build mockups to comply with the following requirements, using materials indicated for the completed Work:
 - 1. Build mockups in the location and of the size indicated or, if not indicated, as directed by Architect.
 - 2. Build mockups full-size, matching architectural site concrete components indicated on the Drawings. Mock-ups shall be complete in every detail, including joints, reveals, chamfers, etc. Include complex joinery conditions where necessary to integrate to other Project components as indicated.
 - 3. Maintain accurate records of variables associated with each mockup to facilitate the matching of accepted mockups during actual construction.
 - 4. Demonstrate curing, cleaning, and protecting of cast-in-place architectural site concrete, finishes, and contraction and expansion joints, as applicable.
 - 5. Required Mock-up Types:
 - a. Walls: Construct at least 6 linear feet by 4 foot height of finished concrete site walls for each color, finish, and mix design. Thickness of walls as noted on plans.
 - 6. Mock-up Acceptance: Obtain Architect's approval of mockups before casting architectural site concrete.
 - a. The mock-up acceptance shall be judged between a distance of 5 feet to 10 feet, at the Architects discretion.
 - b. The Architect may reject mockups that, in the Architect's sole judgment, do not demonstrate an acceptable completed product, including, but not limited to, color, joint work, surface finish, texture, tolerances, and standard of workmanship
 - c. The Architect may require modifications to mockups to obtain acceptable results.
 - d. The Architect may require modifications to mockup repairs to obtain acceptable results.
 - e. The Architect may require removal and reconstruction of mockups to obtain acceptable results. Multiple mock ups may be required.
 - f. Contractor shall provide additional mockups as required to obtain results acceptable to the Architect at no additional cost to the Owner.
 - 7. Mockup Disposition: Accepted mockups shall not become part of the completed Project. Maintain mock-up on-site for the duration of construction and until all work has been accepted. Remove and legally dispose mockups after acceptance of final installed work. If sufficient permanent architectural site work has been completed, Contractor may submit a written request to Architect to transfer quality control for architectural site concrete from the accepted mockups to one or more designated portions of the permanent work.

1.07 PROJECT CONDITIONS:

- A. Traffic Control: Maintain access for Owner's operations and for vehicular and pedestrian control required for construction activities.

1.08 DELIVERY, STORAGE, AND HANDLING

- A. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage.
 - 1. Label bundles with durable identification tags. Maintain reinforcement identification after bundles are broken.
 - 2. Store reinforcement to avoid excessive rusting or fouling with grease, oil, dirt or other bond-weakening contaminants.
 - 3. Avoid damaging applied coatings, if any, on steel reinforcement.

PART 2 - PRODUCTS

2.01 FORM-FACING MATERIALS

- A. General: Comply with Division 03 Section "Cast-in-Place Concrete" for formwork and other form-facing material requirements.
- B. Form-Facing Panels for As-Cast or Exposed-Aggregate Finishes: Steel, glass-fiber-reinforced plastic, or other approved non-absorptive panel materials that will provide continuous, true, and smooth architectural site concrete surfaces. Furnish in largest practicable sizes to minimize number of joints.
- C. Form-Facing Panels for all exposed As-Cast and Exposed-Aggregate Concrete Finishes: Provide steel, glass-fiber-reinforced plastic, or overlain exterior-grade plywood panels, non-absorptive, that will provide continuous, true, and smooth architectural site concrete surfaces, with no wood grain, honeycombing or patch transfer.
 - 1. Faced plywood panels shall comply with, or be equivalent to, DOC PS 1, Structural I. Provide minimum 7-ply plywood and provide balance sheets for panels coated one-side only. Furnish in largest practicable sizes to minimize number of joints.
 - a. Smooth Trowel Finish: High-Density Overlay (HDO). Provide one of the following panels, or comparable substituted product:
 - 1) Olympic Panel Products, "Multipour Concrete Form." Overlay Color: Buff.
 - 2) Pacific Laminate Products, "ProFace HDO." Overlay Color: White.
 - 3) Sylvan Products, LLC, "Armor Ply HDO" Overlay Color: Buff.
 - 2. Curved Work: Kerf back of plywood form-facing panels, or use accepted flexible or curved forms for curved work with a radius of 100 feet or less to match finish provided by form material noted in items 1 and 2 above.
- D. Forms for Cylindrical Columns, Pedestals, and Supports: Metal, glass-fiber-reinforced plastic, paper, or fiber tubes that will provide surfaces without gradual or abrupt irregularities that exceed specified formwork surface class.
 - 1. Provide units with sufficient wall thickness to resist plastic concrete loads without detrimental deformation.
 - 2. Finished work is to be free of seams or form markings.
- E. Pan-Type Forms: Glass-fiber-reinforced plastic or formed steel, stiffened to resist plastic concrete loads without detrimental deformation.
- F. Form Liners: Units of face design, texture, arrangement, and configuration indicated. Furnish with manufacturer's recommended liquid-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent surface treatments of concrete.

- G. Rustication Strips or Reveals: Wood, metal or rigid plastic, with sides beveled and back kerfed; nonstaining; in longest practicable lengths. Align reveals as shown on plans and with form seams.
- H. Form Joint Tape: Compressible foam tape; pressure sensitive; AAMA 800, "Specification 810.1, Expanded Cellular Glazing Tape"; minimum 1/4 inch (6 mm) thick.
- I. Form Joint Sealant: Urethane or silicone elastomeric sealant complying with ASTM C 920, Type M or Type S, Grade NS that adheres to form joint substrates. Form joint sealant shall be compatible with form-facing panels.
- J. Form Sealer: Penetrating, clear, polyurethane wood form sealer formulated to reduce absorption of bleed water and prevent migration of set-retarding chemicals from wood. Form sealer shall be compatible with form-facing panels. All seams and joints are to be sealed.
- K. Form-Release Agent: Commercially formulated, colorless form-release agent that will not bond with, stain, or adversely affect architectural site concrete surfaces and will not impair subsequent treatments of those surfaces. Form-release agent shall be compatible with form-facing panels.
 - 1. Obtain written acceptance of form release agent from integral colored concrete pigment manufacturer.
 - 2. Form-release agents shall be non-staining.
 - 3. Formulate form-release agent with rust inhibitor for steel form-facing materials.
- L. Surface Retarder (In Form): Chemical liquid set retarder, for application on form-facing materials, capable of temporarily delaying final hardening of newly placed concrete surface to depth of reveal specified.
 - 1. Provide Architectural Concrete Chemicals(ACC) "Altus VOC Series" or accepted comparable substitute.
- M. Form Ties: Factory-fabricated, stainless steel or fiberglass color keyed to wall color snap ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.
 - 1. Furnish ties with tapered plastic tie cone spreaders that, when removed, will leave holes 3/4 inch in diameter on concrete surface.
 - 2. Furnish internally disconnecting ties that will leave no metal closer than 1-1/2 inches (38 mm) after exposing aggregate, from the architectural site concrete surface.
 - 3. Furnish glass-fiber-reinforced plastic ties, not less than 1/2 inch (13 mm) in diameter, of color selected by Architect from manufacturer's full range.
 - 4. Furnish ties with integral water-barrier plates to walls indicated to receive damp proofing or waterproofing.
- N. Provide new forms specifically purchased for this project. Reuse of forms from past projects or contractors stock will not be accepted.
- O. Provide custom form boards as required to align seams with reveals indicated on plans.

2.02 STEEL REINFORCEMENT AND ACCESSORIES

- A. General: Comply with Division 03 Section "Cast-in-Place Concrete" for steel reinforcement and other requirements for reinforcement accessories.
- B. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of pre-consumer recycled content not less than 60 percent.
- C. Reinforcing Bars: ASTM A 615/A 615M, Grade 60, deformed, unless otherwise indicated.
- D. Low-Alloy-Steel Reinforcing Bars (for Welding): ASTM A 706/A 706M, Grade 60, deformed, unless otherwise indicated.

- E. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded-wire fabric in place; manufacture according to CRSI's "Manual of Standard Practice."
 - 1. Where legs of wire bar supports contact forms, use CRSI Class 2, stainless-steel bar supports.
- F. Tie Wire: Minimum 16 ga. annealed wire, black, galvanized or coated finish to match rebar.

2.03 CONCRETE MATERIALS

- A. Cementitious Material: Use the following cementitious materials, of the same type, brand, and source, throughout Project:
 - 1. Portland Cement: ASTM C 150, Type II/V, gray, unless white cement is required to achieve colors indicated. Supplement with the following:
 - a. Fly Ash: ASTM C 618, Class F.
- B. Normal-Weight Aggregates: ASTM C 33, Class 1N coarse aggregate or better, graded. Provide aggregates from single source with documented service record data of at least 10 years' satisfactory service in similar applications and service conditions using similar aggregates and cementitious materials].
- C. Normal-Weight Aggregates: ASTM C 33, complying with building code. Provide aggregates from a single source. All aggregates shall be free of materials with deleterious reactivity to alkali in cement when tested in accordance with ASTM C 289.
 - 1. Comply with CBC section 1903A.3.
 - 2. Maximum Coarse-Aggregate Size: 3/4 inch nominal. Maximum size shall also not be larger than 1/4 of the narrowest dimension between forms, 1/3 the depth of slab nor more than 3/4 of the minimum clear spacing between individual reinforcing bars.
 - a. Gradation: Uniformly graded.
 - b. Source: Reliance, San Gabriel, or Carrol Canyon
- D. Normal-Weight Fine Aggregate: ASTM C 33 or ASTM C 144, manufactured or natural sand, from same source for Project, free of materials with deleterious reactivity to alkali in cement and free of materials which may cause staining and light in color
 - 1. Source: Reliance, Fosters or Corona.
 - 2. Color to be white to light with no dark material.
- E. Water: Potable, complying with ASTM C 94/C 94M except free of wash water from mixer washout operations.

2.04 ADMIXTURES

- A. Air-Entraining Admixture: ASTM C 260.
- B. Chemical Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures and that contain no more than 0.1 percent water-soluble chloride ions by mass of cementitious materials. Do not use calcium chloride or admixtures containing calcium chloride.
 - 1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
 - 2. Retarding Admixture: ASTM C 494/C 494M, Type B.
 - 3. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
 - 4. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
 - 5. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
 - 6. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.

- C. Shrinkage-Reducing Admixture: Commercially formulated, shrinkage inhibitor capable of reducing initial shrinkage by 80% and long-term shrinkage by 50%. Provide product suitable for use with either air-entrained or non-air-entrained concrete as appropriate to structural member and project location.
 - 1. Products: Subject to compliance with requirements, provide one of the following(as required):
 - a. Euclid Chemical Company (The), an RPM company; EUCON SRA, SRA+.
 - b. Grace Construction Products, W. R. Grace & Co.; Eclipse Floor, Eclipse Plus.
 - c. Sika Corporation; Control 40.

2.05 CURING MATERIALS

- A. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz. /sq. yd. when dry.
- B. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.
- C. Clear, Waterborne (Non-Colored Concrete): Provide products complying with ASTM C 309, Type 1, Class B, 18 to 25 percent solids, certified by curing compound manufacturer to not interfere with bonding of sealers, with no glossy finish and compatible with specified sealer. Provide products with not more than 100g/L volatile organic content.
 - 1. Products: Subject to compliance with requirements.
- D. Clear, Waterborne (Colored Concrete): Provide products that are acceptable to concrete color pigment manufacturer complying with ASTM C 309, Type 1, Class B, 18 to 25 percent solids, certified by curing compound manufacturer to not interfere with bonding of sealers with no glossy finish and compatible with specified sealer. Provide products with not more than 100g/L volatile organic content.
 - 1. Products: Subject to compliance with requirements.
- E. Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B.
 - 1. For integrally colored concrete, curing compound shall be approved by color pigment manufacturer.
 - 2. For concrete indicated to be sealed, curing compound shall be compatible with sealer.

2.06 SEALERS AND WATER REPELLENTS

- A. Penetrating Liquid Floor and Horizontal Surface Treatment (Sealer): Clear, chemically reactive, water-based lithium quartz water-based lithium materials and proprietary components; odorless; that penetrates, hardens, and densifies concrete surfaces. Materials shall be compatible with concrete admixtures and shall be recommended by manufacturer for intended use. Provide products with 0g/L volatile organic content.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Sinak Corporation; Concrete Sealer HLQ 125.
- B. Penetrating Liquid Wall and Vertical Surface Treatment (Repellent): Clear, chemically reactive, waterborne solution of inorganic silicate or silicate materials and proprietary components; odorless; that penetrates, hardens, and densifies concrete surfaces. Materials shall be compatible with concrete admixtures and shall be recommended by manufacturer for intended use. Provide products with less than 100g/L volatile organic content.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. L&M Construction Chemicals, Inc.; Hydropel WB
 - b. ProSoCo Inc.; SL100 Water Repellent
 - c. Rainguard International; Microseal(For use with VandIGuardTEN Anti-graffiti coating)

2.07 JOINT DEVICES, FILLER MATERIALS AND OTHER ACCESSORY PRODUCTS

- A. Joint Filler at Exterior Sealed Joints: ASTM D 1751
 - 1. 1/4" asphalt-saturated cellulosic fiber.
 - 2. Lightweight, nonstaining, polyethylene closed cell expansion joint filler
 - a. Deck-O-Foam as manufactured by W.R.Meadows, Hampshire, Ill.
 - 3. Exterior Expansion- and Isolation-Joint-Filler Strips: See Division 32 Section "Concrete Paving Joint Sealants" for sealants for exterior joints at concrete pavements.

2.08 CONCRETE MIXTURES, GENERAL

- A. Prepare design mixtures for each type and strength of cast-in-place architectural site concrete proportioned on basis of laboratory trial mixture or field test data, or both, according to ACI 301.
 - 1. Use a qualified independent testing agency for preparing and reporting proposed design mixtures based on laboratory trial mixtures.
 - 2. Proportioning:
 - a. The proportioning of ingredients shall be such that the concrete can be readily worked into forms and around reinforcement under the conditions of placement to be used, without segregation or excessive bleeding.
 - b. When proportioning by weight of loose, dry material, 94 pounds of cement shall be considered 1 cubic foot.
 - c. Fine aggregate volume shall be at least 35 percent, with a maximum of 50 percent, of the sum of the separate fine and coarse aggregate volumes.
 - d. Total water content shall not exceed 35 gallons per cubic yard of concrete.
 - e. Weighing equipment shall be accurate within 1 pound and shall be adjustable for varying aggregate moisture content.
 - f. A beam auxiliary shall register any part of the last 100 pounds of each aggregate. The aggregate hopper shall have a volume adjustment.
 - 3. Prepare compressive strength data for both 7-day and 28-day strengths.
 - a. The 7-day compressive strength shall be at least 60 percent of the required 28-day strength.
 - b. The 28-day compressive strength shall be as indicated.
 - 4. Provide drying shrinkage test data at 28 days, from not less than 3 test specimens.
- B. Cementitious Materials-General: Use fly ash, pozzolan, ground granulated blast-furnace slag, and silica fume as needed to reduce the total amount of Portland cement, which would otherwise be used, by not more than 5 percent. Per ACI 301 limits for concrete exposed to de-icing chemicals, limit percentage, by weight, of cementitious materials other than Portland cement in concrete as follows:
 - 1. Fly Ash: 0-5 percent.
- C. Proportion concrete mixtures as follows:
 - 1. Minimum Compressive Strength (28 Days): 3000 psi.
 - a. Provide the following minimum compressive strength (28 days) where required by high-pressure water or bush hammer finishing techniques: 4500 psi.
 - 2. Maximum Water-Cementitious Materials Ratio: 0.50-0.60.
 - 3. Slump Limit: 4 inches, plus or minus 1 inch, unless indicated otherwise.
 - 4. Slump Limit (High-Range Water-reducing Admixture): 8 inches for concrete with verified slump of 2 to 4 inches before adding high-range water-reducing admixture, plus or minus 1 inch, unless indicated otherwise.
 - 5. Slump Limit (Plasticizing Admixture): 8 inches for concrete with verified slump of 2 to 4 inches before adding plasticizing admixture, plus or minus 1 inch, if required/unless indicated otherwise.
- D. Admixtures: Use admixtures according to manufacturer's written instructions.

1. Limit water-soluble, chloride-ion content in hardened concrete to 0.06 percent by weight of cement. Limit total chloride-ion content in hardened concrete to 0.10 percent by weight of concrete when tested per AASHTO T 260 potentiometric titration.
2. Limit "drying shrinkage" after 28 days of curing hardened concrete to 0.045 percent of the original concrete volume.
3. Admixtures: Admixtures may only be used if they are incorporated into the accepted concrete mix designs. Use admixtures according to manufacturer's written instructions.
 - a. Use [water-reducing] [high-range water-reducing] [or] [plasticizing] admixture in concrete, as required, for placement and workability.
 - b. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
 - c. Use water-reducing admixture in pumped concrete, concrete for heavy-use industrial slabs and parking structure slabs, concrete required to be watertight, and concrete with a water-cementitious materials ratio below 0.50.
 - d. Use corrosion-inhibiting admixture in concrete mixtures where indicated.

2.09 FABRICATING REINFORCEMENT

- A. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."
 1. Splices: Do not splice bars, unless indicated on the Drawings.
 2. Staggered Splices: Stagger splices such that not more than one-half of the reinforcing bars are spliced at any location.

2.10 CONCRETE MIXING

- A. Ready-Mixed Architectural Site Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94/C 94M [and ASTM C 1116/1116M] and furnish batch ticket information.
 1. Clean equipment used to mix and deliver cast-in-place architectural site concrete to prevent contamination from other concrete.
 2. When air temperature is between 85 and 90 deg. F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg. F, reduce mixing and delivery time to 60 minutes.
 3. Provide batch ticket for each batch discharged and used in the Work, indicating Project identification name and number, date, mixture type, mixture time, quantity, and amount of water added. Record approximate location of final deposit in structure.

PART 3 - EXECUTION

3.01 FORMWORK

- A. General: Comply with the following, unless otherwise indicated:
 1. Conform to ACI 318, ACI 347 and CBC Section 1906A.
- B. Structural Loads: Design, erect, shore, brace, and maintain formwork, according to ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads.
- C. Geometry: Construct formwork so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117. Provide for necessary openings, inserts, anchorages, and other features indicated or required. Properly locate all elements.
 1. Limit concrete surface irregularities, designated by ACI 347 as abrupt or gradual, as follows:
 - a. Class A, 1/16 or 1/8 inch for smooth-formed finished surfaces.

- b. Class B, 1/4 inch (6 mm) for rough-formed finished surfaces.
- D. Form Joints: Minimize form joints and make forms watertight to prevent leakage of concrete mortar. Locate form joints at exposed concrete symmetrically about center of panel and aligned with reveals, unless otherwise indicated. Align joints symmetrically at exposed conditions.
 - 1. Seal penetrations at form ties with form joint sealant to prevent cement paste leakage.
 - 2. Provide custom form boards as required to align with reveals.
- E. Removal: Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush or wrecking plates where dismantling or stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical.
 - 1. Install keyways, reglets, recesses, and the like, for easy removal.
 - 2. Do not use rust-stained steel form-facing material.
- F. Chamfers: Chamfered edges are not allowed.

3.02 EARTH FORMS

- A. General: Unless indicated, placement of concrete directly against soil or earth (casting "neat") shall not be permitted only with the prior approval of the Structural Engineer of Record. Concrete placed directly against earth shall require a minimum increase in concrete thickness of 1" at vertical faces. For example, footings shall be 2" wider than indicated if both vertical faces are cast against earth.
- B. Trimming and Cleaning: Hand trim sides and bottoms of soil forms and trenches. Remove loose soil, exposing undisturbed native soil, and prior to placing concrete.

3.03 CONSTRUCTED FORMWORK

- A. Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces. Provide and secure units to support screed strips; use strike-off templates or compacting-type screeds.
- B. Provide temporary openings for cleanouts and inspection ports where interior area of formwork is inaccessible. Close openings with panels tightly fitted to forms and securely braced to prevent loss of concrete mortar. Locate temporary openings in forms at inconspicuous locations.
- C. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the Work. Determine sizes and locations from trades providing such items.
- D. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.
- E. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.
- F. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement.
- G. Provide bracing and shores to ensure stability of formwork and accommodate all loads. Use form ties of sufficient strength and in sufficient quantities to prevent formwork spreading. Maintain principal shores to support concrete until required strength is achieved.

3.04 EMBEDDED ITEMS

- A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

1. Install embedded accessories level, true-to-line and plumb in accordance with manufacturer's instructions.
2. Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of AISC's "Code of Standard Practice for Steel Buildings and Bridges."
3. Provide reveals around embedded items such as light fixtures as shown on Drawings.

3.05 OPENINGS, DEPRESSIONS, RECESSES AND CHASES

- A. Size and locate formed openings, depressions, recesses and chases to accommodate products to be applied to, built-into and/or pass-through concrete Work. Coordinate size, location and placement of inserts, embedded products, openings and recesses with Work of other sections. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

3.06 FORM RELEASE AGENTS

- A. General: Provide either form materials with factory-applied non-absorptive liner or field-applied form coating. Field-applied coating shall be non-staining.
1. Non-absorptive Liner: Rust on steel form surfaces is not acceptable.
 2. Field Applied Coating: Comply with manufacturer's written instructions. Obtain written acceptance of form release agent from integral colored concrete pigment manufacturer.
 - a. Reapply coating to thoroughly cleaned and reconditioned formwork before each use.
 - b. Verify compatibility of release agents with integrally-colored concrete and all subsequently applied curing compounds, coatings, applied finishes, etc. Do not apply release agent if items are non-compatible.
 - c. Do not apply release agent where decorative wood graining is intended for concrete surface. Leave form face dry.

3.07 CONCRETE SURFACE RETARDERS

- A. Coat contact surfaces of forms with surface retarder, according to manufacturer's written instructions, before placing reinforcement.

3.08 FORM LINERS

- A. Place form liners accurately to provide finished surface texture indicated. Provide solid backing and attach securely to prevent deflection and maintain stability of liners during concreting. Prevent form liners from sagging and stretching in hot weather. Seal joints of form liners and form liner accessories to prevent mortar leaks. Coat form liner with form-release agent.

3.09 REMOVING AND REUSING FORMS

- A. General: Formwork for sides of walls, steps, columns, and similar parts of the Work that does not support weight of concrete may be removed after cumulatively curing at not less than 50 deg. F for 72 hours after placing concrete. Concrete has to be hard enough to not be damaged by form-removal operations and curing and protection operations need to be maintained.
1. Schedule form removal to maintain surface appearance that matches accepted mockups.
 2. Leave formwork for beam soffits, joists, slabs, and other structural elements that supports weight of concrete in place until concrete has achieved its 28-day design compressive strength, but not less than 21 days after pour.
 3. Remove forms only if shores have been arranged to permit removal of forms without loosening or disturbing shores.
 4. All formwork is to be new specifically purchased for this project.

- B. Clean and repair surfaces of forms to be reused in the Work in non-exposed areas. Split, frayed, delaminated, or otherwise damaged form-facing material will not be acceptable for exposed surfaces. Apply new form-release agent.
- C. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints. Align and secure joints to avoid offsets. Do not use patched forms for exposed concrete surfaces unless approved by Architect.

3.10 STEEL REINFORCEMENT

- A. General: Place and secure reinforcement as indicated. Comply with CRSI publications "Manual of Standard Practice" and "Placing Reinforcing Bars".
 - 1. Do not cut or puncture vapor retarder. Repair damage and reseal vapor retarder before placing concrete.
 - 2. Do not bend bars more than once.
 - 3. Do not bend or straighten reinforcement in a manner injurious to the material, such as heating.
 - 4. Do not use bars with kinks or bends not indicated.
 - 5. Do not use bars with reduced cross-section due to corrosion or other cause.
 - 6. Remove and replace all defective bars.
- B. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials that would reduce bond to concrete.
- C. Space reinforcement as indicated. If not indicated, maintain clear spacing of not less than the bar diameter, 1-inch, or 1-1/3 times the maximum aggregate size, whichever is greater. Where parallel reinforcing is placed in more than one horizontal layer, place as many bars as possible in the outboard layer, maintaining the required lateral clearances and spacing's. Place bars in the inboard layer in direct vertical alignment with the bars of the outboard layer. Maintain not less than 1-inch or the maximum bar diameter in the inboard/outboard layers, whichever is greater, clear space between vertically stacked bars.
- D. Accurately position, support, and secure reinforcement against displacement.
 - 1. Maintain reinforcing steel positions during placement operations. Properly reset any reinforcement that is displaced by runways, workmen and other causes.
- E. Locate and support reinforcement with bar supports to maintain minimum concrete cover as indicated or as required by ACI 318.
- F. Do not tack weld crossing reinforcing bars.
 - 1. Weld reinforcing bars according to AWS D1.4/D 1.4M, where indicated.
- G. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.
- H. Install welded wire reinforcement in longest practicable lengths on bar supports spaced to minimize sagging. Lap edges and ends of adjoining sheets at least one mesh spacing. Offset laps of adjoining sheet widths to prevent continuous laps in either direction. Lace overlaps with wire.

3.11 JOINTS

- A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.
- B. Construction or Cold Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.
 - 1. Place joints perpendicular to main reinforcement. Continue reinforcement across construction joints unless otherwise indicated. Do not continue reinforcement through sides of strip placements of floors and slabs.
 - 2. Locate horizontal joints in walls and columns as indicated.

3. Space vertical joints in walls as indicated and as may be directed by the Architect. Locate joints beside piers integral with walls, near corners, and in concealed locations where possible.
 4. Use a bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
 5. Use epoxy-bonding adhesive at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
 6. Align joints with reveals indicated. Provide custom cut form boards as required.
 7. Do not place expansion material at cold joints.
- C. Isolation Joints in Slabs-on-Grade: After removing formwork, install joint-filler strips at slab junctions with vertical surfaces, such as column pedestals, walls and other locations, as indicated.
1. Extend joint-filler strips full width and depth of joint, terminating flush with finished concrete surface unless otherwise indicated.
 2. Terminate full-width joint-filler strips not less than 1/2 inch or more than 1 inch below finished concrete surface where joint sealants, specified in Division 07 Section "Joint Sealants," are indicated.
 3. Install joint-filler strips in lengths as long as practicable. Where more than one length is required, lace or clip sections together.

3.12 CONCRETE PLACEMENT

- A. Before placing concrete, verify that installation of formwork, form-release agent, surface retarders, reinforcement, and embedded items is complete and that required inspections have been performed.
1. Provide protective coatings, coverings and masking's to protect adjacent Work.
 2. Provide temporary runways and other appropriate equipment as necessary to access Work area and to avoid soiling or damage to existing Work.
 3. Prevent run-off of concrete hydration water and water polluted by agents and chemicals from soiling existing surfaces or contaminating landscape areas.
- B. Do not add water to concrete during delivery, at Project site, or during placement.
1. Do not add water to concrete after adding high-range water-reducing admixtures to mixture.
 2. If indicated in mix design accepted by the Architect, water added to concrete shall be observed by the Project Inspector, and shall be recorded on the delivery ticket.
- C. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301.
- D. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete will be placed on concrete that has hardened enough to cause seams or planes of weakness. Deposit concrete continuously between construction joints. Deposit concrete to avoid segregation.
1. Deposit concrete in horizontal layers of depth to not exceed formwork design pressures and in a manner to avoid inclined construction joints.
 2. No visible cold joints or lift lines are acceptable in the completed work.
 3. Consolidate placed concrete with mechanical vibrating equipment according to ACI 303.1.
 4. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least 6 inches into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity. Do not permit vibrators to contact forms. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing mixture constituents to segregate.

5. Consolidate concrete during placement operations so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
 6. Maintain reinforcement in position on chairs during concrete placement.
 7. Screed slab surfaces with a straightedge and strike off to correct elevations.
 8. Slope surfaces uniformly to drains where required.
 9. Begin initial floating using bull floats or derbies to form a uniform and open-textured surface plane, before excess bleed water appears on the surface.
- E. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
1. When average high and low temperature is expected to fall below 40 deg. F for three successive days, maintain delivered concrete mixture temperature within the temperature range required by ACI 301.
 2. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
 3. Do not use calcium chloride, salt, or other materials containing antifreeze agents.
 4. Do not use chemical accelerators unless otherwise specified and accepted in design mixtures.
- F. Hot-Weather Placement: Comply with ACI 305R and as follows:
1. Maintain concrete temperature below 90 deg. F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
 2. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.

3.13 FINISHES, GENERAL

- A. Architectural Site Concrete Finishes: Match Architect's design reference sample, identified and described as indicated, to satisfaction of Architect.
- B. Architectural Site Concrete Finishes: Match accepted mockups to satisfaction of Architect.
- C. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a texture matching adjacent formed surfaces.
 1. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces unless otherwise indicated.
- D. Maintain uniformity of special finishes over construction joints unless otherwise indicated.

3.14 AS-CAST FORMED FINISHES

- A. Smooth-Trowel Finish: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Remove fins and other projections exceeding specified limits on formed-surface irregularities. Repair and patch tie holes and defects to match the accepted mockups. Rough-Formed Finish: As-cast concrete texture imparted by form-facing material with tie holes and defects repaired and patched. Remove fins and other projections exceeding specified limits on formed-surface irregularities.

3.15 CONCRETE PROTECTING AND CURING

- A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and with ACI 305R for hot-weather protection during curing.

- B. Begin curing cast-in-place architectural site concrete immediately after removing forms from concrete or after applying as-cast formed finishes to concrete, consistent with mockup preparation. Cure according to ACI 308.1, by one or a combination of the following methods that will not mottle, discolor, or stain concrete:
1. Moisture Curing: Keep exposed surfaces of cast-in-place architectural site concrete continuously moist for no fewer than seven days with the following materials:
 - a. Water.
 - b. Continuous water-fog spray.
 - c. Absorptive cover, water saturated and kept continuously wet. Cover concrete surfaces and edges with 12-inch lap over adjacent absorptive covers.
 2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive. Cure for no fewer than seven days. Immediately repair any holes or tears during curing period; use cover material and waterproof tape.
 3. Curing Compound: Mist concrete surfaces with water. Apply curing compound uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.

3.16 FIELD QUALITY CONTROL

- A. Testing and Inspecting: Owner will engage a special inspector and qualified testing and inspecting agency to perform field tests and inspections and prepare test reports in accordance with the CBC and ACI 301.
1. Comply with the requirements of Division 01 Section "Quality Control-DSA".
- B. Inspections:
1. Steel reinforcement placement.
 2. Steel reinforcement welding.
 3. Headed bolts and studs.
 4. Verification of use of required design mixture.
 5. Structural concrete placement, including conveying and depositing.
 6. Curing procedures and maintenance of curing temperature.
 7. Verification of concrete strength before removal of shores and forms from beams and slabs.
- C. Concrete Tests: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:
1. Testing Frequency: Obtain one composite sample for each day's pour of each concrete mixture exceeding 5 cu. yd. (4 cu. m), but less than 25 cu. yd. (19 cu. m), plus one set for each additional 50 cu. yd. (38 cu. m) or fraction thereof.
 - a. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
 2. Slump: ASTM C 143/C 143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.
 3. Air Content: ASTM C 231, pressure method; one test for each composite sample, but not less than one test for each day's pour of each concrete mix.
 4. Concrete Temperature: ASTM C 1064/C 1064M; one test hourly when air temperature is 40 deg. F and below and when 90 deg. F and above, and one test for each composite sample.
 5. Compression Test Specimens: ASTM C 31/C 31M.

- a. Cast and laboratory cure two sets of two standard cylinder specimens for each composite sample.
 - b. Cast and field cure two sets of two standard cylinder specimens for each composite sample.
6. Compressive-Strength Tests: ASTM C 39/C 39M; test one set of two laboratory-cured specimens at 7 days and one set of two specimens at 28 days.
 - a. Test one set of two field-cured specimens at 7 days and reserve one set of two specimens for testing at 56 days.
 - b. A compressive-strength test shall be the average compressive strength from a set of two specimens obtained from same composite sample and tested at age indicated.
7. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, Contractor shall evaluate operations and provide corrective procedures for protecting and curing in-place concrete.
8. Strength of each concrete mixture will be satisfactory if every average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.
9. Test results shall be reported in writing to Architect, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.
10. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Architect but will not be used as sole basis for approval or rejection of concrete.
11. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42/C 42M or by other methods as directed by Architect.
12. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
13. Correct deficiencies in the Work that test reports and inspections indicate do not comply with the Contract Documents.

3.17 DEFECTIVE CONCRETE

- A. The following list includes, but is not limited to; concrete that will be deemed to be defective and non-conforming. All such concrete shall be removed and replaced with Work complying with the requirements of the Contract:
 1. Concrete not formed as indicated, not true to alignment indicated, not plumb where intended, not level where intended, not true to level or elevation intended.
 2. Concrete voided or honeycombed, including voids and honeycombs that have been cut, resurfaced or filled without prior approval of the Architect.
 3. Concrete with exposed reinforcement.
 4. Concrete with inadequate cover over reinforcement.
 5. Concrete with embedded foreign objects and debris, including sawdust, wood or metal shavings, nails, cans, trash, etc.
 6. Concrete that does not visually match the accepted mockups [or the designated design reference sample].
 7. Other non-conforming work.

- B. All concrete deemed to be defective by the Architect or in non-conformance with the contract documents is to be removed and replaced from expansion joint or cold joint to expansion joint or cold joint at no cost to the owner. Repair defective concrete as directed by the Architect, at no cost to the Owner.

3.18 SEALERS AND REPELLENTS

- A. General: Uniformly apply a continuous sealing coat of sealers or repellents to all exposed surfaces of architectural site concrete by power spray or roller according to manufacturer's written instructions.
 - 1. Remove curing compounds, sealers, oil, dirt, laitance, and other contaminants and complete surface repairs.
 - 2. Do not apply to concrete that is less than 28 days old.
- B. Penetrating Liquid Floor and Horizontal Surface Treatment (Sealer): Prepare, apply, and finish penetrating liquid floor treatment according to manufacturer's written instructions.
 - 1. Apply liquid until surface is saturated, scrubbing into surface until a gel forms; rewet; and repeat brooming or scrubbing. Rinse with water; remove excess material until surface is dry. Apply a second coat in a similar manner if surface is rough or porous.
- C. Penetrating Liquid Wall and Vertical Surface Treatment (Sealer/Repellent): Prepare, apply, and finish penetrating liquid repellent treatment according to manufacturer's written instructions.

3.19 REPAIRS, PROTECTION, AND CLEANING

- A. Patching or sacking of damaged or defective concrete as a determined by the Architect is not permitted. Remove and replace all damaged or defective concrete from joint to joint. Remove/Repair and cure damaged or defective finished surfaces of cast-in-place architectural site concrete when accepted by Architect. Match repairs to color, texture, and for any replaced work/uniformity of surrounding surfaces and to repairs on approved mockups.
- B. Remove and replace cast-in-place architectural site concrete that does not match mockups accepted by Architect.
- C. Protect corners, edges, and surfaces of cast-in-place architectural site concrete from damage; use guards and barricades.
- D. Protect cast-in-place architectural site concrete from staining, laitance, and contamination during remainder of construction period.
- E. Clean cast-in-place architectural site concrete surfaces after finish treatment to remove stains, markings, dust, and debris.
- F. Wash and rinse surfaces according to concrete finish applicator's written instructions. Protect other Work from staining or damage due to cleaning operations.
 - 1. Do not use cleaning materials or processes that could change the appearance of cast-in-place architectural site concrete finishes.

END OF SECTION