

Sonoma County REDCOM Expansion, Tenant Improvements



**2796 Ventura Avenue, 2nd Floor
Santa Rosa, California 95403**

95% Construction Documents

July 9, 2025

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SECTION 05 11 00 -STRUCTURAL AND MISCELLANEOUS STEEL

PART 1 – GENERAL

1.1 SUMMARY

- A. Section Includes: All labor, materials, equipment and operations required to complete structural and miscellaneous metals in shapes and configurations indicated; including:
 - 1. Structural steel columns, beams, bracing, base plates, bolts, joist hangers, and stud bolts welded to structural steel.
 - 2. Miscellaneous structural steel and connections; fabricated connectors and hangers installed by related sections.
 - 3. Anchor bolts and steel inserts embedded in concrete or masonry, installed by related sections.
 - 4. Fabricated steel items embedded in concrete or masonry installed by related sections.
 - 5. Supervision of anchor bolt setting, leveling and elevations to ensure required fit of steel work.
 - 6. Shop priming and field touch-up, galvanizing.
 - 7. Bracing, Shoring, Fabrication and Erection.
- B. Related Sections:
 - 1. Pertinent sections of Division 01 specifying Quality Control and Testing Agency services.
 - 2. Pertinent Sections of other Divisions specifying concrete reinforcement, formwork, concrete, structural and miscellaneous metal fabrications, steel joists, metal decking, cold-formed metal framing, rough carpentry.

1.2 REFERENCES

- A. California Code of Regulations, Title 24, latest adopted edition (herein noted as CBC): Chapter 22 Steel.
- B. American Institute of Steel Construction (AISC) 303 “Code of Standard Practice for Steel Buildings and Bridges”.
- C. AISC 360 “Specification for Structural Steel Buildings”.
- D. American Welding Society (AWS) D1.1 “Structural Welding Code - Steel”.
- E. Underwriters Laboratories (UL) FORD “Fire Resistance Directory”.
- F. Research Council on Structural Connections (RCSC) “Specification for Structural Joints Using High-Strength Bolts”.

1.3 SUBMITTALS

- A. Submit in accordance with pertinent sections of Division 01 specifying submittal procedures. The General Contractor shall review and approve shop drawings prior to submittal to the Architect/Engineer. Submittals that do not meet these requirements will be returned for correction without review.
 - B. Limitation of Review: Structural Engineer's review will be for general conformance with design intent as indicated in the Contract Documents and does not relieve Contractor of full responsibility for conformance with the Contract Documents.
 - C. Product Data: Submit manufacturer's product data, specifications, location and installation instructions for proprietary materials and reinforcement accessories. Provide samples of these items upon request.
 - D. Shop drawings: Submit each building as a complete unit. Do not mix components from multiple buildings or units of work in a submittal. Include all of the following;
 - 1. Profiles, sizes, spacing, locations of structural members, openings, attachments, and fasteners.
 - 2. Fabrication tolerances for all steel.
 - 3. Connections: All, including type and location of shop and field connections.
 - 4. Indicate welded connections with AWS A2.4 welding symbols. Indicate net weld lengths, type, size, and sequence. Designate demand critical welds.
 - 5. Cross-reference all shop drawing detail references to contract document detail references.
 - 6. Secure all field measurements as necessary to complete this work prior to submitting shop drawings for review.
 - 7. Provide holes, welded studs, etc. as necessary to secure work of other sections.
 - 8. Provide the following as separate submittals for each building or unit of work:
 - a. Bolt and anchor setting plans.
 - b. Layout, fabrication and erection drawings.
 - E. Certifications:
 - 1. Steel Materials: Submit the following for identified materials.
 - a. Manufacturer's Mill Certificate: Certify that products meet or exceed specified requirements.
 - b. Mill Test Reports: Indicate structural strength, destructive test analysis, and non-destructive test analysis.
 - c. Contractor's affidavit certifying that all identified steel materials provided are of the grades specified and match the certificates supplied.
 - 2. High-Strength Bolting: Certify all materials provided are the grades specified.
 - 3. Welders Certificates: Certify welders employed on the Work, verifying AWS qualification per AWS D1.1.
 - F. Samples: Provide samples to the Testing Agency as specified in Article SOURCE QUALITY CONTROL, at no additional costs.
- 1.4 QUALITY ASSURANCE
- A. Requirements of Regulatory Agencies, refer to pertinent sections of Division 01 and CBC Chapter 17.

- B. All tests shall be performed by a recognized testing agency as specified in pertinent sections of Division 01.
 - C. Certification and Identification of Materials and Uses: Provide Testing Agency with access to fabrication plant to facilitate inspection of steel. Provide notification of commencement and duration of shop fabrication in sufficient time to allow inspection and all material identification/test information listed below.
 - 1. Test all steel as required by ASTM A6.
 - 2. Provide manufacturer's Mill Test Reports for all materials. Include chemical and physical properties of the material for each heat number manufactured. Tag all fabricated materials with heat number.
 - 3. Provide letter certifying all materials supplied are from heat numbers covered by supplied mill certificates. Include in letter the physical location of each material type and/or heat number in the project (i.e. walls, braced frames etc.).
 - 4. Unidentified Material Tests: Where identification of materials by heat number or mill tests cannot be made, Owner's Testing Agency shall test unidentified materials.
 - 5. Provide all certification, verifications, and other test data required to substantiate specified material properties at no additional cost to the Owner.
 - D. Testing and Inspection: Tests and Inspections performed by Independent Testing Agency are specified below in Articles SOURCE QUALITY CONTROL and FIELD QUALITY CONTROL. Duties and limitations of Independent Testing Agency, test costs and test reports in conformance with pertinent sections of Division 01.
 - E. The following standards are the minimum level of quality required. Provide higher quality work as specifically indicated in the Contract Documents.
 - 1. Workmanship and details of structural steel work shall conform to the CBC and AISC 360.
 - 2. The quality of materials and the fabrication of all welded connections shall conform to AWS D1.1.
 - 3. Comply with Section 10 of AISC 303 for architecturally exposed structural steel.
 - F. The Testing Agency will review all submittals and testing of materials.
 - G. All re-inspections made necessary by non-conforming work shall be at the Contractor's expense.
- 1.5 DELIVERY, STORAGE AND HANDLING
- A. Deliver materials to project site in bundles marked with durable tags indicating heat number, mill, member size and length, proposed location in the structure and other information corresponding with markings shown on placement diagrams.
 - B. Handle and store materials above ground to prevent damage, contamination or accumulation of dirt or rust.
- 1.6 SCHEDULING AND SEQUENCING

- A. Organize the work and employ shop and field crew(s) of sufficient size to minimize inspections by the Testing Agency.
- B. Provide schedule and sequence information to Testing Agency in writing upon request. Update information as work progresses.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Structural Steel W Shapes: ASTM A992 Gr. 50 or ASTM A572 Gr. 50.
- B. Structural Steel Plates: ASTM A36 or ASTM A572 Gr. 50 or ASTM A529 Gr. 50
- C. Structural Steel Channels, Angles: ASTM A36 or ASTM A572 Gr. 50.
- D. HSS (Hollow Structural Sections):
 - 1. Round: ASTM A500, Gr. C.
 - 2. Rectangular or Square: ASTM A500, Gr. C.
- E. Pipe: ASTM A53, Grade B.
- F. Bolts and Washers: See FINISHES section for galvanization, where required.
 - 1. Machine Bolts, Nuts, and Washers: Bearing and shear connections (denoted as "MB"); ASTM A307 Grade A machine bolts with ASTM A563 Grade A nuts and ASTM F844 washers to match.
 - 2. High Strength Bolts, Nuts, and Washers: Bearing and shear connections (denoted as "HSB"); ASTM F3125 Grade A325 with ASTM A563 Grade C nuts and ASTM F436 Type 1 washers. Where noted on the drawings provide ASTM A490 bolts with ASTM A563 Grade DH nuts and ASTM F436 Type 1 washers.
 - a. HSB-N: For use in snug tight (ST), pretensioned (PT), and slip critical (SC) joints. Conform to the RCSC Specifications.
 - b. HSB-X: For use where specified on the drawings.
 - c. At Grade A325 bolts use of Grade F1852 (twist off assemblies) is permitted conforming to requirements of RCSC Specifications. At Grade A490 bolts, Grade F2280 is permitted.
 - d. Use of ASTM F959 Load Indicator Washers is permitted conforming to the requirements of RCSC Specifications.
 - e. Slip critical (SC) bolt faying surfaces shall be prepared per RCSC as Class A, unless noted to be Class B per the drawings. Galvanized surfaces at SC bolts shall be hand wire brushed.
- G. Anchor Bolts/Rods, Nuts, and Washers: ASTM F1554 Gr. 36 or 55 with ASTM A563 Grade A nuts and ASTM F436 Type 1 washers. Grade DH nuts where Grade 105 rod is specified. No upset thread allowed.
- H. Arc-Welding Electrodes: AWS Standards E70 or equivalent, except no E70T-4 allowed.

- I. Other Welding Materials: AWS D1.1; type required for materials being welded.
 - J. Welded Headed/Threaded Studs: AWS D1.1 Type B.
 - K. Deformed Bar Anchors: ASW D1.1 Type C from ASTM A496 material.
- 2.2 ACCESSORIES
- A. High Strength Grout: ASTM C1107, non-shrink, premixed compound consisting of aggregate, cement, and water reducing plasticizing agents. Minimum compressive strength $f'c = 7000$ psi at 28 days, placed in a "fluid" state. Non-metallic where exposed to view. BASF "MasterFlow 928" or equivalent.
 - B. Building Structural Steel Primers: Comply with local VOC limitations of authorities having jurisdiction and the California Green Building Code. Verify compatibility with finish coats specified in other sections. Follow manufacturers printed instructions. Apply one coat unless otherwise directed.
 - 1. Type A: Self-Crosslinking Hydrophobic Acrylic passing 2000 hours ASTM D4585 and 7000 hours ASTM D5894. "Series 115 Uni-Bond DF" by Tnemec (2.0 to 4.0 mils DFT).
 - 2. Type B: Organic Zinc-Rich Urethane passing 50,000 hours ASTM B117 and 15000 hours ASTM G85. "Series 90-97 Tneme-Zinc" by Tnemec (2.5 to 3.5 mils DFT) or "Series 94-H20 Hydro-Zinc" by Tnemec (2.5 to 3.5 mils DFT).
 - 3. Type C: MIO-Zinc Filled Urethane passing 10,000 hours ASTM B117 and 5000 hours ASTM D4585. "Series 394 PerimePrime" by Tnemec (2.5 to 3.5 mils DFT).
 - C. Galvanizing: ASTM A153 and A123.
 - D. Touch-Up Primer for Galvanized Surfaces: Type B primer.
- 2.3 FABRICATION
- A. Shop fabricate to greatest extent possible.
 - B. Continuously seal built up members by continuous welds where exposed to weather.
 - C. Fabricate connections for bolt, nut, and washer connectors.
 - D. Protect all materials, before and after fabrication, from rust, corrosion, dirt, grease, and other foreign matter.
 - E. Fabricate framing members free from twists or bends. Form holes, cut and sheared edges neatly without kinks, burrs, or warped edges.
 - F. Exposed Steel: Straight, smooth, free of nicks, scars or dents.

- G. Gas Cutting: Gas cutting of holes in a member shall not be permitted.
- H. Splicing of members: Members requiring splicing due to length requirements may be spliced using full penetration butt welds when such welds and procedures are inspected and certified by the Testing Agency, in conformance with AWS and AISC standards. The location of splices shall be approved by the Architect/Engineer in writing prior to fabrication.
- I. Welding: Welding of structural steel connections shall be performed by qualified welders in accordance with AWS Standards. All weld sizes shall match those shown on the drawings.
 - 1. Preparation: Clean all surfaces free of rust, paint and all foreign matter. Remove paint or scale by brushing, chipping or hammering as required. Chip clean and wire brush burned or flame cut edges before welding. Space and alternate welds, clamping as necessary to prevent warp or misalignment.
 - 2. Sequence Welding: When welds enclose, or partially enclose, the perimeter or portion of the surface of a member, make weld bead in sequence, or staggered. Minimize internal stresses. Weld groups of members occurring in a single line in staggered sequence to minimize distortion of the structural frame.
 - 3. Faulty and Defective Welding: Welds failing to meet AWS standards and the Contract Documents shall be rejected and remade at Contractor expense. All welds showing cracks, slag inclusion, lack of fusion, bad undercut or other defects, ascertained by visual or other means of inspection shall be removed and replaced with conforming work.
 - 4. Minimum Weld Strengths: All welds shall match the minimum weld sizes recommended by AISC. Details of fabrication not specifically shown shall match similar details which are specifically shown. All bevel and groove welds shall be full penetration unless size is noted otherwise.
 - 5. Threaded studs, headed studs, and deformed bar anchors shall be full-fusion welded conforming to ASW D1.1.
- J. Camber: Fabricate all beams cambered as indicated on the drawings.
 - 1. Fabricate beams without camber for installation with any "natural" crown up.
 - 2. Exception: Fabricate cantilever beams with "crown" down.
- K. Grinding: Grind smooth the following structural steel and connections;
 - 1. Exposed cut ends of structural and fabricated shapes.
 - 2. All welds exposed to view.
 - 3. Mitered and fit-up corners and intersections.
- L. Back-Up Bars: Required for all complete penetration welds.
- M. Bolt Holes: Edge, end distances and spacing shall conform to dimensions shown on the drawings, and as follows;
 - 1. Round: Size indicated and 1/16 inch maximum oversize, except 1 inch

- and larger bolts may have 1/8 inch maximum oversize.
2. Slotted: At locations specifically noted on the drawings, provide size indicated and 1/16 inch by 1/4 inch oversize slotted in direction perpendicular to applied loads.
 3. Holes in base plates for anchor bolts may be 1/8 inch oversize.

N. Comply with Section 10 of AISC 303 for architecturally exposed structural steel (AESS). See architectural & structural drawings for locations of AESS.

2.4 FINISHES

- A. Steel exposed to inclement atmospheric conditions or weather (such as coastal moisture or seasonal rain) shall be sufficiently primed or otherwise protected against corrosion. If condition of steel is suspect due to weathering/corrosion, Contractor shall bear cost of inspection to determine if excessive corrosion is present and if steel member(s) requires repair or replacement. Contractor shall bear cost of repair or replacement.
- B. Prepare and finish structural and miscellaneous steel component surfaces as follows, unless a higher standard-of-care is determined necessary per item A:
1. Unpainted, interior, dry exposure surfaces need not be primed.
 2. Finished painted, interior, dry exposure surfaces:
 - a. Surface Preparation: SSPC-SP2 Hand-Tool and/or SP3 Power-Tool Cleaning. Apply Primer Type A. Field touchup with same primer.
 - b. Where jobsite exposure is expected to exceed 6 months, SSPC-SP6 / NACE No. 3 Commercial Blast-Cleaning is required. Apply Primer Type B or C. Field touchup with same primer.
 3. Finish painted surfaces with exterior exposure, interior exposure subject to wet conditions or fumes, or surfaces to receive high performance finish coatings (for example epoxy or urethane coatings).
 - a. Surface Preparation: SSPC-SP6 / NACE No. 3 Commercial Blast-Cleaning to create a dense, uniform angular surface profile of 2.0 mils minimum. For severe (immersion) exposure, SSPC-SP10 / NACE No. 2 Near-White Blast-Cleaning is required.
 - b. Apply Primer Type B. Field touchup with same primer.
 4. Surfaces to be fire proofed need not be primed unless required by the fireproofing manufacturer or if jobsite exposure is expected to be inclement per item A. Where unprimed steel is to receive fireproofing, prepare steel surface as required by fireproofing manufacturer. If fireproofed surfaces are to be primed, provide primer as follows:
 - a. Surface Preparation: SSPC-SP3 Power-Tool Cleaning.
 - b. Apply Primer Type C. Field touchup with same primer.
 5. Exterior exposed (unpainted) surfaces and as otherwise indicated to receive galvanizing:
 - a. Galvanize per ASTM A123 Class 55 minimum. Passivation agents are not permitted on galvanized metal that is to be painted. Provide vent holes per ASTM A385 at closed sections (such as HSS). Submit proposed location of vent holes for review by

- Engineer.
- b. Connection hardware shall be hot-dip galvanized per ASTM A153 or F2329. Grade A325 high-strength bolt assemblies may be mechanically galvanized per ASTM B695 class 55 or hot-dip galvanized per ASTM F2329. Mating bolts and nuts shall receive the same zinc-coating process.
 - c. Repair all uncoated, damaged, or altered galvanized surfaces per ASTM A780.
- C. Do not prime the following surfaces unless otherwise indicated:
- 1. Connections to be field welded.
 - 2. Steel in contact with concrete.
 - 3. Surfaces to receive welded metal decking.
- D. Do not cover up work with finish materials until inspection is complete and work is approved by the Testing Agency.

2.5 SOURCE QUALITY CONTROL

- A. An independent Testing Agency will perform source quality control tests and submit reports, as specified in pertinent sections of Division 01.
- B. Steel Materials Testing:
- 1. No testing is required for materials identified in accordance with CBC 2202.1 (heat number, grade stencil, etc.).
 - 2. Unidentified steel- General: Test all structural shapes. In addition, test to verify F_y and F_u values when engineering requirements exceed $F_y = 25$ ksi for design.
- C. Shop Welding Inspection:
- 1. Testing Agency shall inspect and certify all structural welds, unless the fabricating shop has been accredited in conformance with CBC requirements. Submit certification to the Architect/Engineer for review and the Building Official for approval.
 - 2. Welder Qualifications: Welding inspector shall verify that all the welders are properly qualified prior to steel fabrication and state the qualifications of each welder in the welding inspection report.
 - 3. Welding Inspection: Continuous inspection required unless otherwise noted below. Comply with requirements of AWS D1.1.
 - a. Welding Inspector shall check all welds, materials, equipment and procedures.
 - b. Welding Inspector shall provide reports certifying the welding is as required and has been done in conformity with the plans, specifications and codes.
 - c. Welding Inspector shall use radiographic, ultrasonic, magnetic particle, or any other necessary aid to visual inspection to assure adequacy of welds.
 - 4. Periodic Inspection Acceptable:
 - a. Single pass fillet welds not exceeding 5/16 inch.

- D. Bolts, Nuts, and Washers: Provide samples to Testing Agency for required testing, at no additional cost.
- E. High Strength Bolted Connections: Provide testing and verification of shop-bolted connections in accordance with RCSC specifications. Test all bolts at each connection.

PART 3 - EXECUTION

3.1 EXAMINATION

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

3.2 ERECTION

- A. Erect structural steel in compliance with AISC 303.
- B. Framing:
 - 1. Erect all structural steel true and plumb.
 - 2. Verify proper final alignment prior to making final connections.
- C. Field Connections:
 - 1. Workmanship of field bolted and welded connections shall conform in all respects to methods and tolerances specified for fabrication.
 - 2. Field weld components indicated on shop drawings. Sequence field welds to minimize built-up stress and distortion of the structural frame. Verify sequence with Engineer. Coordinate field welding schedule with Testing Laboratory.
 - 3. Welded Studs: Install in accordance with manufacturer's instructions and structural welding code AWS D1.1.
- D. Templates: Provide bolt setting templates for all anchor bolts. Provide instructions for the setting of anchors and bearing plates, verify these items are set correctly as work progresses.
- E. Column base plates: Set level to correct elevations, support temporarily on steel wedges, shims, or leveling nuts where shown, until the supported members are plumbed and base plate is grouted.
 - 1. Grout solid the full bearing area under base plates prior to installation of floor and/or roof decks.
 - 2. Comply with manufacturer's instructions for high strength grout. Trowel grouted surfaces smooth, splaying neatly to 45 degrees, or form edges vertical 1in-2in away from base plate edges. Top of grout outside of base plate footprint shall not extend higher than bottom of base plate.
- F. Bolting - General:
 - 1. Inspect mating surfaces to ensure that bolt head and nut will have full bearing and that metal plies will mate flush between bolts.

2. Install bolts in matching holes. Do not distort metal or enlarge holes by drifting during assembly. Remake mismatched components to achieve tolerances indicated.
 3. Holes mismatched in excess of 1/8 inch will be rejected.
 4. Holes mismatched less than 1/8 inch may be reamed to the next larger size bolt.
 5. Do not enlarge holes by flame cutting or air/arc ("plasma") cutting.
 6. Provide flat washer(s) at over-size holes.
 7. Provide washers for all conditions per RCSC Section 6 and under nuts to connected parts less than 1/4 inch thick.
 8. Provide ASTM F436 beveled washers when the slope of the surfaces of parts in contact with the bolt head or nut is greater than 1:20.
 9. Do not install bolts with damaged threads.
 10. Threads shall commence outside of the shear plane where noted as HSB-X on drawings.
- G. Bolting - Specific:
1. Machine Bolts (MB): Install and tighten to a snug condition (ST) such that laminated surfaces bear fully on one another, using an impact wrench or "full effort" of an installer using a standard spud wrench.
 2. High Strength Bolts in Bearing/Shear or Static Tension joints snug tight (ST):
 - a. Provide a hardened washer at the head/nut at slotted holes
 - b. Install and tighten as per Machine Bolts (MB) snug tight (ST) and other requirements of RCSC specification Section 8.
 - c. Use ASTM F436 washer only in snug tight connections with static tension loads.
 3. High Strength Bolts in Pretensioned joints (PT):
 - a. Provide ASTM F436 washer per requirements of RCSC Section 6.
 - b. Install and tighten in accordance with the requirements of RCSC Section 8.
 - c. Install bolts in all holes of the joint and compact the joint until the connected plies are in firm contact prior to pretensioning.
 - d. The following tightening methods and bolt type are acceptable for PT joints:
 - (a) Turn-of-the-nut pretensioning method
 - (b) Calibrated wrench pretensioning method
 - (c) Twist-off-type tension-control bolts
 - (d) Direct-tension-indicator washer pretensioning method.
 4. High Strength Bolts in Slip Critical (SC) joints:
 - a. Provide tensioning for High Strength Bolts (PT) per above.
 - b. Faying surfaces to be prepared per RCSC Section 3 and PART 2.
- H. Supports, Shoring and Bracing: 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. Conform to requirements of all applicable laws and governing safety regulations. Resist imposed loads, including those of stored materials and equipment.
1. Provide all temporary supports, shoring and bracing necessary to

- achieve work of tolerances indicated.
 2. Provide all necessary temporary flooring, planking and scaffolding required for erection of steel, and support of erection machinery.
 3. Construction Loading: Do not overload the structure or temporary supports with stored materials, equipment or other loads.
 4. Maintain temporary bracing and shoring until work is complete, and longer as required to ensure stability and safety of structure.
- I. Do not make final connections until structure is aligned to meet specified tolerances.

3.3 ERECTION TOLERANCES

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

3.4 FIELD QUALITY CONTROL

- A. The independent Testing Agency will perform field quality control tests, as specified in pertinent sections of Division 01.
- B. Field Welding Inspection: Conform to all requirements of section SOURCE QUALITY CONTROL.
 1. Inspect mating surfaces.
 2. Test all materials prior to use. Use only materials meeting specified requirements.
- C. High Strength Bolting: Provide testing and verification of field-bolted connections in accordance with RCSC Section 9.
 1. Inspect mating surfaces.
 2. Test all materials prior to use. Use only materials meeting specified requirements.
 3. Inspector shall review installation and verify "full effort" with installers for ST joints and shall randomly manually verify "full effort" on 10 percent of installed bolts.
 4. Inspector shall verify installation for 100% of SC and PT joints.
 5. Review installation procedures for all types of HSB joints and verify installation of "Twist-off" and load-indicator type bolts.
 6. If any bolt fails testing, all bolts at the joint shall be loosened and re-tightened. Exception: Galvanized bolts shall be replaced prior to re-testing.

3.5 ADJUSTING

- A. Touch-up damaged finishes with compatible specified primer.
- B. Replace defective or damaged work with conforming work. Replace all defective work at Contractor's expense.

- C. Straighten materials by means that will not injure the materials.
- D. Replace defective or damaged work which cannot be corrected in the field with new work, or return defective items to the shop for repair.
- E. Architect/Engineer shall review all proposals for the repair or replacement of damaged, defective, or missing work.
- F. Pay expenses incurred by Owner for Architect/Engineer's costs for (re-)design and obtaining approvals of Authorities Having Jurisdiction (AHJ) necessitated by incomplete, inefficiently scheduled, improperly performed, defective or nonconforming work, as specified in pertinent sections of Division 01.
- G. Pay expenses due to re-testing and re-inspection necessitated by incomplete, inefficiently scheduled, improperly performed, defective or nonconforming work, as specified in pertinent sections of Division 01.

3.6 CLEANING AND PROTECTION

- A. Clean all surfaces upon completion of erection; leave free of grime and dirt. Remove unused materials, tools, equipment and debris from the premises and leave surfaces broomed clean.
- B. Protect work from damage by subsequent operations.

END OF SECTION 05 11 00

SECTION 05 40 00 - COLD-FORMED METAL FRAMING

PART 1 – GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. All design and other services, material, labor and equipment as necessary for the fabrication, erection and completion of all cold formed metal framing including all bracing and shoring required for erection, miscellaneous metal, and related work.
- B. Related Sections:
 - 1. Pertinent Sections of Division 01 Specifying Quality Control and Testing Agency Sections
 - 2. Pertinent Sections of Division 05 Specifying Structural Steel.

1.2 REFERENCE STANDARDS

- A. California Code of Regulations, Title 24, latest adopted edition (herein noted as CBC): Chapter 22 Steel.
- B. American Iron and Steel Institute (AISI) S100 “North American Specification for the Design of Cold-Formed Steel Structural Members”.
- C. AISI S200 “North American Standard for Cold-Formed Steel Framing – General Provisions”.
- D. AISI D100 “Cold-Formed Steel Design Manual.
- E. American Welding Society (AWS) D1.3 “Structural Welding Code – Sheet Steel”
- F. American Society for Testing and Materials (ASTM):
 - 1. ASTM A307 “Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60000 PSI Tensile Strength”.
 - 2. ASTM A606 “Standard Specification for Steel, Sheet and Strip, High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled, with Improved Atmospheric Corrosion Resistance”.
 - 3. ASTM A653 “Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process”.
 - 4. ASTM A780 “Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings”.
 - 5. ASTM A1003 “Standard Specification for Steel Sheet, Carbon, Metallic- and Nonmetallic-Coated for Cold-Formed Framing Members”.
 - 6. ASTM A1008 “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. ASTM A1011 "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".
 8. ASTM C645 "Standard Specification for Nonstructural Steel Framing Members".
 9. ASTM C754 "Standard Specification for Installation of Steel Framing Members to Receive Screw-Attached Gypsum Panel Products".
 10. 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".
 11. ASTM C1007 "Standard Specification for Installation of Load Bearing (Transverse and Axial) Steel Studs and Related Accessories".
 12. ASTM C1513 "Standard Specification for Steel Tapping Screws for Cold-Formed Steel Framing Connections".
- G. The Society for Protective Coatings (SSPC) SSPC-Paint20 "Zinc-Rich Coating (Inorganic or Organic)".
- H. National Institute of Standards and Technology (NIST) / Engineered Wood Association (APA) "PS 1 - Voluntary Product Standard for Structural Plywood".
- I. NIST / APA "PS 2 - Performance Standard for Wood-Based Structural-Use Panels".

1.3 SUBMITTALS

- A. Manufacturer's Literature:
1. Descriptive data illustrating cold-formed framing system components including framing members, fasteners, and accessories, including ICC-ES reports.
 2. Erection instructions containing sequence of operations.
- B. Samples: Provide adequate samples of unidentified material to the Owner's Testing Laboratory for testing purposes.

1.4 QUALITY ASSURANCE

- A. Erector Qualifications:
1. Minimum of three years successful experience on comparable cold-formed metal framing projects.
 2. Welders qualified in accordance AWS D1.3.
- B. Cold form carbon and low alloy steel used for structural purposes shall be identified per CBC Section 2202.1.
- C. Welding inspections shall conform to AWS D1.3 and CBC 1705.2.
- D. Wood product quality standards:
1. All wood products to comply with article REFERENCES.

2. Factory-mark each piece of sheathing with type, grade, mill, and grading agency, except omit marking from surfaces to be exposed with transparent finish or without finish.
3. Sheathing panels to be marked by APA (The Engineered Wood Association).

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Comply with pertinent requirements of Division 01.
- B. Delivery: Time delivery and installation of carpentry products to avoid delaying other trades whose work is dependent on or affected by this section and to comply with moisture content, protection and storage requirements.
- C. Keep materials dry at all times. Protect against exposure to weather and contact with damp or wet surfaces. Stack lumber and sheathing panels to prevent deformation and provide air circulation within stacks.
 1. Store materials for which a maximum moisture content is specified only in areas where relative humidity has been reduced to a level where specified moisture content can be maintained.
 2. Handle and store materials above ground to prevent damage, contamination, or accumulation of dirt or foreign materials.
- D. Provide special protection for horizontal sheathing panels. Deformation of panels due to moisture is not acceptable.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Steel Framing System:
 1. All stud and/or joist framing members shall be of the type & size as shown on the plans and reviewed shop drawings. Framing member section properties (thickness, dimensions, area, section modulus, and moment of inertia) shall match those per AISI D100 unless noted otherwise on drawings.
 2. All runner and end tracks, bridging, and non-load bearing studs shall be of the type & size shown on the plans.
 3. All studs, joists, and tracks 54 mils or greater in thickness shall be formed from steel that corresponds to the requirements of ASTM A1003 (Grade ST50H or ST50L) with a minimum yield of 50,000 psi.
 4. All studs, joists, track, bridging, U-channel, (hat) furring (F) channels, and accessories 43 mils or thinner in thickness shall be formed from steel that corresponds to the requirements of ASTM A1003 (Grade ST33H or ST33L) with a minimum yield of 33,000 psi.
 5. All stud and joist components shall be formed from steel having a minimum G-60 galvanized coating (equivalent coatings such as "G60e" are not acceptable), unless noted otherwise, or shall be primed with

- paint meeting the performance requirements SSPC-Paint20, where noted.
6. Welding Electrodes: Shall conform to AWS D1.3. E60 or E70. Touch up all welds with zinc-rich paint in compliance with ASTM A780.
 7. Primer: SSPC-Paint20.
- B. Screws shall be per ASTM C1513.
 - C. Machine bolts shall be per ASTM A307.
 - D. Power Actuated Fasteners (PAF): Hilti X-U, ICC ESR-2269. For use only where specified by the drawings.
 - E. Accessories: Cold-formed metal framing manufacturer's standard.
 - F. Structural Sheathing Panels:
 1. Plywood: Structural sheathing shall conform to product standard PS-1 or PS-2. All panels shall have a minimum bond classification of "Exposure 1" and bear the trademark of the Engineered Wood Association (APA) or other qualified agency. Grades shall be "Rated Sheathing" or "Structural 1" as required on the drawings.
 - G. Oriented Strand Board (OSB): All structural OSB shall be grade marked by a qualified agency for conformance with Product Standard PS-2 and shall be fabricated with exterior glue. Grades shall be as required on the drawings.

2.2 FABRICATION

- A. Form members to manufacturer's standard shapes meeting design criteria.
- B. Cut right angle connections of framing components to fit squarely against abutting members.
- C. Prime un-galvanized steel to 1.5 mil (0.038) minimum dry film thickness.

PART 3 - EXECUTION

3.1 ERECTION

- A. Clean surfaces that will be in contact after assembly.
- B. Position members plumb, square and true to line.
- C. Seat studs squarely in track with stud web and flange abutting track web with maximum 1/8 inch gap.
- D. Connect members together by welding and/or fasteners in accordance with the drawings.

- E. Do not splice studs. Provide "headers" and "trim studs" at openings as required. Studs shall be securely attached to tracks at all exterior walls except as noted below.
- F. Provide for expansion and contraction between floors at solid wall sections of two stories or more by providing a slip joint between stud and track at one end. This connection shall be capable of transmitting lateral loads to the structure.
- G. Provide and install bridging, fire blocking, etc. per manufacturer's recommendations, the plans, and code requirements.
- H. Perform welding in accordance with AWS D1.3
- I. Remove erection bolts and screws used in welded construction.
- J. Do not use gas cutting for field correction of fabrication without concurrence of Architect/Engineer.
- K. Touch-up field connections and breaks in shop coating with same primer used for shop priming.

3.2 STRUCTURAL SHEATHING

- A. General:
 - 1. Sheathing screwing shall be as required on the drawings. Do not overdrive (Do not break skin of sheathing face sheet). Over driving will be cause for rejection.
- B. Roof and Floor Sheathing: lay with face grain perpendicular to roof rafters, roof trusses or floor joists. Stagger sheets. Block all unsupported sheet edges with 54 mils material unless noted otherwise.
- C. Wall Sheathing: Lay with face grain either parallel or perpendicular to studs. Exposed bottom edges shall be sealed as recommended by manufacturer. Block all unsupported sheet edges with 54 mils materials unless noted otherwise.

3.3 DEFECTIVE WORK AND MATERIALS

- A. Work found to be defective, missing or damaged shall be immediately replaced with proper work. Such replaced work and the inspection for same shall be at the expense of the Contractor.
- B. Straightening of any materials, if necessary, shall be done by a process and in a manner that will not injure the materials, and which is approved by the Architect. Sharp kinks or bends shall be cause for rejection. Heating will not be allowed.

- C. If defects or damaged work cannot be corrected in the field, the material shall be returned to the shop or new parts furnished, as the Architect directs; the Contractor shall replace all work at his own expense.

3.4 CLEANING

- A. After erection, all surfaces shall be cleaned and left free of all grime and dirt. Remove unused materials, tools, equipment and debris from the premises and leave broom clean.

END OF SECTION 05 40 00

SECTION 06 41 00 - ARCHITECTURAL WOODWORK

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Plastic laminate cabinets.
 - 2. Plastic laminate countertops.
- B. Related Sections:
 - 1. Section 06 10 53 - Miscellaneous Rough Carpentry: Finished wood carpentry trims.

1.2 DEFINITIONS

- A. Exposed surfaces include all surfaces visible when:
 - 1. Drawers and opaque doors (if any) are closed.
 - 2. Areas behind clear glass doors.
 - 3. Bottoms of cabinets 42-inches or more above finished floor.
 - 4. Top of cabinets below 78-inches above finished floor.
- B. Semi-exposed surfaces include the following:
 - 1. Open opaque doors or extended drawers.
 - 2. Bottoms of cabinets that are more than 30-inches and less than 42-inches above finished floor.
- C. Concealed surfaces include the following:
 - 1. Surfaces not visible after installation.
 - 2. Bottoms of cabinets less than 30-inches above finished floor.
 - 3. Tops of cabinets over 78-inches above finish floor and not visible from an upper level.
 - 4. Stretchers, blocking, and components concealed by drawers.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated, including cabinet hardware and accessories and finishing materials and processes.
- B. Shop Drawings: Submit shop drawings for each item of architectural woodwork. Indicate dimensions, details of construction, finishes, and hardware.
 - 1. Show details full size.
 - 2. Show locations and sizes of furring, blocking, and hanging strips, including concealed blocking and reinforcement specified in other Sections.

- C. Samples for Verification:
 - 1. Plastic laminates, 8 by 10 inches (200 by 250 mm), for each type, color, pattern, and surface finish, with 1 sample applied to core material and specified edge material applied to 1 edge.
 - 2. Thermoset decorative-panels, 8 by 10 inches (200 by 250 mm), for each type, color, pattern, and surface finish, with edge banding on 1 edge.
- D. Woodwork Quality Standard Compliance Certificates: WI-certified compliance certificates.

1.4 QUALITY CONTROL

- A. Manufacturer Qualifications: A qualified manufacturer that is certified for chain of custody by an FSC-accredited certification body.
- B. NAAWS Quality Standard: Comply with the specified grade(s) of interior architectural woodwork indicated for construction, finishes, and installation, specified section(s), and applicable requirements of the current edition of the "North American Architectural Woodwork Standards – 3.0, United States Version".
 - 1. Provide WI-certified compliance labels and certificates indicating that woodwork, including installation, complies with requirements of grades specified.
 - 2. Provide Seismic certificates indicating that casework is installed with all required wall blocking and that fastener size, frequency and locations requirements have been met.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Do not deliver woodwork until painting and similar operations that could damage woodwork have been completed in installation areas. If woodwork must be stored in other than installation areas, store only in areas where environmental conditions comply with requirements specified in "Project Conditions" Article.

1.6 SITE CONDITIONS

- A. Environmental Limitations: Do not deliver or install architectural woodwork until building is enclosed, wet work is complete, and HVAC system is operating and will maintain temperature between 60 and 90 deg F (16 and 32 deg C) and relative humidity between 25 and 55 percent during the remainder of the construction period.
- B. Conditioning: Place architectural woodwork in room where scheduled to be installed for a minimum of 72 hours prior to installation to allow components to condition to the space.
- C. Field Measurements: Where woodwork is indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication, and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

1. Locate concealed framing, blocking, and reinforcements that support woodwork by field measurements before being enclosed, and indicate measurements on Shop Drawings.
- D. Field Measurements: All casework dimensions shall be field verified prior to fabrication.
- 1.7 COORDINATION
- A. Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related units of Work specified in other Sections to ensure that interior architectural woodwork can be supported and installed as indicated.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. General: Provide materials that comply with requirements of NAAWS's quality standard for each type of woodwork and quality grade specified, unless otherwise indicated.
- B. Hardwood and Softwood Lumber: Custom graded in accordance with NAAWS; average moisture content of 8 percent.
1. Species: Any closed-grain hardwood. For use at concealed areas only.
- C. Hardwood Plywood: ANSI/HPVA HP-1; veneer core material; type of glue recommended for application.
1. Formaldehyde Emission Levels: No urea formaldehyde.
 2. Wood Veneer Species and Cut for Casework: White maple, plain sawn or sliced.
 3. Face Grade: Grade A.
 4. Thickness: 3/4-inch.
 5. Veneer Core: 5-ply.
 6. Cut: Sliced-vertical grain.
 7. Back Grade: Minimum Grade 2.
- D. Cabinet Interiors and Shelves: Plastic-laminate-clad plywood.
- E. Counter Substrate: 3/4-inch plywood.
- F. Plastic Laminate:
1. High-pressure (HPDL) decorative laminate complying with NEMA LD 3.
 2. Plastic Laminate for Exposed Surfaces: GP-50 for nonpostformed surfaces; PF-42 for postformed surfaces.
 3. Plastic Laminate Materials: Provide only plastic laminate materials that are GREENGUARD Certified.
 - a. Individual VOC's: <0.1 TLV.
 - b. Total VOC's: <0.5 mg/m³
 - c. Formaldehyde: <0.05 ppm
 - d. 4-Pheylcyclohexene: <0.0065 mg/m³
 - e. Total Aldehydes: <0.1 ppm

4. Melamine or Low-Pressure Laminate is not allowed as a replacement for High Pressure Plastic Laminate, even for cabinet interiors, drawer interiors, backing sheets or other non-visible conditions.
- G. Edge Banding for Plastic Laminate Shelves: Vinyl, complying with LMA EDG-1, 3 mm thick material, with radiused edges, color and finish to match laminate exactly.
- H. Wall-Hung Countertop Supports: Cold rolled steel supports.
 1. Angle Support Brackets:
 - a. Design: Straight gusset stiffener between support flanges of angle.
 2. Floating Countertop Support Brackets:
 - a. Thickness: 1/2-inch.
 - b. Style: Flat.
- I. Adhesive: FS MMM-A-130 contact adhesive; type recommended by laminate manufacturer to suit application.
 1. VOC Limits for Installation Adhesives and Glues: Use installation adhesives that comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
 - a. Wood Glues: 30 g/L.
 - b. Contact Adhesive: 250 g/L.

2.2 PLASTIC LAMINATE CABINET CONSTRUCTION

- A. Construction:
 1. Quality Standard: Comply with NAAWS Section 10.
 2. NAAWS Grade: Custom.
 3. Type: Type II single-length sections to fit across openings.
 4. Cabinet Style: Style A Frameless.
 5. Interface Style: Overlay, Figure 10-057.
 6. Door and Drawer Front Style: Flush overlay.
 7. Exposed Exterior Surfaces: HPDL as specified.
 8. Exposed Interior Surfaces: HPDL matching exposed exterior surfaces.
 9. Exposed Interior Surfaces of Door and Drawer Fronts: Covered with the same material, pattern, color and thickness as the door face.
 10. Core Material: MDF as specified.
 11. Door and Drawer Edge: Square edge with thin applied band.
 - a. Edge Banding: HPDL, minimum 0.02-inch thick, color-matched to the exposed face.
 12. Shelf Thickness: As specified in Architectural Woodwork Standards (NAAWS) for a uniform load of 50-lb/sq ft.
- B. Semiexposed Surfaces: Provide surface materials indicated below:
 1. Surfaces Other Than Drawer Bodies: Thermoset decorative panels.
 2. Drawer Sides and Backs: MDF.
 3. Drawer Bottoms: MDF.
 4. Exposed Edges: Extruded PVC or self-edged plastic laminate
- C. Colors, Patterns, and Finishes: As selected by Architect.

- D. Cabinet Hardware: ANSI/BHMA A156.9.

2.3 PLASTIC LAMINATE COUNTERTOP CONSTRUCTION

- A. NAAWS Requirements:
 1. Quality Standard: Comply with NAAWS Section 11.
 2. NAAWS Grade: Custom.
 3. Type II adhesive.
 4. Single length sections.
 5. Intermediate support for spans over 48 inches to prevent deflection in excess of ¼ inch under a 50 pound per sq ft load.
 6. Core Material: Fabricator's option.
 7. Edge Treatment: As indicated on Drawings in accordance with NAAWS requirements.
 8. Back Splash Profile: As indicated on Drawings in accordance with NAAWS requirements.
 9. Back Splash Construction: NAAWS Assembly 2.
 10. Joints: Well fit, flush, and watertight.
- B. Colors, Patterns, and Finishes: To be selected.

PART 3 - EXECUTION - NOT USED

3.1 PREPARATION

- A. Before installation, condition woodwork to average prevailing humidity conditions in installation areas.
- B. Verify the adequacy and proper location of any required backing or support framing.
- C. Verify that mechanical, electrical, plumbing and other building items affecting solid surfacing components are in place, complete and to receive the work of this Section.
- D. Before installing architectural woodwork, examine shop-fabricated work for completion and complete work as required, including removal of packing material and backpriming.

3.2 INSTALLATION, GENERAL

- A. Grade: Install woodwork to comply with requirements for the same grade specified in Part 2 for fabrication of type of woodwork involved.
- B. Assemble woodwork and complete fabrication at Project site to comply with requirements for fabrication in Part 2, to extent that it was not completed in the shop.
- C. Install woodwork level, plumb, true, and straight. Shim as required with concealed shims. Install level and plumb (including tops) to a tolerance of 1/8 inch in 96 inches (3 mm in 2400 mm).

- D. Scribe and cut woodwork to fit adjoining work, refinish cut surfaces, and repair damaged finish at cuts.
- E. Anchor woodwork to anchors or blocking built in or directly attached to substrates. Secure with countersunk, concealed fasteners and blind nailing as required for complete installation. Use fine finishing nails or finishing screws for exposed fastening, countersunk and filled flush with woodwork and matching final finish if transparent finish is indicated.

3.3 CABINET INSTALLATION

- A. Install woodwork to comply with NAAWS Section 10 for same grade specified in Part 2 of this Section for type of woodwork involved.
- B. Install without distortion so doors and drawers fit openings properly and are accurately aligned. Adjust hardware to center doors and drawers in openings and to provide unencumbered operation. Complete installation of hardware and accessory items as indicated.
 - 1. Install cabinets with no more than 1/8 inch in 96-inch (3 mm in 2400-mm) sag, bow, or other variation from a straight line.
 - 2. Maintain veneer sequence matching of cabinets with transparent finish.
 - 3. Fasten wall cabinets through back, near top and bottom, at ends and not more than 16 inches (400 mm) oc with No. 10 wafer-head sheet metal screws through metal backing or metal framing behind wall finish
- C. Countertops: Anchor securely to base units.
 - 1. Align adjacent countertops and form seams handtight to minimize joints using adhesive in color to match countertop. Carefully dress joints smooth, remove surface scratches, and clean entire surface.
- 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 cabinet bases to floor using appropriate anchorages. Permanently fix countertops to wall using appropriate angles.
- G. Touch up finishing work specified in this Section after installation of woodwork. Fill nail holes with matching filler where exposed.
- H. Clean casework, counters, shelves, hardware, fittings and fixtures.
- I. Upon completion of installation, clean all installed items. Remove pencil and ink marks from surfaces. Leave area of work broom clean.
- J. Protect countertops after installation; do not allow other trades to use countertops as footstools or ladders to perform their work. Cover completed cabinetwork with 4-mil polyethylene film protective enclosure, applied in a manner to permit easy removal.

3.4 COUNTERTOP INSTALLATION

- A. Install woodwork to comply with NAAWS Section 11 for same grade specified in Part 2 of this Section for type of woodwork involved.
- B. At Base Units: Anchor securely to base units.
- C. Carefully scribe countertops abutting other components, with maximum gaps of 1/32 inch. Do not use additional overlay trim for this purpose. Caulking not to exceed 1/16 inch in width.
- D. Equipment cut-outs indicated on plans within countertops shall be cut by countertop installer.
- E. Mechanical fasteners are not allowed at exposed surfaces.
- F. Upon completion of installation, clean all installed items. Remove pencil and ink marks from surfaces. Leave area of work broom clean.
- G. Protect countertops after installation; do not allow other trades to use countertops as footstools or ladders to perform their work. Cover completed cabinetwork with 4-mil polyethylene film protective enclosure, applied in a manner to permit easy removal.

3.5 ADJUSTING AND CLEANING

- A. Repair damaged and defective woodwork, where possible, to eliminate functional and visual defects; where not possible to repair, replace woodwork. Adjust joinery for uniform appearance.
- B. Construction Waste Management: Manage construction waste in accordance with provisions of Section 01 74 19 Construction Waste Management and Disposal.
- C. Clean, lubricate, and adjust hardware.
- D. Clean woodwork on exposed and semiexposed surfaces. Touch up shop-applied finishes to restore damaged or soiled areas.

3.6 CABINET HARDWARE SCHEDULE

- A. General: Provide cabinet hardware and accessory materials associated with architectural cabinets, except for items specified in Section 08710. Where manufacturer's name or product number is not indicated provide best quality commercially available cabinet hardware.
- B. Cabinet Shelf Pilaster Standards and Rests: BHMA A156.9, all components steel, B04071; with shelf rests, B04081:
 - 1. Acceptable Products, Heavy-Duty Pilaster Standards:
 - a. KV 255 Series.
 - b. Sugatsune SPE-1820.
 - c. Accepted equivalent.

2. Acceptable Products, Shelf Rests:
 - a. KV 237.
 - b. Sugatsune SPF-20
 - c. Accepted equivalent.

- C. Adjustable Shelf Clips: BHMA A156.9, B04013:
 1. KV 346, use with 3/8-inch drilled holes and #129 rubber cushion.

- A. Seismic Shelf Clips: BHMA A156.9, B04013:
 1. Hafele; 282.24.721.

- B. Heavy Weight Drawer Slides: BHMA A156.9, B05091:
 1. Acceptable Products:
 - a. KV 8805.
 - b. Accuride 3640A.
 - c. Accepted equivalent.
 2. Heavy Duty (Grade 1HD-100 and Grade 1HD-200): Side mounted; full-overtravel-extension type; zinc-plated steel ball-bearing slides.
 3. Full extension slides with 1-inch overtravel, side-mount,
 - a. General Purpose Drawers: 200 lb capacity.
 4. Size slides in accordance with manufacturer's recommendations for drawer width.

- C. Drawer and Door Pulls: Doug Mockett Chamfered Edge Drawer Pull
 1. Model: DP2543.
 2. Length: 7-7/8-inches.
 3. Finish: Brushed brass 4B.

- D. Drawer and Door Pulls;
 1. Back-Mounted Pulls: BHMA A156.9, B02011.
 2. Wire Pulls:
 - a. Sugatsune
 - 1) DSI-120-192 at doors
 - 2) DSI-120-160 at drawers
 - 3) 304 stainless steel with satin finish
 3. Location(s): Vehicle Processing, Evidence Team Room and Detention Area.

- E. Frameless Concealed Hinges (European Type): BHMA A156.9, B01602, 110 degrees of opening, self-closing.
 1. Acceptable Products:
 - a. Basis-of-Design: GrassTiomos Hinge System
 - b. Blum BLUMOTION.
 - c. Hafele.
 - d. Accepted equivalent.
 2. Provide three hinges for doors over 48 inches in height.
 3. Provide with soft close function.

- F. Cabinet, Sliding Door, and Drawer Locks:
 1. Medeco High Security Locks.
 2. Door Locks: BHMA A156.11, E07121.

3. Drawer Locks: BHMA A156.11, E07041.
 4. All casework doors and drawers shall be equipped with locks, unless otherwise noted.
- G. Grommets for Cable Passage through Countertops: 2-inch (51-mm) OD, black, molded-plastic grommets and matching plastic caps with slot for wire passage.
- H. Exposed Hardware Finishes: For exposed hardware, provide finish that complies with BHMA A156.18 for BHMA finish number indicated.
1. Satin Chromium Plated: BHMA 626 for brass or bronze base; BHMA 652 for steel base.
 2. Satin Stainless Steel: BHMA 630.
 3. Satin Brass: BHMA 606.
- I. For concealed hardware, provide manufacturer's standard finish that complies with product class requirements in BHMA A156.9.

END OF SECTION 06 41 00

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SECTION 07 60 00 – FLASHING AND SHEET METAL

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Metal flashing and counter flashings.
 - 2. Gravity ventilator installation.
 - 3. Metal flashing and counter flashings.
- B. Miscellaneous sheet metal accessories.
- C. Related Sections:
 - 1. Division 23 – HVAC: Gravity ventilators.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each manufactured product and accessory.
- B. Shop Drawings: Describe material profiles, jointing pattern, jointing details, fastening methods, interface with other work and installation details.
 - 1. Material.
 - 2. Thickness of material.
 - 3. Weight.
 - 4. Finish.
 - 5. Location of each item and details of expansion joint covers, including the direction of expansion and contraction.

1.3 QUALITY ASSURANCE

- A. Conform to profiles and sizes shown on drawings, and comply with "Architectural Sheet Metal Manual" by SMACNA, for each general category of work required.
- B. Applicator: Applicator who has complete sheet metal flashing and trim work similar in material, design, and extent to that indicated for this project and with a record of successful in-service performance and with 5 years' minimum experience.
- C. Preinstallation Conference: Conduct conference at Project site
 - 1. Meet with Owner, Architect, Owner's insurer if applicable, Installer, and installers whose work interfaces with or affects sheet metal flashing and trim including installers of roofing materials, roof accessories, unit skylights, and roof-mounted equipment.
 - 2. Review methods and procedures related to sheet metal flashing and trim.
 - 3. Examine substrate conditions for compliance with requirements, including flatness and attachment to structural members.

4. Document proceedings, including corrective measures and actions required, and furnish copy of record to each participant.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Deliver sheet metal flashing materials and fabrications undamaged. Protect sheet metal flashing and trim materials and fabrications during transportation and handling.
- B. Unload, store, and install sheet metal flashing materials and fabrications in a manner to prevent bending, warping, twisting, and surface damage.
- C. Stack materials on platforms or pallets, covered with a suitable weathertight and ventilated covering. Do not store sheet metal flashing and trim materials in contact with other materials that might cause staining, denting, or other surface damage

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. General: Install sheet metal flashing and trim to withstand wind loads, structural movement, thermally induced movement, and exposure to weather without failing, rattling, leaking, and fastener disengagement.
- B. Fabricate and install flashings and copings capable of resisting forces for the appropriate wind zone, per Factory Mutual's Loss Prevention Data Sheet 1-49.
- C. Temperature Range: 120 deg F ambient; 180 deg F, material surface.
- D. Thermal Movements: Provide sheet metal flashing and trim that allow for thermal movements resulting from the maximum range of ambient and surface temperatures provided above by preventing buckling, opening of joints, hole elongation, overstressing of components, failure of sealant joints, failure of connections, and other detrimental effects. Provide clips that resist rotation and avoid shear stress as a result of sheet metal and trim thermal movements. Base engineering calculations on surface temperatures of materials due to both solar heat gain and nighttime sky heat loss.
- E. Water Infiltration: Provide sheet metal flashing and trim that do not allow water infiltration to the building interior.
 1. Watertight and weatherproof performance of flashing and sheet metal work is required.

2.2 MATERIALS

- A. Zinc-Coated (Galvanized) Steel Sheet: ASTM A653/A653M, G90 (Z275) coating designation; structural quality, mill phosphatized where indicated for field painting.
 1. Do not apply an acrylic passivator coating to galvanized sheet metal scheduled to be painted, or remove this coating mechanically before delivery to the project site.
 2. Prime all surfaces of bonderized metal.
 3. Finish: Standard (dull) mill finish; painted unless noted otherwise on Drawings.

4. Paint: Paint sheet galvanized sheet metal that is not coil-coated.
- B. Sheet Membrane Underlayment at Flashings: Self-adhered, cold-applied composite rubberized asphalt sheet membrane consisting of rubberized asphalt bonded to a cross-laminated high-density polyethylene film with primers and seam sealers as required for a complete watertight installation; provide materials compliant with applicable regulations limiting VOCs.
 1. Under Sheet Metal and Flashing: Minimum 40-mil thick, high temperature self-adhering, polymer-modified, bituminous sheet membrane, complying with ASTM D1970/D1970M, manufacturers and types as follows:
 - a. Grace Construction Products: Grace Ice and Water Shield HT.
- C. Fasteners: Wood screws, annular threaded nails, self-tapping screws, self-locking rivets and bolts, and other suitable fasteners designed to withstand design loads and recommended by manufacturer of primary sheet metal or manufactured item.
 1. General: Blind fasteners or self-drilling screws, gasketed, with hex-washer head.
 - a. Exposed Fasteners: Heads matching color of sheet metal using plastic caps or factory-applied coating.
 - b. Blind Fasteners: High-strength aluminum or stainless-steel rivets suitable for metal being fastened.
 - c. Spikes and Ferrules: Same material as gutter; with spike with ferrule matching internal gutter width.
 2. Fasteners for Aluminum Sheet: Aluminum or Series 300 stainless steel.
 3. Fasteners for Zinc-Coated (Galvanized) Steel Sheet: Hot-dip galvanized steel according to ASTM A153/A153M or ASTM F2329 or Series 300 stainless steel.

2.3 MANUFACTURED SHEET METAL FLASHING AND TRIM

- A. Gravity Ventilator Curb: 1-1/2 inch by 13-1/2 inches high minimum, by others, with complete counterflashings to roof flashing system, sheet metal base to match roof slope.
- B. Dome: Translucent fiberglass with birdscreen.
- C. Drawbands: Stainless steel.

2.4 MISCELLANEOUS SHEET METAL FABRICATIONS

- A. Equipment Support Flashing: Fabricate from galvanized steel 0.0276-inch (0.7 mm) thick.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions under which sheet metal flashing and trim are to be installed and verify that work may properly commence. Do not proceed with installation until unsatisfactory conditions have been corrected. Beginning of installation means acceptance of existing conditions.

- B. Ensure that adjacent work by other trades has been completed as required and as shown on the Drawings.

3.2 INSTALLATION

- A. General: Anchor sheet metal flashing and trim and other components of the Work securely in place, with provisions for thermal and structural movement. Use fasteners, solder, welding rods, protective coatings, separators, sealants, and other miscellaneous items as required to complete sheet metal flashing and trim system.
 - 1. Torch cutting of sheet metal flashing and trim is not permitted.
- B. Anchor work in place with non-corrosive fasteners, adhesives, setting compounds, tapes and other materials and devices as recommended by manufacturer of each material or system.
- C. Install self-adhesive flashing prior to or in conjunction with sheet metal items, as shown on Drawings.
- D. Provide for thermal expansion and building movements. Comply with recommendations of "Architectural Sheet Metal Manual" by SMACNA.
- E. Install exposed sheet metal flashing and trim without excessive oil canning, buckling, and tool marks.
- F. Install sheet metal flashing and trim to fit substrates and to result in watertight performance. Verify shapes and dimensions of surfaces to be covered before fabricating sheet metal.
- G. Comply with accessory manufacturer's instructions and recommendations. Anchor securely to structure to withstand inward and outward loads.
- H. Coordinate with installation of roofing system and related flashings to ensure weathertight installation.
- I. Metal Protection: Where dissimilar metals will contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with bituminous coating or by other permanent separation as recommended by fabricator or manufacturers of dissimilar metals.
- J. Fasteners: Use fasteners of sizes that will penetrate substrate not less than 1-1/4-inches (32 mm) for nails and not less than 3/4-inch (19 mm) for wood screws.
 - 1. Galvanized or Prepainted, Metallic-Coated Steel: Use stainless-steel fasteners.
 - 2. Use concealed fasteners wherever possible. Exposed fasteners should have bonded neoprene washers or should be sealed.

3.3 MISCELLANEOUS FLASHING INSTALLATION

- A. Equipment Support Flashing: Coordinate installation of equipment support flashing with installation of roofing and equipment. Weld or seal flashing with elastomeric sealant to equipment support member.

3.4 CLEANING

- A. Clean exposed surfaces according to manufacturer's written instructions.
- B. Clean and neutralize flux materials. Clean off excess solder and sealants.
- C. Replace sheet metal flashing and trim that have been damaged or that have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.
- D. Performance: Watertight and weatherproof performance of flashing and sheet metal work is required.
- E. Test and operate units; clean, lubricate and adjust moving parts. Leave units ready for field painting.
- F. Construction Waste Management: Manage construction waste in accordance with provisions of Section 01 74 19 Construction Waste Management and Disposal.

END OF SECTION 07 60 00

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SECTION 07 92 00 - JOINT SEALANTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Exterior Joints in Vertical Surfaces and Horizontal Non-traffic Surfaces:
 - a. At flashing and sheet metal.
2. Interior Joints in Vertical Surfaces and Horizontal Non-traffic Surfaces:
 - a. Control and expansion joints on exposed interior surfaces of exterior walls.
 - b. Perimeter joints of exterior openings.
 - c. Interior rated and non-rated sealants.
 - d. Perimeter joints between interior wall surfaces and frames of interior doors and sidelights.
 - e. Acoustical joints in wall and ceiling surfaces.
3. Joint sealant primers and accessories.

B. Related Sections:

1. Section 07 60 00 – Flashing and Sheet Metal.
2. Section 08 81 00 – Glass Glazing: Sealants used in glazing.
3. Section 09 29 00 – Gypsum Board: Sealing concealed perimeter joints of gypsum board partitions to reduce sound transmission.

1.2 ACTION SUBMITTALS

- A. Product Data: Manufacturer's technical data for each product required, including instructions for joint preparation and sealant application. Include certification by joint sealant manufacturer that sealants, primers, and cleaners comply with local regulations controlling the use of volatile organic compounds (VOC). Include tested physical and performance properties. Include data sheets for substrate cleaners and substrate primers recommended by sealant manufacturer for specific substrate surface conditions.
- B. Samples for Verification: For each type and color of joint sealant required, provide Samples with joint sealants in 1/2-inch- (13-mm-) wide joints formed between two 6-inch- (150-mm-) long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.
 1. Submit 2 copies of manufacturer's standard color chart with physical samples of each color. Submit information on availability of custom colored sealants.

1.3 INFORMATIONAL SUBMITTALS

- A. Certification by joint sealant manufacturer that sealants plus the primers and cleaners required for sealant installation comply with local regulations controlling use of volatile organic compounds (VOCs).

- B. Submit manufacturer's letter of certification that products comply with specified requirements and are suitable for the uses intended.
 - C. Product Test Reports:
 - 1. Certified test results of elastomeric sealants showing compliance with specified requirements. Include results of aged performances including hardness, stain-resistance, adhesion and cohesion under cyclic movement, low temperature flexibility, modulus of elasticity at 100-percent strain, effects of heat and aging, and effects of accelerated weathering.
 - 2. Preconstruction field test results indicating which products and joint preparation methods demonstrated acceptable adhesion to joint substrates.
 - D. Qualification Data: For Installer.
 - E. Warranty: Sample of special warranty.
- 1.4 CLOSEOUT SUBMITTALS
- A. Warranties: Executed special warranties specified in this Section.
- 1.5 QUALITY ASSURANCE
- A. Installer Qualifications: Manufacturer's authorized Installer who is approved or licensed for installation of elastomeric sealants required for this Project.
 - B. Source Limitations: Obtain each type of joint sealant through one source from a single manufacturer.
 - C. Sealant manufacturer shall confirm in writing the appropriate joint preparation and priming techniques required to obtain rapid, acceptable adhesion of the joint sealants to the joint substrates.
- 1.6 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 period for use, pot life, curing time, and mixing instructions for multi-component materials intact and legible.
 - B. Store and handle materials in compliance with manufacturer's recommendations to prevent their deterioration or damage due to moisture, high or low temperatures, contaminants, or other causes.
- 1.7 PROJECT CONDITIONS
- A. Do not proceed with installation of joint sealants under the following conditions:
 - 1. When ambient and substrate temperature conditions are outside the limits permitted by joint sealant manufacturer.
 - 2. Below 40 deg F (4.4 deg C).
 - 3. When joint substrates are wet or retaining moisture.

- B. Joint Width Conditions: Do not proceed with installation of joint sealants where joint widths are less than allowed by joint sealant manufacturer for application indicated.
- C. Joint Substrate Conditions: Do not proceed with installation of joint sealants until contaminants capable of interfering with their adhesion are removed from joint substrates.

1.8 WARRANTIES

- A. Special Installer's Warranty: Installer's standard form in which Installer agrees to repair or replace elastomeric joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.
 - 1. Warranty Period: Two years from date of Substantial Completion.
- B. Exterior Sealants: Furnish a written warranty against leaks or other defects of materials, fabrication, and installation.
 - 1. Defects include but are not limited to changes in the structural, physical or chemical properties of the sealant materials that impair function or require abnormal maintenance, changes in surface finish, color or texture, failure in adhesion, weather resistance or durability, failure to prevent entry of water, or failure to comply with specified requirements.
 - 2. This warranty shall not cover formation of cracks or defects in substrate materials adjacent to the seal, joint movement in excess of movement rating of sealant, or physical damage caused by others.
 - 3. Repair or replace defective materials, fabrication, and installation during warranty period without expense to Owner, including removal and replacement of other items as required.
 - 4. This warranty shall be in addition to and not a limitation of other rights the Owner may have against the Contractor under the Contract Documents.
 - 5. Warranty Period: Ten years from date of Substantial Completion.
- C. Special Manufacturer's Warranty: Manufacturer's standard form in which elastomeric sealant manufacturer agrees to furnish elastomeric joint sealants to repair or replace those that do not comply with performance and other requirements specified in this Section within specified warranty period.
 - 1. Warranty Period: Two years from date of Substantial Completion.
- D. Failure of the materials, fabrication, and installation include leakage, hardening, cracking, crumbling, melting, shrinkage or running of the sealant or caulking, or the staining of adjacent materials.
- E. Special warranties specified in this Article exclude deterioration or failure of elastomeric joint sealants from the following:
 - 1. Movement of the structure resulting in stresses on the sealant exceeding sealant manufacturer's written specifications for sealant elongation and compression caused by structural settlement or errors attributable to design or construction.
 - 2. Disintegration of joint substrates from natural causes exceeding design specifications.
 - 3. Mechanical damage caused by individuals, tools, or other outside agents.

4. Changes in sealant appearance caused by accumulation of dirt or other atmospheric contaminants.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Provide elastomeric joint sealants that establish and maintain watertight and airtight continuous joint seals without staining or deteriorating joint substrates.
- B. Provide joint sealants for interior applications that establish and maintain airtight and water-resistant continuous joint seals without staining or deteriorating joint substrates.

2.2 EXTERIOR JOINT SEALANTS

- A. Exterior Silicone Weatherproofing and Control Joint Sealant: ASTM C920, also ASTM C1193 and tested under ASTM C719; Type S, Grade NS, Class 100/50, Use NT, M, G, A, and O; single component, low-modulus, non-sag sealant, use at exterior joints in vertical surfaces and non-traffic horizontal surfaces.
- B. Flashings Silicone Sealant: ASTM C920, Type S, Grade NS, Class 25, Use NT, A, and O; single component elastomeric.

2.3 INTERIOR JOINT SEALANTS

- A. Interior Latex Joint Sealant: Provide product complying with ASTM C834, Type S, Use O, Grade NS; use at interior joints in vertical surfaces and non-traffic horizontal surfaces.
- B. Acoustical Sealant for Exposed and Concealed Joints: Non-sag, paintable, nonstaining, latex sealant, with a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24), complying with ASTM C834 that effectively reduces airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E90; use for drywall or plaster wall systems, bedding electrical boxes and other wall outlets.
 1. Acceptable Products:
 - a. At concealed joints, Tremco Acoustical Sealant, Pecora BA-98, or approved equivalent.
 - b. At exposed joints: Pecora AC-20 FTR, USG Sheetrock Acoustical Sealant, GE Silicones RCS20, or approved equivalent.
 - c. Fire-Rated Acoustical Sealants: HILTI CP 601s, STI Spec Seal ES, Johns Manville Firetemp Cl, 3M Fire Barrier 2001 RTV Foam, 3M™ Fire Barrier Sealant CP 25WB+.

2.4 JOINT SEALANT BACKING

- A. Foam Joint Fillers: Non-gassing, preformed, compressible, resilient, non-staining, non-waxing, non-extruding strips of flexible plastic foam of one of materials indicated below, as recommended by manufacturer for compatibility with their sealant; of size, shape,

and density to control sealant depth, prevent three-sided adhesion, provide a surface against which to tool, and otherwise contribute to producing optimum sealant performance:

1. Cylindrical Sealant Backings: ASTM C1330, Type C (closed-cell material with a surface skin) or Type B (bicellular material with a surface skin), and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance and as recommended by sealant manufacturer.
 2. Elastomeric Tubing Sealant Backings: Flexible cellular rubber tubing complying with ASTM D1056, nonabsorbent to water and gas, and capable of remaining resilient at temperatures down to minus 26 deg F (minus 32 deg C). Provide products with low compression set and of size and shape to provide a secondary seal, to control sealant depth, and to otherwise contribute to optimum sealant performance.
- B. Accessories:
1. Putty pad: moldable pad, equal to Lowry's Electrical Box Pad, SpecSeal SSP, Minerallac Sound Barrier Pad, Dottie Insulpad, Kinetics SealTight or accepted equivalent.

PART 3 - EXECUTION

3.1 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. Verify that joint sizes and surfaces are free of defects and acceptable for installation of joint sealants.
- C. Verify joint dimensions and shapes to ensure they are within the sealant manufacturer's guidelines. Resolve any variances prior to installation. Do not proceed with sealant installation until the unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Thoroughly clean the areas that the new sealant will contact using a de-greasing solvent not harmful to the environment using the two-rag wipe technique. IPA (isopropyl alcohol) is not a degreasing solvent. The new sealant should have a minimum contact area of 1/4".
- B. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions and the following requirements:
 1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.

2. Clean porous joint substrate surfaces by brushing, grinding, blast cleaning, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining after cleaning operations above by vacuuming or blowing out joints with oil-free compressed air. Porous joint substrates include the following:
 - a. Concrete.
 - b. Masonry.
 3. Remove laitance and form-release agents from concrete.
 4. Clean nonporous surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants. Nonporous joint substrates include the following:
 - a. Metal.
 - b. Glass.
 - c. Porcelain enamel.
 - d. Glazed ceramic tile.
- C. Masking Tape: Use masking tape where required to prevent contact of sealant with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

3.3 INSTALLATION OF JOINT SEALANTS

- A. General: Comply with joint sealant manufacturer's printed installation instructions applicable to products and applications indicated, except where more stringent requirements apply.
- B. Sealant Installation Standard: Comply with recommendations of ASTM C1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.
- C. Perform acoustical sealant application work in accordance with ASTM C919.
- D. Installation of Sealants: Install sealants by proven techniques that result in sealants directly contacting and fully wetting joint substrates, completely filling recesses provided for each joint configuration, and providing uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability. Install sealants at the same time sealant backings are installed.
- E. Install joint backing to maintain the following joint ratios, but in no case less than 1/4 inch (6 mm):
 1. Joints up to 1/2 inch wide: 1:1 width to depth ratio.
 2. Joints Greater than 1/2 inch wide: 2:1 width to depth ratio; maximum 1/2 inch joint depth.
 3. Sub-caulk joints that are deep, or joints without suitable backstop, to proper depth.
 4. Protect side walls of joint (to depth of caulking) with bond breaker tape.
 5. Install with adhesive on 2 faces in contact with sides of joints.

- F. Tooling of Non-sag Sealants: Immediately after sealant application and prior to time skinning or curing begins, tool sealants to form smooth, uniform beads of configuration indicated, to eliminate air pockets, and to ensure contact and adhesion of sealant with sides of joint. Remove excess sealants from surfaces adjacent to joint.
 - 1. Remove excess sealant from surfaces adjacent to joints.
 - 2. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.
 - 3. Provide concave joint configuration per Figure 5A in ASTM C1193, unless otherwise indicated.
 - 4. Provide flush joint configuration where indicated per Figure 5B in ASTM C1193.

3.4 CLEANING

- A. Clean off excess sealants and sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.
- B. Construction Waste Management: Manage construction waste in accordance with provisions of Section 01 74 19 Construction Waste Management and Disposal.
- C. Leave finished work in a neat, clean condition with no evidence of spillovers onto adjacent surfaces.

3.5 PROTECTION

- A. Protect joint sealants during and after curing period from contact with contaminating substances or from damage resulting from construction operations or other causes so that they are without deterioration or damage at time of Substantial Completion.
- B. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately so that and installations with repaired areas are indistinguishable from original work.

END OF SECTION 07 92 00

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SECTION 08 11 13 – HOLLOW METAL DOORS AND FRAMES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Standard steel doors and frames indicated and scheduled on Drawings.
 - 2. Commercial grade flush panel steel closet doors.
 - 3. Forcible entry training simulator at Training Tower.
- B. Related Sections:
 - 1. Section 08 11 16 – Aluminum Door and Window Frames: Aluminum door frames.
 - 2. Section 08 71 00 - Door Hardware.
 - 3. Section 09 91 00 – Painting: Finish painting of steel items.

1.2 DEFINITIONS

- A. Steel Sheet Thicknesses: Thickness dimensions, including those referenced in ANSI A250.8, are minimums as defined in referenced ASTM standards for both uncoated steel sheet and the uncoated base metal of metallic-coated steel sheets. Metal thicknesses indicated below correspond to former gage thicknesses:
 - 1. 20 Gage: 0.032-inch (0.8-mm).
 - 2. 18 Gage: 0.042-inch (1.0-mm).
 - 3. 16 Gage: 0.053-inch (1.3-mm).
 - 4. 14 Gage: 0.067-inch (1.7-mm).
 - 5. 12 Gage: 0.093-inch (2.3-mm).

1.3 QUALITY ASSURANCE

- A. Provide doors and frames complying with Steel Door Institute "Recommended Specifications: Standard Steel Doors and Frames", ANSI A250, and as specified herein.
- B. Fire-Rated Door Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by UL, for fire ratings indicated, based on testing according to NFPA 252. Assemblies must be factory-welded or come complete with factory-installed mechanical joints and must not require job site fabrication.
- C. Fire-Rated Window Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by UL, for fire ratings indicated, based on testing according to NFPA 257. Assemblies must be factory-welded or come complete with factory-installed mechanical joints and must not require job site fabrication.
- D. Listings and Labels - Fire Rated Assemblies: Under current follow-up service by Underwriter Laboratory maintaining a current listing or certification. Label assemblies accordance with limits of manufacturer's listing.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Cold-Rolled Steel Sheet: ASTM A1008/A1008M, Commercial Steel (CS), Type B; suitable for exposed applications.
- B. Glazing: Comply with requirements in Section 08 81 00.

2.2 STANDARD STEEL FRAMES

- A. General: Comply with ANSI A250.8 and with details indicated for type and profile.
- B. Interior Frames: Fabricated from cold-rolled steel sheet, unless otherwise indicated to comply with exterior frame requirements.
 - 1. Fabricate frames with mitered or coped and welded face corners and seamless face joints.
 - 2. Knocked-Down Frames: Not permitted.
 - 3. Frames for Level 1 and Level 2 Steel Doors: 0.053-inch- (1.3-mm-) thick steel sheet.
 - 4. Frames for Level 3 and Level 4 Steel Doors: 0.067-inch- (1.7-mm-) thick steel sheet.
 - 5. Frames for Wood Doors: 0.053-inch- (1.3-mm-) thick steel sheet.
 - 6. Frames for Borrowed Lights: 0.053-inch- (1.3-mm-) thick steel sheet.
- C. Fire Rated Units: Construct assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing according to NFPA 252.
 - 1. Labels: Place fire rating labels where visible when door frames are in installed, opened position.
 - 2. Fire Ratings: Refer to Drawings for fire rating requirements.
 - 3. Temperature Rise Rating: Provide doors with maximum 450°F Temperature Rise Rating in 30-minute fire exposure period at doors into exit enclosures.
- D. Hardware Reinforcement: Fabricate reinforcement plates from same material as frames to comply with the following minimum sizes:
 - 1. Hinges: Minimum 0.123 inch (3.0 mm) thick by 1-1/2 inches (38 mm) wide by 6 inches (152 mm) longer than hinge, secured by not less than 6 spot welds.
 - 2. Pivots: Minimum 0.167 inch (4.2 mm) thick by 1-1/2 inches (38 mm) wide by 6 inches (152 mm) longer than hinge, secured by not less than 6 spot welds.
 - 3. Lock Face, Flush Bolts, Closers, and Concealed Holders: Minimum 0.067 inch (1.7 mm) thick.
 - 4. All Other Surface-Mounted Hardware: Minimum 0.067 inch (1.7 mm) thick.
- E. Supports and Anchors: Fabricated from electrolytic zinc-coated or metallic-coated steel sheet.
- F. Jamb Anchors:
 - 1. Metal Stud Anchor: Z-type anchor, welded to frame, 0.053-inch thick steel, UL listed as required for fire rating.

- G. Floor Anchors: Formed from same material as frames, not less than 0.042 inch (1.0 mm) thick, and as follows:
 - 1. Used at all frames installed prior to walls. Where frames are installed after walls, install an additional jamb anchor within the lowest 6-inches of the door jamb, one each side.
 - 2. Monolithic Concrete Slabs: Clip-type anchors, with two holes to receive fasteners.
- H. Fabricate concealed stiffeners and hardware reinforcement from either cold- or hot-rolled steel sheet.

2.3 FABRICATION

- A. Fabricate steel door and frame units to be rigid, neat in appearance and free from defects, warp or buckle. Wherever practicable, fit and assemble units in manufacturer's plant.
- B. Clearly identify work that cannot be permanently factory assembled before shipment, to assure proper assembly at project site.
- C. Hollow Metal Frames: Where frames are fabricated in sections due to shipping or handling limitations, provide alignment plates or angles at each joint, fabricated of same thickness metal as frames.
 - 1. Welded Frames: Weld flush face joints continuously; grind, fill, dress, and make smooth, flush, and invisible.
 - 2. Transom Bar Frames: Provide closed tubular members with no visible face seams or joints, fabricated from same material as door frame. Fasten members at crossings and to jambs by butt welding.
 - 3. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.
 - 4. Grout Guards: Weld guards to frame at back of hardware mortises in frames to be grouted.
 - 5. Floor Anchors: Weld anchors to bottom of jambs and mullions with at least four spot welds per anchor.
 - 6. Fabricate frames, concealed stiffeners, reinforcement, edge channels, louvers and moldings from cold-rolled or hot-rolled steel (at fabricator's option).
 - 7. Provide 3/8-inch back bend return on frames where gypsum board wall material occurs whether on one or both sides.
 - 8. Fabricate frames having multiple openings with mullion members having no visible seams or joints. Continuously weld face, rabbet, and soffit joints between abutted members and finish smooth when exposed to exterior.
- D. Exposed Fasteners: Unless otherwise indicated, provide countersunk flat Phillips heads for exposed screws and bolts. Paint heads to match adjacent surfaces.
- E. Finish Hardware Preparation: Prepare doors and frames to receive mortised and concealed finish hardware in accordance with final Finish Hardware Schedule and templates provided by hardware supplier. Comply with applicable requirements of ANSI A115 series specifications for door and frame preparation for hardware.

1. Locate finish hardware as indicated on final shop drawings or, if not indicated, in accordance with "Recommended Locations for Builder's Hardware", published by Door and Hardware Institute.
2. Prepare frames for silencers except for frames which receive weatherstripping.
3. Provide dust cover boxes or mortar guards of 0.016-inch thick steel at all hardware mortises on frames.
4. Reinforce doors and frames to receive surface-applied hardware. Drilling and tapping for surface-applied finish hardware may be done at project site.

F. Attach fire rated label to each rated frame and door unit.

2.4 STEEL FINISHES

A. General: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

1. Finish standard steel door and frames after assembly.

B. Steel Surface Preparation: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning"; remove dirt, oil, grease, or other contaminants that could impair paint bond. Remove mill scale and rust, if present, from uncoated steel; comply with SSPC-SP 3, "Power Tool Cleaning," or SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."

C. Factory Priming for Field-Painted Finish: Apply shop primer specified below immediately after surface preparation and pretreatment. Apply a smooth coat of even consistency to provide a uniform dry film thickness of not less than 0.7 mils (0.018 mm).

1. Shop Primer: Manufacturer's standard, fast-curing, lead- and chromate-free primer complying with ANSI A250.10 acceptance criteria; recommended by primer manufacturer for substrate; compatible with substrate and field-applied finish paint system indicated; and providing a sound foundation for field-applied topcoats despite prolonged exposure.

D. Finish: Paint in accordance with Section 09 91 00.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: Provide doors and frames of sizes, thicknesses, and designs indicated. Install standard steel doors and frames plumb, rigid, properly aligned, and securely fastened in place; comply with Drawings and manufacturer's written instructions.

B. Install standard steel doors, frames, and accessories in accordance with final shop drawings, manufacturer's data, and as herein specified.

C. Placing Frames: Comply with provisions of ANSI A250.11 "Recommended Erection Instructions for Steel Frames", unless otherwise indicated.

D. Except for frames located at in-place concrete and at drywall installations, place frames prior to construction of enclosing walls. Set frames accurately in position, plumbed,

aligned, and braced securely until permanent anchors are set. After wall construction is completed, remove temporary braces and spreaders leaving surfaces smooth and undamaged.

- E. In metal stud partitions, install at least 3 wall anchors per jamb at hinge and strike levels. In open steel stud partitions, place studs in wall anchor notches and wire tie. In closed steel stud partitions, attach wall anchors to studs with tapping screws.
- F. Standard Steel Frames: Install standard steel frames for doors, sidelights, borrowed lights and other openings, of size and profile indicated. Comply with ANSI A250.11.
 - 1. Set frames accurately in position; plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces, leaving surfaces smooth and undamaged.
 - a. At fire-protection-rated openings, install frames according to NFPA 80.
 - b. Install frames which have removable glazing stops located on secure side of opening.
 - c. Install door silencers in frames before grouting.
 - d. Remove temporary braces necessary for installation only after frames have been properly set and secured.
 - e. Check plumb, squareness, and twist of frames as walls are constructed. Shim as necessary to comply with installation tolerances.
 - f. Apply bituminous coating to backs of frames that are filled with mortar, grout, and plaster containing antifreezing agents.
 - 2. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor and secure with post-installed expansion anchors.
 - a. Floor anchors may be set with powder-actuated fasteners instead of post-installed expansion anchors if so indicated and approved on Shop Drawings.
 - 3. Metal-Stud Partitions: Solidly pack mineral-fiber insulation behind frames.
 - 4. Installation Tolerances: Adjust standard steel door frames for squareness, alignment, twist, and plumb to the following tolerances:
 - a. Squareness: Plus or minus 1/16 inch (1.6 mm), measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
 - b. Alignment: Plus or minus 1/16 inch (1.6 mm), measured at jambs on a horizontal line parallel to plane of wall.
 - c. Twist: Plus or minus 1/16 inch (1.6 mm), measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
 - d. Plumbness: Plus or minus 1/16 inch (1.6 mm), measured at jambs at floor.

3.2 ADJUSTING AND CLEANING

- A. Final Adjustments: Check and readjust operating hardware items immediately before final inspection.
 - 1. Leave work in complete and proper operating condition.
 - 2. Remove and replace defective work, including standard steel doors or frames that are warped, bowed, or otherwise unacceptable.
- B. Construction Waste Management: Manage construction waste in accordance with provisions of Section 01 74 19 Construction Waste Management and Disposal.

- C. Prime-Coat Touchup: Immediately after erection, sand smooth rusted or damaged areas of prime coat and apply touchup of compatible air-drying primer.

END OF SECTION 08 11 13

SECTION 08 11 16 – ALUMINUM DOOR AND WINDOW FRAMES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Standard commercial interior aluminum door and sidelight frames indicated and scheduled on Drawings.
- B. Related Sections:
 - 1. Section 08 14 16 - Flush Wood Doors.
 - 2. Section 08 71 00 - Door Hardware.

1.2 ACTION SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data substantiating that products comply with requirements.
- B. Shop Drawings: Submit for fabrication and installation of aluminum frames. Include details of each frame type, elevations of door design types, conditions at openings, details of construction, location and installation requirements of finish hardware and reinforcements, and details of joints and connections. Show anchorage and accessory items.

1.3 INFORMATIONAL SUBMITTALS

- A. Provide schedule of doors and frames using same reference numbers for details and openings as those on contract drawings.
- B. Indicate coordination of glazing frames and stops with glass and glazing requirements.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Engage an experienced Installer who has completed installations of aluminum framing of similar design and extent to those required for the project and authorized by manufacturer to install products specified in this Section.
- B. Single Source Responsibility: Obtain aluminum frames from one source and from a single manufacturer.
- C. Product Options: Drawings indicate size, profiles, and dimensional requirements of interior aluminum frames and are based on the specific system indicated. Refer to Division 1 Section "Product Requirements."

1.5 DELIVERY, STORAGE AND HANDLING

- A. Deliver frames cartoned or crated to provide protection during transit and job storage. Provide additional sealed plastic wrapping for factory finished doors.

- B. Inspect frames upon delivery for damage. Minor damages may be repaired provided refinished items are equal in all respects to new work and acceptable to Architect; otherwise, remove and replace damaged items as directed.
- C. Store frames at building site under cover. Place units on minimum 4" high wood blocking. Avoid use of non-vented plastic or canvas shelters that could create humidity chamber. If cardboard wrappers become wet, remove carton immediately.
- D. Follow special storage and handling requirements of manufacturer.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.
 - 1. Sheet and Plate: ASTM B209.
 - 2. Extruded Bars, Rods, Profiles, and Tubes: ASTM B221.
 - 3. Extruded Structural Pipe and Tubes: ASTM B429/B429M.
 - 4. Structural Profiles: ASTM B308/B308M.
- B. Carbon Steel Reinforcement: ASTM A36/A36M for structural shapes, plates and bars; ASTM A1008/A1008M for cold rolled sheet and strip, or ASTM A570 for hot rolled sheet and strip.
- C. Anchors, Clips, and Accessories: ASTM A123/A123M, aluminum, non-magnetic stainless steel or hot-dip, zinc-coated steel.
- D. Exposed Fasteners: Use exposed fasteners (Phillips flat-head screws) only to apply hardware. Match the finish of the member or hardware being fastened.

2.2 COMPONENTS

- A. Door Frames: Reinforced for hinges and strikes.
- B. Glazing Frames: For glazing thickness indicated.
- C. Ceiling Tracks: Extruded aluminum.
- D. Trim: Extruded aluminum, not less than 0.062 inch (1.6 mm) thick, with removable snap-in casing trim, glazing stops, and door stops without exposed fasteners.

2.3 INTERIOR ALUMINUM-FRAMED STOREFRONT SYSTEM

- A. Manufacturer: Kawneer, Tri-Fab Versa450, 1-3/4- x 4-inch framing system.
- B. Framing Members: Manufacturer's standard extruded-aluminum framing members of thickness required and reinforced as required to support imposed loads.

- C. Brackets and Reinforcements: Manufacturer's standard high-strength aluminum with nonstaining, nonferrous shims for aligning system components.
- D. Fasteners and Accessories: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding fasteners and accessories compatible with adjacent materials.
- E. Framing System Gaskets and Sealants: Manufacturer's standard recommended by manufacturer for joint type.

2.4 FABRICATION

- A. Fabricate frame units to be rigid, neat in appearance and free from defects, warp or buckle, to shapes as required for each application, for knock down field assembly.
- B. Clearly identify work before shipment to assure proper assembly at project site.
- C. Provide metal frames for doors and other openings, of types and styles as shown on Drawings and schedules. Conceal fastenings, unless otherwise indicated.
 - 1. Provide wool pile or gasketing in door frames to prevent metal-to-metal contact.
- D. Fasteners and Hardware: Aluminum, stainless steel, or other non-corrosive materials compatible with aluminum and acceptable to frame manufacturer, countersunk style. Exposed fasteners not permitted.
- E. Finish Hardware Preparation: Prepare frames to receive finish hardware in accordance with final Finish Hardware Schedule and templates provided by hardware supplier. Comply with applicable requirements of ANSI A115 series specifications for door and frame preparation for hardware.
- F. Fabricate frame members mortised, drilled and tapped for hinge and strike locations.
- G. Locate finish hardware as indicated on final shop drawings or, if not indicated, in accordance with "Recommended Locations for Builder's Hardware", published by Door and Hardware Institute.
- H. Reinforcing: Install reinforcing as required for hardware and as necessary for sag resistance and rigidity.
- I. Door Seals: Provide continuous, nylon backed wool pile sound and light seal around perimeter of doorstop.

2.5 ALUMINUM FINISHES

- A. General: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.

- C. Finish: Thermal-setting powder coating.
 - 1. Type: Hybrid Epoxy-Polyester blend. AAMA 605.2, minimum film thickness of 1.8 mils required.
 - 2. Application: Finish must be factory applied to ensure controlled film thickness and smooth surface.
 - 3. Color: Match existing.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install frames and accessories in accordance with final shop drawings, manufacturer's instructions, and as herein specified.
- B. Coordinate with wall construction for anchor placement.
- C. Set frames accurately in position, plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is completed, remove temporary braces and spreaders leaving surfaces smooth and undamaged.
- D. In metal stud partitions, install at least 3 wall anchors per door jamb at hinge and strike levels. In open steel stud partitions, place studs in wall anchor notches and wire tie. In closed steel stud partitions, attach wall anchors to studs with tapping screws.
- E. Field cut jamb legs if required to fit actual finished opening dimension.

3.2 SIDELIGHT INSTALLATION

- A. Coordinate installation of glass and glazing to comply with Section 08 81 00 for glazed lights.
- B. Install reinforcement channels between two abutting frames. Anchor to structure and floor.
- C. Accurately join, fit and reinforce corners to flush hairline joints.

3.3 INTERIOR ALUMINUM-FRAMED STOREFRONT INSTALLATION

- A. General:
 - 1. Comply with manufacturer's written instructions.
 - 2. Do not install damaged components.
 - 3. Fit joints to produce hairline joints free of burrs and distortion.
 - 4. Rigidly secure nonmovement joints.
 - 5. Install anchors with separators and isolators to prevent metal corrosion and electrolytic deterioration.
- B. Set units plumb, level, and true to line, without warp or rack of framing members, doors, or panels.

1. Install components in proper alignment and relation to established lines and grades indicated. Provide proper support and anchor securely in place.
 - C. Metal Protection:
 1. Where aluminum will contact dissimilar metals, protect against galvanic action by painting contact surfaces with primer or applying sealant or tape, or by installing nonconductive spacers as recommended by manufacturer for this purpose.
 2. Where aluminum will contact mortar, concrete, or masonry, protect against corrosion by painting contact surfaces with bituminous paint.
 3. Paint dissimilar metals where drainage from them passes over aluminum.
 - D. Install frames and accessories in accordance with final shop drawings, manufacturer's instructions, and as herein specified.
 - E. Coordinate with wall construction for anchor placement.
 - F. Set frames accurately in position, plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is completed, remove temporary braces and spreaders leaving surfaces smooth and undamaged.
 - G. In metal stud partitions, install at least 3 wall anchors per door jamb at hinge and strike levels. In open steel stud partitions, place studs in wall anchor notches and wire tie. In closed steel stud partitions, attach wall anchors to studs with tapping screws.
 - H. Field cut jamb legs if required to fit actual finished opening dimension.
 - I. Refer to Section 08 81 00 for installation of glass and other panels indicated to be glazed into framing and doors that are not pre-glazed by manufacturer.
 1. Prepare surfaces that will contact structural sealant according to sealant manufacturer's written instructions to ensure compatibility and adhesion. Preparation includes, but is not limited to, cleaning and priming surfaces.
 2. Install structural silicone sealant according to sealant manufacturer's written instructions.
 3. Mechanically fasten glazing in place until structural sealant is cured.
 4. Remove excess sealant from component surfaces before sealant has cured.
 - J. Install perimeter sealant to comply with requirements of Section 07 92 00 unless otherwise indicated.
- 3.4 DOOR INSTALLATION
- A. Fit wood doors accurately in frames, within clearances specified in AWS Architectural Woodwork Standards, Section 9.
- 3.5 ADJUSTING
- A. Final Adjustments: Check and readjust operating finish hardware items, leaving doors and frames undamaged and in complete and proper operating conditions.

- B. Adjust operating hardware.

3.6 CLEANING

- A. Clean completed systems promptly after erection taking care to avoid damage to finishes.
- B. Construction Waste Management: Manage construction waste in accordance with provisions of Section 01 74 19 Construction Waste Management and Disposal.

END OF SECTION 08 11 16

SECTION 08 14 16 – FLUSH WOOD DOORS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Solid core wood doors, rated and non-rated.

B. Related Sections:

1. Section 08 11 13 – Hollow Metal Doors and Frames: Hollow metal door frames.
2. Section 08 11 16 – Aluminum Door and Window Frames: Aluminum door frames.
3. Section 08 71 00 –Door Hardware: Installation of hardware in wood doors.
4. Section 08 81 00 – Glass Glazing: Glass for glazed wood doors.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of door.

1. Include details of core and edge construction, louvers, and trim for openings.
2. Include adhesive and composite wood materials manufacturers' product data indicating urea-formaldehyde content.

B. Shop Drawings: Indicate location, size, and hand of each door; elevation of each kind of door; construction details not covered in Product Data; location and extent of hardware blocking; and other pertinent data.

1. Indicate dimensions and locations of mortises and holes for hardware.
2. Indicate dimensions and locations of cutouts.
3. Indicate doors to be factory finished and finish requirements.
4. Indicate fire ratings for fire doors.

C. Samples for Verification:

1. Factory finishes applied to actual door face materials, approximately 8 by 10 inches (200 by 250 mm), for each material and finish.
2. Corner sections of doors, approximately 8 by 10 inches (200 by 250 mm), with door faces and edges representing actual materials to be used.
3. Provide Samples for each species of veneer and solid lumber required.
4. Louver blade and frame sections, 6 inches (150 mm) long, for each material and finish specified.
5. Frames for light openings, 6 inches (150 mm) long, for each material, type, and finish required.

1.3 INFORMATIONAL SUBMITTALS

A. Warranty: Sample of special warranty.

1.4 CLOSEOUT SUBMITTALS

A. Warranty: Executed special warranty specified in this Section.

1.5 QUALITY STANDARDS

- A. Manufacturer Qualifications: A qualified manufacturer that is certified for chain of custody by an FSC-accredited certification body.
- B. NAAWS Quality Standard: Comply with the specified grade(s) of doors indicated for construction, finishes, and installation, specified section(s), and applicable requirements of the current edition of the "Architectural Woodwork Standards" by AWI and WI.
 - 1. Provide WI-certified compliance labels and certificates indicating that woodwork, including installation, complies with requirements of grades specified.
- C. WDMA I.S. 1-A Quality Standard: Window and Door Manufacturers Association Quality Standards for grade of door, core, construction, finish, and other requirements, most current edition.
- D. Manufacturer Qualifications: A qualified manufacturer that is certified for chain of custody by an FSC-accredited certification body.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Comply with requirements of referenced standard and manufacturer's written instructions.
- B. Package doors individually in cardboard cartons and wrap bundles of doors in plastic sheeting.
- C. Mark each door on top and bottom rail with opening number used on Shop Drawings.

1.7 PROJECT CONDITIONS

- A. Environmental Limitations: 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 ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.8 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace doors that fail in materials, fabrication, or installation within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Warping (bow, cup, or twist) more than 1/4 inch (6.4 mm) in a 42-by-84-inch (1067-by-2134-mm) section.
 - b. Telegraphing of core construction in face veneers exceeding 0.01 inch in a 3-inch (0.25 mm in a 76.2-mm) span.
 - 2. Warranty Period for Solid-Core Interior Doors: Life of the original installation, including costs of re-hanging.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. General Wood Door Product Requirements: Provide doors with same exposed surface material on both faces of each door; meeting requirements of AWS Section 9; unless otherwise indicated.
- B. Low-Emitting Materials: Provide doors made with adhesives and composite wood products that do not contain urea formaldehyde.
- C. Adhesives: NWWDA IS-1.6, Type II adhesive bond or better for cores, Type I adhesive bond for faces and cross bands. Do not use adhesives containing urea formaldehyde.

2.2 INTERIOR DOOR CONSTRUCTION

- A. General Wood Door Product Requirements: Provide doors with same exposed surface material on both faces of each door; meeting requirements of AWS Section 9 unless otherwise indicated.
- B. Interior, Solid-Core, Veneer-Faced Doors:
 - 1. Construction: Five plies with stiles and rails bonded to core, then entire unit abrasive planed before veneering.
 - 2. WDMA I.S.1-A Performance Grade:
 - a. Heavy Duty: At office, stairwell, mechanical service, hallway, storage doors.
 - b. Extra Heavy Duty: At public bathrooms, assembly areas, and kitchens.
 - 3. Adhesive: Type I or Type II
 - 4. Blocking: Provide wood blocking in particleboard-core doors as follows:
 - a. 5-inch (125-mm) top-rail blocking, in doors indicated to have closers.
 - b. 5-inch (125-mm) bottom-rail blocking, typical, except where specified otherwise for special conditions.
 - c. 5-inch (125-mm) midrail blocking, in doors indicated to have exit devices.
 - d. 10-inch (250-mm) bottom-rail blocking, in exterior doors and doors indicated to have kick, mop, or armor plates.
 - 5. Provide doors with glued-wood-stave cores instead of particleboard cores for doors indicated to receive exit devices.
- C. Particleboard Cores:
 - 1. Core (Solid, Non-Rated): AWS Section 9, HPVA Grade A, particleboard core.
 - 2. Particleboard: ANSI A208.1, Grade LD-1.
 - a. Use particleboard made with binder containing no urea-formaldehyde resin.
 - 3. Blocking: Provide wood blocking in particleboard-core doors as follows:
 - a. 5-inch (125-mm) top-rail blocking, in doors indicated to have closers.
 - b. 5-inch (125-mm) bottom-rail blocking, in exterior doors and doors indicated to have kick, mop, or armor plates.
 - c. 5-inch (125-mm) midrail blocking, in doors indicated to have exit devices.
 - 4. Provide doors with glued-block cores instead of particleboard cores at locations where exit devices are indicated.

- D. Mineral-Core Doors:
1. Core (Solid, Fire Rated): AWS Section 9, HPVA Grade A, noncombustible mineral product complying with requirements of referenced quality standard and testing and inspecting agency for fire-protection rating indicated.
 2. Blocking: Provide composite blocking with improved screw-holding capability approved for use in doors of fire-protection ratings indicated as follows:
 - a. 5-inch (125-mm) top-rail blocking.
 - b. 5-inch (125-mm) bottom-rail blocking, in doors indicated to have protection plates.
 - c. 5-inch (125-mm) midrail blocking, in doors indicated to have armor plates.
 - d. 4-1/2-by-10-inch (114-by-250-mm) lock blocks.
 - e. 5-inch (125-mm) midrail blocking, in doors indicated to have exit devices.
 3. Edge Construction: At hinge stiles, provide laminated-edge construction with improved screw-holding capability and split resistance. Comply with specified requirements for exposed edges.
- E. Veneer-Faced, Interior, Doors for Transparent Finish:
1. Grade: Custom (Grade A faces).
 2. Species and Cut: Match existing.
 3. Match between Veneer Leaves: Match existing.
 4. Assembly of Veneer Leaves on Door Faces: Match existing.
 5. Pair and Set Match: Provide for doors hung in same opening or separated only by mullions.
 6. Room Match: Provide door faces of compatible color and grain within each separate room or area of building.
 7. Corridor Match: Corridor door faces do not need to match where they are separated by 20 feet (6 m) or more.
 8. Stiles: Same species as faces.
 9. Finish: Stained to match existing

2.3 ACCESSORIES

- A. Glazing Stops:
1. Non-rated Areas: Wood, of same species as door facing.
 2. Rated Areas: Wood with metal clips, or welded steel with mitered corners as indicated on Drawings; prepared for countersink-style screws.
 3. Fire-rated doors: ITS – Warnock Hersey or UL approved glazing system.
- B. Metal Frames for Light Openings in Fire-Rated Doors: Manufacturer's standard frame formed of 0.048-inch- (1.2-mm-) thick, cold-rolled steel sheet; with baked-enamel- or powder-coated finish; and approved for use in doors of fire-protection rating indicated.
- C. Fabricate wood doors in accordance with requirements of WDMA I.S. 1-A Quality Standards.
- D. Fabricate fire rated doors in accordance with requirements of ITS – Warnock Hersey or Underwriters' Laboratories, with metal label on each door including UL-10C.
- E. Fabricate doors with WDMA Quality Standards hardware blocking options as follows:
1. Provide HB-1 – head and HB-2 – sill rails and HB-4 – lock block on all doors.

2. Provide HB-6 only when exit devices are specified for door.
 3. Provide HB-8 for pivots or when floor bolts are specified under Section 08 7111 "Door Hardware".
- F. Provide lock blocks at lock edge and top of door for closer as required for hardware reinforcement.
- G. Vertical Exposed Edge of Stiles: Hardwood of species compatible in color with veneer facing for transparent finish; hardwood for paint finish.
- H. Factory machine doors for finish hardware in accordance with hardware requirements and dimensions. Do not machine for surface hardware. Provide solid blocking for through bolted hardware.
- I. Fire Rated Doors: Of rating specified; construction shall be manufacturer's standard, conforming to the requirements of the applicable labeling agency acceptable to the authority having jurisdiction for the label specified.
1. Bevel non-fire-rated doors 1/8 inch in 2 inches (3-1/2 degrees) at lock and hinge edges.
 2. Comply with NFPA 80 for fire-rated doors.
 - a. Bevel fire-rated doors 1/8 inch in 2 inches (3-1/2 degrees) on lock edge; trim stiles and rails only to extent permitted by labeling agency.
- J. Prepare fire rated doors as required by NFPA 80, for locks, latches, hinges, remotely operated or monitored hardware, concealed closures, glass lights, vision panels, louvers, astragals and laminated overlays in conformance with the manufacturer's licensing and label service agreement.

2.4 FACTORY FINISHING

- A. General: Comply with referenced quality standard for factory finishing. Complete fabrication, including fitting doors for openings and machining for hardware that is not surface applied, before finishing.
1. Finish faces, all four edges, edges of cutouts, and mortises. Stains and fillers may be omitted on top and bottom edges, edges of cutouts, and mortises.
- B. Finish doors at factory.
- C. Transparent Finish:
1. Grade: Custom.
 2. NAAWS Finish System 2: Score 99-T, lacquer pre-catalyzed.
 3. Staining: Match existing for color.
 4. Sheen: Satin, 31-45 gloss units measured on 60-degree gloss meter per ASTM D523.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Inspect openings before installation. Verify that rough openings are correct before proceeding.
- B. Examine doors and substrates, with Installer present, for suitable conditions where wood doors and fire-rated wood door frames will be installed.
 - 1. Verify that installed frames comply with indicated requirements for type, size, location, and swing characteristics and have been installed with plumb jambs and level heads.
 - 2. Reject doors with defects.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Handle doors in accordance with recommendations of WDMA I.S. 1-A, "Care and Installation at Job Site."
- B. Condition doors to average temperature and humidity in area of installation for not less than 48 hours prior to installation. Store doors per recommendations of WDMA I.S. 1-A, "Care and Installation at Job Site."
- C. Align and fit doors in frames with uniform clearances and bevels. Machine doors for hardware. Seal cut surfaces after fitting and machining.
- D. Do not impair utility or structural strength of doors in fitting to the opening, in applying hardware, preparing lights, louvers, or plant-ons or other detailing.
- E. Fire-Rated Doors: Install in fire-rated frames in accordance with requirements of NFPA 80.
 - 1. Do not remove labels from fire rated doors.
- F. Install pre-fit and pre-machined doors in accordance with manufacturer's data. Install with a maximum clearance of 1/8 inch on the lock side, 1/8 inch between meeting edges of paired doors and 1/8 inch between top of door and frame header.
- G. If not pre-machined, use a minimum of 1 hinge for each 30 inches of door height. Equally space hinges when using 3 or more.
- H. Job-Fitted Doors: Align and fit doors in frames with uniform clearances and bevels as indicated below; do not trim stiles and rails in excess of limits set by manufacturer or permitted with fire-rated doors. Machine doors for hardware. Seal cut surfaces after fitting and machining.
 - 1. Fitting Clearances:
 - a. Provide 1/8 inch (3.2 mm) at heads, jambs, and between pairs of doors.
 - b. Provide 1/4 - 3/8-inch (6 - 9.5 mm) from bottom of door to top of decorative floor finish or covering.

- c. Where threshold is shown or scheduled, provide 1/4 inch (6.4 mm) from bottom of door to top of threshold.
 - d. Fire-rated Doors: As specified in CBC Section 715 and NFPA 80.
- I. Doors may not extend beyond 1/16 inch from the face of the jamb nor more than 1/8 inch behind jamb face.
 - J. Factory-Fitted Doors: Align in frames for uniform clearance at each edge.
 - K. Cutouts, Recesses, and Exposed Rail Edges: Unless factory provided, paint with two coats of clear sealer, each coat well dried, before hardware is set in place.
 - L. Meeting stiles of pairs of doors shall be in alignment along the entire height, and offset between adjacent leaves shall not exceed 1/8-inch

3.3 ADJUSTMENT AND CLEANING

- A. Adjust doors for smooth and balanced movement.
- B. Operation: Rehang or replace doors that do not swing or operate freely.
- C. Finished Doors: Replace doors that are damaged or that do not comply with requirements. Doors may be repaired or refinished if work complies with requirements and shows no evidence of repair or refinishing.
- D. Construction Waste Management: Manage construction waste in accordance with provisions of Section 01 74 19 Construction Waste Management and Disposal.
- E. Clean glass and hardware units promptly after installation in accordance with manufacturer's printed instructions.
- F. Protect installed units to ensure that they are without damage or deterioration at the time of Substantial Completion.

END OF SECTION 08 14 16

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SECTION 08 81 00 – GLASS GLAZING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Glass in the following locations:
 - a. Interior borrowed lites and interior doors.
 - 2. Glass of the following types:
 - a. Monolithic tempered.
 - b. Translucent tempered.
 - c. Fire-rated.

- B. Related Sections:
 - 1. Section 08 11 13 – Hollow Metal Doors and Frames: Glazing stops.
 - 2. Section 08 11 16 – Aluminum Door and Window Frames: Glazing stops.
 - 3. Section 08 14 16 – Flush Wood Doors: Glazing stops.

1.2 ACTION SUBMITTALS

- A. Product Data: For each glass product and glazing material indicated.

- B. Shop Drawings: Show location of exterior glass units required to be heat strengthened based on glass stress analysis calculations.

- C. Samples for Verification:
 - 1. Glass: 12-inch-square samples of each type of glass indicated except for clear monolithic glass products,

1.3 INFORMATIONAL SUBMITTALS

- A. Product Certificates: Signed by glazing materials manufacturers certifying that their products comply with specified requirements.
 - 1. Separate certifications are not required for glazing materials bearing manufacturer's permanent labels designating type and thickness of glass, provided labels represent a quality control program of a recognized certification agency or independent testing agency acceptable to authorities having jurisdiction.

- B. Warranty: Sample of special warranty.

1.4 CLOSEOUT SUBMITTALS

- A. Warranty: Executed special warranty specified in this Section.

1.5 QUALITY ASSURANCE

- A. Glazing Publications: Comply with published recommendations of glass product manufacturers and organizations below, except where more stringent requirements are indicated. Refer to these publications for glazing terms not otherwise defined in this Section or in referenced standards.
 - 1. FGMA Publications: "FGMA Glazing Manual."
 - 2. LSGA Publications: "LSGA Design Guide."
 - 3. Safety Glass: Products complying with ANSI Z97.1 and testing requirements of 16 CFR Part 1201 for Category II materials.

- B. Safety Glass: Category II materials complying with testing requirements in 16 CFR 1201 and ANSI Z97.1. Subject to compliance with requirements, permanently mark safety glass with certification label of Safety Glazing Certification Council or another certification agency acceptable to authorities having jurisdiction
 - 1. Label shall indicate manufacturer's name, type of glass, thickness, and safety glazing standard with which glass complies.

- C. Single-Source Responsibility for Glass: Obtain glass from one source for each product indicated below:
 - 1. Primary glass of each (ASTM C1036) type and class indicated.
 - 2. Heat-treated glass of each (ASTM C1048) condition indicated.
 - 3. Laminated glass of each (ASTM C1172) kind indicated.
 - 4. No visible strain pattern to the naked eye under various lighting conditions as judged solely by the Architect.

- D. Safety Glass: Category II materials complying with testing requirements in 16 CFR 1201 and ANSI Z97.1. Subject to compliance with requirements, permanently mark safety glass with certification label of Safety Glazing Certification Council or another certification agency acceptable to authorities having jurisdiction
 - 1. Label shall indicate manufacturer's name, type of glass, thickness, and safety glazing standard with which glass complies.

- E. Fire-Protection Rated Glazing for Fire-Rated Door Assemblies: Glazing for assemblies that comply with NFPA 80 and that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated, based on testing according to NFPA 252.
 - 1. Each lite shall bear permanent, nonremovable label of UL certifying it for use in tested and rated fire resistive assemblies.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Protect glazing materials to comply with manufacturer's directions and as needed to prevent damage to glass and glazing materials from condensation, temperature changes, direct exposure to sun, or other causes.

1.7 PROJECT CONDITIONS

- A. Environmental Conditions: Do not proceed with glazing when ambient and substrate temperature conditions are outside the limits permitted by glazing materials

manufacturer or when glazing channel substrates are wet from rain, frost, condensation, or other causes.

- B. Install liquid sealants only when ambient and substrate temperatures are above 40 deg F (4.4 deg C).

1.8 WARRANTY

- A. Laminated Glass: Furnish written warranty signed by glass manufacturer, agreeing to furnish replacements for those laminated glass units which develop manufacturing defects as defined.
 - 1. Warranty Period: 5-years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Thermal and Optical Performance Properties: Provide glass with performance properties specified based on manufacturer's published test data, as determined according to procedures indicated below:
 - 1. For monolithic-glass lites, properties are based on units with lites 6.0 mm thick.
 - 2. For laminated-glass lites, properties are based on products of construction indicated.
 - 3. Tempered Glass Coatings: Apply Low-E, frit, and other specified coatings to glass only after tempering to minimize quench pattern visibility.

2.2 PRIMARY FLOAT GLASS PRODUCTS

- A. Uncoated Clear Float Glass: ASTM C1036, Condition A (uncoated surfaces), Type I (transparent glass, flat), Quality q3 (glazing select), Class 1 (clear), and Kind HS (heat strengthened), Condition A (uncoated surfaces) or Kind FT (fully tempered), Condition A (uncoated surfaces) as required.
 - 1. Thickness in Door Sidelights: 3/8-inch minimum.
- B. Laminated Glass: ASTM C1172; laminated with polyvinyl butyral interlayer with a proven record of no tendency to bubble, discolor, or lose physical and mechanical properties after laminating glass lites and installation.

2.3 HEAT-TREATED FLOAT GLASS

- A. Heat-Treated Float Glass: ASTM C1048, Type I (transparent glass, flat), Quality q3 (glazing select), class and kind as indicated in schedule at the end of Part 3.
- B. Safety Glass: ASTM C1048, fully tempered with horizontal tempering, Condition A uncoated, Type 1 transparent flat, Class 1 clear, Quality q3 glazing select; conforming to ANSI Z97.1; thickness as indicated.

2.4 TRANSLUCENT GLASS

- A. Interior Translucent Glass: ASTM C1172, Condition A (uncoated surfaces), Type I (transparent glass, flat), Quality q3 (glazing select).
1. Overall Thickness: 5/16-inch (8 mm) thick.
 2. Class 1 (clear), uncoated, Kind LT consisting of two lites of tempered float glass.
 3. Outer Lite: Class 1 (clear) float glass.
 - a. Thickness: 4.0 mm.
 4. Plastic Interlayer:
 - a. Thickness: 0.030 inch (0.76 mm), but not less than that required to comply as a Type II safety glass material.
 - b. Interlayer Color: Frosted, opacity to be selected by Architect.
 5. Inner Lite: Class 1 (clear) float glass.
 - a. Thickness: 4.0 mm.

2.5 FIRE-PROTECTION-RATED GLAZING

- A. Fire-Protection-Rated Glazing, General: Listed and labeled by a testing agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated, based on testing according to NFPA 257 for window assemblies; NFPA 252 for door assemblies.
- B. Fire Rated Tempered Glass: The specified fire rated tempered glass is based on the manufacturer identified below. Subject to compliance with requirements, provide the named product or a comparable product by one of the following:
1. Basis of Design: TGP, FireLite Corporation, Fireglass 20.
 2. O’Keeffe SAFTI SuperLite.
 3. Saint-Gobain “Vetrotech” Pyroswiss.
 - a. Tempered 20 Minute Glass: 1/4" thick fire-rated and impact safety-rated glazing material.
 - b. Impact Resistance: ANSI Z97.1 and CPSC 16 CFR Part 1201 Categories I and II.

2.6 GLASS TYPES – SEE DRAWINGS

2.7 ELASTOMERIC GLAZING SEALANTS

- A. Elastomeric Glazing Sealants: Comply with ASTM C920, Class A, and other requirements indicated for each liquid-applied chemically curing sealant specified, including those referencing ASTM C920 classifications for type, grade, class, and uses related to exposure and joint substrates capable of water immersion without loss of properties; cured Shore A hardness of 15-25; color as selected.
1. VOC Content: For sealants used inside of the weatherproofing system, not more than 250 g/L when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- B. Silicone Sealant for Fire-rated Glazing Materials: As recommended by fire-rated glass manufacturer for compatibility with their system.

2.8 GLAZING TAPES

- A. Back-Bedding Mastic Glazing Tape: Preformed, butyl-based elastomeric tape with a solids content of 100 percent, non-staining and non-migrating in contact with nonporous surfaces, with or without spacer rod as recommended in writing by tape and glass manufacturers for application indicated, packaged on rolls with a release paper backing, and complying with ASTM C1281 and AAMA 800 for products indicated below:
 - 1. AAMA 806.3 tape, for glazing applications in which tape is subject to continuous pressure.
 - 2. AAMA 807.3 tape, for glazing applications in which tape is not subject to continuous pressure.
- B. Glazing Tape for Fire-rated Glazing Materials: As recommended by fire-rated glass manufacturer for compatibility with their system and as supplied by manufacturer.

2.9 GLAZING GASKETS

- A. Dense Elastomeric Compression Seal Gaskets: Molded or extruded neoprene, EPDM, or silicone gaskets of profile and hardness required to maintain watertight seal; complying with ASTM C864, D.S. Brown Co., Maloney, Tremco or approved equal.
- B. Soft Compression Gaskets: Extruded or molded closed cell, integral-skinned neoprene, EPDM, or silicone of profile and hardness required to maintain watertight seal; complying with ASTM C509, Type II, black; D.S. Brown Co., Maloney, Tremco or approved equal.

2.10 FABRICATION OF GLASS AND OTHER GLAZING PRODUCTS

- A. Pre-Glazed Units: Fabricate glass and other glazing products in sizes required to preglaze units at the factory, with edge and face clearances, edge and surface conditions, and bite complying with recommendations of product manufacturer and referenced glazing standard as required to comply with system performance requirements.
- B. Field-Glazed Units: Fabricate glass and other glazing products in sizes required to glaze openings indicated for Project, with edge and face clearances, edge and surface conditions, and bite complying with recommendations of product manufacturer and referenced glazing standard as required to comply with system performance requirements.
- C. Clean-cut or flat-grind vertical edges of butt-glazed monolithic lites in a manner that produces square edges with slight kerfs at junctions with indoor and outdoor faces.
 - 1. Grind smooth and polish exposed glass edges.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine glass framing, with glazier present, for compliance with the following:

1. Manufacturing and installation tolerances, including those for size, squareness, offsets at corners.
 2. Presence and functioning of weep system.
 3. Minimum required face or edge clearances.
 4. Effective sealing between joints of glass-framing members.
- B. Do not proceed with glazing until unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Clean glazing channels and other framing members receiving glass immediately before glazing. Remove coatings that are not firmly bonded to substrates.

3.3 GLAZING, GENERAL

- A. General: Watertight and airtight installation of each piece of glass exposed to the weather is required. Each installation must withstand normal temperature changes, wind loading, and impact loading with no failure of any kind, including loss or breakage of glass, failure of sealants or gasketing to remain air and water tight, deterioration of glazing materials or other defects in the materials or their application.
- B. Comply with combined written instructions of manufacturers of glass, sealants, gaskets, and other glazing materials, unless more stringent requirements are indicated, including those in referenced glazing publications.
- C. Adjust glazing channel dimensions as required by Project conditions during installation to provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances.
- D. Protect glass edges from damage during handling and installation. Remove damaged glass from Project site and legally dispose of off Project site. Damaged glass is glass with edge damage or other imperfections that, when installed, could weaken glass and impair performance and appearance.
- E. Apply primers to joint surfaces where required for adhesion of sealants, as determined by preconstruction testing.
- F. Install setting blocks in sill rabbets, sized and located to comply with referenced glazing publications, unless otherwise required by glass manufacturer. Set blocks in thin course of compatible sealant suitable for heel bead.
- G. Do not exceed edge pressures stipulated by glass manufacturers for installing glass lites.
- H. Provide spacers for glass lites where length plus width is larger than 50 inches (1270 mm).
1. Locate spacers directly opposite each other on both inside and outside faces of glass. Install correct size and spacing to preserve required face clearances, unless gaskets and glazing tapes are used that have demonstrated ability to maintain required face clearances and to comply with system performance requirements.

2. Provide 1/8-inch (3-mm) minimum bite of spacers on glass and use thickness equal to sealant width. With glazing tape, use thickness slightly less than final compressed thickness of tape.
 - I. Provide edge blocking where indicated or needed to prevent glass lites from moving sideways in glazing channel, as recommended in writing by glass manufacturer and according to requirements in referenced glazing publications.
 - J. Set glass lites in each series with uniform pattern, draw, bow, and similar characteristics.
 - K. Set glass lites with proper orientation so that coatings face exterior or interior as specified.
 - L. Comply with manufacturer's specifications and recommendations for installation of glazing in window units.
 - M. Do not allow sealants to come in contact with edges of laminated glass units.
- 3.4 GASKET GLAZING (DRY)
- A. Fabricate compression gaskets in lengths recommended by gasket manufacturer to fit openings exactly, with stretch allowance during installation.
 - B. Insert soft compression gasket between glass and frame or fixed stop so it is securely in place with joints miter cut and bonded together at corners.
 - C. Center glass lites in openings on setting blocks and press firmly against soft compression gasket by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.
 - D. Install gaskets so they protrude past face of glazing stops.
- 3.5 INSTALLATION – FIRE-RATED GLAZING
- A. Comply with FGMA standards and instructions of manufacturers of glass, glazing sealants, and glazing compounds.
 - B. Protect glass from edge damage during handling and installation. Inspect glass during installation and discard pieces with edge damage that could affect glass performance.
 - C. Set units of glass in each series with uniformity of pattern, draw, bow, and similar characteristics.
 - D. Cut glazing tape to length and set against permanent stops, flush with sight lines to fit openings exactly, with stretch allowance during installation.

1. Install glazing tape in a straight line so that visibility is minimized in the finished installation.
- E. Place setting blocks located at quarter points of glass with edge block no more than 6 inches from corners.
- F. Glaze vertically into labeled fire-rated metal frames or partition walls with same fire rating as glass and push against tape for full contact at perimeter of pane or unit.
- G. Place glazing tape on free perimeter of glazing in same manner described above.
- H. Install removable stop and secure without displacement of tape.
- I. Use specified glazing compound, without adulteration; bed glazing material in glazing compound; entirely fill all recess and spaces. Provide visible glazing compound with smooth and straight edges.
- J. Install in vision panels in fire-rated doors in accordance with requirements of NFPA 80.
- K. Install so that appropriate approved testing agency and manufacturer's markings remain permanently visible.

3.6 CLEANING AND PROTECTION

- A. Construction Waste Management: Manage construction waste in accordance with provisions of Section 01 74 19 Construction Waste Management and Disposal.
- B. Examine glass surfaces adjacent to or below exterior concrete at frequent intervals during construction, but not less than once a month, for build-up of dirt, scum, alkali deposits, or stains, and remove as recommended by glass manufacturer.
- C. Remove and replace glass that is broken, chipped, cracked, abraded, or damaged in any way, during construction period, including natural causes, accidents and vandalism.
- D. Wash glass on both faces in each area of Project not more than 4 days prior to date scheduled for inspections that establish date of Substantial Completion. Wash glass using non-abrasive soft cloths as recommended by glass manufacturer.
- E. Protect glass from contact with contaminating substances resulting from construction operations including weld splatter. If, despite such protection, contaminating substances do come into contact with glass, remove them immediately as recommended by glass manufacturer.

3.7 CLEANING FIRE-RATED GLASS

- A. Protect glass from damage immediately after installation by attaching crossed streamers to framing held away from glass. Do not apply markers to glass surface. Remove nonpermanent labels, and clean surfaces.
 1. Do not clean with astringent cleaners. Use a clean "grit free" cloth and a small amount of mild soap and water or mild detergent.

2. Do not use any of the following:
 - a. Steam jets
 - b. Abrasives
 - c. Strong acidic or alkaline detergents, or surface-reactive agents
 - d. Detergents not recommended in writing by the manufacturer
 - e. Do not use any detergent above 77 degrees F
 - f. Organic solvents including but not limited to those containing ester, ketones, alcohols, aromatic compounds, glycol ether, or halogenated hydrocarbons.
 - g. Metal or hard parts of cleaning equipment must not touch the glass surface

- B. Wash glass on both exposed surfaces in each area of Project not more than four days before date scheduled for inspections that establish date of Substantial Completion. Wash glass as recommended by glass manufacturer.

END OF SECTION 08 81 00

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SECTION 09 01 65 – ACCESS FLOORING REPAIR

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Evaluation of existing access floor for repair.
 - 2. Replacement of access flooring panels and understructure.

1.2 COORDINATION

- A. Coordinate relocation of mechanical, electrical, and cabling work in underfloor cavity to prevent interference with access flooring pedestals.

1.3 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: A recognized raised access flooring company with experience in removal, repair, and replacement of access flooring systems.
- B. Source Limitations: Obtain access flooring system through one source from the same manufacturer as the existing flooring system.
- C. Regulatory Requirements: Install repaired access flooring to comply with NFPA 75 requirements for raised flooring.
- D. Provide floor panels that are clearly and permanently marked on their underside with panel type and concentrated-load rating.
- E. Preinstallation Conference: Conduct conference at Project site. Use existing layout plans and structural calculations for discussion, if available.
 - 1. Review reconfiguration of raised access floor area to identify new placement of cable entry, ventilation, and brush seals.
 - 2. Inventory any available extra stock available for use in repair and replacement of the access flooring system.
 - 3. Review connection with mechanical and electrical systems to confirm reconfiguration requirements.
 - 4. Confirm availability of lifting tools appropriate to the access flooring system involved in the repair and replacement requirements.
 - 5. Identify existing panels cutouts to evaluate reuse and replacement needs for each panel.
 - 6. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.

1.5 HANDLING

- A. Before attempting to gain access to the under floor void consult any drawings indicating the positions of under floor trunking, services and fire barriers.
- B. Remove and replace panels only by lifting and lowering in the horizontal plane. Do not remove panels by using a 'hinged action' or by 'levering' with screwdrivers or similar. **DO NOT FORCE PANELS INTO POSITION.**
- C. Proper panel lifting devices should always be employed; the use of screwdrivers, chisels etc. to pry up panels will result in damage to the panel edge and any surface covering. Panels should be carefully lifted and replaced in their original orientation.
- D. According to the type of surface material, it may be found that withdrawing and repositioning of panels is accomplished more easily by the use of two lifting devices, which allows the weight and balance to be more easily controlled.
- E. Take care not to dislodge headcaps, gaskets or shims.
- F. Do not remove pedestals from the sub floor.
- G. Care should be taken to avoid damaging neoprene infill on perimeter panels. If the neoprene is dislodged re-glued it with a proprietary adhesive.
- H. If the work under floor has penetrated the fire barriers they should be re-cut to fit neatly around the obstruction. Awkward shapes may need the addition of supplementary fire bags.
- I. Each panel should locate, without the use of force, into its proper position. If it fails to do so, remove it and investigate the reason.

1.6 SAFETY

- A. Do not leave openings in panels unguarded. Do not remove panels out of position unnecessarily. Lift panels in rows and never in blocks.
- B. When panels have been removed in rows, leave single panels in position at approximately 3m centers, i.e. leave every 5th panel in place.
 - 1. Remove no more than 5 panels in a single row and leave at least two complete rows between each row of panels removed.
 - 2. Only remove the minimum number of panels, avoiding long continuous runs of forming islands of panels or pedestals.
 - 3. With panels out of position, extra care must be taken, especially if equipment is being moved.
- C. Do not remove the entire floor.
- D. **BEWARE LIVE CABLES. TAKE CARE TO AVOID DAMAGE TO SERVICES.**
- E. Cordon off or otherwise protect cut-outs in panels. Identify with hazard tape.

- F. Before re-locating panels, ensure that stringers (if any) are in place, the pedestals are firmly fixed to the sub floor, and are upright. Check that the pedestal cap (if any) is correctly aligned and free from dust and debris. Ensure that any electrical continuity devices are properly in position.
- G. Damaged or worn surfaces should be considered for repair or replacement without delay.
- H. When forming apertures in the floor protect the cut edges of the aperture by way of a proprietary grommet or floor box that can shield the user from exposure to any sharp edges.
 - 1. Even when using a grommet or floor box never put one hand into the void through a cut aperture; always remove the panel to get a view of any object that may cause injury in the void eg. live cable, sharp debris.
 - 2. Always wear protective gloves when placing one hand into a grommet.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Access Flooring System: Assemblies composed of modular floor panels on pedestals with or without stringers.
- B. Structural Performance: Maintain existing access flooring system load and stress design according to referenced procedures in CISCA A/F, "Recommended Test Procedures for Access Floors" for the following:
 - 1. Concentrated loads.
 - 2. Ultimate loads.
 - 3. Rolling loads
 - 4. Stringer load testing.
 - 5. Pedestal axial load test..
 - 6. Pedestal overturning moment test.
- C. Floor Panel Impact-Load Performance: Match existing access flooring system impact loads where new and relocated panels are installed to prevent failure. Failure is defined as collapse of access flooring system.
- D. Seismic Performance: Evaluate access flooring system to ensure it will remain capable of withstanding the effects of seismic motions determined according to ASCE 7, "Minimum Design Loads for Buildings and Other Structures": Section 9, "Earthquake Loads" after reconfiguration and panel replacement is completed. Make any adjustments required to ensure compliance.
- E. ESD-Control Properties: Where existing panels have ESD-control properties, install new panels matching these properties.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Evaluate the existing access floor substructure with Installer and manufacturer's representative present, for compliance with requirements for installation tolerances and other conditions affecting performance of work and to access need for adjustments and repairs.
- B. Access existing panels with holes to determine condition and reusability. Remove and replace any panels which cannot be adequately repaired for reuse.
- C. If a floor sealer has been previously applied to the subfloor, repair any cracking or flaking by removing any loose material and reapplying sealer compatible with adhesives used for adhering pedestals to subfloor.
- D. Preinstallation Adhesive Field Test: Before installing new pedestals, field test their adhesion to subfloor surfaces as follows:
 - 1. In areas representative of each subfloor surface, set typical pedestal assemblies in same adhesive and methods required for completed work.
 - 2. Allow test installation to cure for 30 days, with a pressure of 25 lbf (111 N) applied vertically to pedestals during this period.
 - 3. After curing, apply lateral load against a straight steel bar inserted 2 inches (51 mm) into pedestal stems. Measure the force needed to cause adhesive failure of pedestal base.
 - 4. Proceed with installation only after tests show compliance with performance requirement specified for pedestals' capability to resist overturning moment.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Ensure that no part of the floor installation is used as a workshop or as a platform for storage of equipment and materials.
- B. Do not permit traffic within 48 hours (subject to temperature and humidity levels) following the use of adhesives.
- C. Do not permit other trades into the area until the Contractor has accepted responsibility for the installation.
 - 1. Do not leave the floor installation unprotected. Protect the floor installation with hardboard with taped joints applied to the raised floor, prior to access being permitted to other trades to deter abuse and reduce possible damage of the surface finish of the panels.
- D. Do not subject the access flooring to static or dynamic loads which exceed those for which it is designed.
- E. Lay out new floor panel installation to keep the number of cut panels at floor perimeter to a minimum. Avoid using panels cut to less than 6 inches (152 mm).

- F. Locate each pedestal, complete any necessary subfloor preparation, and vacuum clean subfloor to remove dust, dirt, and construction debris before beginning installation.

3.3 REMOVING AND REPLACING PANELS

- A. Always use the correct lifting tool, and ensure the lifting tool is in good condition and fit for the purpose. It is recommended that 2 panel lifters are used. Place the lifters diagonally across the panel and ensure that there is effective grip of suction.
- B. Test the grip by pulling on the handles before starting to raise the panel.
- C. Raise the panel in a horizontal plane so that it will clear adjacent panels without jamming and without the use of excessive force.
- D. Once the panel is lifted clear of the floor surface rotate it through 45 degrees and rest it on the surrounding panels.
- E. Some panels do not have a smooth soffit. Take care to avoid scratching or indenting adjacent panels by placing one panel on another.
- F. Remove the lifting tools from the panel surface then lift and move the panel by holding the sides.
- G. Before replacing a panel ensure that the substructure is properly fixed, aligned, and free of debris.
- H. Replace the panel using 2 lifting tools and set it gently into the opening. It may need gentle foot pressure to press it home but should not be forced. If a panel will not go into place without resort to force, remove it again and investigate. Correct any problems before reattempting.
- I. Failure to observe and implement the correct procedure may result in damage to the flooring system.
- J. Damage to the flooring system will, in turn, affect its future performance and the longevity of the system.

3.4 INSTALLATION

- A. Re-install access flooring system and accessories under supervision of access flooring manufacturer's authorized representative to produce a rigid, firm installation that complies with performance requirements and is free of instability, rocking, rattles, and squeaks.
- B. Replace access flooring panels that are stained, scratched, or otherwise damaged or that do not comply with specified requirements.
- C. Set new pedestals in adhesive as recommended in writing by access flooring manufacturer to provide full bearing of pedestal base on subfloor.

- D. Adjust pedestals to permit top of installed panels to be set flat, level, and to proper height.
- E. Install flooring panels securely in place, properly seated with panel edges flush. Do not force panels into place.
- F. Scribe perimeter panels to provide a close fit with adjoining construction with no voids greater than 1/8 inch (3 mm) where panels abut vertical surfaces.
- G. Cut and trim access flooring and perform other dirt-or-debris-producing activities at a remote location or as required to prevent contamination of subfloor under access flooring already installed.
- H. Exercise care in placing panels containing cut-outs in areas which are likely to be heavily trafficked by rolling loads. When equipment is being moved or maneuvered, spreader plates should be used.
- I. Ground flooring system as recommended by manufacturer and as needed to comply with performance requirements for electrical resistance of floor coverings.
- J. Scribe and install underfloor-cavity dividers to closely fit against subfloor surfaces, and seal with mastic.
- K. Scribe vertical closures to closely fit against subfloor and adjacent finished-floor surfaces. Set in mastic and seal to maintain plenum effect within underfloor cavity.
- L. Clean dust, dirt, and construction debris caused by floor installation, and vacuum subfloor area, as installation of floor panels proceeds.
- M. Seal underfloor air cavities at construction seams, penetrations, and perimeter to control air leakage as recommended in writing by manufacturer.
- N. Install access flooring without change in elevation between adjacent panels and within the following tolerances:
 - 1. Plus or minus 1/16 inch (1.5 mm) 1/8 inch (3 mm) in any 10-foot (3-m) distance.
 - 2. Plus or minus 1/8 inch (3 mm) 1/4 inch (6.5 mm) from a level plane over entire access flooring area.

3.5 MOVING AND RELOCATING EQUIPMENT

- A. Take precautions, including the use of spreader plates during the installation and relocation of materials and equipment.
- B. Evaluate each piece of equipment to determine the following:
 - 1. Gross weight.
 - 2. Distribution of the gross weight.
 - 3. Size and type of wheel, castor, or moving skate.
 - 4. Employ the proper apparatus for moving each equipment piece based on this evaluation.

- C. Do not move heavy and sharp objects or equipment directly over flooring. Place plywood or hardboard panels over flooring and under objects while they are being moved. Slide or roll objects over protective panels without moving panels.
- D. Protect the floor using any of the following:
 - 1. Hardboard sheet.
 - 2. Plywood sheet.
 - 3. Chip board with a minimum thickness of 1/2-inch.
 - 4. Steel or aluminum sheet.
- E. Cable Entry: Do not place heavy equipment over cutouts in panels, especially those close to legs, as the imposed loads may cause failure of the access flooring system. If equipment location is unavoidable, add extra pedestals to transfer the weight axially down the pedestals to the subfloor.
- F. Ventilation: Minimize risk of panel failure cut-outs by positioning so that there is at least 4-inches between the cut-out and the panel edge. Avoid overloading the strip of the panel remaining between the cut-out and the panel edge.
- G. Brush Seals: If the existing access flooring system displays unintended air loss from the floor cavity through any cable entry openings, fit out these openings with brush seals.

3.6 CLEANING

- A. Vacuum floor cavity after removal and before replacement of panels. Take extra care to ensure live cables, fiber optics, and other infrastructure in the floor cavity are not disturbed during cleaning.
- B. Vinyl Panels:
 - 1. Do not impair the static control properties of the ESD panels by using sealing compounds, polishes, wax, etc.
 - 2. If recommended in writing by static-control resilient floor tile manufacturer, apply protective static-control floor polish formulated to maintain or enhance tile's electrical properties to tile surfaces that are free from soil, adhesive, and surface blemishes.
 - 3. Verify that both polish and its application method are approved by tile manufacturer and that polish will not leave an insulating film that reduces tile's effectiveness for static control.
- C. After completing installation, vacuum clean access flooring and cover with continuous sheets of undyed reinforced paper or plastic. Maintain protective covering until time of Substantial Completion.
- D. Construction Waste Management: Manage construction waste in accordance with provisions of Section 01 74 19 Construction Waste Management and Disposal.

3.7 PROTECTION

- A. Protect access flooring panels against mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period. Use protection methods indicated or recommended by access flooring manufacturer.
- B. Prohibit traffic on access flooring for 24 hours and removal of floor panels for 72 hours after installation to allow pedestal adhesive to set.

END OF SECTION 09 01 65

SECTION 09 22 16 – NON-STRUCTURAL METAL FRAMING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Non-load-bearing steel framing members for the following applications:
 - a. Interior framing systems (e.g., supports for partition walls, framed soffits, furring, etc.).
 - b. Flat strap and backing plate for support of wall mounted equipment and fixtures.

B. Related Sections:

1. Section 09 29 00 – Gypsum Board: Application of gypsum board over non-load bearing steel framing.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated, demonstrate compliance with specified attributes.

1.3 INFORMATIONAL SUBMITTALS

- A. Evaluation Reports: For dimpled steel studs and runners and firestop tracks, from ICC-ES.

1.4 QUALITY ASSURANCE

- A. Fire-Test-Response Characteristics: For fire-resistance-rated assemblies that incorporate non-load-bearing steel framing, provide materials and construction identical to those tested in assembly indicated according to ASTM E 119 by an independent testing agency.
- B. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 90 and classified according to ASTM E 413 by an independent testing agency.
1. Engineering Responsibility: Preparation of data for wall framing systems including the following:
 - a. Shop Drawings based on testing and engineering analysis of manufacturer's standard units in assemblies similar to those indicated for this Project and submission of reports of tests performed on manufacturer's standard assemblies.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Structural supports and blocking for light fixtures and miscellaneous wall- or ceiling-mounted items shall be designed and engineered by Contractor.
- B. Performance Requirements:
 - 1. Loads: Comply with CBC requirements for design of metal framing systems for gypsum board wall assemblies.
 - 2. Deflection:
 - a. Partitions to Receive Gypsum Board: L/240.
 - b. Partitions to Receive Tile Backer Board: L/360.
 - c. Framed Ceilings: L/360. L/240 maximum, typical.
 - 3. Seismic Requirements: Comply with code requirements for seismic bracing.

2.2 STEEL FRAMING FOR FRAMED ASSEMBLIES

- A. Framing Members, General: Comply with ASTM C754 for conditions indicated.
 - 1. Steel Studs and Runners: Comply with ASTM C645 requirements for metal and profiles shown on Drawings, unless otherwise indicated.
 - 2. Minimum Base-Metal Thickness: 0.0312 inch (0.79 mm).
 - a. If stud thickness is not indicated, provide thickness as required for specified deflection criteria, based on stud depth and spacing indicated and partition height required.
 - b. If stud spacing is not indicated, space studs at 16-inches oc.
 - 3. Flange Edges of Studs: Bent back 90 deg and doubled over to form 3/16-inch-wide minimum lip (return) and complying with the requirements indicated on Drawings for depth indicated.
 - 4. Protective Coating: ASTM A653/A653M, G60 (Z180) minimum, hot-dip galvanized zinc coating, unless otherwise indicated.
 - 5. Note, stud sizes and thicknesses have been coordinated to avoid the use of kickers in the ceiling for wall deflection. Studs shall not be arbitrarily reduced, at the expense of adding kickers, especially at exposed ceilings.
- B. Slip-Type Head Joints: Where indicated, provide the following:
 - 1. Slotted Slip Track: ASTM C645 top runner with 2-1/2-inch- (63.5-mm-) deep flanges in thickness not less than indicated for studs; with 1-1/2-inch x 1/4-inch vertical slots.
- C. Flat Strap and Backing Plate: Steel sheet for blocking and bracing in length and width indicated and where required by Owner for Owner-installed items. Where backing is not indicated on Drawings comply with the following:
 - 1. Minimum Base-Metal Thickness: 0.0312 inch (0.79 mm).
 - 2. Install continuous plate across minimum 3 studs, attaching to each stud.
 - 3. Notch channel at studs.
 - 4. For Loads Under 50 lbs/ft:
 - a. Plate Size: 6" x 1-1/4", 16 gage track channel.
 - b. Attachment: No. 8 flat head screws, three at each stud.
 - 5. For Loads 51 lbs/ft to 100 lbs/ft:

- a. Plate Size: 6" x 1-1/4", 16 gage track channel.
- b. Attachment: Welding.
6. For Loads 101 lbs/ft to 250 lbs/ft:
 - a. Plate Size: 6-inch wide 14 gage plate with 4" x 1-1/4" 16 gage track channel stiffeners welded to back.
- D. Hat-Shaped, Rigid Furring Channels: ASTM C645.
 1. Minimum Base Metal Thickness: 0.0312 inch (0.79 mm).
 2. Finish: Galvanized, G90 at exterior locations, G60 at interior locations.
 3. Depth: 7/8 inch (22.2 mm).

2.3 AUXILIARY MATERIALS

- A. General: Provide auxiliary materials that comply with referenced installation standards.
 1. Fasteners for Metal Framing: Of type, material, size, corrosion resistance, holding power, and other properties required to fasten steel members to substrates.
- B. Shot Pins: 0.140-inch diameter low velocity powder-actuated drive pins equivalent to Ramset/Red Head No. 1508, or equal, with 7/8-inch minimum penetration into concrete.
- C. Isolation Strip at Exterior Walls: Provide the following:
 1. Foam Gasket: Adhesive-backed, closed-cell vinyl foam strips that allow fastener penetration without foam displacement, 1/8 inch (3.2 mm) thick, in width to suit steel stud size.
- D. Acoustical Gasket at Window System/Framing Interface: Provide sound barrier mullion trim caps of design, basic profile, materials, and operation indicated. Provide units with capability to accommodate variations in adjacent surfaces.
 1. Basis-of-Design Product: MULL-it-OVER Products; Mullion Trim Cap.
 2. Sound Transmission:
 - a. Double-Sided Installations: STC 55 or higher.
 3. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.
 - a. Mullion trim cap to be sized to accommodate thermal movement.
 4. Profile: 55 Classic Mullion Trim Cap
 5. Components:
 - a. Aluminum Extrusions:
 - 1) Thickness: 0.125 inches.
 - 2) Profile: As selected and approved by Architect to allow solid attachment and fastening to the partition wall framing.
 - b. Sound Absorbing Foam:
 - 1) Resistant to smoke, flame, and microbial growth.
 - 2) Fire Rating: ASTM E 84 Class 1.
 - 3) Fungi Resistance: Zero rating per ASTM G 21.
 - c. Compressible Foam: Between edge of extrusion and interior face of curtain wall glass.
 - 1) Thickness: Standard 1/2 inch (12.7 mm), or 1 inch (25.4 mm) to accommodate a larger mullion deflection.

- 2) Color: Light gray.
- d. Fasteners:
 - 1) Self-Tapping or appropriate threaded fastener.
 - 2) Compatible with all materials fasteners will contact and not cause galvanic corrosion.
- e. Snap Cover: Snap-on fastener cover.
- f. Acoustical Sound Sealant: Acrylic latex based.

PART 3 - EXECUTION

3.1 EXAMINATION

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

3.2 PREPARATION

- A. Ceiling Anchorages: Coordinate installation of ceiling suspension systems with installation of overhead structural assemblies to ensure that inserts and other provisions for anchorages to building structure have been installed to receive ceiling hangers that will develop their full strength and at spacing required to support ceilings.

3.3 INSTALLATION, GENERAL

- A. Installation Standard: ASTM C754.
 - 1. Portland Cement Plaster Assemblies: Also comply with requirements in ASTM C1063 that apply to framing installation.
 - 2. Gypsum Board Assemblies: Also comply with requirements in ASTM C840 that apply to framing installation.
- B. Cutting:
 - 1. General: Cut framing components squarely or on angle as required to fit tightly with proper bearing against abutting members.
 - 2. Cutting Studs: If stud web is cut more than 50-percent, or stud flanges are cut, restore stud to original strength by wire-tying, or welding on steel reinforcement.
- C. Install supplementary framing, and blocking to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, or similar construction.
 - 1. Comply with details indicated and with recommendations of gypsum board manufacturer or, if none available, with "Gypsum Construction Handbook" published by United States Gypsum Co.
- D. Backing Plates:
 - 1. Install as indicated and specified for support of wall-hung cabinets, toilet partitions and accessories, and other items to be mounted on vertical surfaces.
 - 2. Welding shall comply with AWS D1.3.

3. Paint welds with a rust-inhibitive paint.
- E. Install bracing at terminations in assemblies.
- F. Do not bridge building control and expansion joints with non-load-bearing steel framing members. Frame both sides of joints independently.
- G. Isolate steel framing from building structure at locations indicated to prevent transfer of loading imposed by structural movement. Comply with details shown on Drawings. Provide slip- or cushioned-type joints as detailed to attain lateral support and avoid axial loading.
- H. Partitions must securely abut to building mullions and walls. Do not use mechanical fasteners to connect framing to mullions; provide closed cell neoprene gasket between mullion and end stud.

3.4 INSTALLING FRAMED ASSEMBLIES

- A. Where studs are installed directly against exterior masonry walls or dissimilar metals at exterior walls, install isolation strip between studs and exterior wall.
- B. Install steel studs and furring in sizes and at spacings indicated but not less than that required by the referenced steel framing installation standard to comply with maximum deflection and minimum loading requirements specified:
 1. Space studs as indicated on Drawings.
 2. Install studs so flanges within framing system point in same direction and so that leading edges or ends of each gypsum board can be attached to open (unsupported) edges of stud flanges first.
- C. Install tracks (runners) at floors and overhead supports. Extend framing full height to structural supports or substrates above suspended ceilings, except where partitions are indicated to terminate at suspended ceilings. Continue framing around ducts penetrating partitions above ceiling.
 1. Deflection Head Joints: Where framing extends to overhead structural supports, install to produce joints at tops of framing systems that prevent axial loading of finished assemblies.
 2. Door Openings: Frame door openings to comply with details indicated and with applicable published recommendations of gypsum board manufacturer. Screw vertical studs at jambs to jamb anchor clips on door frames; install runner track section (for cripple studs) at head and secure to jamb studs.
 - a. Install two studs at each jamb, unless otherwise indicated.
 - b. Extend jamb studs through suspended ceilings and attach to underside of overhead structure, where indicated on Drawings.
 3. Other Framed Openings: Frame openings other than door openings the same as required for door openings, unless otherwise indicated. Install framing below sills of openings to match framing required above door heads.
 4. Fire-Resistance-Rated Partitions: Install framing to comply with fire-resistance-rated assembly indicated and support closures and to make partitions continuous from floor to underside of solid structure.

5. Sound-Rated Partitions: Install framing to comply with sound-rated assembly indicated.
 - D. Stud Wall Lateral Bracing: Comply with requirements of the CBC. Laterally brace walls extending above ceiling height by means of braces installed at not more than 45 degrees from horizontal as follows:
 1. 3-5/8 in x 25 gauge studs at 8 feet oc on each side of wall (in tension only).
 2. 12 gauge wire at 6 feet oc on each side of wall (in tension only).
 3. 3-5/8 inch x 1-1/4 inch x 16 gauge studs at 8 feet oc acting in either tension or compression. They may be on one side of wall only.
 - a. Maximum length is 7 feet when in compression.
 - b. For lengths from 7 to 10 feet (when in compression) form box studs built from two studs welded toe to toe for lengths from 10' to 16' (when in compression).
 - c. Form "T" sections of 4" x 1-5/8" x 18 gauge studs welded together.
 4. Attach stud braces at middle third of beams, purlins or joists.
 - E. Provide horizontal 3/4 inch channel track and web stiffeners continuous at all walls over 17 feet high.
 - F. Installation Tolerance: Install each framing member so fastening surfaces vary not more than 1/8 inch (3 mm) in 10 feet in any direction from the plane formed by faces of adjacent framing.
- 3.5 CLEANING
- A. Construction Waste Management: Manage construction waste in accordance with provisions of Section 01 74 19 Construction Waste Management and Disposal.

END OF SECTION 09 22 16

SECTION 09 29 00 – GYPSUM BOARD

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Gypsum wallboard, rated and non-rated.
 - 2. Gypsum board trims and accessories.
- B. Related Sections:
 - 1. Section 07 92 00 - Joint Sealants: Acoustical sealant.
 - 2. Section 09 22 16 – Non-Structural Metal Framing.

1.2 DEFINITIONS

- A. Gypsum Board Construction Terminology: Refer to ASTM C11 and GA-505 for definitions of terms related to gypsum board assemblies not defined in this Section or in other referenced standards.

PART 2 - PRODUCTS

2.1 GYPSUM BOARD PRODUCTS

- A. General: Provide gypsum board of types indicated in maximum lengths available to minimize end-to-end butt joints.
- B. Gypsum Wallboard: ASTM C1396/C1396M except where noted otherwise:
 - 1. Fire-Rated Gypsum Board: ASTM C1396/C1396M; Type X throughout unless indicated otherwise on Drawings.
 - 2. Gypsum Ceiling Board: ASTM C1396/C1396M; High-strength, sag-resistant type for ceiling surfaces.
 - 3. Long Edges: Tapered.
 - 4. Thickness: ASTM C840, 5/8-inch throughout unless indicated otherwise on Drawings.
 - 5. Finish Levels: As selected by Architect.

2.2 TRIM ACCESSORIES

- A. Accessories for Interior Installation: Corner beads, edge trim, and control joints complying with ASTM C1047.
 - 1. Material: Formed metal or metal combined with paper, with metal sheet steel zinc-coated by hot-dip or electrolytic processes, or with aluminum or rolled zinc.
- B. Square Corner Bead Reinforcement: One of the following or accepted equivalent:
 - 1. Dur-A-Bead as manufactured by USG or accepted equivalent.

2. Wallboard corner bead with 1 1/4-inch flanges as manufactured Gold Bond Building Products Div., National Gypsum Co. or accepted equivalent.
- C. Metal Casing Bead: One of the following or accepted equivalent:
 1. No. 200A Metal Trim manufactured by USG or accepted equivalent.
 2. No. 100 wall board casing manufactured by Gold Bond National Gypsum Company.
- D. Control Joints: One of the following or accepted equivalent:
 1. No. 093; as manufactured by USG or accepted equivalent.
 2. E-Z expansion joint 0.093 zinc control joint, manufactured by Gold Bond National Gypsum Company.
 3. Fire-rated gypsum board control joints.

2.3 JOINT TREATMENT MATERIALS

- A. General: Provide joint treatment materials complying with ASTM C475 and the recommendations of both the manufacturers of sheet products and of joint treatment materials for each application indicated.
- B. Joint Tape for Gypsum Board: ASTM C475 and as follows:
 1. Interior Gypsum Board: Fiberglass mesh reinforcing drywall tape, one grade for bedding tapes and filling depressions, and one for topping and sanding, unless otherwise indicated.
 2. Glass-Mat Gypsum Sheathing Board: 10-by-10 glass mesh.
- C. Setting-Type Joint Compounds for Gypsum Board:
 1. Factory-packaged, job-mixed, chemical-hardening powder products formulated for uses indicated.
 2. Where setting-type joint compounds are indicated as a taping compound only or for taping and filling only, use formulation that is compatible with other joint compounds applied over it.
- D. For filling joints and treating fasteners of water-resistant gypsum backing board behind base for ceramic tile, use formulation recommended by the gypsum board manufacturer for this purpose.
- E. For topping compound, use sandable formulation.
- F. Drying-Type Joint Compounds for Interior Gypsum Board: Factory-packaged vinyl-based products complying with the following requirements for formulation and intended use.
 1. Ready-Mixed Formulation: Factory-mixed product.
 2. All-purpose compound formulated for both taping and topping compounds.
- G. Joint Compound for Exterior Applications:
 1. Basis-of-Design Product: G-P Gypsum; "ToughRock Setting Compound."
 2. Glass-Mat Gypsum Sheathing Board: As recommended by sheathing board manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates to which gypsum board assemblies attach or abut, installed hollow metal frames, cast-in-anchors, and structural framing with Installer present for compliance with requirements for installation tolerances and other conditions affecting performance of assemblies specified in this Section. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 APPLYING AND FINISHING GYPSUM BOARD, GENERAL

- A. Gypsum Board Application and Finishing Standards: Install and finish gypsum panels to comply with ASTM C840 and GA-216.
- B. When cutting gypsum drywall is required, work from the face side. When cutting by scoring, cut through the face paper and then snap the panel back away from the cut face. Then break the back paper by snapping the gypsum board in the reverse direction or by cutting the back paper.
 - 1. Smooth all cut ends and edges of panels where necessary to obtain a smooth joint.
- C. Install wall/partition board panels to minimize the number of abutting end joints or avoid them entirely. Stagger abutting end joints not less than one framing member in alternate courses of board. At high walls, install panels horizontally with end abutting joints over studs and staggered.
- D. Install control joints at locations indicated on Drawings, or if not indicated, install according to ASTM C840 in specific locations as directed by Architect.
- E. Install gypsum panels with face side out. Do not install imperfect, damaged, or damp panels. Butt panels together for a light contact at edges and ends with not more than 1/16 inch of open space between panels. Do not force into place.
- F. Locate both edge or end joints over supports. Position adjoining panels so that tapered edges abut tapered edges, and field-cut edges abut field-cut edges and ends. Do not place tapered edges against cut edges or ends. Stagger vertical joints over different studs on opposite sides of partitions. Avoid joints at corners of framed openings where possible.
- G. Attach gypsum panels to studs so that the leading edge or end of each panel is attached to nailing members except where joints are at right angles to framing members.
- H. Apply wall board first to ceilings and then to walls, using maximum practical lengths to minimize end joints.
- I. Isolate perimeter of non-load-bearing gypsum board partitions at structural abutments, except floors, as detailed. Provide 1/4-inch-to-1/2-inch-wide spaces at these locations and trim edges with U-bead edge trim where edges of gypsum panels are exposed. Seal joints between edges and abutting structural surfaces with acoustical sealant.

- J. Space fasteners in gypsum panels according to referenced gypsum board application and finishing standard and manufacturer's recommendations.
- K. Treat cut edges and holes in moisture resistant gypsum board with sealant.
- L. Place control joints to be consistent with lines of building spaces.
 - 1. Provide where system abuts structural elements.
 - 2. Provide at dissimilar materials.
 - 3. Provide where lengths in partitions exceed 30'-0".
- M. At recesses for equipment and accessories in fire rated walls, line recess with fire rated gypsum board to maintain specified fire rating of wall.
- N. For partitions, apply full height sheets with long dimension parallel to framing members with abutting edges over supports. Where ceiling heights exceed 10'-0" and where required by fire resistive ratings, apply sheets with long dimension perpendicular to framing members. For ceilings, apply sheets with long dimension either perpendicular or parallel to framing members to result in fewest joints. For fire-rated assemblies, apply gypsum board in accordance with CBC Tables 720.1(2) and 720.1(3) as applicable.

3.3 INSTALLATION OF FASTENERS

- A. Start screws at the center of the gypsum board sheet.
- B. Do not locate fasteners less than 3/8-inch from edges or ends of sheets. Do not locate fasteners less than one-inch from edges or ends in horizontal applications.
- C. Fire-Rated Partitions: Install fasteners in accordance with the more restrictive of either CBC Table 720.1(2) or the Underwriters' Laboratories assemblies as denoted on partition schedule.
- D. Non-Fire-Rated Partitions: Install fasteners in accordance with GA-216 and ASTM C840.
- E. Install screws using powered screw guns with adjustable screw-depth control head. Drive shank perpendicular to gypsum board surface. Do not hammer screws.
- F. Set fastener heads slightly below surface of gypsum board, but do not break or strip paper face around fastener.
- G. Stagger fasteners opposite each other on adjacent ends and edges.
- H. Omit fasteners at edges where metal edge trim will be installed.

3.4 INSTALLING TRIM ACCESSORIES

- A. General: For trim accessories with back flanges, fasten to framing with the same fasteners used to fasten gypsum board. Otherwise, fasten trim accessories according to accessory manufacturer's directions for type, length, and spacing of fasteners.

- B. Install corner beads at external corners.
- C. Install edge trim where edge of gypsum panels would otherwise be exposed or semi-exposed. Provide edge trim type with face flange formed to receive joint compound except where other types are indicated.
- D. Control Joints:
 - 1. Ceilings: Maximum area for ceilings with perimeter relief shall be 2,500-sq. ft.; maximum area for ceilings without perimeter relief shall be 900-sq. ft. Do not exceed 50-feet between control joints in ceilings with perimeter relief; 30-feet between control joints in ceilings without perimeter relief.
 - 2. Walls and Partitions: Maximum spacing between control joints shall not exceed 30-feet.
 - 3. Control joint locations shall occur only where indicated on reviewed layout drawings.
- E. Install L-bead where edge trims can only be installed after gypsum panels are installed.

3.5 FINISHING GYPSUM BOARD ASSEMBLIES

- A. General: Apply joint treatment at gypsum board joints (both directions); flanges of corner bead, edge trim, and control joints; penetrations; fastener heads, surface defects, and elsewhere as required to prepare gypsum board surfaces for decoration and levels of gypsum board finish indicated.
- B. Carefully inspect the Drawings and verify the desired location of metal trim. Install all metal trim in strict accordance with the approved submittal of the manufacturer's recommendations, paying particular attention to make all trim installations plumb, level and true to line with firm attachment to supporting members.
- C. Prefill open joints, rounded or beveled edges, and damaged areas using setting-type joint compound.
- D. Apply joint tape over gypsum board joints and to trim accessories with concealed face flanges as recommended by trim accessory manufacturer and as required to prevent cracks from developing in joint compound at flange edges.
 - 1. Taping is not required under wainscot surfaces, except at moisture-resistant type and fire-rated type walls.
- E. Fold reinforcing tape along its centerline and apply to all interior angles, following the same procedure for all joints.
- F. Lightly sand and dry compound with fine sandpaper between coats to remove all irregularities.
- G. Apply a second coat of compound to all joints, feathering approximately 3 inches beyond edges of the tape. Also apply a second coat to all nail recesses, leaving flush with the adjacent surface. When compound is dry, sand again.

- H. Apply final skim coat, feathering out approximately 2 inches beyond the second coat. Third coat nail recesses and metal trims. Skim coat interior angles. After drying, lightly sandpaper surfaces, using caution not to excessively damage the face paper of the gypsum drywall.
- I. Examine surfaces to ensure against defects. Touch up as required for uniformity.
- J. Interior Gypsum Board Finishing:
 - 1. Corners: Square.
 - 2. Taping (Level 1):
 - a. Use taping or all-purpose compound.
 - b. Butter taping compound into inside corners and joints.
 - c. Center tape over joints and press down into fresh compound.
 - d. Remove excess compound. Tape joints of gypsum board above suspended ceilings.
 - 3. First Coat (Level 2):
 - a. Use taping or all-purpose drying-type compound or setting-type joint compound.
 - b. Immediately after bedding tape, apply skim coat of compound over body of tape and allow to dry completely in accordance with manufacturer's instructions.
 - c. Apply first coat of compound over flanges of trim and accessories, and over exposed fastener heads and finish level with board surface.
 - 4. Second Coat (Level 3):
 - a. Use all purpose or topping drying type joint compound.
 - b. After first coat treatments is dried, apply second coat of compound over tape and trim, feathering compound 2-inches beyond edge of first coat.
 - 5. Third Coat (Level 4):
 - a. Use all purpose or topping drying type joint compound.
 - b. After second coat has dried, sand surface lightly and apply thin finish coat to joints, fasteners and trim, feathering compound 2-inches beyond edge of second coat.
 - c. Allow third coat to dry. Apply additional compound, and touch-up and sand, to provide surface free of visual defects, tool marks, and ridges, ready for application of finish.

3.6 CLEANING AND PROTECTION

- A. Construction Waste Management: Manage construction waste in accordance with provisions of Section 01 74 19 Construction Waste Management and Disposal.
- B. Take all means necessary to prevent spilling and splashing compound. Promptly remove any residual joint compound from adjacent surfaces.
- C. Do not allow the accumulation of scrap and debris resulting from the gypsum drywall installation and finishing operations.

- D. Provide final protection and maintain conditions, in a manner suitable to Installer that ensures gypsum board assemblies remain without damage or deterioration at time of Substantial Completion.

END OF SECTION 09 29 00

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SECTION 09 51 23 – ACOUSTICAL TILE CEILINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Acoustical tile ceilings.
2. Suspended metal grid ceiling system and perimeter trim.
3. Existing suspension grid renovation.

B. Related Sections:

1. Section 09 29 00 – Gypsum Board: Suspended gypsum board ceilings.
2. Division 21: Sprinkler heads in acoustical ceilings.
3. Division 23: Grilles, registers, and diffusers in acoustical ceilings.
4. Division 26: Lighting fixtures in acoustical ceilings.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated, including the following:

1. Preparation instructions and recommendations.
2. Storage and handling requirements and recommendations.
3. Installation methods.
4. Ceiling suspension members.

B. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:

1. Ceiling suspension system members.
2. Method of attaching hangers to building structure.
3. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.

C. Shop Drawings: Submit reflected ceiling plans on which the following items are shown and coordinated with each other for the fabrication and installation of the Work, based on input from installers of the items involved for Architect's action.

1. Layout of suspension systems, location of hangers, seismic braces and trapezes.
2. Hanger spacing and fastening details.
3. Trapeze details.
4. Splicing method for main and cross runners.
5. Method of attaching hangers to building structure.
6. Support at ceiling fixtures and air diffusers.
7. Change in level details.
8. Locations and dimensions of access panels, light fixtures, supply and exhaust grilles and diffusers, sprinkler heads, speakers, and detection devices.
9. Seismic control details.

10. Develop and coordinate location of all Work which is to be located in ceiling with the Sections involved per Section 013300 prior to making shop drawing submittal.
 - D. Samples for Verification: Submit samples of each type of exposed finish required, prepared on samples of size indicated below and of same thickness and material indicated for final unit of Work.
 1. Furnish sufficient samples to establish full range of colors and textures for materials exposed in the finished Work. Label samples to indicate product and location in the Work. Samples will be reviewed for appearance only. Compliance with other requirements is the responsibility of the Contractor.
 2. Ceiling Tiles: Samples of each acoustical tile type, pattern, and color; 12" x 24" minimum.
 3. Set of 12-inch-long samples of suspension system members.
- 1.3 INFORMATIONAL SUBMITTALS
- A. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for each acoustical tile ceiling.
 - B. Calculations: Submit for Architect's information. Submit calculations prepared by a qualified Structural Engineer, registered in State of California, for details other than as shown or specified.
 - C. Research/Evaluation Reports: For each acoustical tile ceiling and components and anchor and fastener type.
- 1.4 MAINTENANCE MATERIAL SUBMITTALS
- A. Maintenance Data: For finishes to include in maintenance manuals.
 - B. Deliver extra materials to Owner. Furnish extra materials described below that match products installed, are packaged with protective covering for storage, and are identified with appropriate labels.
 1. Ceiling Units: Furnish quantity of full-size units equal to 2.0 percent of amount installed.
 2. Suspension System Components: Quantity of each exposed component equal to 2.0 percent of quantity installed.
- 1.5 QUALITY ASSURANCE
- A. Source Limitations: Obtain each type of acoustical ceiling tile and supporting suspension system through one source from a single manufacturer.
 - B. Fire-Test-Response Characteristics: Provide acoustical tile ceilings that comply with the following requirements:
 1. Surface-Burning Characteristics: Provide acoustical tiles with the following surface-burning characteristics complying with ASTM E1264 for Class A materials as determined by testing identical products per ASTM E84:
 - a. Smoke-Developed Index: 450 or less.

- C. Seismic Standard: Provide acoustical tile ceilings designed and installed to withstand the effects of earthquake motions according to requirements of authorities having jurisdiction.

1.6 DELIVERY, STORAGE, AND HANDLING

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

1.7 PROJECT CONDITIONS

- A. Install acoustical units after interior wet work is dry.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Acoustic Tiles (AC1): ASTM E1264, conforming to the following:
 - 1. Basis of Design: Armstrong Ultima.
 - 2. Type: IV, Form: 2, Pattern: E.
 - 3. Size: 24 x 24 inches.
 - 4. Thickness: 7/8-inches
 - 5. Composition: Mineral Fiber
 - 6. Light Reflectance: . 0.87
 - 7. NRC Range: 0.80
 - 8. CAC Range: 35
 - 9. Edge: Beveled Tegular.
 - 10. Surface Color: White.
 - 11. Surface Texture: Non-directional fissured.
 - 12. Surface Finish: Factory-applied latex paint.
 - 13. Grid: 9/16-inch.
- B. Acoustic Tiles (AC2): ASTM E1264, conforming to the following:
 - 1. Basis of Design: Armstrong Ultima.
 - 2. Type: IV, Form: 2, Pattern: E.
 - 3. Size: 24 x 48 inches.
 - 4. Thickness: 7/8-inches
 - 5. Composition: Mineral Fiber
 - 6. Light Reflectance: . 0.87
 - 7. NRC Range: 0.80
 - 8. CAC Range: 35
 - 9. Edge: Beveled Tegular.

10. Surface Color: White.
11. Surface Texture: Non-directional fissured.
12. Surface Finish: Factory-applied latex paint.
13. Grid: 9/16-inch.

2.2 SUSPENSION SYSTEM COMPONENTS

- A. Suspension System: ASTM C635/C635M, bolt slot tee with 1/8" reveal.
 1. Exposed Grid Surface Width: 9/16.
 2. Finish: White, low gloss, hot-dipped galvanized coating, color to match ceiling tiles exactly.
 3. Main Runners: 9/16-inch flange, 1-11/16-inch high, double web construction.
 4. Cross Runners: 9/16-inch flange, double web construction.
 5. Wall Angle, Reveals, and Miscellaneous Trim: Roll-formed from electro-galvanized steel strip to profiles indicated.
- B. Attachment Devices: Size for 5 times design load indicated in ASTM C635/C635M, Table 1, Direct Hung, double web, Intermediate-Duty System, unless otherwise indicated.
- C. Wire for Hangers and Ties: ASTM A641/A641M, Class 1 zinc coating, soft temper.
 1. Gage: Provide wire sized so that stress at 3 times hanger design load (ASTM C635/C635M, Table 1, Direct-Hung) will be less than yield stress of wire, but provide not less than 0.106-inch diameter (12-gage).
- D. Support Hangers and Channels: Mild steel, zinc coated, or protected with rust-inhibitive paint, size and shape to suit application and seismic requirements.
 1. Hanger Wires: Connection device capable of carrying not less than 100-pounds.
 2. Bracing Wires: Connection device capable of carrying not less than 200-pounds or the actual design load, whichever is greater, with a safety factor of 2 without yielding.
- E. Roll-Formed, Sheet-Metal Edge Moldings and Trim: Type and profile indicated or, if not indicated, manufacturer's standard moldings for edges and penetrations that comply with seismic design requirements; formed from sheet metal of same material, finish, and color as that used for exposed flanges of suspension system runners.
 1. Provide manufacturer's standard edge moldings that fit acoustical panel edge details and suspension systems indicated and that match width and configuration of exposed runners, unless otherwise indicated.
 2. For lay-in panels with reveal edge details, provide stepped edge molding that forms reveal of same depth and width as that formed between edge of panel and flange at exposed suspension member.
- F. Seismic Struts: Manufacturer's standard compression struts designed to accommodate seismic forces.
- G. Seismic Clips: Manufacturer's standard seismic clips designed and spaced to secure acoustical tiles in-place.
- H. Hold-Down Clips: Where indicated, provide manufacturer's standard hold-down clips spaced 24-inches (610 mm) oc on all cross tees.

2.3 ACOUSTICAL SEALANT

- A. Acoustical Sealant for Exposed and Concealed Joints: Manufacturer's standard nonsag, paintable, nonstaining latex sealant, with a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24), complying with ASTM C834 and effective in reducing airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E90.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and structural framing to which ceiling system attaches or abuts, with Installer present, for compliance with requirements specified in this and other sections that affect installation and anchorage of ceiling system.
- B. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Measure each ceiling area and establish layout of acoustical units to balance border widths at opposite edges of each ceiling. Avoid use of less-than-half-width units at borders, and comply with reflected ceiling plans.

3.3 INSTALLATION, GENERAL

- A. General: Install acoustical panel ceilings to comply with seismic design requirements indicated, in accordance with manufacturer's written instructions and CISCA's "Ceiling Systems Handbook."
- B. Standard for Installation of Ceiling Suspension Systems: Comply with ASTM C636.
- C. Arrange acoustical units and orient directionally patterned units (if any) in manner shown by reflected ceiling plans.

3.4 INSTALLATION, SUSPENSION SYSTEM

- A. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structural or ceiling suspension system.
- B. Splay hangers only where required to miss obstructions; offset resulting horizontal forces by bracing, counter-splaying, or other equally effective means.
- C. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with the location of hangers at spacings required to support standard suspension system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices. Size supplemental suspension

members and hangers to support ceiling loads within performance limits established by referenced standards.

- D. Secure wire hangers to ceiling suspension members and to supports above with a minimum of four tight turns. Connect hangers directly either to structures or to inserts, eye screws, or other devices that are secure and appropriate for substrate and that will not deteriorate or otherwise fail due to age, corrosion, or elevated temperatures.
- E. Do not support ceilings directly from permanent metal forms or floor deck. Fasten hangers to cast-in-place hanger inserts, post-installed mechanical or adhesive anchors, or power-actuated fasteners that extend through forms into concrete.
- F. Do not attach hangers to steel deck tabs.
- G. Do not attach hangers to steel roof deck. Attach hangers to structural members.
- H. Space hangers not more than 48-inches oc along each member supported directly from hangers, unless otherwise shown, and provide hangers not more than 8-inches from ends of each member.
- I. Ceiling grid members shall be attached to not more than 2 adjacent walls in accordance with ASCE 7, Section 13.5.6.2(b). Ceiling grid members shall be at least 3/8-inch and not more than 3/4-inch free of other walls. If walls run diagonally to ceiling grid system runners, one end of main and cross runners shall be free, and a minimum of 3/4-inch clear of wall.
- J. The width of the perimeter supporting closure angle shall be not less than 7/8-inch.
- K. Install suspension system runners so they are square and securely interlocked with one another. Remove and replace dented, bent, kinked or otherwise damaged runners.
- L. Secure bracing wires to ceiling suspension members and to supports with a minimum of four tight turns. Suspend bracing from building's structural members as required for hangers, without attaching to permanent metal forms, steel deck, or steel deck tabs. Fasten bracing wires into concrete with cast-in-place or post-installed anchors.
- M. Provide expansion joints in the ceiling at intersections of corridors and at junctions of corridors with lobbies or other areas.
- N. Provide lateral-force bracing assemblies consisting of a compression strut and four 12-gauge splayed bracing wires oriented 90-degrees from each other at the following spaces:
 - 1. Place sets of bracing wires spaced not more than 12-feet by 12-feet on center.
 - 2. Provide bracing wires at locations not more than 1/2 the specified spacing from each perimeter wall and at the edge of vertical ceiling offsets.
 - 3. The slope of these wires shall not exceed 45-degrees from the plane of the ceiling and shall be taut without causing the ceiling to lift. Splices in bracing wires are not permitted.
 - 4. Compression struts shall not be more than 1 (horizontal) in 6 (vertical) out of plumb.

- O. Provide seismic separation joints for ceiling areas greater than 2,500-square feet.
- P. Testing of Concrete Anchors:
 - 1. When drilled-in concrete anchors or shot-in anchors are used in reinforced concrete for hanger wires, 1 out of 10 shall be field tested for 200-pounds of tension.
 - 2. When drilled-in concrete anchors are used for bracing wires, 1 out of 2 shall be field tested for 440-pounds in tension. Shot-in anchors in concrete are not permitted for bracing wires.
- Q. Support of Light Fixtures and Air Terminals: Comply with ASTM C635.
 - 1. Ceiling suspension systems that support light fixtures, air-ventilation grilles or partitions shall have a classification of heavy-duty.
 - 2. Recessed or drop-in light fixtures and grilles shall be supported directly from the fixture housing to the structure above with a minimum of two 12-gauge wires located at diagonally opposite corners. Fixture support wires may be slightly loose to allow the fixture to seat in the grid system.
 - 3. Fixture shall not be supported from main runners or cross runners if the weight of the fixtures causes the total dead load to exceed the deflection capability of the ceiling suspension system.
- R. Perimeter Trim:
 - 1. Provide in longest lengths available and combinations of lengths to minimize number of joints required.
 - 2. Do not use pieces shorter than 48-inches.
 - 3. Miter joints at corners.
 - 4. Install to neatly close with adjoining vertical surfaces.

3.5 INSTALLATION OF ACOUSTICAL SEALANT

- A. Install edge moldings and trim of type indicated at perimeter of acoustical ceiling area and where necessary to conceal edges of acoustical panels.
- B. Apply acoustical sealant in a continuous ribbon concealed on back of vertical legs of moldings before they are installed.
- C. Screw attach moldings to substrate at intervals not more than 16-inches (400 mm) oc and not more than 3-inches (75 mm) from ends, leveling with ceiling suspension system to a tolerance of 1/8-inch in 12-feet (3.2 mm in 3.66 m). Miter corners accurately and connect securely.
- D. Do not use exposed fasteners, including pop rivets, on moldings and trim.

3.6 INSTALLATION, CEILING TILES

- A. Install units after above-ceiling work is complete.
- B. Install acoustical panels with undamaged edges and fit accurately into suspension system runners and edge moldings. Scribe and cut panels at borders and penetrations to provide a neat, precise fit.

- C. Install acoustical tile in coordination with suspension system and exposed moldings and trim. Place splines or suspension system flanges into kerfed edges so that every tile-to-tile joint is closed by double lap of material.
- D. Install acoustical units level, in uniform plane, and free from twist, warp and dents.
- E. Arrange directionally patterned acoustical tiles as follows:
 - 1. As indicated on reflected ceiling plans.
- F. Fit adjoining tile to form flush, tight joints and to fit irregular grid and perimeter edge trim. Scribe and cut for accurate fit at borders and around penetrating work.
- G. Trim cut tiles at wall junctures so that tegular edges fit properly into grid and edge moldings. Trim edges of tegular tiles to match edges on untrimmed sides as indicated on Drawings. Paint cut edges to match ceiling tile face.
- H. Install hold-down clips to retain panels tight to grid system within 20-feet of exterior doors.
- I. Conform to State safety orders and applicable codes, including the seismic bracing requirements of CBC.

3.7 RENOVATION OF EXISTING SUSPENSION GRID

- A. Straighten and repair existing grid where necessary to give suspension system like-new appearance. Prepare grid for field-applied paint.
- B. Refinish grid with paint as recommended by grid manufacturer. Provide color and sheen to match new grid and ceiling tiles.
- C. Where less than 25 percent of the existing grid in each room requires renovation, remove and replace with new grid. Confirm determinations with Architect before proceeding with removal and replacement.

3.8 ADJUSTING

- A. Adjust hangers as required. Addition of kinks or bends in hanger are not acceptable; take up in ties only.
- B. When complete, grid members of each assembly shall be mutually parallel/square, accurately aligned, with joints neatly formed and closely fitted and aligned flush; each assembly shall be securely anchored and braced to structure to prevent movement.

3.9 CLEANING

- A. Construction Waste Management: Manage construction waste in accordance with provisions of Section 01 74 19 Construction Waste Management and Disposal.

- B. Clean exposed surfaces of acoustical ceilings, including trim, edge moldings, and suspension members. Comply with manufacturer's instructions for cleaning and touch-up of minor finish damage.
- C. Adjust hangers as required. Addition of kinks or bends in hanger are not acceptable; take up in ties only.
- D. When complete, grid members of each assembly shall be mutually parallel/square, accurately aligned, with joints neatly formed and closely fitted and aligned flush; each assembly shall be securely anchored and braced to structure to prevent movement.
- E. Exposed surfaces of grids shall be clean and free from scratches, dents, tool marks, stains, discoloration, fingerprints, and other defects and damage.
- F. Remove and replace work that cannot be successfully cleaned and repaired to permanently eliminate evidence of damage.

END OF SECTION 09 51 23

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SECTION 09 65 13 – RESILIENT WALL BASE

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
1. Rubber wall base, reducer strips, and other accessories.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product specified.
1. Provide manufacturers' product data for adhesives, including printed statement of VOC content.
- B. Samples for Verification: In manufacturer's standard size, but not less than 6-by-9-inch (150-by-230-mm) sections of each different color and pattern of floor covering required.
1. Wall Base: For each color and texture specified, not less than 12 inches (300 mm) long.

PART 2 - PRODUCTS

2.1 RUBBER BASE

- A. Wall Base (RB1): ASTM F1861, Type TP (rubber, thermoplastic).
1. Group (Manufacturing Method): I (solid, homogeneous).
 2. Product: As indicated on Drawings.
 3. Style:
 - a. At Hard Floor Surfaces: Cove (with top-set toe).
 - b. At Soft Floor Surfaces: Straight.
 4. Minimum Thickness: 0.125-inch (3.2 mm).
 5. Height: 4-inches (102 mm).
 6. Lengths: Coils in manufacturer's standard length, but not less than 100 feet.
 7. Outside Corners: Premolded.
 8. Inside Corners: Premolded.
 9. Surface: Smooth.
 10. Color: As selected by Architect from manufacturer's full range of colors.

2.2 INSTALLATION ACCESSORIES

- A. Concrete Slab Primer: Nonstaining type as recommended by flooring manufacturer.
- B. Adhesives (Cements): Water-resistant type recommended by tile manufacturer to suit resilient floor tile products and substrate conditions indicated.

1. Use adhesives that comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24 and South Coast Air Quality Management District Rule #1168).
 - a. VCT and Asphalt Tile Adhesives: 50 g/L.
 - b. Cove Base Adhesives: 50 g/L.
 - c. Rubber Floor Adhesives: 60 g/L.

- C. Metal Edge Strips: Schluter Systems:
 1. Tile-to-Resilient Flooring: Reno-V.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. General: Examine areas where installation of wall base will occur, with Installer present, to verify that substrates and conditions are satisfactory for wall base installation and comply with manufacturer's requirements and those specified in this Section.

3.2 PREPARATION

- A. General: Comply with manufacturer's installation specifications to prepare substrates indicated to receive resilient wall base.
- B. Use trowelable leveling and patching compounds per manufacturer's directions to fill cracks, holes, and depressions in substrates.

3.3 WALL BASE INSTALLATION

- A. Apply wall base to walls, columns, pilasters, casework and cabinets in toe spaces, and other permanent fixtures in rooms and areas where base is required.
- B. Install wall base in lengths as long as practicable without gaps at seams and with tops of adjacent pieces aligned.
- C. Tightly adhere wall base to substrate throughout length of each piece, with base in continuous contact with horizontal and vertical substrates.
- D. Do not stretch wall base during installation.
- E. Fit joints tight and vertical. Maintain minimum measurement of 24-inches between joints.
- F. 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.
- G. Install base on solid backing. Bond tight to wall and floor surfaces.
- H. Scribe and fit to door frames and other interruptions.

- I. Premolded Corners: Install premolded corners before installing straight pieces.
 - J. Job-Formed Corners:
 - 1. Inside Corners: Use straight pieces of maximum lengths possible. Form by cutting an inverted V-shaped notch in toe of wall base at the point where corner is formed. Shave back of base where necessary to produce a snug fit to substrate.
 - 2. Outside Corners: Use straight pieces of maximum lengths possible. Form without producing discoloration (whitening) at bends. Shave back of base at points where bends occur and remove strips perpendicular to length of base that are only deep enough to produce a snug fit without removing more than half the wall base thickness.
 - K. Where base wraps around columns, ensure that seams are terminated with a mitered joint at the corners of the column. Offset, asymmetrical seams are not permissible.
- 3.4 CLEANING
- A. Perform the following operations immediately after completing resilient wall base installation:
 - 1. Remove visible adhesive and other surface blemishes using cleaner recommended by wall base manufacturers.
 - B. Construction Waste Management: Manage construction waste in accordance with provisions of Section 01 74 19 Construction Waste Management and Disposal.
- 3.5 PROTECTION
- A. Protect resilient wall base against mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period. Use protection methods indicated or recommended by wall base manufacturer.

END OF SECTION 09 65 13

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SECTION 09 68 13 - TILE CARPETING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Modular carpet tile.
- B. Related Sections:
 - 1. Section 09 65 13 – Resilient Wall Base: Resilient wall base installed with carpet tile.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include manufacturer's written data on physical characteristics, durability, and fade resistance. Include installation recommendations for each type of substrate.
- B. Samples: For each of the following products and for each color and texture required. Label each Sample with manufacturer's name, material description, color, pattern, and designation indicated on Drawings and in schedules.
 - 1. Carpet Tile: Full-size Sample.
 - 2. Exposed Edge, Transition, and other Accessory Stripping: 12-inch- (300-mm-) long Samples.

1.3 INFORMATIONAL SUBMITTALS

- A. Product Schedule: For carpet tile. Use same designations indicated on Drawings.
- B. Qualification Data: For Installer.
- C. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency.
- D. Warranty: Sample of special warranty.

1.4 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For carpet tiles to include in maintenance manuals. Include the following:
 - 1. Methods for maintaining carpet tile, including cleaning and stain-removal products and procedures and manufacturer's recommended maintenance schedule.
 - 2. Precautions for cleaning materials and methods that could be detrimental to carpet tile.
- B. Warranty: Executed special warranty specified in this Section.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials described below, before installation begins, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Carpet Tile: Full-size units equal to 5 percent of amount installed for each type indicated, but not less than 10 sq. yd. (8.3 sq. m).

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: An experienced installer who is approved by carpet tile manufacturer and certified by the Floor Covering Installation Board or who can demonstrate compliance with its certification program requirements with a minimum of 5 years continuous experience in the installation of the types of carpet tile specified.
- B. Carpet Surface Burning Characteristics: Provide carpet identical to that tested for the following fire performance characteristics, per test method indicated below. Identify carpet with appropriate markings of applicable testing and inspecting organization.
 - 1. Test Method: ASTM E84.
 - 2. Flame Spread: 75 or less.
 - 3. Fire Hazard Classification: Class I floor finish.
 - 4. Minimum critical flux limit of 0.45-watts/square centimeter when tested in accordance with NFPA 253.
- C. Static electricity generation of installed carpet shall not exceed 3.5 KV at 70-deg. F and 20-percent R.H. for life of carpet tile.
- D. Carpet Tile Low-VOC Emissions: Provide carpet and cushion materials that have been tested and certified to indicate carpet, carpet backings, cushions, and adhesives emit no or low VOCs (volatile organic compounds). Provide products carrying the following certifications:
 - 1. CRI Green Label.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Comply with CRI 104, Section 5, "Storage and Handling."
- B. Deliver and store packaged materials in original containers labels intact until time for use, with seals unbroken and store rolls in a flat position. Protect from damage, dirt, stains and moisture.
- C. Do not store carpet tile near products that can off gas harmful substances.

1.8 SITE CONDITIONS

- A. Comply with CRI 104, Section 7.2, "Site Conditions; Temperature and Humidity" and Section 7.12, "Ventilation."
- B. Environmental Limitations:

1. Do not install carpet tiles until wet work in spaces is complete and dry, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.
 2. Use adhesives in strict compliance with manufacturer's recommendations, and ventilate area with maximum outside air for a minimum of 48-hours after installation.
- C. Do not install carpet tiles over concrete slabs until slabs have cured and are sufficiently dry to bond with adhesive and concrete slabs have pH range recommended by carpet tile manufacturer.
1. Test substrates to ensure that no dusting will occur through installed carpet tile. Apply sealer on porous concrete surfaces where required to prevent dusting.

1.9 WARRANTY

- A. Special Warranty for Carpet Tiles: Manufacturer's standard form in which manufacturer agrees to repair or replace components of carpet tile installation that fail in materials or workmanship within specified warranty period.
1. Warranty does not include deterioration or failure of carpet tile due to unusual traffic, failure of substrate, vandalism, or abuse.
 2. Failures include, but are not limited to, more than 10 percent loss of face fiber, edge raveling, snags, runs, loss of tuft bind strength, dimensional stability, excess static discharge, and delamination.
 3. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 CARPET TILE

- A. Available Products (CPT1): Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
1. Basis-of-Design: As indicated on Drawings.
 2. Construction: Match existing.
 3. Size: Match existing.
 4. Radiant Panel: ASTM E648; Passes Class 1, >0.45 W/cm².
 5. Smoke Density: ASTM E662; <450 Dm corr, Flaming.
 6. Static: <3.5 kV (AATCC-134), Step.
 7. Flammability: Passes Methenamine Pill Test (CPSC-FF1-70).
 8. Installation Pattern: Ashlar.

2.2 INSTALLATION ACCESSORIES

- A. Adhesives: Water-resistant, mildew-resistant, nonstaining, pressure-sensitive type to suit products and subfloor conditions indicated, that complies with flammability requirements for installed carpet tile and is recommended by carpet tile manufacturer for releasable installation.
1. VOC Limits: Provide adhesives that comply with the following limits for VOC content when tested according to ASTM D5116:
 - a. Total VOCs: 10.00 mg/sq. m x h.

- b. Formaldehyde: 0.05 mg/sq. m x h.
 - c. 2-Ethyl-1-Hexanol: 3.00 mg/sq. m x h.
- B. Trowelable Leveling and Patching Compounds: Latex-modified, hydraulic-cement-based formulation provided or recommended by carpet tile manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for maximum moisture content, alkalinity range, installation tolerances, and other conditions affecting carpet tile performance. Examine carpet tile for type, color, pattern, and potential defects.
- B. Concrete Subfloors: Verify that concrete slabs comply with ASTM F710 and the following:
- 1. Slab substrates are dry and free of curing compounds, sealers, hardeners, and other materials that may interfere with adhesive bond. Determine adhesion and dryness characteristics by performing bond and moisture tests recommended by carpet tile manufacturer.
 - 2. Subfloor finishes comply with requirements specified in Division 3 Section "Cast-in-Place Concrete" for slabs receiving carpet tile.
 - 3. Subfloors are free of cracks, ridges, depressions, scale, and foreign deposits.
 - 4. Adhesion Testing: Perform tests recommended by manufacturer. Proceed with installation only after substrates pass testing.
 - 5. Moisture and Alkalinity Testing:
 - a. Perform at a rate of three tests for the first 1,000 square feet and one additional test for each 1,000 square feet thereafter.
 - b. Anhydrous Calcium Chloride Test: ASTM F1869; proceed with installation only after substrates have maximum moisture-vapor-emission rate of 3 lb of water/1000 sq. ft. (1.36 kg of water/92.9 sq. m) in 24 hours.
 - c. Internal Relative Humidity Test: ASTM F2170; proceed with installation only after substrates have a maximum relative humidity level of 75%RH or less.
 - d. Digital Alkalinity-pH Test: ASTM F710; proceed with installation only after substrates have a result of 9.0pH or less.
 - e. Perform tests recommended by manufacturer. Proceed with installation only after substrates pass testing.

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

3.2 PREPARATION

- A. General: Comply with CRI 104, Section 6.2, "Site Conditions; Floor Preparation," and with carpet tile manufacturer's written installation instructions for preparing substrates indicated to receive carpet tile installation.

- B. Use trowelable leveling and patching compounds, according to manufacturer's written instructions, to fill cracks, holes, depressions, and protrusions in substrates. Fill or level cracks, holes and depressions 1/8 inch (3 mm) wide or wider and protrusions more than 1/32 inch (0.8 mm), unless more stringent requirements are required by manufacturer's written instructions.
- C. Remove coatings, including curing compounds, and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, without using solvents. Use mechanical methods recommended in writing by carpet tile manufacturer.
- D. Broom and vacuum clean substrates to be covered immediately before installing carpet tile.

3.3 INSTALLATION

- A. General: Comply with CRI 104, Section 14, "Carpet Modules," and with carpet tile manufacturer's written installation instructions.
- B. Installation Method: As recommended in writing by carpet tile manufacturer.
- C. Maintain dye lot integrity. Do not mix dye lots in same area.
- D. Cut and fit carpet tile to butt tightly to vertical surfaces, permanent fixtures, and built-in furniture including cabinets, pipes, outlets, edgings, thresholds, and nosings. Bind or seal cut edges as recommended by carpet tile manufacturer.
- E. Extend carpet tile into toe spaces, door reveals, closets, open-bottomed obstructions, removable flanges, alcoves, and similar openings.
- F. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on finish flooring as marked on subfloor. Use nonpermanent, nonstaining marking device.
- G. Install pattern parallel to walls and borders.

3.4 CLEANING AND PROTECTION

- A. Construction Waste Management: Manage construction waste in accordance with provisions of Section 01 74 19 Construction Waste Management and Disposal.
- B. Perform the following operations immediately after installing carpet tile:
 - 1. Remove excess adhesive, seam sealer, and other surface blemishes using cleaner recommended by carpet tile manufacturer.
 - 2. Remove yarns that protrude from carpet tile surface.
 - 3. Vacuum carpet tile using commercial machine with face-beater element.
- C. Protect installed carpet tile to comply with CRI 104, Section 16, "Protection of Indoor Installations."

- D. Protect carpet tile against damage from construction operations and placement of equipment and fixtures during the remainder of construction period. Use protection methods indicated or recommended in writing by carpet tile manufacturer.

END OF SECTION 09 68 13

SECTION 09 81 00 – ACOUSTIC INSULATION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Acoustic insulation in batt form.
- B. Related Sections:
 - 1. Section 07 92 00 – Joint Sealants.

1.2 ACTION SUBMITTALS

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

1.3 INFORMATIONAL SUBMITTALS

- A. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency for insulation products.

1.4 QUALITY ASSURANCE

- A. Fire Performance Characteristics: Provide insulation materials identical to those whose indicated fire performance characteristics have been determined per the ASTM test method indicated below, by UL or other testing and inspecting organizations acceptable to authorities having jurisdiction. Identify products with appropriate markings of applicable testing and inspecting organization.
 - 1. Surface Burning Characteristic: ASTM E84.
 - 2. Fire Resistance Ratings: ASTM E119.
 - 3. Combustion Characteristics: ASTM E136.
- B. Single-Source Responsibility for Insulation Products: Obtain each type of building insulation from a single source with resources to provide products of consistent quality in appearance and physical properties without delaying progress of the Work.
- C. Acoustical Performance: ASTM E413; provide acoustic insulation capable of providing the minimum STC ratings specified.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Protect insulation materials from physical damage and from deterioration by moisture, soiling, and other sources. Store inside and in a dry location. Comply with manufacturer's recommendations for handling, storage, and protection during installation.

PART 2 - PRODUCTS

2.1 GLASS FIBER INSULATING MATERIALS

- A. Preformed Units: Sizes to fit applications indicated, selected from manufacturer's standard thicknesses, widths, and lengths.
- B. Insulation for Sound Attenuation: ASTM C665; Type I preformed glass fiber batts conforming to the following:
 - 1. Batt Width: Maximum width as required for application.
 - 2. Thickness: 3-5/8-inches.
 - 3. Facing: Unfaced.
 - 4. Flame Spread Rating: Less than 25, as tested in accordance with ASTM E84.
 - 5. Smoke Developed: Less than 50, as tested in accordance with ASTM E84.
 - 6. Overall Sound Transmission: STC 50.
 - 7. Minimum density of 6 lb/cu ft (96 kg/cu m), thermal resistivity of 4.5 deg F x h x sq ft/Btu x in. at 75 deg F (31.2 K x m/W at 24 deg C).

2.2 AUXILIARY INSULATING MATERIALS

- A. Adhesive for Bonding Insulation: Product with demonstrated capability to bond insulation or mechanical anchors securely to substrates indicated without damaging or corroding insulation, anchors, or substrates.
- B. Acoustical Sealants: See Section 07 92 00.
- C. Staples: Steel wire; type and size to suit application.
- D. Tape: Mesh reinforced, self-adhering type, 2-inch wide.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions with Installer present, for compliance with requirements of the Sections in which substrates and related work are specified and to determine if other conditions affecting performance of insulation are satisfactory.
- B. Verify that substrate, adjacent materials, and insulation are dry and ready to receive insulation.
- C. Verify mechanical and electrical services within walls have been installed and tested.
- D. Do not proceed with installation of insulation until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Comply with insulation manufacturer's instructions applicable to products and application indicated. If printed instructions are not available or do not apply to project

conditions, consult manufacturer's technical representative for specific recommendations before proceeding with installation of insulation.

- B. Extend insulation full thickness as indicated to envelop entire area to be insulated. Cut and fit tightly around obstructions, and fill voids with insulation. Remove projections that interfere with placement.
- C. Apply a single layer of insulation of required thickness, unless otherwise shown or required to make up total thickness. Trim insulation neatly to fit spaces.
- D. Install for sound attenuation in interior walls, above toilet room ceilings, and over suspended ceilings where indicated, without gaps or voids.

3.3 INSTALLATION OF ACOUSTIC BATT INSULATION

- A. Apply insulation units to substrates by method indicated, complying with manufacturer's written instructions. If no specific method is indicated, bond units to substrate with adhesive or use mechanical anchorage to provide permanent placement and support of units.
- B. Install glass-fiber insulation in cavities formed by framing members according to the following requirements:
 - 1. Use insulation widths and lengths that fill the cavities formed by framing members. If more than one length is required to fill cavity, provide lengths that will produce a snug fit between ends.
 - 2. Place insulation in cavities formed by framing members to produce a friction fit between edges of insulation and adjoining framing members.
 - 3. Maintain 3-inch (76-mm) clearance of insulation around recessed lighting fixtures.
 - 4. For metal-framed wall cavities where cavity heights exceed 96 inches (2438 mm), support unfaced blankets mechanically and support faced blankets by stapling paper flanges to flanges of metal studs.
- C. Tape seal butt ends, lapped flanges, and tears or cuts in insulation membrane.

3.4 CLEANING

- A. Construction Waste Management: Manage construction waste in accordance with provisions of Section 01 74 19 Construction Waste Management and Disposal.

3.5 PROTECTION

- A. Protect installed insulation from damage due to physical abuse and other causes.
- B. Provide temporary coverings or enclosures where insulation will be subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.

END OF SECTION 09 81 00

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SECTION 09 84 14 – ACOUSTICAL WALL PANELS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Fabric-wrapped acoustical wall panels.
- B. Related Sections:
 - 1. Section 09 81 00 – Acoustic Insulation: Batt insulation installed in wall cavities.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Show fabrication and installation details for acoustical wall panels, including plans, elevations, sections, details, and attachments to other Work.
 - 1. Show orientation of fabric application, pattern matching, and seams.
- C. Coordination Drawings: Show intersections with wall base, electrical outlets and switches, thermostats, lighting fixtures, air outlets and inlets, speakers, sprinklers, access panels, and other adjacent work.
- D. Samples for Verification: Units of each type of acoustical wall panel indicated; in sets for each color, texture, and pattern specified for facing materials, showing the full range of variations expected in these characteristics. Include samples of installation devices and accessories.
 - 1. Fabric: 12" by 12" samples.
 - 2. Panels: Original production in finish specified for final use.
 - 3. Panel Edge: 12-inch- (300-mm-) long Sample showing edge profile, corner, and finish.
 - 4. Core Material: 12-inch- (300-mm-) square Sample showing corner.
 - 5. Mounting Device: Full-size Sample.
 - 6. Sample Panels: No larger than 36 by 36 inches (914 by 914 mm). Show joints and mounting methods.

1.3 INFORMATIONAL SUBMITTALS

- A. Product Certificates: Signed by manufacturers of acoustical wall panels certifying that products furnished comply with requirements.
- B. Qualification Data: For firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.

- C. Product Test Reports: From a qualified testing agency indicating acoustical wall panels comply with requirements, based on comprehensive testing of current products.

1.4 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For acoustical wall panels and facings to include in maintenance manuals specified in Division 01.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials described below, before installation begins, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Tackable Wall Panels: Full-size units equal to 2 percent of amount installed.

1.6 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A firm experienced in manufacturing acoustical wall panels similar to those indicated for this Project and with a record of successful in-service performance.
- B. Source Limitations for Acoustical Wall Panels: Obtain acoustical wall panels from one source with resources to provide products of consistent quality in appearance and physical properties.
- C. Fire-Test-Response Characteristics: Provide acoustical wall panels with the following surface-burning characteristics as determined by testing identical products per ASTM E84 by UL or another testing and inspecting agency acceptable to authorities having jurisdiction. Identify acoustical wall panels with appropriate markings of applicable testing and inspecting agency.
 - 1. Flame Spread: 25 or less.
 - 2. Smoke Developed: 450 or less.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Protect acoustical wall panels from excessive moisture when shipping, storing, and handling. Deliver in unopened bundles and store in a dry place with adequate air circulation. Do not deliver material to building until wet-work, such as concrete and plaster, has been completed and cured to a condition of equilibrium. Protect panel edges from crushing and impact.

1.8 SITE CONDITIONS

- A. Environmental Limitations: Do not install acoustical wall panels until construction in spaces is complete and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.
 - 1. Do not install acoustical panels until building is closed in and HVAC system is operational.
 - 2. Locate materials onsite at least 24 hours before beginning installation to allow materials to reach temperature and moisture content equilibrium.

3. Maintain the following conditions in areas where acoustical materials are to be installed 24 hours before, during and after installation:
 - a. Relative Humidity: 65 - 75%.
 - b. Uniform Temperature: 55 - 70 degrees F (13 - 21 degrees C).

- B. Air-Quality Limitations: Protect acoustical wall panels from exposure to airborne odors, such as tobacco smoke, and install panels under conditions free from odor contamination of ambient air.

- C. Field Measurements: Verify wall surface dimensions by field measurements before fabrication and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
 1. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish surface dimensions and proceed with fabricating acoustical wall panels without field measurements. Coordinate wall construction to ensure that actual surface dimensions correspond to established dimensions.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Acceptable Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to manufacturers named below.
 1. AlphaSorb® Anchorage Acoustical Wall Panels.

2.2 TACKABLE ACOUSTICAL WALL PANELS

- A. Construction: Noncombustible and dimensionally stable glass fiber core, 6-7 pcf, laminated with 1/4-inch cork surface.
 1. Panel Thickness: 1-inch.
 2. Edges: Square.
 3. Corners: Square.
 4. Finish: Factory-applied, fine-textured coating, applied to porous textile material,
 - a. Color: As selected from manufacturer's full range of available colors.
 5. Fabric: Manufacturer-approved Guilford of Maine fabric, color to be selected.
 - a. Flammability: ASTM E84 Tunnel Test:
 - 1) Flame Spread Rating: Class A, 25 or less.
 - 2) Smoke Developed Rating: 15 or less.
 6. Light Reflectance: ASTM C523; using a standard white finish, the average light reflectance value of .82.
 7. Sound-Absorption Performance: Provide acoustical wall panels with minimum noise reduction coefficients indicated, as determined by testing per ASTM C423 for mounting type specified.

Thickness	Mounting	Frequency/Absorption						NRC
		125	250	500	1000	2000	4000	
1"	A (wall)	0.08	0.32	0.84	1.12	1.07	1.03	.85

- B. Fabric-Wrapped Acoustical/Tackable Wall Panels: Criteria, sizes, fabrics, composition, mounting method, and fabrication requirements to be selected.
- C. Fabricate panels to sizes and configurations indicated; attach facing materials to cores to produce installed panels with visible surfaces fully covered and free from waves in fabric weave, wrinkles, sags, blisters, seams, adhesive, or other foreign matter.
 - 1. Fabricate back-mounted panels in factory to exact sizes required to fit wall surfaces, based on field measurements of completed substrates indicated to receive acoustical wall panels.
 - 2. Where square corners are indicated, tailor corners.
 - 3. Where fabrics with directional or repeating patterns, or directional weave, are indicated, mark fabric top and attach fabric in same direction.
 - 4. Where fabric facings with seams are indicated, fabricate invisible seams and comply with Shop Drawings for location.
- D. Dimensional Tolerances of Finished Units: Plus or minus 1/16 inch (1.6 mm) for the following:
 - 1. Thickness.
 - 2. Edge straightness.
 - 3. Overall length and width.
 - 4. Squareness from corner to corner.

2.3 ACCESSORIES

- A. Mounting Devices: Concealed on back of unit, recommended by manufacturer to support weight of unit, and as follows:
 - 1. Metal Clips or Bar Hangers: Manufacturer's standard two-part metal "Z" clips, with one part of each clip mechanically attached to back of unit and the other part to substrate, designed to permit unit removal.
- B. Back-Mounting Accessories: Manufacturer's standard or recommended accessories for securely mounting panels, of type and size indicated, to substrates provided; and complying with the following requirements:
 - 1. Mechanically Mounted Panels: Z-clip hanger system designed to engage steel mounting plates that are secured to wall with appropriate fasteners.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and blocking, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting acoustical wall panel performance. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install acoustical wall panels in locations indicated with vertical surfaces and edges plumb, top edges level and in alignment with other panels, and scribed to fit adjoining

work accurately at borders and at penetrations. Comply with panel manufacturer's written instructions for installation of panels using type of mounting accessories indicated or, if not indicated, as recommended by manufacturer.

1. Cut spline-mounted units to be at least 50 percent of unit width, with facing material extended over cut edge to match uncut edge. Scribe acoustical wall panels to fit adjacent work. Butt joints tightly.
- B. Screw head to be flush with panel surface.
- C. Securely affix wall panels by means of splines attached vertically to smooth wall or furring strips. Engage vertical kerfs on the edges of the wall panels with splines. Apply adhesive or use Velcro hook and loop fastening where necessary.
- D. Cover field cut edges by means of trim or other moldings.
- E. Construction Tolerances: As follows:
 1. Variation from Plumb and Level: Plus or minus 1/16 inch (1.6 mm).
 2. Variation of Joints from Hairline: Not more than 1/16 inch (1.6 mm).

3.3 ADJUSTING

- A. Touch up any minor finish damage.
- B. Clip loose threads; remove pills and extraneous materials.

3.4 CLEANING

- A. Clean exposed surfaces of acoustical panel, trim, moldings and suspension members to comply with manufacturer's instructions for cleaning.
- B. Remove and replace work which cannot be successfully cleaned and repaired to permanently eliminate evidence of damage.
- C. Clean panels with fabric facing, on completion of installation, to remove dust and other foreign materials according to manufacturer's written instructions.
- D. Remove surplus materials, rubbish, and debris resulting from acoustical wall panel installation, on completion of the Work, and leave areas of installation in a neat and clean condition.
- E. Construction Waste Management: Manage construction waste in accordance with provisions of Section 01 74 19 Construction Waste Management and Disposal.

3.5 PROTECTION

- A. Provide final protection and maintain conditions, including temperature and humidity limitations and dust control, in a manner acceptable to manufacturer and Installer that ensure acoustical wall panels are without damage or deterioration at time of Substantial Completion.

- B. Replace panels that cannot be cleaned and repaired, in a manner approved by Architect, before time of Substantial Completion.

END OF SECTION 09 84 14

SECTION 09 91 23 - INTERIOR PAINTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Surface preparation, painting, and finishing of exposed interior and exterior items and surfaces.
2. Surface preparation, priming, and finish coats specified in this Section are in addition to shop-priming and surface treatment specified under other Sections.
3. Painting exposed surfaces whether or not colors are designated in schedules, except where a surface or material is specifically indicated not to be painted or is to remain natural. Where an item or surface is not specifically mentioned, paint the same as similar adjacent materials or surfaces. If color or finish is not designated, the Architect will select from standard colors or finishes available.
4. Painting includes field-painting exposed bare and covered pipes and ducts (including color coding), hangers, exposed steel and iron work, and primed metal surfaces of mechanical and electrical equipment.
5. Painting is not required on prefinished items, finished metal surfaces, concealed surfaces, operating parts, and labels.
6. Labels: Do not paint over Underwriters Laboratories, Factory Mutual or other code-required labels or equipment name, identification, performance rating, or nomenclature plates.

B. Related Sections:

1. Section 08 11 13 - Hollow Metal Doors and Frames: Shop-priming steel doors and frames.
2. Section 08 11 16 - Aluminum Doors and Frames: Powder coated finishing of door frames.

1.2 DEFINITIONS

A. VOC Ranges: Ranges listed are as prescribed by Master Painters Institute (MPI), Architectural Painting Specification Manual as follows:

1. VOC Range E3: Lowest; <51 g/l.
2. VOC Range E2: Next lowest; 51-200 g/l.
3. VOC Range E1: Highest allowable; 201-350 g/l.
4. VOC Range E0: Outside range.

B. General: Standard coating terms defined in ASTM D16 apply to this section.

1. Low Gloss (G1): Refers to a 'velvet-like' finish with a gloss maximum of 10 when measured with a 60-degree meter per ASTM D523.
2. Low Sheen (G2): Refers to an eggshell finish with a gloss range between 5 and 20 when measured with a 60-degree meter per ASTM D523.
3. Satin(G3-G4): Refers to a low-sheen finish with a gloss range between 15 and 35 when measured with a 60-degree meter per ASTM D523.

4. Semi-gloss (G5): Refers to a satin-like finish with a gloss range between 20 and 35 when measured with a 60-degree meter per ASTM D523.
5. Gloss (G6): Refers to a high-sheen finish with a gloss range higher than 65 when measured with a 60-degree meter per ASTM D523.

1.3 ACTION SUBMITTALS

- A. Product Data: For each paint system specified.
 1. Material List: Provide an inclusive list of required coating materials. Indicate each material and cross-reference specific coating, finish system, and application. Identify each material by manufacturer's catalog number and coating material proposed for use.
 2. Manufacturer's Information: Provide manufacturer's technical information, including label analysis and instructions for handling, storing and applying each coating material proposed for use.
 3. Certification by the manufacturer that products supplied comply with local regulations controlling use of volatile organic compounds (VOCs).
- B. Samples for Verification Purposes: Provide samples of each color and material to be applied, with texture to simulate actual conditions, on representative samples of the actual substrate.
 1. Submit Sample Brush Outs on rigid backing, 8-1/2" x 11" minimum.
 2. Step coats on Samples to show each coat required for system.
 3. Label each coat of each Sample.
 4. Label each Sample for location and application area.
 5. Opaque Colors and Finishes: Submit samples, on hardboard, using materials accepted for Project, of each color and paint finish selected with texture to simulate actual conditions.

1.4 CLOSEOUT SUBMITTALS

- A. Provide paint cards fully labeled with manufacturer of each paint system applied on the project. Provide the following with each system:
 1. Manufacturer name.
 2. Manufacturer's paint product.
 3. Primer name and number.
 4. Color name and number.
 5. Gloss level.
 6. Locations where used.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials described below that are from same production run (batch mix) as materials applied and that are packaged for storage and identified with labels describing contents.
 1. Quantity: Furnish an additional 5 percent, but not less than 1 gal. (3.8 L) of each material and color applied.

1.6 QUALITY ASSURANCE

- A. Single-Source Responsibility: Provide primers and undercoat paint produced by the same manufacturer as the finish coats.
- B. Field Samples: Apply field sample of each paint system indicated and each color and finish selected to verify preliminary selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution prior to commencing work.
 - 1. Architect will select one surface to represent surfaces and conditions for application of each paint system specified in Part 3.
 - a. Vertical and Horizontal Surfaces: Provide samples of at least 100 sq. ft. (9 sq. m).
 - b. Other Items: Architect will designate items or areas required.
 - 2. Components: One full component as directed.
 - 3. Simulate finished lighting conditions for review.
 - 4. Install field sample using means and methods identical to those that are going to be employed during full production.
 - 5. Allow coating to cure in accordance with manufacturer's written instructions.
 - 6. Perform adhesion test on existing paint to remain using X-cut method per ASTM D3359. Ratings 4A and 5A acceptable.
 - 7. Final approval of color selections will be based on field sample.
 - a. If preliminary color selections are not approved, apply additional mockups of additional colors selected by Architect at no added cost to Owner.
 - 8. Approval of field sample does not constitute approval of deviations from the Contract Documents contained in field sample unless Architect specifically approves such deviations in writing.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials to the job site in the manufacturer's original, unopened packages and containers bearing manufacturer's name and label, and the following information:
 - 1. Product name or title of material.
 - 2. Product description (generic classification or binder type).
 - 3. Manufacturer's stock number and date of manufacture.
 - 4. Contents by volume, for pigment and vehicle constituents.
 - 5. Thinning instructions.
 - 6. Application instructions.
 - 7. Color name and number.
- B. Store materials not in use in tightly covered containers in a well-ventilated area at a minimum ambient temperature of 45 deg F (7 deg C). Maintain containers used in storage in a clean condition, free of foreign materials and residue.
- C. Protect from freezing. Keep storage area neat and orderly. Remove oily rags and waste daily. Take necessary measures to ensure that workers and work areas are protected from fire and health hazards resulting from handling, mixing, and application.

1.8 SITE CONDITIONS

- A. Apply water-based paints only when the temperature of surfaces to be painted and surrounding air temperatures are between 50 deg F (10 deg C) and 90 deg F (32 deg C).
- B. Apply solvent-thinned paints only when the temperature of surfaces to be painted and surrounding air temperatures are between 45 deg F (7 deg C) and 95 deg F (35 deg C).
- C. Do not apply paint in snow, rain, fog, or mist; or when the relative humidity exceeds 85 percent; or at temperatures less than 5 deg F (3 deg C) above the dew point; or to damp or wet surfaces.
- D. Painting may continue during inclement weather if surfaces and areas to be painted are enclosed and heated within temperature limits specified by the manufacturer during application and drying periods.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Acceptable Manufacturers: Subject to compliance with requirements, manufacturers offering 0-low products that may be incorporated into the Work include the following:
 - 1. Benjamin Moore; EcoSpec WB.

2.2 PAINT MATERIALS, GENERAL

- A. Material Compatibility: Provide block fillers, primers, finish coat materials, and related materials that are compatible with one another and the substrates indicated under conditions of service and application, as demonstrated by the manufacturer based on testing and field experience.
- B. Material Quality: Provide the manufacturer's best-quality trade sale paint material of the various coating types specified. Paint material containers not displaying manufacturer's product identification will not be acceptable.
- C. Proprietary Names: Use of manufacturer's proprietary product names to designate colors or materials is not intended to imply that products named are required to be used to the exclusion of equivalent products of other manufacturers. Furnish the manufacturer's material data and certificates of performance for proposed substitutions.
- D. Colors: Match colors indicated by reference to the manufacturer's standard color designations.
- E. VOC Content: Products shall comply with VOC limits of authorities having jurisdiction and, for interior paints and coatings applied at Project site, the following VOC limits, exclusive of colorants added to a tint base, when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 1. Flat Paints and Coatings: 50 g/L.

2. Nonflat Paints and Coatings: 150 g/L.
3. Dry-Fog Coatings: 400 g/L.
4. Primers, Sealers, and Undercoaters: 200 g/L.
5. Anticorrosive and Antirust Paints Applied to Ferrous Metals: 250 g/L.
6. Zinc-Rich Industrial Maintenance Primers: 340 g/L.
7. Pretreatment Wash Primers: 420 g/L.
8. Floor Coatings: 100 g/L.
9. Shellacs, Clear: 730 g/L.
10. Shellacs, Pigmented: 550 g/L.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions under which painting will be performed for compliance with paint application requirements. Surfaces receiving paint must be thoroughly dry before paint is applied.
- B. Do not begin to apply paint until unsatisfactory conditions have been corrected.
- C. Coordination of Work: Review other Sections in which primers are provided to ensure compatibility of the total system for various substrates. On request, furnish information on characteristics of finish materials to ensure use of compatible primers.
- D. Notify the Architect about anticipated problems using the materials specified over substrates primed by others.
- E. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:
 1. Wood: 15 percent.
 2. Gypsum Board: 12 percent.
- F. Commencement of painting will be construed as the Applicator's acceptance of surfaces and conditions within a particular area.

3.2 PREPARATION

- A. General: Remove hardware and hardware accessories, plates, machined surfaces, lighting fixtures, and similar items already installed that are not to be painted, or provide surface-applied protection prior to surface preparation and painting. Remove these items, if necessary, to completely paint the items and adjacent surfaces.
- B. Following completion of painting operations in each space or area, have items reinstalled by workers skilled in the trades involved.
- C. Cleaning: Before applying paint or other surface treatments, clean the substrates of substances that could impair the bond of the various coatings. Remove oil and grease prior to cleaning. Schedule cleaning and painting so dust and other contaminants from the cleaning process will not fall on wet, newly painted surfaces.

- D. Surface Preparation: Clean and prepare surfaces to be painted according to the manufacturer's instructions for each particular substrate condition and as specified.
- E. Provide barrier coats over incompatible primers or remove and reprime. Notify Architect in writing about anticipated problems using the specified finish-coat material with substrates primed by others.
- F. Cementitious Materials: Prepare concrete, cement plaster, and mineral-fiber-reinforced cement panel surfaces to be painted. Remove efflorescence, chalk, dust, dirt, grease, oils, and release agents. Roughen, as required, to remove glaze. If hardeners or sealers have been used to improve curing, use mechanical methods of surface preparation.
- G. Determine alkalinity and moisture content of surfaces by performing appropriate tests. If surfaces are sufficiently alkaline to cause the finish paint to blister and burn, correct this condition before application. Do not paint surfaces where moisture content exceeds that permitted in manufacturer's printed directions.
- H. Exposed Equipment: Verify installations are complete before initiating preparation of surfaces of exposed mechanical and electrical piping, conduit, ductwork, and equipment for field-painting.
- I. Ferrous Metals: Clean ungalvanized ferrous metal surfaces that have not been shop-coated; remove oil, grease, dirt, loose mill scale, and other foreign substances. Use solvent or mechanical cleaning methods that comply with recommendations of the Steel Structures Painting Council (SSPC).
- J. Touch up bare areas and shop-applied prime coats that have been damaged. Wire-brush, clean with solvents recommended by the paint manufacturer, and touch up with the same primer as the shop coat.
- K. Galvanized Surfaces: Clean galvanized surfaces with nonpetroleum-based solvents so that the surface is free of oil and surface contaminants. Remove pretreatment from galvanized sheet metal fabricated from coil stock by mechanical methods.

3.3 SURFACE PREPARATION

- A. Clean and prepare surfaces to be painted according to manufacturer's written instructions for each particular substrate condition and as specified.
- B. Apply primers to metal surfaces in the field under any of the following circumstances:
 - 1. Where it can be established that shop primer was applied more than 30 days (7 days for some primers, verify with metal shop) before delivery to the site.
 - 2. If shop-applied primer is contaminated during transport or storage.

3.4 MATERIALS PREPARATION

- A. Carefully mix and prepare paint materials according to manufacturer's directions.

- B. Maintain containers used in mixing and applying paint in a clean condition, free of foreign materials and residue.
- C. Stir material before application to produce a mixture of uniform density; stir as required during application. Do not stir surface film into material. Remove film and, if necessary, strain material before using.
- D. Use only thinners approved by the paint manufacturer and only within recommended limits.

3.5 APPLICATION

- A. General: Apply paint according to manufacturer's directions. Use applicators and techniques best suited for substrate and type of material being applied.
- B. Do not paint over dirt, rust, scale, grease, moisture, scuffed surfaces, or conditions detrimental to formation of a durable paint film.
- C. Paint colors, surface treatments, and finishes are indicated in the schedules.
- D. Provide finish coats that are compatible with primers used.
- E. The number of coats and the film thickness required are the same regardless of the application method. Do not apply succeeding coats until the previous coat has cured as recommended by the manufacturer. Sand between applications where sanding is required to produce a smooth even surface according to the manufacturer's directions.
- F. Apply additional coats if undercoats, stains, or other conditions show through final coat of paint until paint film is of uniform finish, color, and appearance. Give special attention to ensure that surfaces, including edges, corners, crevices, welds, and exposed fasteners, receive a dry film thickness equivalent to that of flat surfaces.
- G. Paint surfaces behind movable equipment and furniture the same as similar exposed surfaces. Before the final installation of equipment, paint surfaces behind permanently fixed equipment or furniture with prime coat only.
- H. Omit primer on metal surfaces that have been shop-primed and touch-up painted.

3.6 SCHEDULING PAINTING

- A. Apply first coat to surfaces that have been cleaned, pretreated, or otherwise prepared for painting as soon as practicable after preparation and before subsequent surface deterioration.
- B. Allow sufficient time between successive coats to permit proper drying. Do not recoat until paint has dried to where it feels firm, does not deform or feel sticky under moderate thumb pressure, and where application of another coat of paint does not cause the undercoat to lift or lose adhesion.

3.7 APPLICATION PROCEDURES

- A. Apply paints and coatings by brush, roller, spray, or other applicators according to the manufacturer's directions.
- B. Brushes: Use brushes best suited for the material applied.
- C. Rollers: Use rollers of carpet, velvet back, or high-pile sheep's wool as recommended by the manufacturer for the material and texture required.
- D. Spray Equipment: Use airless spray equipment with orifice size as recommended by the manufacturer for the material and texture required.
- E. Minimum Coating Thickness: Apply materials no thinner than the manufacturer's recommended spreading rate. Provide the total dry film thickness of the entire system as recommended by the manufacturer.
- F. Prime Coats: Before applying finish coats, apply a prime coat of material, as recommended by the manufacturer, to material that is required to be painted or finished and that has not been prime-coated by others. Recoat primed and sealed surfaces where evidence of suction spots or unsealed areas in first coat appears, to ensure a finish coat with no burn-through or other defects due to insufficient sealing.
- G. Stipple Enamel Finish: Roll and redistribute paint to an even and fine texture. Leave no evidence of rolling such as laps, irregularity in texture, skid marks, or other surface imperfections.
- H. Completed Work: Match approved samples for color, texture, and coverage. Remove, refinish, or repaint work not complying with specified requirements.

3.8 CLEANING

- A. Cleanup: At the end of each work day, remove empty cans, rags, rubbish, and other discarded paint materials from the site.
- B. After completing painting, clean glass and paint-spattered surfaces. Remove spattered paint by washing and scraping. Be careful not to scratch or damage adjacent finished surfaces.
- C. Construction Waste Management: Manage construction waste in accordance with provisions of Section 01 74 19 Construction Waste Management and Disposal.

3.9 PROTECTION

- A. Protect work of other trades, whether being painted or not, against damage by painting. Correct damage by cleaning, repairing or replacing, and repainting, as acceptable to Architect.

- B. Provide "Wet Paint" signs to protect newly painted finishes. Remove temporary protective wrappings provided by others to protect their work after completing painting operations.
- C. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.10 PAINT SYSTEMS SCHEDULES

- A. Schedule: Only major areas are scheduled. Treat miscellaneous and similar items and areas within room or space with similar system.
- B. Number of Coats: Where number of coats are specified, it is only as a minimum requirement. Apply additional coats, at no additional cost to Owner, if necessary to completely hide base material, produce uniform color, and provide satisfactory finish result.
- C. Systems Specifications: These specifications are a guide and are meant to establish procedure and quality. Confer with Architect to determine exact finish desired.
- D. Acceptance of Final Colors: Do not apply final coats of paint for either exterior and interior systems until colors have been accepted by Architect.
- E. Painted surface shall be considered unacceptable if any of the following are evident under final lighting source (including daylight) for interior surfaces:
 - 1. Visible defects are evident on vertical surfaces when viewed at normal viewing angles from a distance of not less than 39-inches (1000 mm).
 - 2. Visible defects are evident on horizontal surfaces when viewed at normal viewing angles from a distance of not less than 39-inches (1000 mm).
 - 3. Visible defects are evident on ceiling, soffit and other overhead surfaces when viewed at normal viewing angles.
 - 4. When the final coat on any surface exhibits a lack of uniformity of color, sheen, texture, and hiding across full surface area.
 - 5. Coating exhibits lack of full adhesion to surfaces, including but not limited to bubbling, peeling, chipping, and other adhesion defects.

3.11 INTERIOR FINISH SCHEDULE

- A. References used in this schedule are based on systems described in the Painting and Decorating Contractors of America, Master Painters Institute, Architectural Painting Specification Manual (MPI).
- B. Steel Door Frames- Primed:
 - 1. Latex (over Q.D. shop primer): MPI INT 5.1X
 - a. Prime Coat: Q.D. Shop primer.
 - b. Intermediate Coat: Interior 100% acrylic latex matching topcoat.
 - c. Topcoat: Interior 100% acrylic latex (semi-gloss).
- C. Gypsum Board Walls:
 - 1. Latex System: MPI INT 9.2A.

- a. Prime Coat: Interior latex primer/sealer.
 - b. Intermediate Coat: Interior latex matching topcoat.
 - c. Topcoat: Interior latex (low sheen).
- D. Acoustical Ceiling Tiles (cut edges):
- 1. Latex, Flat: MPI INT 9.3A
 - a. Prime Coat: Latex flat paint.
 - b. Topcoat: Latex flat paint.

END OF SECTION 09 91 23

SECTION 10 11 00 – VISUAL DISPLAY UNITS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Magnetic glass markerboards.
 - 2. Television mounting brackets.
- B. Related Sections:
 - 1. Section 09 22 16 – Non-Load Bearing Steel Framing: Backing plate supports for marker boards.
 - 2. Section 09 29 00 - Gypsum Board: Gypsum board surface finishes.

1.2 ACTION SUBMITTALS

- A. Product Data: Provide manufacturer's product data for markerboards.
- B. Shop Drawings: Provide shop drawings for markerboards. Include sections of typical trim members and dimensioned elevations. Show anchors, grounds, reinforcement, accessories, layout and installation details.
- C. Samples for Verification: For each type of visual display surface indicated and as follows:
 - 1. Visual Display Surface: Not less than 8-1/2 by 11 inches (215 by 280 mm), mounted on substrate indicated for final Work. Include one panel for each type, color, and texture required.
 - 2. Trim: 6-inch- (152-mm-) long sections of each trim profile.
 - 3. Accessories: Full-size Sample of each type of accessory.

1.3 QUALITY ASSURANCE

- A. Source Limitations: Obtain each type of visual display surface through one source from a single manufacturer.

1.4 DELIVERY, STORAGE AND HANDLING

- A. Deliver factory-built markerboards completely assembled in 1 piece without joints, wherever possible. Where dimensions exceed panel size, provide 2 or more pieces of equal length as acceptable to the Architect.
- B. When overall dimensions require delivery in separate units, prefit components at the factory, disassemble for delivery, and make final joints at the site. Use splines at joints to maintain surface alignment.
- C. Store visual display units vertically with packing materials between each unit.

1.5 SITE CONDITIONS

- A. Field Measurements: Verify dimensions by field measurements before fabrication and indicate measurements on Shop Drawings.
 - 1. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish dimensions and proceed with fabricating visual display surfaces without field measurements. Coordinate wall construction to ensure that actual dimensions correspond to established dimensions.
 - 2. Allow for trimming and fitting where taking field measurements before fabrication might delay the Work.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Provide anchorage of visual display units capable of withstanding the effects of earthquake motions determined according to ASCE 7, "Minimum Design Loads for Buildings and Other Structures": Section 9, "Earthquake Loads."

2.2 GLASS MARKERBOARD ASSEMBLY

- A. Acceptable Manufacturers:
 - 1. Clarus Glassboards.
 - 2. Fulbright Glass Boards.
 - 3. Accepted equivalent.
- B. Components:
 - 1. Glass: 1/4-inch PPG Starphire Tempered Safety Writing glass.
 - 2. Non-staining writing surface compatible with any type of marker.
 - 3. Concealed hardware.
 - 4. Eased corners, polished edges.
 - 5. Color: White.

2.3 TELEVISION MOUNTING BRACKETS

- A. Manufacturer: As indicated on Drawings.
- B. Television Mount:
 - 1. Style: Yoke, wall mount.
 - 2. Swivel Angle: 240 degrees.
 - 3. Tilt Angle: 0-15 degrees.
 - 4. Load Capacity: 150 lbs, minimum.
 - 5. Color: Black.

2.4 MARKER BOARD ACCESSORIES

- A. Aluminum Frames and Trim: Fabricated from not less than 0.062-inch- (1.57-mm-) thick, extruded aluminum; of size and shape indicated.

1. Factory-Applied Trim: Manufacturer's standard.
- B. Chalktray: Manufacturer's standard, continuous.
 1. Solid Type: Extruded aluminum with ribbed section and smoothly curved exposed ends.
- C. Marking Implements: Provide two new boxes of approved markers and one new eraser for each markerboard.

PART 3 - EXECUTION - NOT USED

3.1 EXAMINATION

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

3.2 INSTALLATION

- A. General: Install visual display surfaces in locations and at mounting heights indicated on Drawings, or if not indicated, at heights indicated below. Keep perimeter lines straight, level, and plumb. Provide grounds, clips, backing materials, adhesives, brackets, anchors, trim, and accessories necessary for complete installation.
- B. Visual Display Units: Attach concealed clips, hangers, and grounds to wall surfaces and to visual display units with fasteners at not more than 16 inches (400 mm) oc. Secure both top and bottom of boards to walls.

3.3 ADJUSTING

- A. Touch up factory-applied finishes to restore damaged or soiled areas.

3.4 CLEANING

- A. Clean visual display surfaces according to manufacturer's written instructions. Attach one cleaning label to visual display surface in each room.
- B. Construction Waste Management: Manage construction waste in accordance with provisions of Section 01 74 19 Construction Waste Management and Disposal

3.5 PROTECTION

- A. Cover and protect visual display surfaces after installation and cleaning.

END OF SECTION 10 11 00

SECTION 10 56 13 – METAL STORAGE SHELVING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Cantilever-bracket shelving supported by wall-mounted standards.

1.2 ACTION SUBMITTALS

- A. Product Data: Include rated capacities, construction details, material descriptions, dimensions of individual components and profiles, and finishes for metal storage shelving.
- B. Shop Drawings: Show fabrication and installation details for metal storage shelving, including upright-to-shelf/arm connections, lateral bracing, and attachments to other work. Include plans, elevations, sections, details, and relationship to other work.
- C. Samples for Verification: For the following components, of size indicated below.
 - 1. Uprights: 12 inches (305 mm) long.
 - 2. Shelves: Full size, but not more than 24 inches (610 mm) wide by 12 inches (305 mm) deep.
 - 3. Brackets: Full size.

1.3 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For metal storage shelving to include in maintenance manuals.

1.4 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials described below, before installation begins, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Shelves: Six full-size units for each type of shelving indicated.
 - 2. Clamps: Thirty units for each type of shelving indicated.
 - 3. Brackets: Sixteen units for each type of shelving indicated.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
- B. Source Limitations: Obtain metal storage shelving through one source from a single manufacturer.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver metal storage shelving palletted, wrapped, or crated to provide protection during transit and Project-site storage.

1.7 SITE CONDITIONS

- A. Environmental Limitations: Do not deliver or install metal storage shelving until spaces are enclosed and weatherproof, wet work in spaces is completed and dry, and ambient temperature is being maintained at the levels indicated for Project when occupied for its intended use.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Basis-of-Design Product: The design for each type of metal storage shelving is based on the product named.
 - 1. Basis-of-Design: E-Z Shelving Systems, Inc.; Cantilever shelving and shelving hardware.

2.2 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Provide metal storage shelving capable of withstanding the effects of earthquake motions determined according to ASCE 7, "Minimum Design Loads for Buildings and Other Structures": Section 9, "Earthquake Loads."

2.3 CANTILEVERED SHELVING COMPONENTS

- A. General: Factory-formed, field-assembled, freestanding, cantilever-supported metal storage shelving system; designed for shelves to span between and be supported by steel brackets, with shelves adjustable over the entire height of shelving unit. Fabricate shelf units so each unit is independent.
- B. Uprights: Fabricated from 0.0785-inch- (2.0-mm-) thick steel sheet, with slots or holes at 2 inches (50 mm) oc for shelf brackets.
- C. Brackets: Fabricated from 0.108-inch- (2.8 mm-) thick steel.
 - 1. Provide double-shelf brackets for adjoining shelves and single-shelf brackets for end shelves.
 - 2. Supply sufficient quantity of steel clamps for connecting brackets to uprights and shelves.
- D. Shelves: Fabricated from 0.064-inch- (1.60-mm-) thick steel sheet, with slots or holes for connection to shelf brackets. Fabricate shelves with vertical front that is flanged and returned.
 - 1. Load-Carrying Capacity: 100 lbs/sq ft minimum.
- E. Shelf Quantity: As indicated on Drawings.

- F. Overall Unit Width: As indicated on Drawings.
 - G. Overall Unit Depth: As indicated on Drawings.
 - H. Overall Unit Height: As indicated on Drawings.
 - I. Finish: Stainless steel, Type 304.
- 2.4 STAINLESS-STEEL FINISHES
- A. General: Remove tool and die marks and stretch lines or blend into finish. Grind and polish surfaces to produce uniform, directionally textured, polished finish indicated, free of cross scratches. Run grain with long dimension of each piece.
 - B. Bright, Directional Polish: No. 4 finish.
 - C. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of work.
- B. Examine floors for suitable conditions where metal storage shelving will be installed.
- C. Examine walls to which metal storage shelving will be attached for properly located blocking, grounds, or other solid backing for attachment of support fasteners.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install metal storage shelving level, plumb, square, rigid, and true.
 - 1. Install seismic supports and bracing as recommended by manufacturer and authorities having jurisdiction, and as required for stability. Extend and fasten members to supporting structure.
 - 2. Install shelves in each shelving unit at spacing indicated on Drawings or, if not indicated, at equal spacing.
 - a. Install clamps at each upright for support of each shelf; with clamps fully engaged in upright perforations.

3.3 ADJUSTING

- A. Verify that shelves adjust easily and properly.

- B. Touch up marred finishes or replace metal storage shelving that cannot be restored to factory-finished appearance. Use only materials and procedures recommended or furnished by metal storage shelving manufacturer.
- C. Replace metal storage shelving that has been damaged or has deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

3.4 CLEANING

- A. On completion of installation, clean exposed surfaces as recommended by manufacturer.
- B. Construction Waste Management: Manage construction waste in accordance with provisions of Section 01 74 19 Construction Waste Management and Disposal.

END OF SECTION 10 56 13

SECTION 22 00 00 – GENERAL REQUIREMENTS – PLUMBING

PART 1 – GENERAL

1.1 DESCRIPTION – THIS SECTION 22 00 00 INCLUDES GENERAL REQUIREMENTS FOR THE WORK COMPRISING THE FOLLOWING SECTIONS:

- A. Section 22 05 29 Hangers and Supports
- B. Section 22 05 53 Identification for Plumbing Piping and Equipment
- C. Section 22 13 13 Condensate Drainage

1.2 WORK INCLUDED

- A. Provide all materials, equipment, labor, fabrication, specialties, and items necessary and incidental to the installations.
- B. Work included shall also include transportation, storage, utilities and required licenses and permits.

1.3 RELATED WORK AND REQUIREMENTS

- A. The work of this Section shall require work in coordination with other Divisions outside of this Section as follows:
 - 1. Section 01 00 00 General Requirements
 - 2. Section 01 33 23 Shop Drawings, Product Data and Samples
 - 3. Section 26 00 00 General Requirements, Electrical

1.4 QUALITY ASSURANCE

- A. Comply with Division 1 requirements regarding Quality Control and Assurance.
- B. Products Criteria:
 - 1. Standard Products: Material and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of the products for at least 3 years. However, digital electronics devices, software and systems such as controls, instruments, computer workstation, shall be the current generation of technology and basic design that has a proven satisfactory service record of at least three years.
 - 2. Equipment Service: There shall be permanent service organizations, authorized and trained by manufacturers of the equipment supplied, located within 100 miles of the project. These organizations shall come to the site

and provide acceptable service to restore operations within four hours of receipt of notification by phone, e-mail or fax in event of an emergency, such as the shut-down of equipment; or within 24 hours in a non-emergency. Names, mail and e-mail addresses and phone numbers of service organizations providing service under these conditions for (as applicable to the project): pumps, critical instrumentation, computer workstation and programming shall be submitted for project record and inserted into the operations and maintenance manual.

3. All items furnished shall be free from defects that would adversely affect the performance, maintainability and appearance of individual components and overall assembly.
 4. The products and execution of work specified in Division 22 shall conform to the referenced codes and standards as required by the specifications. Local codes and amendments enforced by the local code official shall be enforced, if required by local authorities such as the natural gas supplier. If the local codes are more stringent, then the local code shall apply. Any conflicts shall be brought to the attention of the Engineer of Record.
 5. Multiple Units: When two or more units of materials or equipment of the same type or class are required, these units shall be products of one manufacturer.
 6. Assembled Units: Manufacturers of equipment assemblies, which use components made by others, assume complete responsibility for the final assembled product.
 7. Nameplates: Nameplate bearing manufacturer's name or identifiable trademark shall be securely affixed in a conspicuous place on equipment, or name or trademark cast integrally with equipment, stamped, or otherwise permanently marked on each item of equipment.
 8. Asbestos products or equipment or materials containing asbestos shall not be used.
- C. Manufacturer's Recommendations: Where installation procedures or any part thereof are required to be in accordance with the recommendations of the manufacturer of the material being installed, printed copies of these recommendations shall be furnished to the Engineer of Record prior to installation. Installation of the item will not be allowed to proceed until the recommendations are received. Failure to furnish these recommendations can be cause for rejection of the material.
- D. Execution (Installation, Construction) Quality:
1. All items shall be applied and installed in accordance with manufacturer's written instructions. Conflicts between the manufacturer's instructions and the contract drawings and specifications shall be referred to the Engineer of Record for resolution. Written hard copies or computer files of manufacturer's installation instructions shall be provided to the Engineer of Record at least two weeks prior to commencing installation of any item.

2. Complete layout drawings shall be required by Paragraph, SUBMITTALS. Construction work shall not start on any system until the layout drawings have been approved.

E. Plumbing Systems: CPC, California Plumbing Code, 2022.

1.5 SUBMITTALS

A. Comply with Division 1 requirements regarding submittals and the requirements herein.

B. Contractor shall make all necessary field measurements and investigations to assure that the equipment and assemblies will meet contract requirements.

C. If equipment is submitted which differs in arrangement from that shown, provide drawings that show the rearrangement of all associated systems. Approval will be given only if all features of the equipment and associated systems, including accessibility, are equivalent to that required by the contract.

D. Prior to submitting layout drawings for approval, contractor shall certify in writing that manufacturers of all major items of equipment have each reviewed drawings and specifications and have jointly coordinated and properly integrated their equipment and controls to provide a complete and efficient installation.

E. Upon request by Engineer of Record, lists of previous installations for selected items of equipment shall be provided. Contact persons who will serve as references, with telephone numbers and e-mail addresses shall be submitted with the references.

F. Manufacturer's Literature and Data: Manufacturer's literature shall be submitted under the pertinent section rather than under this section.

1. Electric motor data and variable speed drive data shall be submitted with the driven equipment.

2. Equipment and materials identification.

3. Fire stopping materials.

4. Hangers, inserts, supports and bracing. Provide load calculations for variable spring and constant support hangers.

5. Wall, floor, and ceiling plates.

G. Layout and Coordination Drawings:

1. Complete, consolidated, and coordinated layout drawings shall be submitted for all new systems, and for existing systems that are in the same areas. The drawings shall include plan views, elevations and sections of all systems and shall be on a scale of not less than 1/8-inch equal to one foot. Clearly identify and dimension the proposed locations of the principal items of equipment. The drawings shall clearly show the proposed location and adequate clearance for all equipment, piping, pumps, valves, and other items. All

valves, trap primer valves, water hammer arrestors, strainers, and equipment requiring service shall be provided with an access door sized for the complete removal of plumbing device, component, or equipment. Equipment foundations shall not be installed for equipment or piping until layout drawings have been approved. Detailed layout drawings shall be provided for all piping systems. In addition, details of the following shall be provided:

- a. Interstitial space.
 - b. Hangers, inserts, supports, and bracing.
- H. Maintenance Data and Operating Instructions:
1. Maintenance and operating manuals in accordance with Division 01 for systems and equipment and as stated herein.
 2. Listing of recommended replacement parts for keeping in stock supply, including sources of supply, for equipment shall be provided.
 3. The listing shall include belts for equipment: Belt manufacturer, model number, size and style, and distinguished whether of multiple belt sets.
- I. Clearly and neatly strike out of irrelevant information. Clearly and neatly tag and mark equipment, options and specialties and special features. Key tags to match tags on Drawings.
1. If substituting on Specified equipment provide comprehensive written comparison of characteristics between specified and substituted equipment. Doing a data "dump" of Operation and Maintenance manuals, and similar "total catalog dumps" shall not be an acceptable method of submission.
- J. Provide information in an easily readable and legible format presentation.
- K. Provide an index with corresponding labeled and tabbed dividers for sections, in a three-ring hard cover binder or hard cover binding folder. Loose leaf sections, provided separately, shall not be acceptable. Front index shall include, at a minimum:
1. Full, formal, name and address, including zip code, for job.
 2. Company name, address, phone, and fax numbers of General Contractor, including phone land line number of job trailer and cellular phone number and name of job site Superintendent. Also provide contact name of office Project Manager.
 3. Name, address, phone, and fax number of Plumbing Contractor, including phone land line of job trailer, if applicable, and cellular phone number and name of job site Superintendent. Also provide contact name of office Project Manager.
- L. Submit all items at the same time.

- M. Unless specified otherwise in Division 1 requirements submit 5 copies of data. Engineer will return 4 copies while retaining one for internal office use as a Project Record Document.
- N. Paper copies shall be the only acceptable submittal medium.
- O. Submittals shall be prepared and submitted in a timely fashion to allow adequate time for ordering of long lead time equipment and materials.

1.6 DELIVERY, STORAGE AND HANDLING

A. Protection of Equipment:

1. Equipment and material placed on the job site shall remain in the custody of the Contractor until phased acceptance, whether the Owner has reimbursed the Contractor for the equipment and material, or not. The Contractor is solely responsible for the protection of such equipment and material against any damage.
2. Damaged equipment shall be replaced with an identical unit as determined and directed by the Engineer of Record. Such replacement shall be at no additional cost to the Owner.
3. Interiors of new equipment and piping systems shall be protected against entry of foreign matter. Both inside and outside shall be cleaned before painting or placing equipment in operation.
4. Existing equipment and piping being worked on by the Contractor shall be under the custody and responsibility of the Contractor and shall be protected as required for new work.

B. Cleanliness of Piping and Equipment Systems:

1. Care shall be exercised in the storage and handling of equipment and piping material to be incorporated in the work. Debris arising from cutting, threading, and welding of piping shall be removed.
2. Piping systems shall be flushed, blown, or pigged as necessary to deliver clean systems.
3. The interior of all tanks shall be cleaned prior to delivery and beneficial use by the Owner. All piping shall be tested in accordance with the specifications and the California Plumbing Code (CPC), latest edition. All filters, strainers, fixture faucets shall be flushed of debris prior to final acceptance.
4. Contractor shall be fully responsible for all costs, damage, and delay arising from failure to provide clean systems.

1.7 APPLICABLE PUBLICATIONS

- A. The publications listed below shall form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. American Society of Mechanical Engineers (ASME):
 - 1. Boiler and Pressure Vessel Code (BPVC):
 - 2. SEC IX-2021 Boiler and Pressure Vessel Code; Section IX, Welding and Brazing Qualifications.
- C. American Society for Testing and Materials (ASTM):
 - 1. A36/A36M-2019 Standard Specification for Carbon Structural Steel
 - 2. A575-96-2020 Standard Specification for Steel Bars, Carbon, Merchant Quality, M-Grades R (2002)
 - 3. E84-2021 Standard Test Method for Surface Burning Characteristics of Building Materials
 - 4. E119-2021 Standard Test Methods for Fire Tests of Building Construction and Materials
- D. Manufacturers Standardization Society (MSS) of the Valve and Fittings Industry, Inc:
 - 1. SP-58 Pipe Hangers and Supports-Materials, Design and Manufacture
 - 2. SP 69 Pipe Hangers and Supports-Selection and Application
- E. National Electrical Manufacturers Association (NEMA):
 - 1. MG1-2003 Motors and Generators

1.8 CODES, REGULATIONS, STANDARDS, AND GUIDELINES

- A. Work shall be in accordance with requirements of the latest jurisdiction adopted editions of the following:
 - 1. CBC - California Building Code, 2022 Edition
 - 2. CMC - California Mechanical Code, 2022 Edition
 - 3. CPC - California Plumbing Code, 2022 Edition
 - 4. CGBCS California Green Building Construction Standards, 2022 Edition
 - 5. CEC - California Electrical Code, 2022 Edition
 - 6. CFC - California Fire Code, 2022 Edition
 - 7. CEC - California Energy Commission, Title 24, Part VI, 2022 Edition

- B. The work shall comply with the latest editions of the following guidelines and standards:
1. AABC Associated Air Balance Council
 2. AGA American Gas Association
 3. AMCA Air Movement and Control Association
 4. ANSI American National Standards Institute
 5. ARI American Refrigeration Institute
 6. ASHRAE American Society of Heating Refrigerating and Air Conditioning Engineers
 7. ASME American Society of Mechanical Engineers
 8. ASTM American Society for Testing and Materials
 9. NEC National Electric Code
 10. NFPA National Fire Protection Association
 11. SMACNA Sheetmetal and Air-Conditioning Contractors National Association
 12. UL Underwriters Laboratories
- C. When the work calls for more stringent requirements than the above listings the Specifications and Drawings shall take precedence.

1.9 SITE VISIT AND FAMILIARIZATION

- A. Visit the site and become familiar with the Drawings and Specifications. Examine the site and understand the conditions under which the Contract shall be performed.
- B. Refer to Division 1 for Pre-Bid Conference requirements.

1.10 REVIEW OF CONSTRUCTION

- A. Work may be reviewed, without prior notice, at any time by representatives of Owner.
- B. Advise Owner and Owner Representative when work is ready for review at the following times:
 1. Prior to concealment of Work in walls and above ceilings and any other enclosable spaces. Conceal Work only after obtaining Owner and Architect consent.
- C. Maintain an on the job set of Specifications and Drawings for use by Owner and representatives.

1.11 BID DOCUMENT DESCRIPTION

- A. Specifications describe quality of materials and equipment.
- B. Drawings describe the work in diagrammatic form. Drawings do not show exact detail and arrangements. Final requirements of the Work shall be determined by the Contractor after coordination with other trades.
- C. Do not scale drawings. Contractor is required to visit the site prior to bid and verify all physical sizing of equipment, systems, and components independently prior to bid.

1.12 DEFINITIONS

- A. Definitions following may not match those in other sections. Definitions listed here govern this part of the Work and take precedence over those listed elsewhere.
 - 1. Concealed: Embedded in masonry or other construction, installed in furred spaces, within partitions or hung ceilings, in trenches, crawl spaces, or in enclosures.
 - 2. Connect: Complete hook-up of items with required services.
 - 3. Down: A vertical pipe or piece of work that does penetrate a floor.
 - 4. Drop: A vertical pipe or piece of work that does not penetrate a floor.
 - 5. Exposed: Not installed underground or “concealed” as defined within this list.
 - 6. Provide: To furnish, supply, install and connect up complete and ready safe and regular operation of particular work referred to unless specifically noted.
 - 7. Supply: To purchase, procure, acquire and deliver complete with related accessories.
 - 8. Work: Labor, materials, equipment, apparatus, controls, accessories and other items required for complete and proper operation.
 - 9. Install: To erect, mount and connect complete with related accessories.
 - 10. Riser: A vertical pipe or piece of work having a vertical length greater than one story height.
 - 11. Indicated, Shown or Noted: As indicated, shown, or noted on Drawings and Specifications.
 - 12. Other Division(s): Specification Sections that do not include the HVAC Divisions.

13. Motor Controllers: Manual or magnetic starters (with or without switches), individual pushbuttons or hand-off-automatic (HOA) switches controlling the operation of the motors.

PART 2 – PRODUCTS

2.1 MATERIALS

- A. Materials, equipment, and supplies shall be new and latest types and models of manufacturers and shall bear identification markings, nameplates, and labels.
- B. Equipment specified by manufacturer's number shall include all accessories, controls, etc., listed in catalog as standard with equipment. Provide optional or additional accessories as specified or scheduled incidental to the Work such as, but not limited to, caulking, gaskets, sealants, fasteners, etc.
- C. Where no specific make of material or equipment is mentioned, any first-class product of good reputable manufacturer may be used, provided it conforms to requirements of system and meets acceptance of Owner.
- D. Equipment, material and supplies damaged during transportation, installation and operation is considered as totally damaged and shall be replaced with new. Variance from this is permitted only with approval of Owner.
- E. Provide an authorized representative to constantly supervise work of this Division, check all materials prior to installation for conformance with Drawings, Specifications, reviewed Submittals and reviewed Coordination Drawings as referenced in Part 1.
- F. Electrical Work performed in the service of the plumbing and piping installation shall conform to Division 26 Electrical requirements. Provide weatherproof devices and installations for Work exposed to the elements.

2.2 FACTORY-ASSEMBLED PRODUCTS

- A. Standardization of components shall be maximized to reduce spare part requirements.
- B. Manufacturers of equipment assemblies that include components made by others shall assume complete responsibility for final assembled unit.
 - 1. All components of an assembled unit need not be products of same manufacturer.
 - 2. Constituent parts that are alike shall be products of a single manufacturer.
 - 3. Components shall be compatible with each other and with the total assembly for intended service.
 - 4. Contractor shall guarantee performance of assemblies of components and shall repair or replace elements of the assemblies as required to deliver specified performance of the complete assembly.
- C. Components of equipment shall bear manufacturer's name and trademark, model number, serial number and performance data on a name plate securely affixed in a

conspicuous place, or cast integral with, stamped or otherwise permanently marked upon the components of the equipment.

- D. Major items of equipment, which serve the same function, shall be the same make and model

2.3 COMPATIBILITY OF RELATED EQUIPMENT

- A. Equipment and materials installed shall be compatible in all respects with other items being furnished and with existing items so that the result will be a complete and fully operational system that conforms to contract requirements.

2.4 EQUIPMENT AND MATERIALS IDENTIFICATION

- A. Interior (Indoor) Equipment: Engraved nameplates, with letters not less than 3/16-inch high of brass with black-filled letters, or rigid black plastic with white letters.
- B. Exterior (Outdoor) Equipment: Brass nameplates, with engraved black filled letters, not less than 3/16-inch high riveted or bolted to the equipment.
- C. Control Items: All temperature, pressure, and controllers shall be labeled, and the component's function identified. Identify and label each item as they appear on the control diagrams.
- D. Valve Tags and Lists:
 - 1. Plumbing: All valves shall be provided with valve tags and listed on a valve list (Fixture stops not included).
 - 2. Valve tags: Engraved black filled numbers and letters not less than 1/2-inch high for number designation, and not less than 1/4-inch for service designation on 19 gage, 1-1/2 inches round brass disc, attached with brass "S" hook or brass chain.
 - 3. Valve lists: Valve lists shall be created using a word processing program and printed on plastic coated cards. The plastic-coated valve list card(s), sized 8-1/2 inches by 11 inches shall show valve tag number, valve function and area of control for each service or system. The valve list shall be in a punched 3-ring binder notebook. A copy of the valve list shall be mounted in picture frames for mounting to a wall.
 - 4. A detailed plan for each floor of the building indicating the location and valve number for each valve shall be provided. Each valve location shall be identified with a color-coded sticker or thumb tack in ceiling.

2.5 PIPE AND EQUIPMENT SUPPORTS AND RESTRAINTS

- A. Model numbers listed are by Cooper Industries.
- B. For Attachment to Concrete Construction:

1. Concrete insert: Type 18, MSS SP-58.
 2. Self-drilling expansion shields and machine bolt expansion anchors: Permitted in concrete not less than 4 inches thick when approved by the Structural Engineer of Record for each job condition.
 3. Power-driven fasteners: Permitted in existing concrete or masonry not less than 4 inches thick when approved by the Structural Engineer of Record for each job condition.
- C. For Attachment to Steel Construction: MSS SP-58.
1. Welded attachment: Type 22.
 2. Beam clamps: Types 20, 21, 28 or 29. Type 23 C-clamp may be used for individual copper tubing up to 7/8-inch outside diameter.
- D. For Attachment to Wood Construction: Wood screws or lag bolts.
- E. Hanger Rods: Hot-rolled steel, ASTM A36 or A575 for allowable load listed in MSS SP-58. For piping, provide adjustment means for controlling level or slope. Types 13 or 15 turn-buckles shall provide 1-1/2 inches minimum of adjustment and incorporate locknuts. All-thread rods are acceptable.
- F. Multiple (Trapeze) Hangers: Galvanized, cold formed, lipped steel channel horizontal member, not less than 1-5/8 inches by 1-5/8 inches, No. 12 gage, designed to accept special spring held, hardened steel nuts. Trapeze hangers are not permitted for steam supply and condensate piping.
1. Allowable hanger load: Manufacturers rating less 200 pounds.
 2. Guide individual pipes on the horizontal member of every other trapeze hanger with 1/4-inch U-bolt fabricated from steel rod. Provide Type 40 insulation shield, secured by two 1/2-inch galvanized steel bands, or insulated calcium silicate shield for insulated piping at each hanger.
- G. Pipe Hangers and Supports: (MSS SP-58), use hangers sized to encircle insulation on insulated piping. To protect insulation, provide Type 39 saddles for roller type supports or insulated calcium silicate shields. Provide Type 40 insulation shield or insulated calcium silicate shield at all other types of supports and hangers including those for insulated piping.
1. General Types (MSS SP-58):
 - a. Standard clevis hanger: Type 1; provide locknut.
 - b. Riser clamps: Type 8.
 - c. Wall brackets: Types 31, 32 or 33.
 - d. Roller supports: Type 41, 43, 44 and 46.

- e. Saddle support: Type 36, 37 or 38.
 - f. Turnbuckle: Types 13 or 15.
 - g. U-bolt clamp: Type 24.
 - h. Copper Tube:
 - 1. Hangers, clamps and other support material in contact with tubing shall be painted with copper colored epoxy paint, plastic coated or taped with isolation tape to prevent electrolysis.
 - 2. For vertical runs use epoxy painted or plastic-coated riser clamps.
 - 3. For supporting tube to strut: Provide epoxy painted pipe straps for copper tube or plastic inserted vibration isolation clamps.
 - 4. Insulated Lines: Provide pre-insulated calcium silicate shields sized for copper tube.
 - i. Spring hangers are required on all plumbing system pumps one horsepower and greater.
2. Plumbing Piping (Other Than General Types):
- a. Horizontal piping: Type 1, 5, 7, 9, and 10.
 - b. Chrome plated piping: Chrome plated supports.
 - c. Hangers and supports in pipe chase: Prefabricated system ABS self-extinguishing material, not subject to electrolytic action, to hold piping, prevent vibration and compensate for all static and operational conditions.
 - d. Blocking, stays and bracing: Angle iron or preformed metal channel shapes, 18 gage minimum.
- H. Pre-insulated Calcium Silicate Shields:
- 1. Provide 360-degree water resistant high density 140 psi compressive strength calcium silicate shields encased in galvanized metal.
 - 2. Pre-insulated calcium silicate shields to be installed at the point of support during erection.
 - 3. Shield thickness shall match the pipe insulation.
 - 4. The type of shield is selected by the temperature of the pipe, the load it must carry, and the type of support it will be used with.

- a. Shields for supporting cold water shall have insulation that extends a minimum of one inch past the sheet metal.
 - b. The insulated calcium silicate shield shall support the maximum allowable water filled span as indicated in MSS-SP 69. To support the load, the shields shall have one or more of the following features: structural inserts 600 psi compressive strength, an extra bottom metal shield, or formed structural steel (ASTM A36) wear plates welded to the bottom sheet metal jacket.
5. Shields may be used on steel clevis hanger type supports, roller supports or flat surfaces.

2.6 PIPE PENETRATIONS

- A. Pipe penetration sleeves shall be installed for all piping other than rectangular blocked out floor openings for risers in mechanical bays.
- B. Pipe penetration sleeve materials shall comply with all fire stopping requirements for each penetration.
- C. To prevent accidental liquid spills from passing to a lower level, provide the following:
 1. For sleeves: Extend sleeve 1 inch above finished floor and provide sealant for watertight joint.
 2. For blocked out floor openings: Provide 1-1/2 inch angle set in silicone adhesive around opening.
 3. For drilled penetrations: Provide 1-1/2 inch angle ring or square set in silicone adhesive around penetration.
- D. Penetrations are not allowed through beams or ribs but may be installed in concrete beam flanges. Any deviation from these requirements must receive prior approval of Structural Engineer of Record.
- E. Sheet metal, plastic, or moisture resistant fiber sleeves shall be provided for pipe passing through floors, interior walls, and partitions, unless brass or steel pipe sleeves are specifically called for below.
- F. Cast iron or zinc coated pipe sleeves shall be provided for pipe passing through exterior walls below grade. The space between the sleeve and pipe shall be made watertight with a modular or link rubber seal. The link seal shall be applied at both ends of the sleeve.
- G. Galvanized steel or an alternate black iron pipe with asphalt coating sleeves shall be for pipe passing through concrete beam flanges, except where brass pipe sleeves are called for. A galvanized steel Sleeve shall be provided for pipe passing through floor of mechanical rooms, laundry work rooms, and animal rooms above basement. Except in mechanical rooms, sleeves shall connect to a floor plate.

- H. Brass Pipe Sleeves shall be provided for pipe passing through quarry tile, terrazzo or ceramic tile floors. The sleeve shall connect to a floor plate.
- I. Sleeve clearance through floors, walls, partitions, and beam flanges shall be 1 inch greater in diameter than external diameter of pipe. Sleeve for pipe with insulation shall be large enough to accommodate the insulation plus 1 inch in diameter. Interior openings shall be caulked tight with fire stopping material and sealant to prevent the spread of fire, smoke, and gases.

2.7 WALL, FLOOR AND CEILING PLATES

- A. Material and Type: Chrome plated brass or chrome plated steel, one piece or split type with concealed hinge, with set screw for fastening to pipe, or sleeve. Use plates that fit tight around pipes, cover openings around pipes and cover the entire pipe sleeve projection.
- B. Thickness: Not less than 3/32-inch for floor plates. For wall and ceiling plates, not less than 0.025-inch for up to 3-inch pipe, 0.035-inch for larger pipe.
- C. Locations: Use where pipe penetrates floors, walls, and ceilings in exposed locations, in finished areas only. Wall plates shall be used where insulation ends on exposed water supply pipe drop from overhead. A watertight joint shall be provided in spaces where brass or steel pipe sleeves are specified.

2.8 ASBESTOS

- A. Materials containing asbestos are not permitted.

PART 3 - EXECUTION

3.1 ARRANGEMENT AND INSTALLATION OF EQUIPMENT AND PIPING

- A. Location of piping, sleeves, inserts, hangers, and equipment, access provisions shall be coordinated with the work of all trades. Piping, sleeves, inserts, hangers, and equipment shall be located clear of windows, doors, openings, light outlets, and other services and utilities. Equipment layout drawings shall be prepared to coordinate proper location and personnel access of all facilities. The drawings shall be submitted for review.
- B. Manufacturer's published recommendations shall be followed for installation methods not otherwise specified.
- C. Operating Personnel Access and Observation Provisions: All equipment and systems shall be arranged to provide clear view and easy access, without use of portable ladders, for maintenance and operation of all devices including, but not limited to: all equipment items, valves, filters, strainers, transmitters, sensors, and control devices. All gages and indicators shall be clearly visible by personnel standing on the floor or on permanent platforms. Maintenance and operating space and access provisions that are shown on the drawings shall not be changed nor reduced.

- D. Structural systems necessary for pipe and equipment support shall be coordinated to permit proper installation.
- E. Location of pipe sleeves, trenches and chases shall be accurately coordinated with equipment and piping locations.
- F. Cutting Holes:
 - 1. Holes through concrete and masonry shall be cut by rotary core drill. Pneumatic hammer, impact electric, and hand or manual hammer type drill will not be allowed, except as permitted by Structural Engineer of Record where working area space is limited.
 - 2. Holes shall be located to avoid interference with structural members such as beams or grade beams. Holes shall be laid out in advance and drilling done only after approval by Structural Engineer of Record. If the Contractor considers it necessary to drill through structural members, this matter shall be referred to Structural Engineer of Record for approval.
 - 3. Waterproof membrane shall not be penetrated. Pipe floor penetration block outs shall be provided outside the extents of the waterproof membrane.
- G. Minor Piping: Generally, small diameter pipe runs from drips and drains, water cooling, and other service are not shown but must be provided.
- H. Protection and Cleaning:
 - 1. Equipment and materials shall be carefully handled, properly stored, and adequately protected to prevent damage before and during installation, in accordance with the manufacturer's recommendations and as approved by the Engineer of Record. Damaged or defective items in the opinion of the Engineer of Record, shall be replaced.
 - 2. Protect all finished parts of equipment, such as shafts and bearings where accessible, from rust prior to operation by means of protective grease coating and wrapping. Close pipe openings with caps or plugs during installation. Pipe openings, equipment, and plumbing fixtures shall be tightly covered against dirt or mechanical injury. At completion of all work thoroughly clean fixtures, exposed materials and equipment.
- I. Interconnection of Controls and Instruments: Electrical interconnection is generally not shown but shall be provided. This includes interconnections of sensors, transmitters, transducers, control devices, control and instrumentation panels, instruments and computer workstations. Comply with NFPA-70.
- J. Work in bathrooms, restrooms, housekeeping closets: All pipe penetrations behind escutcheons shall be sealed with plumber's putty.
- K. Switchgear Drip Protection: Every effort shall be made to eliminate the installation of pipe above electrical and telephone switchgear. If this is not possible, encase pipe in a second pipe with a minimum of joints.

L. Inaccessible Equipment:

1. Where the Owner determines that the Contractor has installed equipment not conveniently accessible for operation and maintenance, equipment shall be removed and reinstalled or remedial action performed as directed at no additional cost to the Owner.
2. The term "conveniently accessible" is defined as capable of being reached without the use of ladders, or without climbing or crawling under or over obstacles such as electrical conduit, motors, fans, pumps, belt guards, transformers, high voltage lines, piping, and ductwork.

3.2 TEMPORARY PIPING AND EQUIPMENT

- A. Continuity of operation of existing facilities may require temporary installation or relocation of equipment and piping. Temporary equipment or pipe installation or relocation shall be provided to maintain continuity of operation of existing facilities.
- B. The Contractor shall provide all required facilities in accordance with the requirements of phased construction and maintenance of service. All piping and equipment shall be properly supported, sloped to drain, operate without excessive stress, and shall be insulated where injury can occur to personnel by contact with operating facilities.
- C. Temporary facilities and piping shall be completely removed and any openings in structures sealed. Necessary blind flanges and caps shall be provided to seal open piping remaining in service.

3.3 PIPE AND EQUIPMENT SUPPORTS

- A. Where hanger spacing does not correspond with joist or rib spacing, use structural steel channels secured directly to joist and rib structure that will correspond to the required hanger spacing, and then suspend the equipment and piping from the channels. Holes shall be drilled or burned in structural steel ONLY with the prior written approval of the Structural Engineer of Record.
- B. The use of chain pipe supports, wire or strap hangers; wood for blocking, stays and bracing, or hangers suspended from piping above shall not be permitted. Rusty products shall be replaced.
- C. Hanger rods shall be used that are straight and vertical. Turnbuckles for vertical adjustments may be omitted where limited space prevents use. A minimum of 15 mm (1/2-inch) clearance between pipe or piping covering and adjacent work shall be provided.
- D. For horizontal and vertical plumbing pipe supports, refer to the California Plumbing Code (CPC), latest edition, and these specifications.
- E. Overhead Supports:

1. The basic structural system of the building is designed to sustain the loads imposed by equipment and piping to be supported overhead.
2. Provide steel structural members, in addition to those shown, of adequate capability to support the imposed loads, located in accordance with the final approved layout of equipment and piping.
3. Tubing and capillary systems shall be supported in channel troughs.

F. Floor Supports:

1. Provide concrete bases, concrete anchor blocks and pedestals, and structural steel systems for support of equipment and piping. Concrete bases and structural systems shall be anchored and doweled to resist forces under operating and seismic conditions (if applicable) without excessive displacement or structural failure.
2. Bases and supports shall not be located and installed until equipment mounted thereon has been approved. Bases shall be sized to match equipment mounted thereon plus 2 inch excess on all edges. Structural drawings shall be reviewed for additional requirements. Bases shall be neatly finished and smoothed, shall have chamfered edges at the top, and shall be suitable for painting.
3. All equipment shall be shimmed, leveled, firmly anchored, and grouted with epoxy grout. Anchor bolts shall be placed in sleeves, anchored to the bases. Fill the annular space between sleeves and bolts with a grout material to permit alignment and realignment.

3.4 LUBRICATION

- A. All equipment and devices requiring lubrication shall be lubricated prior to initial operation. All devices and equipment shall be field checked for proper lubrication.
- B. All devices and equipment shall be equipped with required lubrication fittings. A minimum of one quart of oil and one pound of grease of manufacturer's recommended grade and type for each different application shall be provided. All materials shall be delivered to the Owner in unopened containers that are properly identified as to application.
- C. A separate grease gun with attachments for applicable fittings shall be provided for each type of grease applied.
- D. All lubrication points shall be accessible without disassembling equipment, except to remove access plates.
- E. All lubrication points shall be extended to one side of the equipment.

3.5 CLEANING AND PAINTING

- A. Prior to final inspection and acceptance of the plant and facilities for beneficial use by the Owner, the plant facilities, equipment, and systems shall be thoroughly cleaned and painted.
- B. In addition, the following special conditions apply:
 - 1. Cleaning shall be thorough. Solvents, cleaning materials and methods recommended by the manufacturers shall be used for the specific tasks. All rust shall be removed prior to painting and from surfaces to remain unpainted. Scratches, scuffs, and abrasions shall be repaired prior to applying prime and finish coats.
 - 2. The following Material And Equipment shall NOT be painted:
 - a. Motors, controllers, control switches, and safety switches.
 - b. Control and interlock devices.
 - c. Regulators.
 - d. Pressure reducing valves.
 - e. Control valves and thermostatic elements.
 - f. Lubrication devices and grease fittings.
 - g. Copper, brass, aluminum, stainless steel and bronze surfaces.
 - h. Valve stems and rotating shafts.
 - i. Pressure gages and thermometers.
 - j. Glass.
 - k. Name plates.
 - 3. Control and instrument panels shall be cleaned and damaged surfaces repaired. Touch-up painting shall be made with matching paint obtained from manufacturer or computer matched.
 - 4. Pumps, motors, steel and cast-iron bases, and coupling guards shall be cleaned, and shall be touched-up with the same color as utilized by the pump manufacturer.
 - 5. Temporary Facilities: Apply paint to surfaces that do not have existing finish coats.
 - 6. The result shall be a smooth, even-colored, even-textured factory finish on all items. The entire piece of equipment shall be repainted, if necessary, to achieve this.

3.6 IDENTIFICATION SIGNS

- A. Laminated plastic signs, with engraved lettering not less than 3/16-inch high, shall be provided that designates equipment function, for all equipment, switches, motor controllers, relays, meters, control devices, including automatic control valves. Nomenclature and identification symbols shall correspond to that used in maintenance manual, and in diagrams specified elsewhere. Attach by chain, adhesive, or screws.
- B. Factory Built Equipment: Metal plate, securely attached, with name and address of manufacturer, serial number, model number, size, performance shall be placed on factory-built equipment.

3.7 STARTUP AND TEMPORARY OPERATION

- A. Startup of equipment shall be performed as described in the equipment specifications. Vibration within specified tolerance shall be verified prior to extended operation.

3.8 OPERATING AND PERFORMANCE TESTS

- A. Should evidence of malfunction in any tested system, or piece of equipment or component part thereof, occur during or because of tests, make proper corrections, repairs or replacements, and repeat tests at no additional cost to the Owner.
- B. When completion of certain work or system occurs at a time when final control settings and adjustments cannot be properly made to make performance tests, then make performance tests such systems respectively during first actual seasonal use of respective systems following completion of work.

3.9 OPERATION AND MAINTENANCE MANUALS

- A. Provide four bound copies. The operations and maintenance manuals shall be delivered to the Owner not less than 30 days prior to completion of a phase or final inspection.
- B. All new and temporary equipment and all elements of each assembly shall be included.
- C. Data sheet on each device listing model, size, capacity, pressure, speed, horsepower, impeller size, and other information shall be included.
- D. Manufacturer's installation, maintenance, repair, and operation instructions for each device shall be included. Assembly drawings and parts lists shall also be included. A summary of operating precautions and reasons for precautions shall be included in the Operations and Maintenance Manual.
- E. Lubrication instructions, type and quantity of lubricant shall be included.
- F. Schematic diagrams and wiring diagrams of all control systems corrected to include all field modifications shall be included.
- G. Set points of all interlock devices shall be listed.

- H. Trouble-shooting guide for the control system troubleshooting guide shall be inserted into the Operations and Maintenance Manual.
- I. The combustion control system sequence of operation corrected with submittal review comments shall be inserted into the Operations and Maintenance Manual.
- J. Emergency procedures.

3.10 PROTECTION OF WORK

- A. Cap all fixture, pipe and equipment openings daily to protect from dust, moisture and incidental debris.
- B. Porous materials that become wetted shall be replaced with new. Drying is not sufficient as it introduces the possibility of microbial growth. This applies to insulation and any material that acts as a sponge.
- C. All air distribution shall be capped during construction to prevent accumulation of dirt, dust, and debris.

3.11 SAFETY

- A. The contractor shall be solely responsible for conditions of the job site, including safety of all persons and property during performance of the work. This shall also apply to non-normal working hours.

3.12 RECORD DRAWINGS

- A. Contractor is required to provide record Drawings in accordance with Division 01 – General Requirements and this section.
- B. Keep an accurate record of job progress including as-built locations and of the Work. Keep record up-to-date on legible full-size copies as job progresses. Make available to Owner and Owner representatives during project.
- C. In addition to any other requirements, include on as-built Drawings the following:
 - 1. Changes in location of piping or equipment.
 - 2. Ceiling access panel locations.
 - 3. Position of buried or concealed mains accurately dimensioned, both horizontally and vertically.

3.13 COMPLETION

- A. When Work is completed, or when Owner or Owner representative directs, remove surplus equipment, material, waste, and rubbish, and leave building in satisfactory condition.

- B. Adjust faucets and flush valves to give proper supply of water and leave in first class condition.

3.14 WARRANTIES AND GUARANTEES

- A. Contractor is required to provide warranties in accordance with Division 1 - General Requirements.
 - 1. Collect all warranties and guarantees for materials and equipment and neatly fill out all required information for the Owner. Provide one copy of each certificate for turn over to Architect. Arrange certificates in a tabbed and indexed binder for Architect ease of use.
- B. At the completion of the work contractor shall guarantee to repair or replace materials and workmanship found defective for a period of one year from date of filing of Notice of Completion. This work shall be performed at no cost to the Owner.
 - 1. Work of other trades damaged because of faulty workmanship or materials shall be repaired at no cost to the Owner.

END OF SECTION 22 00 00

SECTION 22 05 29 - HANGERS AND SUPPORTS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. The work covered under this section consists of providing all necessary labor, supervision, materials, equipment and services to completely execute the hangers and supports as described in this specification.
- B. All work of this section shall comply with Section 22 00 00 GENERAL REQUIREMENTS - PLUMBING.

1.2 REFERENCES

- A. ASTM International:
 - 1. ASTM B633-2019 - Specification for Electrodeposited Coatings of Zinc on Iron and Steel
 - 2. ASTM A123 - Specification for Zinc (Hot-Galvanized) Coatings on Products Fabricated from Rolled, Pressed, and Forged Steel Shapes, Plates, Bars, and Strip
 - 3. ASTM A653 - Specification for Steel Sheet, Zinc-Coated by the Hot-Dip Process
 - 4. ASTM A1011 - Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability (Formerly ASTM A570)

1.3 SUBMITTALS

- A. Submit product data on all hanger and support devices, including shields and attachment methods. Product data to include, but not limited to materials, finishes, approvals, load ratings, and dimensional information.

1.4 QUALITY ASSURANCE

- A. Steel pipe hangers and supports shall have the manufacturer's name, part number, and applicable size stamped in the part itself for identification.
- B. Hangers and supports shall be designed and manufactured in conformance with MSS SP 58.
- C. Supports for sprinkler piping shall be in conformance with NFPA 13.

1.5 QUALIFICATIONS

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

1.6 DELIVERY, STORAGE, AND HANDLING

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

PART 2 – PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Model numbers are Cooper B-Line. Engineer approved equivalent is acceptable.

2.2 HANGERS AND SUPPORTS

A. Single Pipe Hangers

- 1. Uninsulated pipes 2 inch and smaller:
 - a. Adjustable steel swivel ring (band type) hanger, B-Line B3170.
 - b. Adjustable steel swivel J-hanger, B-Line B3690.
 - c. Malleable iron ring hanger, B-Line B3198R or hinged ring hanger, B3198H.
 - d. Malleable iron split-ring hanger with eye socket, B-Line B3173 with B3222.
 - e. Adjustable steel clevis hanger, B-Line B3104 or B3100.

B. Pipe Clamps

- 1. When flexibility in the hanger assembly is required due to horizontal movement, use pipe clamps with weld-less eye nuts, B-Line B3140 or B3142 with B3200. For insulated lines use double bolted pipe clamps, B-Line B3144 or B3146 with B3200.

C. Wall Supports

- 1. Pipes 4 inch and smaller:
 - a. Carbon steel hook, B-Line B3191.
 - b. Carbon steel J-hanger, B-Line B3690.

D. Floor Supports

1. Hot piping under 6 inch and all cold piping:
 - a. Carbon steel adjustable pipe saddle and nipple attached to steel base stand sized for pipe elevation. B-Line and B3088T or B3090 and B3088. Pipe saddle shall be screwed or welded to appropriate base stand.

E. Vertical Supports

1. Steel riser clamp sized to fit outside diameter of pipe, B-Line B3373.

F. Copper Tubing Supports

1. Hangers shall be sized to fit copper tubing outside diameters.
 - a. Adjustable steel swivel ring (band type) hanger, B-Line B3170CT.
 - b. Malleable iron ring hanger, B-Line B3198RCT or hinged ring hanger B3198HCT.
 - c. Malleable iron split-ring hanger with eye socket, B-Line B3173CT with B3222.
 - d. Adjustable steel clevis hanger, B-Line B3104CT.
2. For supporting vertical runs use epoxy painted or plastic coated riser clamps, B-Line B3373CT or B3373CTC.
3. For supporting copper tube to strut use epoxy painted pipe straps sized for copper tubing, B-Line B2000 series, or plastic inserted vibration isolation clamps, B-Line BVT series.

G. Supplementary Structural Supports

1. Design and fabricate supports using structural quality steel bolted framing materials as manufactured by Cooper B-Line. Channels shall be roll formed, 12 gauge ASTM A1011 SS Grade 33 steel, 1-5/8 inch by 1-5/8 inch or greater as required by loading conditions. Submit designs for pipe tunnels, pipe galleries, etc., to engineer for approval. Use clamps and fittings designed for use with the

2.3 UPPER ATTACHMENTS

A. Beam Clamps

1. Beam clamps shall be used where piping is to be suspended from building steel. Clamp type shall be selected on the basis of load to be supported, and load configuration.

2. C-Clamps shall have locknuts and cup point set screws, B-Line B351L, or B3036L. Top flange c-clamps shall be used when attaching a hanger rod to the top flange of structural shapes, B-Line B3034 or B3033. Refer to manufacturer's recommendation for setscrew torque. Retaining straps shall be used to maintain the clamps position on the beam where required.
3. Center loaded beam clamps shall be used where specified. Steel clamps shall be B-Line B3050, or B3055. Malleable iron or forged steel beam clamps with cross bolt shall be B-Line B3054 or B3291-B3297 Series as required to fit beams.

B. Concrete Inserts

1. Cast in place spot concrete inserts shall be used where applicable; either steel or malleable iron body, B-Line B2500 or B3014. Spot inserts shall allow for lateral adjustment and have means for attachment to forms. Select inserts to suit threaded hanger rod sizes, B-Line N2500 or B3014N series.
2. Continuous concrete inserts shall be used where applicable. Channels shall be 12 gauge, ASTM A1011 SS Grade 33 structural quality carbon steel, complete with styrofoam inserts and end caps with nail holes for attachment to forms. The continuous concrete insert shall have a load rating of 2,000 lbs/ft. in concrete, B-Line B22I, 32I, or 52I. Select channel nuts suitable for strut and rod sizes.

2.4 VIBRATION ISOLATION AND SUPPORTS

- A. For refrigeration, air conditioning, hydraulic, pneumatic, and other vibrating system applications, use a clamp that has a vibration dampening insert and a nylon inserted locknut. For copper and steel tubing use B-Line BVT series Vibraclamps, for pipe sizes use BVP series.
- B. For larger tubing or piping subjected to vibration, use neoprene or spring hangers as required.
- C. For base mounted equipment use vibration pads, molded neoprene mounts, or spring mounts as required.
- D. Vibration isolation products as manufactured by B-Line, Vibratrol systems.

2.5 ACCESSORIES

- A. Hanger Rods shall be threaded on both ends, or be continuously threaded rods of circular cross section. Use adjusting locknuts at upper attachments and hangers. No wire, chain, or perforated straps are allowed.
- B. Shields shall be 180 degree galvanized sheet metal, 12 inch minimum length, 18 gauge minimum thickness, designed to match outside diameter of the insulated pipe, B-Line B3151.

- C. Pipe protection saddles shall be formed from carbon steel, 1/8 inch minimum thickness, sized for insulation thickness. Saddles for pipe sizes greater than 12 inch shall have a center support rib.

2.6 FINISHES

A. Indoor Finishes

1. Hangers and clamps for support of bare copper piping shall be coated with copper colored epoxy paint, B-Line Dura-Copper®. Additional PVC coating of the epoxy painted hanger shall be used where necessary.
2. Hangers for other than bare copper pipe shall be zinc plated in accordance with ASTM B633 OR shall have an electro-deposited green epoxy finish, B-Line Dura-Green®.
3. Strut channels shall be pre-galvanized in accordance with ASTM A653 SS Grade 33 G90 OR have an electro-deposited green epoxy finish, B-Line Dura-Green®.

B. Outdoor and Corrosive Area Finishes

1. Hangers and strut located outdoors shall be hot dip galvanized after fabrication in accordance with ASTM A123. All hanger hardware shall be hot dip galvanized or stainless steel. Zinc plated hardware is not acceptable for outdoor or corrosive use.
2. Hangers and strut located in corrosive areas shall be type 304 [316] stainless steel with stainless steel hardware.

PART 3 – EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation products in accordance with the manufacturer's written instruction, commercial and industrial standards, and recognized industry practices to ensure that the installation serves the intended purpose. Surfaces to be attached to shall be thoroughly cleaned prior to making attachments.

3.2 PIPE HANGERS AND SUPPORTS

- A. Pipe shall be adequately supported by pipe hanger and supports specified in PART 2 PRODUCTS. Hangers for insulated pipes shall be sized to accommodate insulation thickness.
- B. Horizontal copper tubing shall be supported in accordance with MSS SP-69 Tables 3 and 4, excerpts of which follow below:

<u>NOMINAL PIPE SIZE (in)</u>	<u>ROD DIAMETER (in)</u>	<u>MAXIMUM SPACING (ft)</u>
1/2 TO 3/4	3/8	5
1	3/8	6
1-1/4	3/8	7
1-1/2	3/8	8
2	3/8	8

- C. Provide means of preventing dissimilar metal contact such as plastic coated hangers, copper colored epoxy paint, or non-adhesive isolation tape- B-Line Iso-pipe. Galvanized felt isolators sized for copper tubing may also be used, B-Line B3195CT.
- D. Install hangers to provide a minimum of 1/2 inch space between finished covering and adjacent work.
- E. Place a hanger within 12 inches of each horizontal elbow.
- F. Support vertical piping independently of connected horizontal piping. Support vertical pipes at every floor. Wherever possible, locate riser clamps directly below pipe couplings or shear lugs.
- G. Where several pipes can be installed in parallel and at the same elevation, provide trapeze hangers as specified in Part 2. Trapeze hangers shall be spaced according to the smallest pipe size, or install intermediate supports according to schedule in this section.
- H. Do not support piping from other pipes, ductwork or other equipment that is not building structure.

END OF SECTION 22 05 29

SECTION 22 05 53 – PIPING IDENTIFICATION

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Provide complete piping system identification work from equipment for all types of piping systems identified as a part of these specifications. Types of piping identification shall consist of:
 - 1. Painted Identification Materials
 - 2. Plasticized Tags
 - 3. Engraved Plastic Laminate Signs
 - 4. Plastic Tape
- B. Lettering, Size, Colors, and viewing angles of identification devices shall comply with ANSI A13.1.
- C. All work of this section shall comply with Section 22 00 00 GENERAL REQUIREMENTS – PLUMBING.

PART 2 – PRODUCTS

2.1 PIPING PAINT IDENTIFICATION

- A. All exposed piping and piping in accessible chases and areas above ceilings with panels, including stainless steel, galvanized steel, copper, PVC, and Fiberglass RTR piping, shall be completely and totally painted for identification purposes. Piping shall be identified with lettering or tags designating the service of each piping system, shall have flow directional arrows, and shall be completely painted and color coded as scheduled below. All piping scheduled to be color coded shall be completely painted or coated with the indicated colors.
- B. Each pipe identification shall consist of color coding in accordance with PART 3, a painted label, and a directional flow arrow. The painted label and directional arrow shall be placed between color bands.

- C. Color Bands and Arrows: Pipe color bands shall be painted on the pipe. Paper or plastic banding of pipe shall not be acceptable. Arrows shall be of the same color as the lettering and shall point away from the lettered labels in the direction of the flow. Color band size shall be as follows:

PIPE SIZE	COLOR BAND SIZE
Less than 1" diameter	1" wide
1" to 12" diameter	1 pipe diameter wide
Greater than 12" diameter	12" wide

- D. For cases where there are insulated lines wrapped with aluminum sheathing, stainless steel sheathing, or gray fabric, the background color shall be applied to a 24-inch length of pipe section and color band centered within the 24 inch field of background color.

- E. Paint Colors: Paint colors shall conform to the following Federal designations:

1.	Light Blue	15200
2.	Dark Blue	15102
3.	Red	11105
4.	Yellow	13655
5.	Orange	12246
6.	White	17875
7.	Light Brown	10219
8.	Dark Brown	10080
9.	Light Green	34540
10.	Green	14187
11.	Black	17038
12.	Silver	17178
13.	Grey	16314
14.	Purple	27144

- F. Lettering: Contents identification labels shall be stenciled directly on pipes. Black identification letters shall be used where the background pipe color is light, and white identification letters where the background color is dark. The size of the letters for identification labels shall be as follows:

Pipe Diameter	Letter Size
5/8" to 1"	5/16" high
1" to 3"	3/4" high
over 3"	2" high

2.2 EXISTING IDENTIFICATION SYSTEMS

- A. In installations where existing piping identification systems have been established, the CONTRACTOR shall continue to use the existing system. Where existing identification systems are incomplete, utilize the existing system as far as practical and supplement with the specified system. The objective is to fully identify all new piping, valves and appurtenances to the level specified herein.

2.3 SMALL PIPE IDENTIFICATION

- A. Identifying devices for valves and the sections of pipe that are too short to be identified with color bands, lettered labels, and arrows shall be identified with metal tags as specified herein.
- B. Metal tags shall be of stainless steel with embossed lettering. All tags shall be designed to be firmly attached to the valves or short pipes or to the structure immediately adjacent to such valves or short pipes.

2.4 IDENTIFICATION LOCATIONS

- A. Straight lines of pipe shall be identified at intervals of 30 feet maximum, and at least once in each room unless otherwise directed by the Engineer.
- B. Piping shall also be identified at a point approximately within 2 feet of all turns, ells, valves, and on the upstream side of all distribution fittings or branches and on both sides of each floor, wall or barrier through which the line passes.
- C. For pipe runs of 50 feet or less the distance between bands shall be 30 inches. For pipe runs of 50 feet or more, spacing between bands shall be 72 inches.
- D. Sections of pipe that are too short to be identified with color bands, lettered labels, and directional arrows shall be tagged and identified similar to valves.

2.5 PIPING IDENTIFICATION TAPE/SIGNS

- A. Plastic Tape

1. General: Manufacturer's standard color-coded pressure sensitive self adhesive vinyl tape, not less than 3 mils thick.
 - a. Width: Provide 1-1/2" inch wide tape markers on pipes with outside diameters (including insulation, if any) of less than 6 inches, 2-1/2 inch wide tape for larger pipes.
 - b. Color: By ANSI A13.1 designation except where other color selection is indicated.
- B. Engraved-Plastic Laminate Signs:
 1. General: Provide engraving stock melamine plastic laminate complying with FS L-P-387 in the size and thickness indicated, engraved with engraver's standard letter style of the size, and working indicated, black with white core (letter core) except as otherwise indicated, punched for mechanical fastening except where adhesive mounting is necessary because of substrate.
 - a. Thickness: 1/6 inch for units up to 20 sq. in. or 8 inch in length; 1/8 inch for larger units.
 - b. Fasteners: Self-tapping stainless screws, except contact type permanent adhesive where screws cannot or should not penetrate the substrate.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

- A. Where identification is to be applied to surfaces which require insulation, painting or other covering or finish, including valve tags in mechanical spaces, install identification after completion of covering and painting. Install identification prior to installation of acoustical ceiling and removable concealment.

END OF SECTION 22 05 53

SECTION 22 13 13 – CONDENSATE DRAINAGE SYSTEM

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Provide complete condensate drainage system from point of connection at HVAC equipment to termination points, whether shown on the drawings or not. Connections to include, but not limited to:
 - 1. Primary condensate routed to an approved receptor per 2022 CPC from each piece of HVAC equipment.
 - 2. Secondary condensate routed to a readily observable location per 2022 CPC from each piece of HVAC equipment.
 - 3. Condensate drain lines routed to an approved receptors from all condensing flues and gas-fired heating equipment.
- B. System shall be complete with piping, pressure reducing valves, plug valves and related specialties required for an operational system.
- C. All work of this section shall comply with Section 22 00 00 GENERAL REQUIREMENTS – PLUMBING

PART 2 - PRODUCTS

2.1 PIPE

- A. All:
 - 1. DWV copper or type L copper with 95/5 solder joints and DWV or wrought fittings.
 - 2. All condensate piping located in freezing conditions shall be heat traced with Raychem XL-Trace and shall be installed in accordance with manufacturer's instructions.

2.2 INSULATION

- A. All:
 - 1. Refer to 23 07 00 for insulation requirements.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION

- A. Piping shall be run parallel to buildings lines and supported at intervals specified. All changes in direction shall be made with standard fittings. Clean out plugs shall

be installed at all cumulative changes of direction of 135 degrees or more as a minimum and as shown on the Drawings.

- B. Piping shall be run free of traps (except trap at equipment connection) and shall be pitched at ¼" vertical drop for every foot of horizontal run.
- C. Provide complete condensate drainage system as shown on the drawings
- D. Remove cutting and threading burrs before assembling piping.

3.2 PIPE JOINTS

- A. Cut square and remove all burrs. Ream both ends to full size of pipe inside diameter. Clean ends of tubing to depth of fittings. Use sand cloth, sandpaper or steel wool for cleaning. Apply a coat of Nibco Copperized Flux to tubing and fittings. Solder paste or liquid flux shall not be permitted.

3.3 TESTING

- A. All tests shall be made in the presence of the Engineer and the local authorities having jurisdiction. At least 72 hours (three days) notice shall be given in advance of all tests. Contractor shall make preliminary tests prior to giving notice of final test.
 - 1. Contractor shall furnish all pumps, gauges, instruments, and any other equipment, including test medium necessary for conducting prescribed tests.
- B. Condensate Drainage System
 - 1. Test condensate drainage systems prior to final connection to equipment. Test shall be for 4 hours with the piping filled full of water. If piping system fails, the test the leaky portion(s) shall be redone, and the system retested until it passes.

END OF SECTION 22 13 13

**SECTION 23 00 00 -
GENERAL REQUIREMENTS - HEATING, VENTILATING, AND AIR-CONDITIONING (HVAC)**

PART 1 - GENERAL

1.1 DESCRIPTION

- A. The requirements of this section apply to all sections of Division 23.
- B. Section 23 00 00 includes General Requirements for Division 23 work including, but not limited to the following sections:
 - 1. Section 23 0 01 Coordination
 - 2. Section 23 01 30 51 HVAC Air-Distribution System Cleaning
 - 3. Section 23 05 48 Vibration and Seismic Control for HVAC
 - 4. Section 23 05 53 Identification for HVAC Piping and Equipment
 - 5. Section 23 05 93 Testing, Adjusting, and Balancing
 - 6. Section 23 07 00 Thermal Insulation for Mechanical Systems
 - 7. Section 23 08 01 Commissioning of HVAC Systems (w/o CxA)
 - 8. Section 23 23 00 Refrigerant Piping
 - 9. Section 23 31 13 Metal Ducts
 - 10. Section 23 37 13 Diffusers, Registers and Grilles
 - 11. Section 23 80 00 Decentralized HVAC Equipment
 - 12. Section 23 80 10 Multi-Zone Fan Coils
 - 13. Section 23 90 00 ALC Integration

1.2 WORK INCLUDED

- A. Provide all materials, equipment, labor, fabrication, specialties, and items necessary and incidental to the installations of a complete system or piece of equipment.
- B. Work included shall also include transportation, storage, utilities and required licenses and permits.

1.3 RELATED WORK AND REQUIREMENTS

- A. The work of this Section shall require work in coordination with other Divisions outside of this Section as follows:
 - 1. Section 01 00 00 General Requirements
 - 2. Section 01 33 23 Shop Drawings, Product Data and Samples
 - 3. Section 26 00 00 General Requirements, Electrical

1.4 QUALITY ASSURANCE

- A. Comply with Division 01 requirements regarding Quality Control.
- B. Mechanical, electrical, and associated systems shall be safe, reliable, efficient, durable, easily and safely operable and maintainable, easily and safely accessible, and in compliance with applicable codes as specified. The systems shall be comprised of high quality institutional-class and industrial-class products of manufacturers that are experienced specialists in the required product lines. All construction firms and personnel shall be experienced and qualified specialists in their respective industrial and institutional HVAC system, as applicable.
- C. Products Criteria:
 - 1. Standard Products: Material and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of the products for at least 3 years. The design, model and size of each item shall have been in satisfactory and efficient operation on at least three installations for approximately three years. However, digital electronics devices, software and systems such as controls, instruments, computer workstation, shall be the current generation of technology and basic design that has a proven satisfactory service record of at least three years. See other specification sections for any exceptions.
 - 2. All items furnished shall be free from defects that would adversely affect the performance, maintainability and appearance of individual components and overall assembly.
 - 3. Conform to codes and standards as required by the specifications. Conform to local codes, if required by local authorities such as the natural gas

supplier, if the local codes are more stringent than those specified, the more stringent requirement shall be used.

4. Multiple Units: When two or more units of materials or equipment of the same type or class are required, these units shall be products of one manufacturer.
5. Assembled Units: Manufacturers of equipment assemblies, which use components made by others, assume complete responsibility for the final assembled product.
6. Nameplates: Nameplate bearing manufacturer's name or identifiable trademark shall be securely affixed in a conspicuous place on equipment, or name or trademark cast integrally with equipment, stamped or otherwise permanently marked on each item of equipment.

1.5 SUBMITTALS

- A. Comply with Division 01 requirements regarding submittals.
- B. Contractor shall make all necessary field measurements and investigations to assure that the equipment and assemblies will meet contract requirements.
- C. If equipment is submitted which differs in arrangement from that shown, provide drawings that show the rearrangement of all associated systems. Approval will be given only if all features of the equipment and associated systems, including accessibility, are equivalent to that required by the contract.
- D. Prior to submitting layout drawings for approval, contractor shall certify in writing that manufacturers of all major items of equipment have each reviewed drawings and specifications and have jointly coordinated and properly integrated their equipment and controls to provide a complete and efficient installation.
- E. Upon request by Engineer, provide lists of previous installations for selected items of equipment. Include contact persons who will serve as references, with telephone numbers and e-mail addresses.
- F. Submittals and layout drawings for interdependent items, containing applicable descriptive information, shall be furnished together and complete in a group. Coordinate and properly integrate materials and equipment in each group to provide a completely compatible and efficient installation. Final review and approvals will be made only by groups. Submittals and shop drawings shall also incorporate the following items:
 1. Clear and neat strike out of irrelevant information.
 2. Clearly and neatly tag and mark equipment, options and specialties and special features.
 3. Key tags to match tags on Drawings.

- a. If substituting on Specified equipment provide comprehensive written comparison of characteristics between specified and substituted equipment.
 4. Provide information in an easily readable and legible format presentation.
 5. Provide an index with corresponding labeled and tabbed dividers for sections, in a three-ring hard cover binder or hard cover binding folder. Loose leaf sections, provided separately, shall not be acceptable. Front index shall include, at a minimum:
 - a. Full, formal, name and address, including zip code, for job.
 - b. Company name, address, phone and fax numbers of General Contractor, including phone land line number of job trailer and cellular phone number and name of job site Superintendent.
 6. Submit all items at same time, including all controls information, in one binder/folder. Excluding controls for a later, separate, review shall not be acceptable.
 7. Unless specified otherwise in Division 01 requirements submit 5 copies of data. Engineer will return 4 copies while retaining one for internal office use as a Project Record Document.
 8. Electronic copies shall be an acceptable submittal medium provided requirements of Division 01 are met.
 9. Submittals shall be prepared and submitted in a timely fashion to allow adequate time for ordering of long lead time equipment and materials.
- G. Layout and Coordination Drawings:
1. Submit complete, consolidated, and coordinated layout drawings for all new systems, and for existing systems that are in the same areas. Refer to the General Conditions.
 2. The drawings shall include plan views, elevations and sections of all systems and shall be on a scale of not less than 1/8-inch equal to one foot. Clearly identify and dimension, horizontally and vertically, the proposed locations of the principal items of equipment. The drawings shall clearly show locations and adequate clearance for all equipment, piping, valves, control panels and other items. Show the access means for all items requiring access for operations and maintenance. Provide detailed layout drawings of all piping and duct systems.
 3. Do not install equipment foundations, equipment or piping until layout drawings have been approved.
 4. In addition, for HVAC systems, provide details of the following:
 - a. Interstitial space.

- b. Hangers, inserts, supports, and bracing.
 - c. Pipe sleeves.
 - d. Duct or equipment penetrations of floors, walls, ceilings, or roofs.
 5. Failure of Contractor to provide adequate coordination and Coordination Drawings shall not be grounds for adjustment of Project cost or extension of time.
- H. Manufacturer's Literature and Data: Submit under the pertinent section rather than under this section.
 1. Submit belt drive with the driven equipment. Submit selection data for specific drives when requested by the Engineer of Record.
 2. Submit electric motor data and variable speed drive data with the driven equipment.
 3. Equipment and materials identification.
 4. Fire-stopping materials.
 5. Hangers, inserts, supports and bracing. Provide load calculations for variable spring and constant support hangers.
 6. Wall, floor, and ceiling plates.

1.6 DELIVERY, STORAGE AND HANDLING

- A. Protection of Equipment:
 1. Equipment and material placed on the job site shall remain in the custody of the Contractor until phased acceptance, whether the Owner has reimbursed the Contractor for the equipment and material, or not. The Contractor is solely responsible for the protection of such equipment and material against any damage.
 2. Place damaged equipment in first class, new operating condition; or replace same as determined and directed by the Engineer.
 3. Protect interiors of new equipment and piping systems against entry of foreign matter. Clean both inside and outside before painting or placing equipment in operation.
 4. Existing equipment and piping being worked on by the Contractor shall be under the custody and responsibility of the Contractor and shall be protected as required for new work.
- B. Cleanliness of Equipment and Products:
 1. Exercise care in storage and handling of equipment and piping material to be incorporated in the work. Remove debris arising from cutting, threading and welding of piping or ductwork.

2. Contractor shall be fully responsible for all costs, damage, and delay arising from failure to provide clean systems.

1.7 CODES, REGULATIONS, STANDARDS, AND GUIDELINES

A. Work shall be in accordance with requirements of the latest jurisdiction adopted editions of the following:

1. CBC - California Building Code, 2022 Edition
2. CMC - California Mechanical Code, 2022 Edition
3. CPC - California Plumbing Code, 2022 Edition
4. CGBCS California Green Building Construction Standards, 2022 Edition
5. CEC - California Electrical Code, 2022 Edition
6. CFC - California Fire Code, 2022 Edition
7. CEC - California Energy Commission, Title 24, Part VI, 2022 Edition

B. The work shall comply with the latest editions of the following guidelines and standards:

1. AABC Associated Air Balance Council
2. AGA American Gas Association
3. AMCA Air Movement and Control Association
4. ANSI American National Standards Institute
5. ARI American Refrigeration Institute
6. ASHRAE American Society of Heating Refrigerating and Air Conditioning Engineers
7. ASME American Society of Mechanical Engineers
8. ASTM American Society for Testing and Materials
9. NEC National Electric Code
10. NFPA National Fire Protection Association
11. SMACNA Sheetmetal and Air-Conditioning Contractors National Association
12. UL Underwriters Laboratories

C. When the work calls for more stringent requirements than the above listings the Specifications and Drawings shall take precedence.

1.8 SITE VISIT AND FAMILIARIZATION

- A. Visit the site and become familiar with the Drawings and Specifications. Examine the site and understand the conditions under which the Contract shall be performed.
- B. Refer to Division 01 for any Pre-Bid Conference requirements.

1.9 REVIEW OF CONSTRUCTION

- A. Work may be reviewed, without prior notice, at any time by representatives of the Owner.
- B. Advise Owner when work is ready for review at the following times:
 - 1. Prior to concealment of work in walls.
 - 2. Prior to concealment of work and above ceilings and any other enclosable spaces. Conceal Work only after obtaining Owner and Architect consent.
 - 3. Maintain an on the job set of Specifications and Drawings for use by Owner and representatives.

1.10 BID DOCUMENT DESCRIPTION

- A. Specifications describe quality of materials and equipment.
- B. Drawings describe the work in diagrammatic form. Drawings do not show exact detail and arrangements. Final requirements of the Work shall be determined by the Contractor after coordination with other trades.
- C. All equipment, systems and items indicated on the drawings and specifications are to be assumed as new unless specifically noted otherwise.
- D. Do not scale drawings. Contractor is required to visit the site prior to bid and verify all physical sizing of equipment, systems, and components independently prior to bid.

1.11 DEFINITIONS

- A. Definitions following may not match those in other sections. Definitions listed here govern this part of the Work and take precedence over those listed elsewhere.
 - 1. Concealed Embedded within the construction or installed in furred spaces, within partitions or hung ceilings, in trenches, crawl spaces, or within enclosures.
 - 2. Connect Complete hook-up of items with required services including all final items necessary for a completely functional installation.

- | | | |
|-----|-----------|---|
| 3. | Down | A vertical pipe, duct or piece of work that does penetrate a floor. |
| 4. | Drop | A vertical pipe, duct or piece of work that does not penetrate a floor. |
| 5. | Exposed | Not installed underground or concealed as defined within this list. |
| 6. | Indicated | As indicated on the Drawings and Specifications. |
| 7. | Install | To erect, mount and connect complete with related accessories. |
| 8. | Noted | As indicated on the Drawings and Specifications. |
| 9. | Provide | To furnish, supply, install and connect up complete, ready, safe and in regular operation of particular work referred to. |
| 10. | Riser | A vertical pipe, duct or piece of work having a vertical length greater than one story height. |
| 11. | Shown | As indicated on the Drawings and Specifications. |
| 12. | Supply | To purchase, procure, acquire and deliver complete with related accessories. |
| 13. | Work | Labor, materials, equipment, apparatus, controls, accessories and other items required for complete and proper operation. |

PART 2 - PRODUCTS

2.1 NOT USED

PART 3 – EXECUTION

3.1 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Delivery and handling shall be performed in accordance with manufacturer's recommendations. Provide dust and weather covers.
- B. Protect materials from loss or damage. Lost or damaged materials shall be replaced with new at no increase in Contract Sum.
- C. All mechanical equipment requiring power shall be installed with the required working spaces clearances required by the California Electrical Code, Table 110.26 (A)(1) Working Spaces.
- D. All facility service piping and conduits shall be concealed behind finishes. No exposed piping or raceways will be permitted unless specifically noted in writing on the drawings. Coordinate with pertinent sections of other Divisions providing demolition and new finishes. Jointly determine extent of demolition and finish removal necessary to install all indicated facilities services systems concealed behind wall, floor, ceiling finishes.

3.2 PROTECTION OF WORK

- A. Cap all duct, pipe, and equipment openings daily to protect from dust, moisture and incidental debris. Equipment not capped shall be thoroughly cleaned prior to recommencing construction.
- B. Porous materials that become wetted shall be replaced with new. Drying is not sufficient as it introduces the possibility of microbial growth. This applies to duct liner, insulation wrap, flex duct and any material that has the potential to absorb moisture.
- C. All air distribution shall be capped during construction to prevent accumulation of dirt, dust, and debris.

3.3 CLEANING AND PRESENTATION

- A. Prepare Work for painting by leaving surfaces free of oil, dust, rust, scale, adhesions, and debris.
- B. Remove all shipping labels and tags.
- C. Exterior surfaces of piping, insulation, ducting and equipment shall be left clean.
- D. Inside visible portions of grille cans and adjacent ducting including insulation stick pins, dampers and specialties shall be painted with two coats of flat black paint.
- E. Scratched and marred surfaces of factory painted equipment and materials shall be touched up with matching color/type paint.

1. Clean as recommended by manufacturer. Do not use material or methods which may damage finish surface or surrounding construction.

F. Cut ends of strut pieces and uncoated/non-galvanized steel materials exposed to the elements shall be painted with two coats of rust inhibiting paint with color and type matched to installation.

3.4 SAFETY

A. The contractor shall be solely responsible for conditions of the job site, including safety of all persons and property during performance of the work. This shall also apply to normal and non-normal working hours.

3.5 CUTTING OF STRUCTURE

A. Do not cut beams, girders, columns, or any other structural members, or run any pipes, ducts, or work through slabs, unless specifically shown on the Drawings, or unless written approval is obtained from the Owner.

B. Cutting of walls, floors, or other parts of the building or repairing any work due to neglect of properly directing the locations of necessary openings and framing beforehand shall be done at no additional cost to the Owner.

3.6 SPECIAL TOOLS

A. Furnish to Owner one set of special tools required to operate, adjust, dismantle, or repair any equipment within this Division. Special tools mean those not normally found in possession of mechanics or maintenance personnel. Also provide location of supplier where extra sets can be purchased.

3.7 RECORD DRAWINGS

A. Contractor is required to provide record Drawings in accordance with Division 01 and this section.

B. Keep and accurate record of job progress including as-built locations and of the Work. Keep record up-to-date on legible copies as job progresses. Drawings shall be of the same size as provided to the contractor. Make available to Owner and Owner representatives during job.

C. In addition to any other requirements, include on as-built Drawings the following:

1. Changes in location of piping, duct, or equipment.

2. Ceiling access panel locations.

3. Position of buried or concealed mains accurately dimensioned, both horizontally and vertically.

3.8 COMPLETION

- A. When work is completed, or when Owner or Owner representative directs, remove surplus equipment, material, waste, and rubbish, and leave building in satisfactory condition.
- B. Adjust and program thermostats and controls per owner direction and as indicated within Division 23 requirements.

3.9 WARRANTIES AND GUARANTEES

- A. Contractor is required to provide warranties in accordance with Division 01 – General Requirements.
 - 1. Collect all warranties and guarantees for materials and equipment and neatly fill out all required information for the Owner. Provide one copy of each certificate for turn over to Architect. Arrange certificates in a tabbed and indexed binder for Architect ease of use.
- B. At the completion of the work contractor shall guarantee to repair or replace materials and workmanship found defective for a period of one year from date of filing of Notice of Completion. This work shall be performed at no cost to the Owner.
 - 1. Work of other trades damaged because of faulty workmanship or materials shall be repaired at no cost to the Owner.

END OF SECTION 23 00 00

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SECTION 23 00 01 - COORDINATION

PART 1 - GENERAL

SUMMARY

Section Includes: Provision of coordination of the Work of the Contract.

WORK INCLUDED

Provide all materials, equipment, labor, fabrication, specialties, measurements, IOMs and items necessary and incidental to the coordinated installation of complete systems or equipment as indicated on the Contract Documents.

RELATED WORK AND REQUIREMENTS

The work of this Section shall require work in coordination with other Divisions outside of this Section as follows:

Section 01 00 00 General Requirements

GENERAL COORDINATION

Contractor shall be responsible for all project coordination.

Coordinate schedules, submittals, and work of the various trades to ensure efficient and orderly sequence of installation of construction, with provisions for accommodating items to be installed later. Coordinate the work among the Specifications and Drawings. Work shown on any drawing or specification is required by the Contract irrespective of the trade sub-division. Contractor shall require each trade subcontractor to review all other subdivisions of the documents for related work and shall coordinate the subcontracts accordingly.

Require all parties involved in the performance of the Work to cooperate in the overall coordination of the work under the direction of the Contractor. Each party, when requested to do so, shall furnish information concerning its portion of the work and shall respond promptly and reasonably to the decisions and requests of persons designated with coordination, supervisory, administrative, or similar authority.

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The Drawings use graphic symbols to show certain physical relationships of the various elements and systems and their interfacing with other elements and systems. Establishing and coordinating the actual physical relationships is the responsibility of the Contractor. Layout and arrange all elements to contribute to safety and efficiency while maintaining the intent of the design. Before work proceeds in areas of potential conflict for installing different components of the work, Contractor shall prepare supplementary drawings for review by the Architect and resolve the conflict.

Coordinate continuous checking of architectural and structural clearances for accessibility of equipment and mechanical and electrical systems. No allowances of any kind will be made for the Contractor's failure to coordinate sequence of installing materials/equipment into position. Contractor shall verify that equipment will fit within the prescribed equipment room spaces.

Prior to installation of each major unit of work which requires coordination and interfacing with other work, meet at project site with installer and representatives of manufacturers and fabricators who are involved in or affected by unit of work. Review progress of other work and preparations for the work under consideration.

Coordinate the tolerances of all materials to ensure a proper fit in achieving the requirements of the Contract Documents.

Coordinate matching finish, texture, color, etc. for the new work on existing components in the project.

Coordinate work of like materials by submitting pilot samples to the Architect for review of acceptable ranges of finish textures and color variation.

Coordinate completion and cleanup Work of various trades in preparation for the Substantial Completion and for occupancy of the building.

SUBCONTRACT COORDINATION

The General Contractor shall coordinate the Work and do not delegate responsibility for coordination to any Subcontractor.

Anticipate the interrelationship of all Subcontractors and their relationship with the Work.

Resolve differences or disputes between Subcontractors concerning coordination, interference, or extent of work between sections of the specifications. Contractor's decisions, if consistent with the Contract Document requirements, shall be final.

Coordinate the work of Subcontractors so that their portions of the work are performed in a manner that minimizes interference with the progress of the Work.

ADMINISTRATION

COORDINATION

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General: Prepare a written memorandum on required coordination activities. Include such items as required notices, reports, and attendance at meetings. Distribute this memorandum to each trade performing work at the project site. Prepare similar memorandum for separate contractors where interfacing of their work is required.

Coordination Meetings: Conduct general project coordination meetings with Subcontractors at least weekly at regularly scheduled times convenient for all parties involved. These meetings are in addition to specific meetings held for other purposes, such as regular project meetings and special preinstallation meetings. Request representation at each meeting by every party currently involved in coordination or planning for the work of the entire project. Keep the Owner Representatives informed about coordination meetings. Conduct meetings in a manner which will resolve coordination problems. Record results and minutes of each meeting and distribute copies to everyone in attendance and to the Owner Representatives. Owner Representatives may attend weekly jobsite meetings with subcontractors.

Superintendent: Provide a full-time Superintendent experienced in administration and supervision of building construction. This Superintendent shall be authorized to act as general coordinator of interfaces between units of work. This Superintendent shall be on site, continuously during the construction period. Construction coordination shall be his/her principal duty.

For the purpose of this provision, "interface" is defined to include scheduling and sequencing of work, sharing of access to workspaces, installations, protection of each other's work, cutting and patching, tolerances, cleaning, selections for compatibility, preparation of coordination drawings, inspections, tests and temporary facilities and services.

Mechanical/Electrical Coordinator: Provide a single individual, a mechanical/ electrical coordinator, experienced in administrative and supervisory coordination of mechanical and electrical work. This experience in coordination shall include coordination of the type of mechanical/electrical work required for this project. The mechanical/electrical coordinator is required to act as the specialized coordinator of interfaces both within mechanical/electrical work and between that work and other trades. The Mechanical/Electrical Coordinator shall be on site, full time during the construction period. Project Superintendent may serve as mechanical/electrical coordinator.

COORDINATION DRAWINGS AND SUBMISSION

Prepare Coordination Drawings where required before beginning fabrication or delivery of materials and equipment to the jobsite.

Coordination Drawings shall clearly indicate coordination of mechanical, plumbing, fire protection, electrical, lighting, signal, and equipment installations with structural, architectural and finish elements.

Scale: 1/2" = 1'-0". Scale may be revised to 1/4"=1'-0" with consent of all involved subcontractors.

Keep copies of Coordination Drawings at the jobsite.

COORDINATION

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Contractor shall provide the Owner with a record copy of initial Coordination Drawings and with revisions to Coordination Drawings, within three (3) working days of completion of each drawing or revised drawing and 30 days before work begins. The Owner will verify that Coordination Drawings have been made, but no approval of these drawings will be made. Include in submission of drawings the names of coordination staff.

Coordination Drawings shall include, but are not limited to structural, fire protection, plumbing, heating, ventilation and air conditioning, electrical power and lighting, security, life safety, data, telephone system, existing or reinstalled equipment and new equipment.

Coordination Drawings, shall indicate layout of Work for all trades, for purposes of showing overlays and potential conflicts of crossover work and adjoining work.

Conditionally revise Coordination Drawings as subsequent work is added to areas containing existing work.

Provide dimensions and elevations where conflicts may exist and coordinate conflicts on Coordination Drawings to prevent conflicts in the field.

Contractor shall require Subcontractors to develop Subcontractor Coordination Plans of the same scale as Contractor's Coordination Drawings to assist in making transcripts for transfer to Coordination Drawings; use approved Shop Drawings for Coordination Drawings where available.

Coordination Drawings shall include dates and signatures of Contractor and Subcontractors involved in coordination; signed Coordination Drawings shall be subject to examination by the Owner at any time. Failure to maintain up-to-date drawings will be considered non-conformance with Contract Documents and progress payment will be withheld.

Failure of Contractor to provide adequate coordination and Coordination Drawings shall not be grounds for adjustment of Project cost or extension of time.

STRUCTURAL, MECHANICAL, PLUMBING AND ELECTRICAL COORDINATION

Use Coordination Drawings of structural, mechanical, plumbing, and electrical Work, together with shop drawings and layout drawings of affected Work to check, coordinate and integrate the Work to prevent interferences.

Coordinate space requirements and installation of mechanical and electrical Work which are indicated by graphic symbols on Contract Documents.

Routing shown for pipes, ducts and conduits on Drawings are shown by graphic symbols only; make runs parallel with lines of building.

Utilize spaces efficiently to maximize accessibility for other installations, for maintenance and for repairs.

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Conceal pipes, ducts and wiring in finished areas, unless otherwise indicated, coordinate locations of fixtures and outlets with finish elements.

Where there is a potential conflict in the layout or interferences between the work, including structural and architectural, layout the work with tape or other means to depict the layout on site to reduce or resolve the conflict and to allow the Owner to review the work prior to execution. The tape or other means to depict layout shall not cause any damage, change in color or appearance of any work to remain, or leave a residue.

Contractor shall coordinate steel shop drawings to include all penetrations of framing members resulting from the coordination of and with the work of the mechanical and electrical subcontractors. See Section 05120 for additional structural coordination requirements.

Steel shop drawings shall be reviewed and approved by the mechanical, electrical and plumbing subcontractors prior to submission and fabrication.

INTERSTITIAL SPACE COORDINATION

Contractor shall provide Coordination Drawings for the Interstitial Spaces to resolve installation conflicts prior to final approval of any shop drawings.

All conflicts shall be brought to the attention of the Architect.

Elements to include in the Coordination Drawings:

Mechanical ducts and pipes, including floor penetrations.

Plumbing pipes.

Fire branch lines and sprinkler heads.

Electrical bus ducts.

Telephone communication and data lines.

Interstitial space access.

Structural elements including, but not limited to, beams, columns, slabs, hangers and seismic bracing.

Suspended ceilings.

Insulation.

Security system elements.

Others as necessary.

Schedule of Submission

Refer to Coordination Drawings and Submission specified in this Section.

COORDINATION

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Review of the coordinated drawings shall be required prior to approval of any of the sub-system shop drawings for the elements listed above.

An as-built version of this drawing should be required at the end of installation.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

NOT USED

END OF SECTION 23 00 01

SECTION 23 05 48 - VIBRATION AND SEISMIC CONTROL

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Provide complete vibration and seismic control for the Work as required by this Section for HVAC equipment and accessories indicated in the Contract Documents.
- B. All work of this section shall comply with Section 22 00 00 GENERAL REQUIREMENTS - HEATING, VENTILATING, AND AIR-CONDITIONING (HVAC).

1.2 QUALITY ASSURANCE

- A. Only firms whose products of vibration isolation products, of types and sizes required and have been in exceptional use in similar service for not less than five years shall be considered.
- B. Unless otherwise indicated, obtain isolation units from a single manufacturer.
- C. Where vibration isolation support units are indicated for minimum static deflection, provide manufacturer's certification that units have been tested and comply with the indicated requirements.

1.3 SUBMITTALS

- A. Submit in accordance with specification Division 01 and Section 23 00 00.
- B. In addition, manufacturer's literature and data shall include:
 - 1. Vibration isolators:
 - a. Hangers
 - 2. Bases
 - 3. Duct liner
- C. Isolator manufacturer shall furnish with submittal load calculations for selection of isolators, including supplemental bases, based on lowest operating speed of equipment supported.
- D. Seismic Requirements: Submittals are required for all equipment anchors, supports and seismic restraints. Submittals shall include; weights, dimensions, standard connections, and manufacturer's certification that all specified equipment will withstand seismic lateral force requirements as shown on drawings and required by their scheduled weights and centers of gravity.

PART 2 - PRODUCTS

2.1 FLEXIBLE DUCT CONNECTORS

- A. Isolate all equipment from ductwork with flexible ductwork connections and, for outside installations, UV resistant flexible connections, reinforced with steel wire mesh where required for strength to withstand duct pressure indicated. Form connectors with full-faced flanges and accordion bellows to perform as flexible isolation units, and manufacturer's standard length for each size unless otherwise indicated.
- B. Equip each unit with galvanized steel retaining rings for airtight connections to ductwork. Flexible duct connectors exposed to the outside shall be watertight and exteriors finished with an impregnated fiberglass cloth bonded to flexible connectors. All flexible connectors shall meet or exceed the requirements of NFPA bulletin 90A, U.L. listing 181, Class 1.

2.2 DUCT LINER

- A. Supply and return ductwork shall have acoustic lining where shown on the drawings and as specified herein. Acoustic lining shall be a minimum of 1-1/2 inches thickness and incorporate an integral mat-face of type in accordance with NFPA 90A, of minimum 1-1/2 lb. per cubic foot density. Adhere mat-faced duct liner with a fire retardant adhesive. Mechanical fasteners that do not pierce the sheet metal shall be on min. 16 inch centers on top sections (when duct width exceeds 12 inches) and on sides when height exceeds 24 inches. All leading edges at beginning of runs and all exposed edges shall be installed with sheet metal nosings to prevent delamination and prevent peel off.
 - 1. Insulate all supply and return ductwork min. 20 ft. from HVAC units, or to lengths shown on drawings.
 - 2. Where ductwork is acoustically lined, thermal insulation is not required if the thermal performance is at least equal to that specified for thermal insulation.
 - 3. Sizes shown on drawings for lined ducts are inside-clear dimensions.
- B. Duct dimensions listed on the Drawings are net interior clear dimensions. Incorporate allowances for linings and insulation to provide the net clear dimensional data provided.
- C. Provide duct lining including facings and adhesives with incombustible materials meeting all code requirements and fire and smoke hazard ratings as tested by procedure ASTM E-84M, NFPA 225, and U.L. 723, not exceeding flame spread 25 and developed smoke of 50.

2.3 VIBRATION ISOLATORS

- A. Vertically restrained spring isolators: Units shall be equipped with an adjustable assembly which will limit vertical movement, both up and down, without degrading performance of unit for normal equipment loading and operation.
- B. Type of isolator, base, and minimum static deflection shall be as required for each specific equipment application as recommended by isolator or equipment manufacturer but subject to minimum requirements indicated herein and in the schedule on the drawings.
- C. Hangers: Shall be combination neoprene and springs unless otherwise noted and shall allow for expansion of pipe.
 - 1. Neoprene (Type HN): Vibration hanger shall contain a double deflection type neoprene isolation element. Hanger rod shall be separated from contact with hanger bracket by a neoprene grommet.
 - 2. Spring (Type HS): Vibration hanger shall contain a coiled steel spring in series with a neoprene grommet. Spring shall have a diameter not less than 0.8 of compressed operating spring height. Spring shall have a minimum additional travel of 50 percent between design height and solid height. Spring shall permit a 15 degree angular misalignment without rubbing on hanger box.
 - 3. Hanger supports for piping 50 mm (2 inches) and larger shall have a pointer and scale deflection indicator.

2.4 SEISMIC RESTRAINT REQUIREMENTS FOR EQUIPMENT

- A. Bolt pad mounted equipment, without vibration isolators, to the floor or other support using ASTM A307 standard bolting materials and methods.
- B. Floor mounted equipment, with vibration Isolators: Type SS. Where Type N isolators are used provide channel frame base horizontal restraints bolted to the floor, or other support, on all sides of the equipment size and material required for the base shall be as recommended by the isolator manufacturer.
- C. On all sided of suspended equipment, provide bracing for rigid supports and provide restraints for resiliently supported equipment. The slack cable restraint method, Mason Industries, or equal, is acceptable.

2.5 BASES

- A. Double Fiberglass continuous support material shall be high-density matrix of compressed molded fiberglass; individually coated with a flexible, moisture-impervious elastomeric membrane, designed to allow controlled air movement in the fiber media. It shall ne manufactured in such a way that the pumping action of air between fibers provides viscous damping, reducing motion caused by transient shock and vibration. The material is to be non-corrosive, non-combustible, non-

absorbent, and resists rust, ozone, mildew and fungus, vermin proof and it will not shrink, swell, or decompose. Isolation characteristics of the media are to be constant over a temperature range of -40°F to 250°F (40°C to 121°C). Fiberglass isolation strips shall be Model KIP-RT, as manufactured by Kinetics Noise Control, Inc., or MEOR approved equal

- B. Curb Mounted Isolation Base (Type CB): Fabricate from aluminum to fit on top of standard curb with overlap to allow water run-off and have wind and water seals which shall not interfere with spring action. Provide resilient snubbers with 6 mm (1/4 inch) clearance for wind resistance. Top and bottom bearing surfaces shall have sponge type weather seals. Integral spring isolators shall comply with Spring Isolator (Type S) requirements.

PART 3 – EXECUTION

3.1 ISOLATOR PERFORMANCE

- A. Comply with minimum static deflection recommended ASHRAE including definitions of critical and non-critical locations, for selection and application of vibration isolation materials and devices.
- B. Comply with manufacturer's recommendations for selection and application of vibration isolation materials and units.

3.2 ISOLATOR INSTALLATION

- A. Anchor and attach unit to substrate and equipment as required for secure operation and to prevent displacement by seismic forces, and as indicated.
- B. Adjust leveling devices as required to distribute loading uniformly onto isolators. Shim units as required where leveling devices cannot be used to distribute loading properly. Install so that HVAC units are level.
- C. Adjust isolators to ensure that units do not exceed rate operating deflections or bottom out under loading, and are not short circuited by other contacts or bearing points. Remove space blocks and similar devices (if any) intended for temporary protection against overloading during installation.
 - 1. No metal-to-metal contact will be permitted between fixed and floating parts.
 - 2. Connections to Equipment: Allow for deflections equal to or greater than equipment deflections. Electrical, drain, piping connections, and other items made to rotating or reciprocating equipment (pumps, compressors, etc.) which rests on vibration isolators, shall be isolated from building structure for first three hangers or supports.
 - 3. Common Foundation: Mount each electric motor on same foundation as driven machine. Hold driving motor and driven machine in positive rigid alignment with provision for adjusting motor alignment and belt tension.

Bases shall be level throughout length and width. Provide shims to facilitate pipe connections, leveling, and bolting.

4. Provide heat shields where elastomers are subject to temperatures over 38 degrees C (100 degrees F).
5. Extend bases for pipe elbow supports at discharge and suction connections at pumps. Pipe elbow supports shall not short circuit pump vibration to structure.
6. Non-rotating equipment such as heat exchangers and convertors shall be mounted on isolation units having the same static deflection as the isolation hangers or support of the pipe connected to the equipment.

3.3 ISOLATOR ADJUSTMENTS

- A. Adjust vibration isolators after piping systems are filled and equipment 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. Attach thrust limits at centerline of thrust and adjust to a maximum of 1/4 inch (6-mm) movement during start and stop.
- D. Adjust active height of spring isolators.
- E. Adjust snubbers according to manufacturer's recommendations.
- F. Adjust seismic restraints to permit free movement of equipment within normal mode of operation.
- G. Torque anchor bolts according to equipment manufacturer's recommendations to resist seismic forces.

3.4 DEFLECTION MEASUREMENTS

- A. At job close out prepare and submit to Engineer a record showing measured equipment deflection for each major item of equipment.

3.5 ACOUSTIC LINING INSTALLATION

- A. Acoustic linings shall be adhered to all interior sides of duct with minimum 100% coverage for fire-retardant adhesive similar to Benjamin Foster 4 and with weld pins and washer or equivalent mechanical fastening starting 3 inches from edges and sides, 12 inches on center, all sides. Minimum one row per side for duct size of 12 inches size or less. Mechanical fasteners shall cause quilting of surface. Neoprene coated surface shall be toward air stream. Before installing liner seal all butting edges and final edges with heavy coat of adhesive to seal off air between lining and duct. All exposed edges of lining shall be installed with sheet metal

nosing 1-1/2" wide, two gauges heavier than duct. Installation shall be suitable for duct velocities up to 3,000 feet per minute.

3.6 BALANCING AND ALIGNMENT OF ROTATING EQUIPMENT

- A. Statically and dynamically balance all pumps, fans, compressors and drivers. Align shafts of pumps, fans, and drivers to limit noise and vibration to specified values. Level and anchor equipment as necessary to achieve and maintain proper alignment.

3.7 SOUND LEVELS

- A. Sound level limitations apply to all burners, fans, blowers, pumps, compressors, control valves, pressure reducing valves, motors, and turbines.
- B. Sound levels shall not exceed 85 DBA when measured 1400 mm (4.5-feet) above the floor and 910 mm (3-feet) horizontally from each surface of the smallest imaginary rectangular box which could completely enclose the entire unit which contains the sound source. Sound level limitations apply to the operation of the equipment at all loads within the equipment requirements.
- C. If sound levels exceed requirements, modify or replace the equipment as necessary to achieve required sound levels and other specified requirements.
 - 1. Submit all proposed modifications or replacements for review prior to starting the work.
 - 2. After completing the work, provide complete retest of equipment operation and performance.

END OF SECTION 23 05 48

SECTION 23 05 53 – HVAC IDENTIFICATION

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Provide complete HVAC system identification work for all equipment and ducting from point of connection at HVAC equipment to termination points. Types of HVAC identification shall consist of:
 - 1. Painted Identification Materials
 - 2. Plasticized Tags
 - 3. Engraved Plastic Laminate Signs
 - 4. Plastic Tape
- B. Lettering, Size, Colors, and viewing angles of identification devices shall comply with ANSI A13.1.
- C. All work of this section shall comply with Section 23 00 00 GENERAL REQUIREMENTS - HEATING, VENTILATING, AND AIR-CONDITIONING (HVAC)

PART 2 – PRODUCTS

2.1 HVAC IDENTIFICATION MATERIALS

- A. Painted Identification Materials:
 - 1. Stencils: Standard fiberboard stencils with letters not less than 1-1/4 inches high for ductwork and not less than 3/4" inches high for access door signs and similar operational instructions.
 - 2. Identification paint: Standard exterior type stenciling enamel of wither brushing grade or pressurized spray can form and grade.
 - 3. Identification Paint: Standard identification enamel.
- B. Plastic Tape
 - 1. General: Manufacturer's standard color-coded pressure sensitive self-adhesive vinyl tape, not less than 3 mils thick.
 - a. Width: Provide 1-1/2" inch wide tape markers on pipes with outside diameters (including insulation, if any) of less than 6 inches, 2-1/2 inch wide tape for larger pipes.

- b. Color: By ANSI A13.1 designation except where other color selection is indicated.
- C. Engraved-Plastic Laminate Signs:
 - 1. General: Provide engraving stock melamine plastic laminate complying with FS L-P-387 in the size and thickness indicated, engraved with engraver's standard letter style of the size and working indicated, black with white core (letter core) except as otherwise indicated, punched for mechanical fastening except where adhesive mounting is necessary because of substrate.
 - a. Thickness: 1/6 inch for units up to 20 sq. in. or 8 inch in length; 1/8 inch for larger units.
 - b. Fasteners: Self-tapping stainless screws, except contact type permanent adhesive where screws cannot or should not penetrate the substrate.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

- A. Where identification is to be applied to surfaces which require insulation, painting or other covering or finish, including valve tags in mechanical spaces, install identification after completion of covering and painting. Install identification prior to installation of acoustical ceiling and removable concealment.

3.2 GENERAL DUCTWORK IDENTIFICATION

- A. Identify air supply, return, exhaust, outside air and intake relief ducting with stenciled signs and arrows, showing ductwork service in direction of flow, in black or white (whichever provides best contrast)
- B. In each space where ductwork is exposed, or concealed by removable ceiling system, locate signs near points of ductwork origin or where the ducts continue on into concealed enclosures and at 50 ft. spacing along exposed runs.
 - 1. Access doors shall be provided with stenciled or plastic-laminate type signs on each access door in ductwork and housings, indicating purpose of access (to what equipment) and other maintenance and operating instructions and appropriate safety and procedural information.

3.3 HVAC EQUIPMENT IDENTIFICATION

- A. Install engraved plastic laminate signs on or near each equipment item and each operational device, if not otherwise specified for each item or device. Provide signs for the following general categories of equipment and operational devices:
 - 1. Package Units (RTU)
 - 2. Energy Recovery Ventilators (ERV)
 - 3. Power Exhaust (PE)
 - 4. Split System Fan Coils (FC)
 - 5. Heat Pumps (HP)
 - 6. Significant Shut Off Valves (Isolation)
 - 7. Main control and operating dampers, including safety devices and hazardous units.
- B. Where lettering larger than 1 inch height is needed for proper identification, because of distance from normal location of required identification, stenciled signs may be provided in lieu of engraved plastic, at Installer's option.
- C. Minimum 1/4" high lettering for name of unit where viewing distance is less than 2 feet and 1/2" high for distances up to 6 feet and proportionately larger lettering for greater distances. Provide secondary lettering of 2/3 or 3/4 the size of the principal lettering.
- D. In addition to name of identified unit, provide lettering to distinguish between multiple units, inform operator of operating requirements, indicate safety and emergency precautions, and warn of hazard and improper operations.

END OF SECTION 23 05 53

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SECTION 23 05 93 – TESTING, ADJUSTING AND BALANCING

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. Work Included: This Section covers requirements for testing, adjusting, and balancing work for the air distribution systems and associated equipment and apparatus described herein.
- B. All work of this section shall comply with Section 23 00 00 GENERAL REQUIREMENTS - HEATING, VENTILATING, AND AIR-CONDITIONING (HVAC).

1.2 QUALITY ASSURANCE

- A. Engage the services of an independent balancing and testing agency specializing in the balancing and testing of heating, ventilating and air conditioning systems to perform the work.
- B. TAB Agency:
 - 1. The TAB agency shall be a subcontractor of the General Contractor and shall report to and be paid by the General Contractor.
 - 2. The TAB agency shall be a certified member of AABC, NEBB or TABB to perform TAB service for HVAC. The certification shall be maintained for the entire duration of duties specified herein. If, for any reason, the agency loses subject certification during this period, the General Contractor shall immediately notify the Engineer of Record and submit another TAB firm for approval. Any agency that has been the subject of disciplinary action by AABC, NEBB, and/or TABB within the five years preceding Contract Award shall not be eligible to perform any work related to the TAB. All work performed in this Section and in other related Sections by the TAB agency shall be considered invalid if the TAB agency loses its certification prior to Contract completion, and the successor agency's review shows unsatisfactory work performed by the predecessor agency.
- C. TAB Specialist:
 - 1. The TAB specialist shall be a member of. The certification shall be maintained for the entire duration of duties specified herein. If, for any reason, the Specialist loses subject certification during this period, the General Contractor shall immediately notify the Resident Engineer and submit another TAB Specialist for approval. Any individual that has been the subject of disciplinary action by the AABC within the five years preceding Contract Award shall not be eligible to perform any duties related to the HVAC systems, including TAB. All work specified in this Section and in other related Sections performed by the TAB specialist shall be considered invalid

if the TAB Specialist loses its certification prior to Contract completion and must be performed by an approved successor.

2. TAB Specialist shall be identified by the General Contractor within 60 days after the notice to proceed. The TAB specialist will be coordinating, scheduling and reporting all TAB work and related activities and will provide necessary information as required by the Resident Engineer. The responsibilities would specifically include:
 - a. Shall directly supervise all TAB work.
 - b. Shall sign the TAB reports that bear the seal of the TAB standard. The reports shall be accompanied by report forms and schematic drawings required by the TAB standard, AABC.
 - c. Would follow all TAB work through its satisfactory completion.
 - d. Shall provide final markings of settings of all HVAC adjustment devices.
 - e. Permanently mark location of duct test ports.
3. All TAB technicians performing actual TAB work shall be experienced and must have done satisfactory work on a minimum of 3 projects comparable in size and complexity to this project. Qualifications must be certified by the TAB agency in writing.
4. Test Equipment Criteria: The instrumentation shall meet the accuracy/calibration requirements established by AABC National Standards. Provide calibration history of the instruments to be used for test and balance purpose.
5. Tab Criteria:
 - a. One or more of the applicable AABC or SMACNA publications, supplemented by ASHRAE Handbook "HVAC Applications" Chapter 36, and requirements stated herein shall be the basis for planning, procedures, and reports.
 - b. Flow rate tolerance: Following tolerances are allowed. For tolerances not mentioned herein follow ASHRAE Handbook "HVAC Applications", Chapter 36, as a guideline. Air Filter resistance during tests, artificially imposed if necessary, shall be at least 90 percent of final values for pre-filters and after-filters.
 - 1) Air handling unit and all other fans, cubic meters/min (cubic feet per minute): Minus 0 percent to plus 10 percent.
 - 2) Air terminal units (maximum values): Minus 2 percent to plus 10 percent.
 - 3) Exhaust hoods/cabinets: 0 percent to plus 10 percent.

- 4) Minimum outside air: 0 percent to plus 10 percent.
 - 5) Individual room air outlets and inlets, and air flow rates not mentioned above: Minus 2 percent to plus 10 percent except if the air to a space is 100 CFM or less the tolerance would be 0 to plus 5 percent.
- c. Systems shall be adjusted for energy efficient operation as described in PART 3.
 - d. Typical TAB procedures and results shall be demonstrated to the Resident Engineer for one air distribution system (including all fans, three terminal units, three rooms) and one hydronic system (pumps and three coils) as follows:
 - 1) When field TAB work begins.
 - 2) During each partial final inspection and the final inspection for the project if requested by VA.
- D. AABC Compliance: Comply with AABC's Manual MN-1 "AABC National Standards", as applicable to mechanical air distribution systems and associated equipment and apparatus, except as otherwise specified.
- E. Industry Standards: Comply with American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc. (ASHRAE) recommendations pertaining to measurements, instruments, and testing, adjusting and balancing, except as otherwise specified.

1.3 SUBMITTALS

- A. Comply with Submittal Requirements of Division 01.
- B. Submit names and qualifications of TAB agency and TAB specialists within 60 days after the notice to proceed. Submit information on three recently completed projects and a list of proposed test equipment.
- C. For use by the Resident Engineer staff, submit one complete set of applicable AABC publications that will be the basis of TAB work.
- D. Submit Following for Review and Approval:
 1. Design Review Report within 90 days for conventional design projects and within 60 days for design-build projects after the system layout on air and water side is completed by the Contractor.
 2. Systems inspection report on equipment and installation for conformance with design.
 3. Duct Air Leakage Test Report.
 4. Systems Readiness Report.

5. Intermediate and Final TAB reports covering flow balance and adjustments, performance tests, vibration tests and sound tests.
 6. Include in final reports uncorrected installation deficiencies noted during TAB and applicable explanatory comments on test results that differ from design requirements.
 7. Submit certification that balancing personnel have been trained in accordance with AABC, NEBB or TABB standards.
 8. Submit certification of test equipment calibration and currency.
 9. Maintenance Data: Include in maintenance manuals, copies of certified test reports.
 10. Submit certified test reports signed by the Test and Balance Supervisor who performed testing and balancing work. In addition, have report certified by a Registered Professional Engineer who is familiar with testing and balancing work and also with project.
- E. Prior to request for Final or Partial Final inspection, submit completed Test and Balance report for the area.
- F. Make all other submittals specified under this Section.

1.4 JOB CONDITIONS

- A. Do not proceed with TAB work until work has been completed and is operable. Ensure that there is no latent residual work still to be completed.
- B. Do not proceed until work scheduled for testing, adjusting, and balancing is clean and free from debris, dirt and discarded building materials.

PART 2 - PRODUCTS

2.1 GENERAL

- A. **PATCHING MATERIALS:** Except as otherwise indicated, use same products as used by original installer for patching holes in insulation, ductwork and housings which have been cut or drilled for test purposes, including access for test instruments, attaching jigs, and similar purposes. In each case, patching shall be completed by original installer.
- B. **TEST INSTRUMENTS:** Utilize test instruments and equipment for testing and balancing work required, of type, precision, and capacity as recommended in AABC's Manual MN-1 "AABC National Standards".

2.2 PLUGS

- A. Provide plastic plugs to seal holes drilled in ductwork for test purposes.

2.3 INSULATION REPAIR MATERIAL

- A. Provide for repair of insulation removed or damaged for TAB work.

PART 3 – EXECUTION

3.1 GENERAL REQUIREMENTS

- A. Examine installed work and conditions under which testing is to be done to ensure that work has been completed, cleaned and is operable. Do not proceed with testing and balancing work until unsatisfactory conditions have been corrected in manner acceptable to Tester.
- B. Test, adjust and balance environmental systems and components, as indicated, in accordance with procedures outlined in applicable standards.
- C. Test, adjust and balance system during summer season for air conditioning systems and during winter season for heating systems, including at least period of operation at outside conditions within 5 °F (3 °C) wet bulb temperature of maximum summer design condition, and within 10 °F (6 °C) dry bulb temperature of minimum winter design condition. When seasonal operation does not permit measuring final temperatures, then take final temperature readings when seasonal operation does permit.
- D. Prepare report of test results, including instrumentation calibration reports, in format recommended by applicable standards.
- E. Patch holes in insulation, ductwork and housings, which have been cut or drilled for test purposes.
- F. Mark equipment settings, including damper control positions, valve indicators, fan speed control levers and similar controls and devices, to show final settings at completion of testing and balancing work. Provide markings with paint or other suitable permanent identification materials.
- G. Prepare a report of recommendations for correcting unsatisfactory mechanical performances when system cannot be successfully balanced, including, where necessary, modifications which exceed requirements of the Contract Documents. Submit report to the Engineer for review. Carry out corrective modifications as approved by the Engineer.
- H. Retest, adjust, and balance systems subsequent to significant system modifications, and resubmit test results.
- I. Units shall not be operated without air filters. Air filters shall be replaced completely after construction is complete and just prior to air balancing.

3.02 BALANCING PROCEDURES - AIR SYSTEMS

- A. Prior to balancing, the Contractor shall complete construction of air handling system with all components installed, and controls operative and calibrated. Schedule balancing for completion four calendar weeks prior to the completion of the building or the area the air system is servicing.
- B. Before balancing, check alignment of fan and motor sheaves.
- C. Obtain copies of fan pressure volume power characteristics at rated speed. Prepare line drawings of systems with identifying designations for each section of the distribution systems and all outlets.
- D. Set all fans at rated speeds for design volumes and pressure. Simultaneously operate all supply and exhaust systems serving common areas on 100% outside air or full recirculation throughout the balancing period.
- E. Measure flow and pressure in ducts by means of pitot tube and manometer or U-gage having a minimum sensitivity of 0.02 inch of water.
- F. For rectangular ducts, take readings at the center point of equal rectangles with not less than 16 and a maximum of 64 readings. Center distances between rectangular areas shall be not more than 6 inches. Take readings as far downstream of fittings as is practicable up to an equivalent of seven duct diameters.
- G. Measure fan and motor speed with a direct reading tachometer and Strobe Tach. Measure amperage and voltage with direct connected or clamp-on instruments.
- H. Measure flow at air outlets and inlets with velometer in accordance with air outlet manufacturer's instructions.
- I. Submit to the Engineer duplicate copies of final test and balancing measurements, drawings and operating data on fan curves.
- J. Determine actual air volume delivery of all fans by measuring fan performance point on fan pressure volume curve.
 - 1. Measure and record fan performance data on Fan Data Sheet. Plot operating point on fan pressure volume curve. Plot BHP on fan power CFM curve.
 - 2. Measure total system flow in main supply duct by means of pitot tube traverse.
 - 3. If volumes determined by each method described in 1 and 2 above are within 5% of one another, continue test. If, in excess of 5% notify Engineer and have fan checked by manufacturer, then repeat pitot tube traverse.
 - 4. If measured volumes are within 5% of one another but at other than design volume, readjust fan speed for design volume delivery.
- K. Test and record static pressure drop across all filters and note the condition of the filter at the time of test.

- L. Test and record entering and leaving db and wb temperature after the air systems have been balanced. Note whether system is on the heating or ventilation cycle.
- M. After all fans have been adjusted, proceed with balancing of systems. Adjust outside quantities by temperature of outside air, recirculated air and mixture on a day in which outside air is at least 30 °F colder than room air. Maximum and minimum air volumes through outdoor, return and exhaust air combination are to be adjusted in conjunction with automatic controls manufactured by means of linkage stops on damper motors.
- N. Balance systems to the following tolerances:
 - 1. Fans: Design volume plus 5%
 - 2. Outlets: Design volume plus 5%
 - 3. Leakage: 3%
- O. Where duct joints present leakage, the contractor shall reseal joints with 3M EC-800 cement, or equal.
- P. The following data shall be measured and recorded for all systems after balancing and adjusting to within limits specified herein, for submission of balancing report:
 - 1. Fan Data:
 - a. Manufacturer and model number (where available)
 - b. CFM, design
 - c. CFM, actual
 - d. RPM
 - e. Inlet static pressure
 - f. Discharge static pressure
 - g. Total static pressure
 - h. For purpose of balancing, fan BHP shall be calculated as follows:

Actual Amps X Actual Volts

$$\text{BHP} = \text{Nameplate Amps} \times \text{Nameplate Volts} \times \text{Nameplate HP}$$

- i. If more accurate reading is necessary for resolution of performance data conflict, use a calibrated wattmeter for measuring power.
- 2. Motor Data:

- a. Manufacturer model number
 - b. Horsepower
 - c. Phase
 - d. Frequency
 - e. NEMA code letter
 - f. Rated volts
 - g. Actual volts
 - h. Rated amperes
 - i. Actual amperes
 - j. Calculated operating BHP
 - k. Locked rotor amperes
3. Hydronic Coils (where occurs):
- a. Coil tag or note to which air handler coil serves.
 - b. Airflow in CFM
 - c. Inlet air temperature
 - d. Outlet air temperature
 - e. Air inlet pressure
 - f. Air outlet pressure
4. Electric Heaters (where occurs):
- a. Manufacturer model number
 - b. Heater size
 - c. Line voltage
 - d. Ampere rating
 - e. Control voltage
 - f. Frequency

5. Air Outlet Data:
 - a. Schedule showing all air outlet locations and numbers assigned to outlets for purpose of test
 - b. Air outlet manufacturer and model number where available
 - c. Size
 - d. Actual free area
 - e. Manufacturers test factor
 - f. Measured velocity
 - g. CFM, design
 - h. CFM, actual
 - i. CFM, percentage above or below design

6. Outdoor Air Data:
 - a. Size and inlet
 - b. Actual free area
 - c. Manufacturers test factor
 - d. Measured velocity
 - e. Outdoor air temperature
 - f. Return air temperature
 - g. Mixed air temperature with averaged traverse readings

3.03 AUTOMATIC CONTROL DEVICES:

- A. Automatically operated devices that are pertinent to the adjustment of the air system shall be set and adjusted to deliver the required quantities of air. All control work shall be done in collaboration with the representative of the control device manufacturer.

3.04 PATCHING MATERIALS:

- A. Except as otherwise indicated, use the same products as used in the original installation for patching holes in insulation, ductwork and housings which have been cut or drilled for test purposes, including access for test instruments, attaching jigs, and similar purposes. In each case, patching is to be completed by original installer.

3.05 MARKINGS:

- A. Mark equipment settings, including damper control positions, valve indicators, fan speed control levers, and similar controls and devices, to show final settings at completion of testing, adjusting and balancing work. Provide markings with paint or other suitable permanent identification materials.

3.06 IDENTIFICATION OF TEST PORTS

- A. The TAB Specialist shall permanently and legibly identify the location points of duct test ports. If the ductwork has exterior insulation, the identification shall be made on the exterior side of the insulation. All penetrations through ductwork and ductwork insulation shall be sealed to prevent air leaks and maintain integrity of vapor barrier.

3.07 RECOMMENDATIONS

- A. Prepare a report of recommendations to the Engineer for correcting unsatisfactory mechanical performance when systems cannot be successfully balanced, including, where necessary, modifications.
- B. Retest, adjust and balance systems subsequent to significant system modifications and resubmit test results.

END OF SECTION 23 05 93

SECTION 23 07 00 – THERMAL INSULATION FOR MECHANICAL SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. The work covered under this section consists of providing all necessary labor, supervision, materials, equipment and services to completely execute the complete HVAC system insulation work for equipment, piping, ductwork and other items where shown on the drawings and required herein.
- B. Insulate equipment and products at the following locations;
 - 1. Where the fluid being transported is 60 degrees Fahrenheit or below in temperature.
 - 2. Where the fluid being transported is 100 degrees Fahrenheit or above in temperature.
 - 3. All hot surfaces above 120 degrees in temperature to prevent personnel burns.
 - 4. All piping, equipment, ducting, valves, etc., which require insulation but come uninsulated from the manufacturer.
- C. All work of this section shall comply with Section 23 00 00 GENERAL REQUIREMENTS - HEATING, VENTILATING, AND AIR-CONDITIONING (HVAC).

1.2 REFERENCES

- A. Insulation work shall comply with the requirements of the 2013 California Energy Commission requirements.
- B. ASTM E84 – Standard Test Method for surface Burning Characteristics of Building Materials (NFPA 255).
- C. UL 723 – Test for Surface Burning Characteristics of Building Materials.
- D. UL 263 – Fire Tests of Building Construction and Materials.

1.3 SUBMITTALS

- A. Comply with Division 01 requirements in addition to Section 23 00 00 for submittals and coordinated shop drawings.
- B. Submit product data on all insulation products inclusive of R-Value, flame spread rating, developed smoke rating and locations.

PART 2 - PRODUCTS

2.1 GENERAL

- A. The type of insulation and its installation shall be in accordance with this Specification for each service and the application technique shall be as recommended by the manufacturer.
- B. Fire Rating of all insulation shall have a composite (insulation, jacket/facing and adhesive used to adhere facing or jacket to insulation) fire and smoke hazard, as tested by ASTM E84, UL 263, and UL 723, not to exceed a flame spread of 25 and smoke developed by 50.
 - 1. Accessories such as adhesives, mastics, tapes, and cements shall have the same component ratings as listed herein.
 - 2. Products shall have integral factory labeling indicating that flame spread and developed smoke ratings do not exceed the above requirements.

PART 3 – EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation products in accordance with the manufacturer's written instruction, commercial and industrial standards, and recognized industry practices to ensure that the insulation serves the intended purpose. Surfaces shall be thoroughly cleaned with all testing successfully completed prior to insulating.
- B. In addition to where specified, provide insulation by type and locations as indicated on the Drawings.
- C. After the installation of insulation protect the insulation from moisture and weather damage.
- D. Provide complete weather protection for all outdoor piping insulation.

3.2 INSULATION LOCATIONS

- A. Apply insulation by type and location as follows:
 - 1. Ductwork Insulation
 - a. Insulate supply, return, and outside air ductwork located in concealed and/or interstitial spaces.
 - 1) Provide metal jacketing at locations exposed to weather.
 - 2. Refrigerant Piping (Direct-Expansion) Insulation:
 - a. Insulate liquid line and suction/gas piping at all locations. Liquid line and a suction/gas line shall be insulated separately with insulation thickness in accordance with 2022 California Energy Code, Section 120.3 requirements.
 - 1) Provide metal jacketing at locations exposed to weather.
 - 3. Condensate Piping (Mitsubishi Systems):
 - a. Insulate drainage piping within attic and/or interstitial spaces us 1/2" thickness using polyethylene foam insulation.

3.3 PIPING APPLICATION

- A. Apply insulation to clean dry pipes after all pressure tests have been completed. Firmly butt all joints of insulation and seal all joints per manufacturer's recommendations.
- B. Hangers and supports shall be provided with metal pipe saddles to hold calcium silicate blocks in position and provide an even transition between the insulation,

blocking, pipe hanger and adjacent fiberglass insulation. Extend vapor barrier across all calcium silicate pipe blocking including through pipe hanger.

- C. Metal jacketing shall extend over PVC jacketing or vapor barrier, down through roof. Longitudinal seals shall provide a 3 inch overlap installed at the 9 o'clock or 3 o'clock positions to shed water. Butt joints shall be overlapped a minimum of 3 inches in a manner to prevent entry of water. Seal metal jacketing with $\frac{3}{4}$ inch stainless steel sealing bands installed on 12 inch centers, minimum, along the metal jacket. Locate strap joints to prevent personnel contact. Metal jacket on valves and flanges shall be removable without disturbing the adjacent jacket.
- D. Extend piping insulation without interruption through walls, floors and similar penetrations.
- E. Provide adequate ventilation during initial start-up of piping systems to remove smoke and odor given off when the organic binders in the insulation are initially heated.

3.4 AFTER INSTALLATION CHECK

- A. Visually inspect the complete installation and repair or replace any improperly sealed joints.
- B. Where there is evidence of vapor barrier failure or wet insulation after installation the damaged insulation shall be removed, the surfaces shall be cleaned and dried and the new insulation shall be installed.

END OF SECTION 23 07 00

SECTION 23 08 01 - HVAC COMMISSIONING

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Provide complete commissioning services for the all components associated with the Heating, Ventilating and Air Conditioning equipment, distribution and systems in accordance with the AABC Commissioning Guidelines and the requirements herein.
- B. All work of this section shall comply with;
 - 1. Division 01 General Requirements
 - 2. Division 22 Plumbing
 - 3. Section 23 00 00 General Requirements - Heating, Ventilating & Air Conditioning (HVAC)
 - 4. ACG Commissioning Guideline

1.2 COMMISSIONING PROCESS

- A. The commissioning process is a systematic method of ensuring a building's HVAC systems function as designed and generally acts as the third-party verification for owner acceptance.
- B. Generally, the standard commissioning process mandates the commissioning agent (CxA) to be retained independently by the owner. As there is no third-party commissioning agent for this project, the commissioning team for this project shall consist of:
 - 1. Commissioning Agent: Mechanical Engineer of Record (MEOR)
 - 2. Commissioning Contractor(s): HVAC & General Contractor
 - 3. Owner's Agent: Owner's Project Manager (PM)
- C. HVAC and General Contractor must review Part 2 of this specification for system to be commissioned and reference Part 3 of this specification for testing requirements.

1.3 COMMISSIONING AGENCY

- A. The commissioning agency (CA) has **NOT** been contracted directly with the owner for this project and the MEOR shall act as the CxA and CA. The CA has overall responsibility for planning and coordinating the commissioning process. However commissioning involves all parties to the design and construction process, including the contractor.

1.4 CONTRACTOR RESPONSIBILITY

- A. This Section of the specifications defines the contractor's responsibilities with respect to the commissioning process. Each contractor and sub-contractor shall review this Section, and shall include in their bids for carrying out the work described, as it applies to each Division and Section of these specifications, individually and collectively.

1.5 DESCRIPTION OF WORK

- A. The purpose of the commissioning process is to provide the owner/operator of the facility with assurance that the mechanical systems have been installed according to the contract documents and operate within the performance guidelines set out in the specifications. The commissioning process does not take away or reduce the responsibility of the installing contractors to provide a finished product, installed and fully functional in accordance with the contract documents.
- B. Commissioning is intended to enhance the quality of system start-up and aid in the orderly completion and transfer of systems for beneficial use by the owner. The CxA will be the leader of the commissioning team, planning and coordinating all commissioning activities in conjunction with the design professionals, construction manager, subcontractors, manufacturers and equipment suppliers.
- C. The General Contractor, Mechanical Contractor, all Division 23 sub-contractors, and the Electrical Contractor shall be responsible for cooperating, and coordinating their work, with the CA. They shall also be responsible for carrying out all the physical activities required for installation of components and systems, and operating them during the commissioning process as required in this Section.

1.6 RELATED DOCUMENTS

- A. Drawings and general provisions of the contract, including general and supplementary conditions, general mechanical provisions and applicable Division 23 specification sections, apply to work of this section

PART 2 – PRODUCTS

2.1 HVAC SYSTEMS TO BE COMMISSIONED

- A. HVAC systems installed under this contract are to be observed, tested, and signed-off as complete and operational, and operated for commissioning agent verification as described in Part 3 of this Section. This includes, but is not necessarily limited to the work listed for each system:
 - 1. Split and refrigerant/direct-expansion piping systems – work includes installation inspections and checks; pressure tests and documentation; confirmation of refrigerant quantity/pounds; confirmation of subcooling and superheat within manufacturer’s tolerances; seismic restraints installation certification. Refer to Functional Performance Test checklist #X in 2.3.
 - 2. Duct and air-handling systems – work includes installation inspections and checks; confirmation of flow balancing completion; leak testing as applicable; seismic restraints installation certification. Refer to Functional Performance Test checklists #X through #Y in 2.3.
 - 3. Energy Recovery Ventilator(s) – work includes installation inspections and checks (including seismic restraints installation certification); checkout and startup by manufacturer's representative; documented performance measurements including capacity, motor amperage, controls operation, and sound levels. Refer to Systems Verification checklist #X in 2.2.
- B. The contractor shall be responsible for carrying out all work required for commissioning these systems that is defined as a contractor responsibility in Part 3 of this Section.

2.2 SEQUENCE OF OPERATIONS

- A. PFC #1 Heat Pump (HP-X)
- B. PFC #2 Fan Coil (FC-X)
- C. PFC #3 Rooftop Packaged Unit (RTU-X)
- D. PFC #4 Power Exhaust Economizer (PE-X)
- E. PFC #5 Energy Recovery Ventilator (ERV-X)

2.3 PRE-FUNCTIONAL CHECKLISTS (PFCs) FORMS

This specification contains the pre-functional checklists as listed below. For execution of forms, refer to Part 3:

- A. PFC #1 Heat Pump (HP-X)
- B. PFC #2 Fan Coil (FC-X)
- C. PFC #3 Rooftop Packaged Unit (RTU-X)
- D. PFC #4 Power Exhaust Economizer (PE-X)
- E. PFC #5 Energy Recovery Ventilator (ERV-X)

2.4 FUNCTIONAL PERFORMANCE TESTS (FPTs) FORMS

This specification contains functional performance test checklists as listed below. For execution of forms, refer to Part 3.

- A. FPT #1 Heat Pump (HP-X)
- B. FPT #2 Fan Coil (FC-X)
- C. FPT #3 Rooftop Packaged Unit (RTU-X)
- D. FPT #4 Power Exhaust Economizer (PE-X)
- E. FPT #5 Energy Recovery Ventilator (ERV-X)

PART 3 – EXECUTION

3.1 GENERAL

- A. Commissioning agent to conform to all the written requirements ACG Commissioning Group including all matrixes and letter templates for required equipment and systems.

3.2 INSTALLATION

- A. Install additional balancing dampers, balancing valves, access doors, test ports, and pressure and temperature taps required by Commissioning Authority.
- B. Place HVAC systems and equipment into full operation and continue operation during each working day of commissioning.
- C. Install replacement sheaves, belts, and impellers to obtain system performance, as requested by Commissioning Authority.
- D. Prior to start of functional performance test, install replacement filters in equipment as specified in individual section.
- E. Adjust and re-adjust all VFDs, pumps, and control valves to meet design requirements.

3.3 PRE-FUNCTIONAL CHECKLISTS (PFCs) ACTIVITIES

Contractor shall print and sign-off verification for each piece of equipment. Sampling is not allowed unless specifically addressed herein. Submit completed forms to CxA for acceptance.

- A. PFC #1 Heat Pump (HP-X)
- B. PFC #2 Fan Coil (FC-X)
- C. PFC #3 Rooftop Packaged Unit (RTU-X)
- D. PFC #4 Power Exhaust Economizer (PE-X)
- E. PFC# 5 Energy Recovery Ventilator (ERV-X)

3.4 FUNCTIONAL PERFORMANCE TESTS (FPTs) ACTIVITIES

Contractor shall print and sign-off verification for each piece of equipment. Sampling is not allowed unless specifically addressed herein. Submit forms to CxA for acceptance.

- A. FPT #1 Heat Pump (HP-X)
- B. FPT #2 Fan Coil (FC-X)
- C. FPT #3 Rooftop Packaged Unit (RTU-X)

- D. FPT #4 Power Exhaust Economizer (PE-X)
- E. FPT #5 Energy Recovery Ventilator (ERV-X)

3.5 COMMISSIONING CLOSEOUT

- A. Test equipment and systems which are affected by occupancy variations at minimum and peak loads to observe system performance.
- B. Participate in testing beyond final completion to test performance with actual occupancy conditions.
- C. Contractor shall sign-off verification of each FPT for each piece of equipment installed and commissioned as a part of this work. Commissioning sign-off forms (FPT) shall be required for filing of Notice of Completion.

END OF SECTION 23 08 01

SECTION 23 90 13 - DIRECT DIGITAL CONTROLS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. The Building Management System (BMS) manufacturer shall furnish and install a fully integrated building automation system, incorporating direct digital control (DDC) for energy management, equipment monitoring and control, and subsystems with open communications capabilities as herein specified.
- B. The installation of the control system shall be performed under the direct supervision of the manufacturer with the shop drawings, control diagrams, bill of materials, component designation or identification number and sequence of operation all bearing the name of the manufacturer. The installation contractor shall certify in writing that the shop drawings have been prepared by the equipment manufacturer and that the equipment manufacturer has supervised their installation. In addition, the equipment manufacturer shall certify, in writing, that the shop drawings were prepared by their company and that all temperature control equipment was installed under their direct supervision.
- C. All materials and equipment used shall be standard components, regularly manufactured for this and/or other systems and not custom designed especially for this project. All systems and components shall have been thoroughly tested and proven in actual use for at least two years.
- D. BMS manufacturer shall be responsible for all BMS and Temperature Control wiring for a complete and operable system. All wiring shall be done in accordance with all local and national codes.
- E. All work of this section shall comply with Section 23 00 00 GENERAL REQUIREMENTS - HEATING, VENTILATING, AND AIR-CONDITIONING (HVAC)

1.2 WORK BY OTHERS

- A. The mechanical contractor installs all components, dampers, flow stations, etc. furnished by BMS manufacturer.
- B. Electrical Contractor provides:
 - 1. 120V power to all BMS an/or Temperature control panels
 - 2. Wiring of all power feeds through all disconnect starters to electrical motor.
 - 3. Wiring of any remote start/stop switches and manual or automatic motor speed control devices not furnished by BMS manufacturer.

1.3 PRODUCTS INSTALLED BUT NOT FURNISHED UNDER THIS SECTION

- A. Refrigerant Piping
 - 1. Refrigerant leak detection system
- B. Fire Detection and Alarm
 - 1. Smoke Detectors/Fire Stats

1.4 RELATED WORK

- A. Division 01 General, Shop Drawings
- B. Division 23 HVAC
- C. Division 26 Electrical

1.5 COMMUNICATIONS WITH THIRD PARTY EQUIPMENT

- A. General: The BMS shall be capable of integrating to any third-party equipment using any of the following standard open protocols:
 - 1. BACnet (IP, SC, Arcnet, or MS/TP)
 - 2. Modbus (RTU or IP)
- B. The third-party equipment provider shall provide the details of the proposed interface including PICS for BACnet equipment, hardware and software identifiers for the interface points, network identifiers, wiring requirements, communication speeds, and required network accessories.
- C. The third-party equipment provider is responsible for furnishing and installing their interface pre-programmed and configured with the correct parameters to integrate with the BMS. These parameters include, but are not limited to the following:
 - 1. Communication protocol
 - 2. Correct communication protocol baud rate
 - 3. Points required to be viewed through the BMS. This includes ensuring the points are “in service” and visible to the BMS.
 - 4. Addressing of controller/interface. The BMS provider shall furnish the address.
- D. The third party equipment manufacturer shall include a minimum of 16 hours of onsite technical support for integration into the BMS.

1.6 QUALITY ASSURANCE

- A. The BMS system shall be designed and installed, commissioned, and serviced by manufacturer employed, factory trained personnel. The manufacturer shall have an in-place support facility within 50 miles of the site with technical staff, spare parts inventory and necessary test and diagnostic equipment. Distributors or licensed installing contractors are not acceptable.
- B. The manufacturer shall provide an onsite, experienced project manager for this work, responsible for direct supervision of the design, installation, and start up and commissioning of the BMS.
- C. The Bidder shall be regularly engaged in the manufacturing, installation, and maintenance of BMS systems and shall have a minimum of ten (10) years of demonstrated technical expertise and experience in the manufacture, installation and maintenance of B.M.S. systems similar in size and complexity to this project.
- D. Materials and equipment shall be the catalogued products of manufacturers regularly engaged in production and installation of automatic temperature control systems and shall be manufacturer's latest standard design that complies with the specification requirements.
- E. All BMS peer-to-peer network controllers, central system controllers and local user displays shall be UL Listed under Standard UL 916, category PAZX; Standard ULC C100, category UUKL7; and under Standard UL 864, categories UUKL, UDTZ, and QVAX. and be so listed at the time of bid. All floor level controllers shall comply, at a minimum, with UL Standard UL 916 category PAZX; Standard UL 864, categories UDTZ, and QVAX. and be so listed at the time of Bid.
- F. The BMS peer-to-peer network controllers and local user display shall also comply with the Australian Electromagnetic Compatibility (EMC) Framework and bear the C-Tic Mark to show compliance. The purpose of the regulation is to minimize electromagnetic interference between electronic products, which may diminish the performance of electrical products or disrupt essential communications.
- G. All electronic equipment shall conform to the requirements of FCC Regulation, Part 15, Governing Radio Frequency Electromagnetic Interference and be so labeled.
- H. The manufacturer of the building automation system shall provide documentation supporting compliance with ISO-9002 (Model for Quality Assurance in Production, Installation, and Servicing) and ISO-140001 (The application of well-accepted business management principles to the environment). The intent of this specification requirement is to ensure that the products from the manufacturer are delivered through a Quality System and Framework that will assure consistency in the products delivered for this project.
- I. This system shall have a documented history of compatibility by design for a minimum of 15 years. Future compatibility shall be supported for no less than 10 years. Compatibility shall be defined as the ability to upgrade existing field panels to

current level of technology and extend new field panels on a previously installed network.

- J. Compatibility shall be defined as the ability for any existing field panel microprocessor to be connected and directly communicate with new field panels without bridges, routers or protocol converters.

1.7 CODES AND STANDARDS

- A. Work, materials, and equipment shall comply with the most restrictive of local, state, and federal authorities' codes and ordinances or these plans and specifications. As a minimum, the installation shall comply with the current editions in effect 30 days prior to the receipt of bids of the following codes:
 - 1. National Electric Code (NEC)
 - 2. International Building Code (IBC)
 - 3. International Mechanical Code (IMC)
 - 4. Underwriters Laboratories (UL/CUL)
 - 5. ANSI/ASHRAE Standard 135, BACnet - A Data Communication Protocol for Building Automation and Control Systems

1.8 SYSTEM PERFORMANCE

- A. Performance Standards. System shall conform to the following minimum standards over network connections. Systems shall be tested using manufacturer's recommended hardware and software for display through the user's web browser.
 - 1. Graphic Display. A graphic with 20 dynamic points shall display with current data within 10 sec.
 - 2. Graphic Refresh. A graphic with 20 dynamic points shall update with current data within 8 sec. and shall automatically refresh every 15 sec.
 - 3. Configuration and Tuning Screens. Screens used for configuring, calibrating, or tuning points, PID loops, and similar control logic shall automatically refresh within 6 sec.
 - 4. Object Command. Devices shall react to command of a binary object within 2 sec. Devices shall begin reacting to command of an analog object within 2 sec.
 - 5. Alarm Response Time. An object that goes into alarm shall be annunciated at the browser within 45 sec.
 - 6. Program Execution Frequency. Custom and standard applications shall be capable of running as often as once every 5 sec.

7. Performance. Programmable controllers shall be able to completely execute DDC PID control loops at a frequency adjustable down to once per sec. Select execution times consistent with the mechanical process under control.
8. Multiple Alarm Annunciation. Each user, connected to network accessing the system through their browser (workstation), shall receive alarms within 5 seconds of one another.
9. Reporting Accuracy. BMS Manufacturer shall submit accuracy values with minimum end-to-end accuracy for all control devices and/or sensors.
10. Control Stability and Accuracy. BMS Manufacturer shall submit with minimum end-to-end accuracy for all control devices and/or sensors.

1.9 SUBMITTALS

- A. Product Data and Shop Drawings: The contractor shall provide shop drawings and product data on hardware, software, and equipment to be installed or provided. No work may begin on any segment of this project until submittals have been approved for conformity with design intent. Provide submittal data in a digital format on suitable digital media such as a USB drive. The submittal data shall be in standard Microsoft (Word, Excel, etc.) or PDF file formats. The shop drawings shall be formatted to fit on 11" x 17" pages and hardware/software product data shall be formatted to fit on 8.5" x 11" pages. When manufacturer's cutsheets apply to a product series rather than a specific product, the data specifically applicable to the project shall be highlighted or clearly indicated by other means. Each submitted piece of literature and drawing shall clearly reference the specification and/or drawing that the submittal is to cover. General catalogs shall not be accepted as cutsheets to fulfill submittal requirements. Select and show submittal quantities appropriate to scope of work. Submittal approval does not relieve Contractor of responsibility to supply sufficient quantities to complete work. Submittals shall be provided within 12 weeks of contract award. Submittals shall include:

1. DDC System Hardware

- a. A complete bill of materials to be used indicating quantity, manufacturer, model number, and relevant technical data of equipment to be used.
- b. Manufacturer's description and technical data such as performance curves, product specifications, and installation and maintenance instructions for items listed below and for relevant items not listed below:
 1. Direct digital controllers (controller panels)
 2. Transducers and transmitters
 3. Sensors (including accuracy data)
 4. Actuators
 5. Valves

6. Relays and switches
 7. Control panels
 8. Power supplies
 9. Batteries
 10. Operator interface equipment
 11. Wiring
- c. Wiring diagrams and layouts for each control panel. Show termination numbers.
- d. Schematic diagrams for all field sensors and controllers. Provide floor plans of all sensor locations and control hardware. Riser diagrams showing control network layout, communication protocol, and wire types.
2. Central System Hardware and Software
- a. A complete bill of material of equipment used indicating quantity, manufacturer, model number, and relevant technical.
- b. Manufacturer's description and technical data such as product specifications and installation and maintenance instructions for items listed below and for relevant items furnished under this contract not listed below:
1. Central Processing Unit (CPU) or web server
 2. Monitors
 3. Keyboards
 4. Power supplies
 5. Battery backups
 6. Interface equipment between CPU or server and control panels
 7. Operating System software - web server
 8. Color graphic software
 9. Third-party software
- c. Schematic diagrams for all control, communication, and power wiring. Provide a schematic drawing of the central system installation. Label all cables and ports with computer manufacturers' model numbers and functions. Show interface wiring to control system.
- d. Network riser diagrams of wiring between central control unit and control panels.

3. Controlled Systems
 - a. Riser diagrams showing control network layout, communication protocol, and wire types.
 - b. A schematic diagram of each controlled system. The schematics shall have all control points labeled with point names shown or listed. The schematics shall graphically show the location of all control elements in the system.
 - c. A schematic wiring diagram of each controlled system. Label control elements and terminals. Where a control element is also shown on control system schematic, use the same name.
 - d. An instrumentation list (Bill of Materials) for each controlled system. List each control system element in a table. Show element name, type of device, manufacturer, model number, and product data sheet number.
 - e. A mounting, wiring, and routing plan-view drawing. The design shall take into account HVAC, electrical, and other systems' design and elevation requirements. The drawing shall show the specific location of all concrete pads and bases and any special wall bracing for panels to accommodate this work.
 - f. A complete description of the operation of the control system, including sequences of operation. The description shall include and reference a schematic diagram of the controlled system.
 - g. A point list for each control system. List I/O points and software points required to provide specified sequence of operations. Indicate alarmed and trended points.
 4. Quantities of items submitted shall be reviewed but are the responsibility of the Contractor.
 5. BACnet Protocol Implementation Conformance Statement (PICS) for each submitted type of controller and operator interface.
- B. Project Documentation.
1. Upon completion of installation, submit record (as-built) documents for approval before final completion. Provide record documents in a digital format on suitable digital media such as a USB drive. The record documents shall be in standard Microsoft (Word, Excel, etc.) or PDF file formats except as noted below. Record documentation shall include the following:
 - a. Project Record Drawings.
 - b. Testing and Commissioning Reports and Checklists.

- c. Operation and Maintenance (O&M) Manual.
 - d. As-built versions of submittal product data.
 - e. Names, addresses, and telephone numbers of installing contractors and service representatives for equipment and control systems.
 - f. Operator's manual with procedures for operating control systems: logging on and off, handling alarms, producing point reports, trending data, overriding computer control, and changing setpoints and variables.
 - g. Programming manual or set of manuals with description of programming language and syntax, of statements for algorithms and calculations used, of point database creation and modification, of program creation and modification, and of editor use.
 - h. Engineering, installation, and maintenance manual or set of manuals that explains how to design and install new points, panels, and other hardware; how to perform preventive maintenance and calibration; how to debug hardware problems; and how to repair or replace hardware.
 - i. Documentation of programs operating in the system and object database that can be viewed using technician software tools furnished with system.
 - j. Graphic files, programs, and database to be viewed using technician software tools furnished with system.
 - k. List of recommended spare parts with part numbers and suppliers.
 - l. Complete original-issue documentation, installation, and maintenance information for furnished third-party hardware including computer equipment and sensors.
 - m. Complete original-issue copies of furnished software, including operating systems, custom programming language, operator workstation or web server software, and graphics software.
 - n. Licenses, guarantees, and warranty documents for equipment and systems.
 - o. Recommended preventive maintenance procedures for system components, including schedule of tasks such as inspection, cleaning, and calibration; time between tasks; and task descriptions.
2. Load into the control system for access by the operator through any operator workstation closeout documentation. There shall be a menu or navigation tab to access the documentation. The documentation can be

loaded into the control system in a pdf format. The following documentation shall be included:

- a. As-built control diagrams including wiring diagrams and sequences of operations for each controller/piece of equipment.
- b. All IOM data as follows:
 1. IOM from each equipment manufacturer for each piece of equipment (AHUs, FCUs, Chillers, pumps etc.)
 2. IOM for each control module and end device installed in the system.
- C. Training Materials: Provide course outline and materials for each class at least six weeks before first class. Training shall be furnished via instructor-led sessions, computer-based training, or web-based training. Engineer will modify course outlines and materials if necessary to meet Owner's needs. Engineer will review and approve course outlines and materials at least three weeks before first class.

1.10 WARRANTY

- A. Provide all services, materials, and equipment necessary for the successful operation of the entire BMS system for a period of one year after system completion.
- B. Warrant work as follows:
 1. Warrant labor and materials for specified control system free from defects for a period of 12 months after final acceptance. Control system failures during warranty period shall be adjusted, repaired, or replaced at no additional cost or reduction in service to Owner. Respond during normal business hours within 24 hours of Owner's warranty service request.
 2. Work shall have a single warranty date, even if Owner receives beneficial use due to early system start-up. If specified work is split into multiple contracts or a multi-phase contract, each contract or phase shall have a separate warranty start date and period.
 3. If the engineer determines that equipment and systems operate satisfactorily at the end of final start-up, testing, and commissioning phase, the engineer will certify in writing that control system operation has been tested and accepted in accordance with the terms of this specification. Date of acceptance shall begin warranty period.
 4. All Manufacturer's software/firmware for web server/workstation and controllers shall be updated to the latest versions that are available from the manufacturer within 30 days from the date of end of the warranty. These updates shall be installed and checked out before the end of the warranty.
 5. Provide updates to web server software, project-specific software, graphic software, database software, and firmware that resolve the contractor-

identified software deficiencies at no charge during warranty period. If available, Owner can purchase in-warranty service agreement to receive upgrades for functional enhancements associated with above-mentioned items. Do not install updates or upgrades without Owner's written authorization.

6. Exception: Contractor shall not be required to warrant reused devices except those that have been rebuilt or repaired and factory recertified. Installation labor and materials shall be warranted. Demonstrate operable condition of reused devices at time of Engineer's acceptance.

1.11 APPLICABLE PUBLICATIONS

The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.

- A. American Society of Heating, Refrigeration and Air Conditioning Engineers.
- B. National Fire Protection Association (NFPA):
 1. 90A-09 Standard for the Installation of Air Conditioning and Ventilating Systems.
- C. Underwriters Laboratories, Inc. (UL):
 1. 181-08 UL Standard for Safety Factory-Made Air Ducts and Connectors.

PART 2 – PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Automated Logic (ALC). Any proposed substitution must be pre-approved prior to bidding utilizing the pre-bid substitution form, if available. If not available, owner has deemed the product as a client-wide standards.
- B. No substitutions or equals will be accepted with pre-approval.

2.2 SYSTEM ARCHITECTURE

- A. The design of the BMS must connect to, and provide full operability, of the existing ALC network throughout the client properties to a single user interface, location as selected by owner.
- B. The system shall be configured as a distributed processing network(s) capable of expansion as specified below.
- C. The design of BMS shall allow the co-existence of new Primary controllers with existing Primary controllers in the same network without the use of gateways or protocol converters.
- D. Interbuilding LAN
 - 1. Interbuilding LAN: Used for communication between Primary Controller LANs located in each building, and multiple networked Operator Workstations located in selected buildings. The LAN will consist of using Ethernet backbone TCP/IP protocol. EMS workstation(s) shall employ native TCP/IP protocol with the Ethernet 10baseT (IEEE802.3) physical layer standard. The Apogee Ethernet Microserver (AEM) shall employ native TCP/IP on the Ethernet. The AEM should not require third party routers, gateways, or translators for TCP/IP protocol for Interbuilding and Primary LAN's.
 - 2. Primary Controller LAN: Used to control Primary Controllers which generally control central plant equipment, air handling within a building. This LAN may be Ethernet or a separate high-speed peer-to-peer network. The AEM shall employ native TCP/IP on the Ethernet.
 - 3. Secondary Controller LAN: Polling or peer-to-peer LAN to support Terminal Control Units/application specific controllers and interfaces to other third-party LANs. The secondary controller LAN shall interconnect with the Primary Controller LAN.

2.3 MATERIALS

- A. Use new products the manufacturer is currently manufacturing and selling for use in new installations. Do not use this installation as a product test site unless

explicitly approved in writing by Owner. Spare parts shall be available for at least five years after completion of this contract.

2.4 COMMUNICATION

- A. Control products, communication media, connectors, repeaters, hubs, and routers shall comprise a BACnet internetwork. Controller and operator interface communication shall conform to ANSI/ASHRAE Standard 135, BACnet.
- B. All IP based controllers shall be capable of providing IPv4 and IPv6 protocol standards as defined by the Internet Data Communications Standard.
- C. The BMS contractor shall furnish and install all communication media, connectors, repeaters and network switches/routers, and network devices necessary to provide a complete and workable control network for both high speed Ethernet communications network/LAN and serial networks. The control network shall adhere to the owner's testing, labeling, administration, and documentation requirements established and presented for the site. The dedicated control's network shall be capable of connecting to a separate owner/customer LAN.
- D. Each controller shall have a communication port for temporary connection to a laptop computer or other operator interface. Connection shall support memory downloads and other commissioning and troubleshooting operations.
- E. Internetwork operator interface and value passing shall be transparent to internetwork architecture.
 - 1. An operator interface connected to a controller shall allow the operator to interface with each internetwork controller as if directly connected. Controller information such as data, status, and control algorithms shall be viewable and editable from each internetwork controller.
 - 2. Inputs, outputs, and control variables used to integrate control strategies across multiple controllers shall be readable by each controller on the internetwork. Program and test all cross-controller links required to execute specified sequences of operation. An authorized operator shall be able to edit cross-controller links by typing a standard object address or by using a point-and-click interface.
- F. BACnet Secure Connect (BACnet/SC). BACnet/SC is a datalink option that makes the full use of TLS WebSocket connections as defined by addendum to the ANSI/ASHRAE Standard 135.
 - 1. The BMS contractor shall furnish and install a network designed to allow for implementation of BACnet/SC. The network shall be installed with as many devices capable of using BACnet/SC at time of installation.
 - 2. The BMS contractor shall furnish and install all BACnet workstations/servers, routers, and building controllers capable of using BACnet/SC. Any BACnet workstations/servers, routers, or building

controllers that do not have BACnet/SC capability at time of installation shall have the ability to provide BACnet/SC capability with a software/firmware update/patch. BACnet/SC capability shall not require the physical replacement of the BACnet workstation/server, router, or building controller hardware.

- G. Building Control Panels, and Controllers with real-time clocks shall use the BACnet Time Synchronization service. System shall automatically synchronize system clocks daily from an operator-designated device via the internetwork. The system shall automatically adjust for daylight saving and standard time as applicable.
- H. System shall be expandable to at least twice the required BACnet objects. No additional licensing/software fees shall be required to add controllers, associated devices, and wiring.
- I. System shall support Web services data exchange with any other system that complies with XML (extensible markup language) and SOAP (simple object access protocol) standards. Web services support shall as a minimum be provided at the workstation or web server level and shall enable data to be read from or written to the system.
 - 1. System shall support Web services read data requests by retrieving requested trend data or point values (I/O hardware points, analog value software points, or binary value software points) from any system controller or from the trend history database.
 - 2. System shall support Web services write data request to each analog and binary object that can be edited through the system operator interface by downloading a numeric value to the specified object.
 - 3. For read or write requests, the system shall require user name and password authentication and shall support TLS (Transport Layer Security) or equivalent data encryption.
 - 4. System shall support discovery through a Web services connection or shall provide a tool available through the Operator Interface that will reveal the path/identifier needed to allow a third party Web services device to read data from or write data to any object in the system which supports this service.

2.5 OPERATOR INTERFACE

- A. Operator Interface. The web server shall reside on high-speed network with building controllers. Web pages generated by this server shall be compatible with the latest versions of Microsoft Internet Explorer or Edge, Google Chrome, Mozilla Firefox, and Apple Safari browsers. Any of these supported browsers connected to the server shall be able to access all system information. Mobile devices shall be recognized by the web server and shall supply the appropriate system content as needed. The Operator Interface (web server with client devices) shall conform to the BACnet Operator Workstation (B-OWS) or BACnet Advanced Workstation (B-

AWS) device profile as specified in ASHRAE/ANSI 135 BACnet Annex L. This includes the ability to configure and/or reconfigure the system from the client device (change programs, graphics, labels, etc.).

- B. Communication. Web server and controllers shall communicate using BACnet protocol, including BACnet/SC. Web server and control network backbone shall communicate using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol and BACnet/IP addressing as specified in ANSI/ASHRAE 135, BACnet Annex J. Communication between the web server and client (workstation) shall be HTTP or HTTPS protocol utilizing HTML5 language. Use of Adobe Flash in any part of the communication infrastructure is not acceptable.
- C. Hardware.
 - 1. Web server and/or workstation. Industry-standard hardware shall meet or exceed DDC system manufacturer's recommended specifications and shall meet response times specified elsewhere in this document. The web server may also be configured in client/server fashion to accommodate a "workstation" definition. In "workstation" configuration, the workstation will also perform as a server supplying additional clients as needed. The following hardware requirements apply:
 - a. System storage shall have sufficient memory to accommodate:
 - 1. All required system software.
 - 2. A DDC database to accommodate, as a minimum, twice the size of the delivered system database.
 - 3. One year of archival trend data based on the points specified to be trended at their specified trend intervals.
 - b. Provide additional hardware (communication ports, video drivers, network interface cards, cabling, etc.) to facilitate all control functions and software requirements specified for the DDC system.
 - c. Minimum hardware configuration shall include the following:
 - 1. Quad Core Processor
 - 2. 4-24 GB RAM (size dependent on size of system)
 - 3. 500 GB hard disk providing data at 3.0 Gb/sec (size dependent on historical data storage requirements)
 - 4. 16x DVD+/-RW drive
 - 5. Qwerty Keyboard
 - 6. Optical Mouse
 - 7. 24-inch LED Color monitor with 75Hz refresh rate and 1080P resolution to provide a minimum screen resolution of 1920 x 1080 pixels.

8. Serial (USB) and network communication ports, with cables as required for proper DDC system operation.

D. System Software.

1. Operating System. Web server shall have an industry-standard professional-grade operating system. Operating system shall meet or exceed the BMS manufacturer's minimum requirements for their software. Acceptable systems include Microsoft Windows 8.1 or 10, Windows Server 2012 R2 or 2016 or 2019 or 2020, Red Hat Enterprise Linux 8.3, or Ubuntu Desktop 18.04 or 20.04 LTS.
2. Security. The web server application shall support Transport Layer Security (TLS) 1.3 capable of encryption of up to 256 bit elliptical curve for transmitting private information over the Internet using HTTPS. Additionally, the web server shall have SHA-2 certificate support capability.
3. Database. System shall support any JDBC (Java Database Connectivity) compliant engine. This includes: MS SQL, My SQL, Apache Derby, PostgreSQL and Oracle.
4. The BMS system shall allow an unlimited number of concurrent users.
5. The BMS manufacturer shall provide all software and tools necessary to provide the following capabilities:
 - a. Create and/or edit any programming used in controllers
 - b. Create and/or edit any graphics used in the system
 - c. Software shall not be subscription based and be given to owner at time of turnover. If software is subscription based, manufacturer shall include 10 years of subscription service.
 - d. The owner shall have the ability to install software on a minimum of five (5) additional owner furnished computers without additional licenses or fees.
6. System Graphics. The operator interface software shall be graphically based and shall include at least one graphic per piece of equipment or occupied zone, graphics for each chilled water and hot water system, and graphics that summarize conditions on each floor of each building included in this contract. Indicate thermal comfort on floor plan summary graphics using dynamic colors to represent zone temperature relative to zone setpoint.
 - a. Minimum graphics resolution shall be 1920 x 1080 for display of detailed system graphics.

- b. Floor Plan Graphics. Floor plan graphics shall be capable of allowing the floor plan graphic to dynamically size relative to the end user's monitor resolution.
 - c. Functionality. Graphics shall allow operator to monitor system status, to view a summary of the most important data for each controlled zone or piece of equipment, to use point-and-click navigation between zones or equipment, and to edit setpoints and other specified parameters.
 - d. Animation. Graphics shall be able to animate by displaying different image files for changed object status.
 - e. Alarm Indication. Indicate areas or equipment in an alarm condition using color or other visual indicator.
 - f. Format. Graphics shall be saved in an industry-standard format such as BMP, JPEG, PNG, GIF, or SVG. Web-based system graphics shall be viewable on browsers compatible with World Wide Web Consortium browser standards. Web graphic format shall require no plug-in or shall only require widely available no-cost plug-ins.
7. Custom Graphics. Custom graphic files shall be created with the use of a graphics generation package furnished with the system. The graphics generation package shall be a graphically based system used to create and modify graphics that are saved in the same formats as are used for system graphics.
8. Graphics Library. Furnish a complete library of standard HVAC equipment graphics such as chillers, boilers, air handlers, terminals, fan coils, and unit ventilators. This library also shall include standard symbols for other equipment including fans, pumps, coils, valves, piping, dampers, and ductwork. The library shall be furnished in a file format compatible with the graphics generation package program.
- E. System Applications. System shall provide the following functionality to authorized operators as an integral part of the operator interface or as stand-alone software programs. If furnished as part of the interface, the tool shall be available from each workstation or web browser interface. If furnished as a stand-alone program, software shall be installable on a standard PC type personal computer with no limit on the number of copies that can be installed under the system license.
1. Automatic System Database Configuration. Each workstation or web server shall store on its hard disk a copy of the current system database, including controller firmware and software. Stored database shall be automatically updated with each system configuration or controller firmware or software change.
 2. Manual Controller Memory Download. Operators shall be able to download memory from the system database to each controller.

3. System Configuration. The workstation software shall provide a method of configuring the system. This shall allow for future system changes or additions by users under proper password.
4. On-Line Help. Provide a context-sensitive, on-line help system to assist the operator in operating and editing the system. On-line help shall be available for all applications and shall provide the relevant data for that particular screen. Additional help information shall be available through the use of hypertext.
5. Security. Each operator shall be required to log on to the system with user name and password in order to view, edit, add, or delete data.
 - a. Operator Access. The user name and password combination shall define accessible viewing, editing, adding, and deleting privileges for that operator. Users with system administrator rights shall be able to create new users and edit the privileges of all existing users. System administrators shall also be able to vary and deny each operator's privileges based on the geographic location, such as the ability to edit operating parameters in Building A, to view but not edit parameters in Building B, and to not even see equipment in Building C.
 - b. Password Policy Rules. System administrator shall invoke policies for minimum password strength, including number of characters, special characters and numbers, upper and lower case, etc.
 - c. Automatic Log Out. Automatically log out each operator if no keyboard or mouse activity is detected. This auto logoff time period shall be user-adjustable.
 - d. Encrypted Security Data. Store system security data including operator passwords in an encrypted format. System shall not display operator passwords.
6. System Diagnostics. The system shall automatically monitor the operation of all building management panels and controllers. The failure of any device shall be annunciated to the operator.
7. Alarm Processing. System input and status objects shall be configurable to alarm on departing from and on returning to normal state. Operator shall be able to enable or disable each alarm and to configure alarm limits, alarm limit differentials, alarm states, and alarm reactions for each system object. Configure and enable alarm points as required by sequences of operation. Alarms shall be BACnet alarm objects and shall use BACnet alarm services. BMS system shall be capable of assigning alarm sources to categories such as HVAC Critical, or HVAC General. The BMS shall include at a minimum HVAC and FDD categories. BMS system shall allow user to create custom alarm categories.

8. Alarm Messages. Alarm messages shall use the English language descriptor for the object in alarm in such a way that the operator will be able to recognize the source, location, and nature of the alarm without relying on acronyms or mnemonics.
9. Alarm Reactions. Operator shall be able to configure (by object) what, if any actions are to be taken during an alarm. As a minimum, the workstation or web server shall be able to log, print, start programs, display messages, send e-mail, send SMS text, and audibly announce.
10. Alarm and Event log. Operators shall be able to view all system alarms and changes of state from any location in the system. Events shall be listed chronologically. An operator with the proper security level may acknowledge and delete alarms, and archive closed alarms to the workstation or web server hard disk.
11. Trend Logs. The operator shall be able to configure trend sample or change of value (COV) interval, start time, and stop time for each system data object and shall be able to retrieve data for use in spreadsheets and standard database programs. Controller shall sample and store trend data and shall be able to archive data to the hard disk. Configure trends as specified by the sequences of operation. Trends shall be BACnet trend objects.
12. Object and Property Status and Control. Provide a method for the operator to view, and edit if applicable, the status of any object or property in the system. The status shall be available by menu, on graphics, or through custom programs.
13. Reports and Logs. Operator shall be able to select, to modify, to create, and to print reports and logs. Operator shall be able to store report data in a format accessible by standard spreadsheet and word processing programs.
14. Audit and Security Detail. All users accessing the system shall have their actions recorded. Information recorded shall include:
 - a. Login/logout time and date
 - b. System modifications - with before and after values
 - c. Ability to report user activity based on individual and/or date and time.
15. Standard Reports. Furnish the following standard system reports:
 - a. Objects. System objects and current values filtered by object type, by status (in alarm, locked, normal), by equipment, by geographic location, or by combination of filter criteria.
 - b. Alarm Summary. Current alarms and closed alarms. System shall retain closed alarms for an adjustable period.

- c. Logs. System shall log the following to a database or text file and shall retain data for an adjustable period:
 1. Alarm History.
 2. Trend Data. Operator shall be able to select trends to be logged.
 16. Custom Reports. Operator shall be able to create custom reports that retrieve data, including archived trend data, from the system, that analyze data using common algebraic calculations, and that present results in tabular or graphical format. Reports shall be launched from the operator interface. Operator shall be able to schedule reports to automatically run and be emailed to recipients on a recurring basis from the BMS system.
- F. Workstation Application Editors. Each PC or browser workstation shall support editing of all system applications. The applications shall be downloaded and executed at one or more of the controller panels.
 1. Controller. Provide a full-screen editor for each type of application that shall allow the operator to view and change the configuration, name, control parameters, and set points for all controllers.
 2. Scheduling. An editor for the scheduling application shall be provided at each workstation. Provide a method of selecting the desired schedule and schedule type. Exception schedules and holidays shall be shown clearly on the calendar. The start and stop times for each object shall be adjustable from this interface.
 3. Custom Application Programming. Provide the tools to create, edit, debug, and download custom programs. System shall be fully operable while custom programs are edited, compiled, and downloaded. Programming language shall have the following features:
 - a. Language. Language shall be graphically based or English oriented. If graphically based, language shall use function blocks arranged in a logic diagram that clearly shows control logic flow. Function blocks shall directly provide functions listed below, and operators shall be able to create custom or compound function blocks. If English language oriented, language shall be based on the syntax of BASIC, FORTRAN, C, or PASCAL, and shall allow for free-form programming that is not column-oriented or "fill-in-the-blanks."
 - b. Programming Environment. Tool shall provide a full-screen, cursor-and-mouse-driven programming environment that incorporates word processing features such as cut and paste. Operators shall be able to insert, add, modify, and delete custom programming code, and to copy blocks of code to a file library for reuse in other control programs.

- c. Independent Program Modules. Operator shall be able to develop independently executing program modules that can disable, enable and exchange data with other program modules.
- d. Debugging and Simulation. Operator shall be able to step through the program observing intermediate values and results. Operator shall be able to adjust input variables to simulate actual operating conditions. Operator shall be able to adjust each step's time increment to observe operation of delays, integrators, and other time-sensitive control logic. Debugger shall provide error messages for syntax and for execution errors.
- e. Conditional Statements. Operator shall be able to program conditional logic using compound Boolean (AND, OR, and NOT) and relational (EQUAL, LESS THAN, GREATER THAN, NOT EQUAL) comparisons.
- f. Mathematical Functions. Language shall support floating-point addition, subtraction, multiplication, division, and square root operations, as well as absolute value calculation and programmatic selection of minimum and maximum values from a list of values.
- g. Variables. Operator shall be able to use variable values in program conditional statements and mathematical functions.
 - 1. Time Variables. Operator shall be able to use predefined variables to represent time of day, day of the week, month of the year, and date. Other predefined variables or simple control logic shall provide elapsed time in seconds, minutes, hours, and days. Operator shall be able to start, stop, and reset elapsed time variables using the program language.
 - 2. System Variables. Operator shall be able to use predefined variables to represent status and results of Controller Software and shall be able to enable, disable, and change setpoints of Controller Software as described in Controller Software section.

2.6 CONTROLLER SOFTWARE

- A. All controller software applications shall reside and operate in the system controllers.
- B. All application software in controllers furnished by BMS manufacturer shall be editable through operator workstation, web browser interface, or workstation.
- C. Each controller furnished by BMS manufacturer shall have all of its local on-board software applications backed up and saved to the BMS web server. In the event of a controller failure, the BMS server shall download backed up software applications to replacement controller. Controllers furnished by others and integrated into the BMS are not required to be backed up to BMS server.

- D. Furnish the following applications for building and energy management:
1. System Security
 2. Scheduling. Provide the capability to execute control functions according to a user created or edited schedule. Each schedule shall provide the following schedule options as a minimum:
 - a. Weekly Schedule. Provide separate schedules for each day of the week. Each schedule shall be able to include up to 5 occupied periods (5 start-stop pairs or 10 events).
 - b. Exception Schedules. Provide the ability for the operator to designate any day of the year as an exception schedule. Exception schedules may be defined up to a year in advance. Once an exception schedule has executed, the system shall discard and replace the exception schedule with the standard schedule for that day of the week.
 - c. Holiday Schedules. Provide the capability for the operator to define up to 24 special or holiday schedules. These schedules will be repeated each year. The operator shall be able to define the length of each holiday period.
 3. System Coordination. Operator shall be able to group related equipment based on function and location and to use these groups for scheduling and other applications.
 4. Binary Alarms. Each binary object shall have the capability to be configured to alarm based on the operator-specified state. Provide the capability to automatically and manually disable alarming.
 5. Analog Alarms. Each analog object shall have both high and low alarm limits. The operator shall be able to enable or disable these alarms.
 6. Alarm Reporting. The operator shall be able to determine the action to be taken in the event of an alarm. An alarm shall be able to start programs, print, be logged in the event log, generate custom messages, and display on graphics.
 7. Remote Communication. System shall automatically contact operator workstation or server on receipt of critical alarms. If no network connection is available, system shall use a modem connection.
 8. Demand Limiting.
 - a. The demand-limiting program shall monitor building power consumption from a building power meter (provided by others) which generates pulse signals or a BACnet communications interface. An acceptable alternative is for the system to monitor a

- watt transducer or current transformer attached to the building feeder lines.
- b. When power consumption exceeds adjustable levels, system shall automatically adjust setpoints, de-energize low-priority equipment, and take other programmatic actions to reduce demand as specified in in sequences of operation. When demand drops below adjustable levels, system shall restore loads as specified.
9. Maintenance Management. The system shall be capable of generating maintenance alarms when equipment exceeds adjustable runtime, equipment starts, or performance limits. Configure and enable maintenance alarms as specified in sequences of operation.
 10. Sequencing. Application software shall sequence chillers, boilers, and pumps as specified in sequences of operation.
 11. PID Control. System shall provide direct- and reverse-acting PID (proportional-integral-derivative) algorithms. Each algorithm shall have anti-windup and selectable controlled variable, setpoint, and PID gains. Each algorithm shall calculate a time-varying analog value that can be used to position an output or to stage a series of outputs. The calculation interval, PID gains, and other tuning parameters shall be adjustable by a user with the correct security level.
 12. Staggered Start. System shall stagger controlled equipment restart after power outage. Operator shall be able to adjust equipment restart order and time delay between equipment restarts.
 13. Energy Calculations.
 - a. The system shall accumulate and convert instantaneous power (kW) or flow rates (L/s [gpm]) to energy usage data.
 - b. The system shall calculate a sliding-window average (rolling average). Operator shall be able to adjust window interval to 15 minutes, 30 minutes, or 60 minutes.
 14. Anti-Short Cycling. All binary output objects shall be protected from short cycling by means of adjustable minimum on-time and off-time settings.
 15. On and Off Control with Differential. Provide an algorithm that allows a binary output to be cycled based on a controlled variable and a setpoint. The algorithm shall be direct-acting or reverse-acting.
 16. Runtime Totalization. Provide software to totalize runtime for each binary input and output. Operator shall be able to enable runtime alarm based on exceeded adjustable runtime limit. Configure and enable runtime totalization and alarms as required by sequences of operation.

17. Fault Detection and Diagnostics (FDD). The system shall follow NIST and ASHRAE standards for enhanced monitoring and alarming. The FDD shall reside in the controller and be integral to the programming. Overlay software for primary FDD reporting is not acceptable. FDD capabilities shall include diagnostics for: Simultaneous Heating and Cooling; Continuous Operation; Fraction of Outdoor Air; Analog Output Cycling; Discrete Output Cycling; Sensor Failures; and Run Requests Analytics. These FDD alarms must be fully programmed, configured and active within the system. It is not acceptable for the system to have simply have the capability for FDD alarming, the alarming must be fully functional. The alarms shall be categorized and displayed on the BMS system. The FDD alarms shall be categorized into one of the following four categories:
 - a. FDD Comfort
 - b. FDD Critical
 - c. FDD Energy
 - d. FDD Maintenance

2.7 CONTROLLERS

- A. General. Provide an adequate number of Building Controllers (BC), Advanced Application Controllers (AAC), Application Specific Controllers (ASC), Smart Actuators (SA), and Smart Sensors (SS) as required to achieve performance specified by system performance. Every device in the system which executes control logic and directly controls HVAC equipment must conform to a standard BACnet Device profile as specified in ANSI/ASHRAE 135, BACnet Annex L. Unless otherwise specified, hardwired actuators and sensors may be used in lieu of communicating actuators, communicating sensors, BACnet Smart Actuators and BACnet Smart Sensors.
- B. BACnet.
 1. Building Controllers (BCs). Each BC shall conform to BACnet Building Controller (B-BC) device profile as specified in ANSI/ASHRAE 135, BACnet Annex L and shall be listed as a certified B-BC in the BACnet Testing Laboratories (BTL) Product Listing.
 2. Advanced Application Controllers (AACs). Each AAC shall conform to BACnet Advanced Application Controller (B-AAC) device profile as specified in ANSI/ASHRAE 135, BACnet Annex L and shall be listed as a certified B-AAC in the BACnet Testing Laboratories (BTL) Product Listing.
 3. Application Specific Controllers (ASCs). Each ASC shall conform to BACnet Application Specific Controller (B-ASC) device profile as specified in ANSI/ASHRAE 135, BACnet Annex L and shall be listed as a certified B-ASC in the BACnet Testing Laboratories (BTL) Product Listing.

4. Smart Actuators (SAs). An actuator which is controlled by a network connection rather than a binary or analog signal (0-10v, 4-20mA, relay, etc.). Each SA shall conform to BACnet Smart Actuator (B-SA) device profile as specified in ANSI/ASHRAE 135, BACnet Annex L and shall be listed as a certified B-SA in the BACnet Testing Laboratories (BTL) Product Listing.
5. Smart Sensors (SSs). A sensor which provides information to the BAS via network connection rather than a binary or analog signal (0-10000 ohm, 4-20mA, dry contact, etc.). Each SS shall conform to BACnet Smart Sensor (B-SS) device profile as specified in ANSI/ASHRAE 135, BACnet Annex L and shall be listed as a certified B-SS in the BACnet Testing Laboratories (BTL) Product Listing.
6. BACnet Communication.
 - a. Building Controllers (BC). Each BC shall connect to a network using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol using BACnet/IP or BACnet/SC.
 - b. BACnet routing shall be performed by BCs or other BACnet device routers as necessary to connect BCs to networks of AACs and ASCs.
 - c. Each AAC shall connect to a network using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol using BACnet/IP or BACnet/SC.
 - d. Each ASC shall reside on a BACnet network using the ARCNET or MS/TP Data Link/Physical layer protocol.
 - e. Each SA shall reside on a BACnet network using the ARCNET or MS/TP Data Link/Physical layer protocol.
 - f. Each SS shall reside on a BACnet network using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol with BACnet/IP addressing, or it shall reside on a BACnet network using ARCNET or MS/TP Data Link/Physical layer protocol.
- C. Security.
 1. Provide BACnet firewall capability, as defined in the BACnet standard.
- D. Building Controllers (BC)
 1. Communication
 - a. Network Connection. Controller shall support a single point ethernet connection.
 - b. Ethernet Port. Provide one (1) Gig-E port capable of full duplex communication up to 1000 Mbps

- c. Service Port. Provide one (1) ethernet port for connection to a Portable Operator's Terminal.
 - d. Serial Port. Provide two (2) serial ports for communication to serial BACnet or serial Modbus networks.
 - e. Signal Management. BC shall have the ability to manage input and output communication signals to allow distributed controllers to share real and virtual object information and to allow for central monitoring and alarms.
 - f. Data Sharing. Each BC and AAC shall share data as required with each networked BC and AAC.
 - g. Stand-Alone Operation. Each piece of equipment shall be controlled by a single controller to provide stand-alone control in the event of communication failure. All I/O points specified for a piece of equipment shall be integral to its controller. Provide stable and reliable stand-alone control using default values or other method for values normally read over the network such as outdoor air conditions, supply air or water temperature coming from source equipment, etc.
2. Environment. Controller hardware shall be suitable for anticipated ambient conditions.
 - a. Controllers used outdoors or in wet ambient conditions shall be mounted in waterproof enclosures and shall be rated for operation at -29°C to 60°C (-20°F to 140°F).
 - b. Controllers used in conditioned space shall be mounted in dust-protective enclosures and shall be rated for operation at 0°C to 50°C (32°F to 120°F).
 3. Serviceability. Provide diagnostic LEDs for power, communication, and processor. All wiring connections shall be made to a field-removable modular terminal strip or to a termination card connected by a ribbon cable. Each BC and AAC shall continually check its processor and memory circuit status and shall generate an alarm on abnormal operation. System shall continuously check controller network and generate alarm for each controller that fails to respond.
 4. Real-time Clock. Controller shall have a real-time clock to keep track of time in the event of a power failure for up to three (3) days.
 5. Memory
 - a. Controller memory shall support operating system, database, and programming requirements.

4. Real-time Clock. Controller shall have a real-time clock to keep track of time in the event of a power failure for up to three (3) days.
5. Memory
 - a. Controller memory shall support operating system, database, and programming requirements.
 - b. Each AAC shall use nonvolatile memory and shall retain BIOS and application programming in the event of power loss. System shall automatically download dynamic control parameters following power loss.
- F. Immunity to Power and Noise. Controllers shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shutdown below 80% nominal voltage.
- G. Transformer. Power supply shall be fused or current limiting and shall be rated at a minimum of 125% of controller power consumption.

2.8 INPUT AND OUTPUT INTERFACE

- A. General. Hard-wire input and output points to BCs, AACs, or ASCs.
- B. Protection. All input points and output points shall be protected such that shorting of the point to itself, to another point, or to ground shall cause no damage to the controller. All input and output points shall be protected from voltage up to 24 V of any duration, such that contact with this voltage will cause no controller damage.
- C. Binary Inputs. Binary inputs shall allow the monitoring of ON/OFF signals from remote devices. Binary inputs shall sense dry contact closure without application of power external to the controller.
- D. Pulse Accumulation Inputs. Pulse accumulation inputs shall conform to binary input requirements and shall also accumulate up to 10 pulses per second.
- E. Analog Inputs. Analog inputs shall monitor low-voltage (0–10 Vdc), current (4–20 mA), or resistance (thermistor or RTD) signals. Analog inputs shall be compatible with and field configurable to commonly available sensing devices.
- F. Binary Outputs. Binary outputs shall provide for ON/OFF operation or a pulsed low-voltage signal for pulse width modulation control. Binary outputs on Building Controllers shall have three-position (on-off-auto) override switches and status lights. Outputs shall be selectable for normally open or normally closed operation.
- G. Analog Outputs. Analog outputs shall provide a modulating signal for the control of end devices. Outputs shall provide either a 0–10 Vdc or a 4–20 mA signal as required to properly control output devices. Each Building Controller analog output shall have a two-position (auto-manual) switch, a manually adjustable

potentiometer, and status lights. Analog outputs shall not drift more than 0.4% of range annually.

- H. Tri-State Outputs. Control three-point floating electronic actuators without feedback with tri-state outputs (two coordinated binary outputs). Tri-State outputs may be used to provide analog output control in zone control and terminal unit control applications such as VAV terminal units, duct-mounted heating coils, and zone dampers.
- I. Universal Inputs and Outputs. Inputs and outputs that can be designated as either binary or analog in software shall conform to the provisions of this section that are appropriate for their designated use.
- J. Operator Displays. Provide a 4", 7", or 10" operator display as noted on drawings for each controller. Operator displays shall be as follows:

- 1. Physical Display. The display shall be a fully customizable capacitive multi-touch color display unit with the following minimum capabilities:

	• 4" Display	• 7" Display	• 10" Display
• Display Size (diagonal)	• 4"	• 7"	• 10.1"
• Resolution (pixels)	• 480 x 272	• 1024 x 600	• 1280 x 800
• Brightness (cd/m2)	• 400	• 320	• 350
• Contrast Ratio	• 1000:1	• 1000:1	• 800:1

- 2. Power. Display shall be powered by 24Vdc power.
- 3. Maximum Colors: The display shall provide 8 bit capability for 16.7 million colors.
- 4. Touch Screen: The screen shall be a capacitive multi-touch screen using Projected Capacitive Touch (PCAP) technology.
- 5. Environmental: The display shall operate in conditions of -4° to 140°F with a front IP65 water and dustproof rating and a rear IP20 water and dustproof rating.
- 6. Communication: The following communication ports shall be provided:
 - a. Ethernet LAN port
 - b. Serial Port
 - c. USB Port
 - d. USB OTG Port
- 7. System/Memory: The display shall have a dual core processor, flash memory, and a 365-day real time clock/calendar with time and date

maintained for a minimum of 72 hours after loss of power(at room temperature).

8. User Interface: Display shall provide the following user interface capabilities:
 - a. Multi-level password protection for security
 - b. Access virtually any point in the controller
 - c. View trends
 - d. View and edit BACnet time schedules
 - e. Change setpoints

2.9 POWER SUPPLIES AND LINE FILTERING

- A. Power Supplies. Control transformers shall be listed by UL. Furnish Class 2 current-limiting type or furnish over-current protection in primary and secondary circuits for Class 2 service in accordance with NEC requirements. Limit connected loads to 80% of rated capacity.
 1. DC power supply output shall match output current and voltage requirements. Unit shall be full-wave rectifier type with output ripple of 5.0 mV maximum peak-to-peak. Regulation shall be 1.0% line and load combined, with 100-microsecond response time for 50% load changes. Unit shall have built-in over-voltage and over-current protection and shall be able to withstand 150% current overload for at least three seconds without trip-out or failure.
 - a. Unit shall operate between 0°C and 50°C (32°F and 120°F). EM/RF shall meet FCC Class B and VDE 0871 for Class B and MILSTD 810C for shock and vibration.
 - b. Line voltage units shall be UL recognized and CSA listed.
- B. Power Line Filtering.
 1. Provide internal or external transient voltage and surge suppression for workstations and controllers. Surge protection shall have:
 - a. Dielectric strength of 1000 V minimum
 - b. Response time of 10 nanoseconds or less
 - c. Transverse mode noise attenuation of 65 dB or greater
 - d. Common mode noise attenuation of 150 dB or greater at 40–100 Hz

2.10 LOCAL CONTROL PANELS

- A. All indoor control cabinets shall be fully enclosed NEMA 1 construction with (hinged door) key-lock latch and removable subpanels. A single key shall be common to all field panels and subpanels.
- B. Interconnections between internal and face-mounted devices shall be prewired with color-coded stranded conductors neatly installed in plastic troughs and/or tie-wrapped. Terminals for field connections shall be UL listed for 600 volt service, individually identified per control/interlock drawings, with adequate clearance for field wiring. Control terminations for field connection shall be individually identified per control drawings.
- C. Provide ON/OFF power switch with overcurrent protection for control power sources to each local panel.

2.11 WIRING AND RACEWAYS

- A. General. Provide copper wiring, plenum cable, conduit, and raceways as specified in applicable sections of Division 26.
- B. Insulated wire shall use copper conductors and shall be UL listed for 90°C (200°F) minimum service.

2.12 PERSONAL COMPUTER OPERATOR WORKSTATION HARDWARE

- A. New system graphics will reside on (E) computer database server.

2.13 MISCELLANEOUS DEVICES

- A. Thermostats
 - 1. Room thermostats shall be of the gradual acting type with adjustable sensitivity.
 - 2. They shall have a bi-metal sensing element capable of responding to a temperature change of one-tenth of one degree. (Provide all thermostats with limit stops to limit adjustments as required.)
 - 3. Thermostats shall be arranged for either horizontal or vertical mounting.
 - 4. In the vertical position thermostat shall fit on a mullion of movable partitions without overlap.
- B. Freeze stats:
 - 1. Install freeze stats as indicated on the plans and provide protection for every square foot of coil surface area with one linear foot of element per square foot of coil.

- a. Upon detection of low temperature, the freeze stats shall stop the associated supply fans and return the automatic dampers to their normal position. Provide manual reset.
- C. Current Sensing Relay:
1. Provide solid-state, adjustable, current operated relay. Provide a relay which changes switch contact state in response to an adjustable set point value of current in the monitored A/C circuit.
 2. Adjust the relay switch point so that the relay responds to motor operation under load as an "on" state and so that the relay responds to an unloaded running motor as an "off" state. A motor with a broken belt is considered an unloaded motor.
 3. Provide a status device for all fans and pumps.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. The project plans shall be thoroughly examined for control device and equipment locations. Any discrepancies, conflicts, or omissions shall be reported to the architect/engineer for resolution before rough-in work is started.
- B. The contractor shall inspect the site to verify that equipment may be installed as shown. Any discrepancies, conflicts, or omissions shall be reported to the engineer for resolution before rough-in work is started.
- C. The contractor shall examine the drawings and specifications for other parts of the work. If headroom or space conditions appear inadequate—or if any discrepancies occur between the plans and the contractor’s work and the plans and the work of others—the contractor shall report these discrepancies to the engineer and shall obtain written instructions for any changes necessary to accommodate the contractor’s work with the work of others. Any changes in the work covered by this specification made necessary by the failure or neglect of the contractor to report such discrepancies shall be made by—and at the expense of—this contractor.

3.2 PROTECTION

- A. The contractor shall protect all work and material from damage by his/her work or employees and shall be liable for all damage thus caused.
- B. The contractor shall be responsible for his/her work and equipment until finally inspected, tested, and accepted. The contractor shall protect any material that is not immediately installed. The contractor shall close all open ends of work with temporary covers or plugs during storage and construction to prevent entry of foreign objects.

3.3 COORDINATION

- A. Site
 - 1. Where the mechanical work will be installed in close proximity to, or will interfere with, work of other trades, the contractor shall assist in working out space conditions to make a satisfactory adjustment. If the contractor installs his/her work before coordinating with other trades, so as to cause any interference with work of other trades, the contractor shall make the necessary changes in his/her work to correct the condition without extra charge.
 - 2. Coordinate and schedule work with other work in the same area and with work dependent upon other work to facilitate mutual progress.

B. Test and Balance.

1. The contractor shall furnish a single set of all tools necessary to interface to the control system for test and balance purposes.
2. The contractor shall provide training in the use of these tools. This training will be planned for a minimum of 4 hours.
3. In addition, the contractor shall provide a qualified technician to assist in the test and balance process, until the first 20 terminal units are balanced.
4. The tools used during the test and balance process will be returned at the completion of the testing and balancing.

C. Life Safety.

1. Duct smoke detectors required for air handler shutdown are provided under Division 28. Interlock smoke detectors to air handlers for shutdown as specified in sequences of operation.
2. Smoke dampers and actuators required for duct smoke isolation are provided under Division 23. Interlock smoke dampers to air handlers as specified in sequences of operation.
3. Fire and smoke dampers and actuators required for fire-rated walls are provided under Division 23. Fire and smoke damper control is provided under Division 28.

D. Coordination with controls specified in other sections or divisions. Other sections and/or divisions of this specification include controls and control devices that are to be part of or interfaced to the control system specified in this section. These controls shall be integrated into the system and coordinated by the contractor as follows:

1. All communication media and equipment shall be provided as specified in Section 23 09 23 Article 2.2 (Communication).
2. Each supplier of a controls product is responsible for the configuration, programming, start up, and testing of that product to meet the sequences of operation described in Section 23 09 93.
3. The contractor shall coordinate and resolve any incompatibility issues that arise between control products provided under this section and those provided under other sections or divisions of this specification.
4. The contractor is responsible for providing all controls described in the contract documents regardless of where within the contract documents these controls are described.

5. The contractor is responsible for the interface of control products provided by multiple suppliers regardless of where this interface is described within the contract documents.

3.4 GENERAL WORKMANSHIP

- A. Install equipment, piping, and wiring/raceway parallel to building lines (i.e. horizontal, vertical, and parallel to walls) wherever possible.
- B. Provide sufficient slack and flexible connections to allow for vibration of piping and equipment.
- C. Install equipment in readily accessible locations as defined by Chapter 1 Article 100 Part A of the National Electrical Code (NEC).
- D. Verify integrity of all wiring to ensure continuity and freedom from shorts and grounds.
- E. All equipment, installation, and wiring shall comply with industry specifications and standards for performance, reliability, and compatibility and be executed in strict adherence to local codes and standard practices.

3.5 FIELD QUALITY CONTROL

- A. All work, materials, and equipment shall comply with rules and regulations of applicable local, state, and federal codes and ordinances as identified in Section 23 09 23 Article 1.8 (Codes and Standards).
- B. Contractor shall continually monitor the field installation for code compliance and quality of workmanship.
- C. Contractor shall have work inspection by local and/or state authorities having jurisdiction over the work.

3.6 WIRING

- A. All control and interlock wiring shall comply with national and local electrical codes, and Division 26 of this specification, Where the requirements of this section differ from Division 26, the requirements of this section shall take precedence.
- B. All NEC Class 1 (line voltage) wiring shall be UL listed in approved raceway according to NEC and Division 26 requirements.
- C. All low-voltage wiring shall meet NEC Class 2 requirements. Low-voltage power circuits shall be sub-fused when required to meet Class 2 current limit.
- D. Where NEC Class 2 (current-limited) wires are in concealed and accessible locations, including ceiling return air plenums, approved cables not in raceway may be used provided that cables are UL listed for the intended application.

- E. All wiring in mechanical, electrical, or service rooms – or where subject to mechanical damage – shall be installed in raceway at levels below 3 m (10ft).
- F. Do not install Class 2 wiring in raceways containing Class 1 wiring. Boxes and panels containing high-voltage wiring and equipment may not be used for low-voltage wiring except for the purpose of interfacing the two (e.g. relays and transformers).
- G. Do not install wiring in raceway containing tubing.
- H. Where Class 2 wiring is run exposed, wiring is to be run parallel along a surface or perpendicular to it and neatly tied at 3 m (10 ft) intervals.
- I. Where plenum cables are used without raceway, they shall be supported from or anchored to structural members. Cables shall not be supported by or anchored to ductwork, electrical raceways, piping, or ceiling suspension systems.
- J. All wire-to-device connections shall be made at a terminal block or terminal strip. All wire-to-wire connections shall be at a terminal block.
- K. All wiring within enclosures shall be neatly bundled and anchored to permit access and prevent restriction to devices and terminals.
- L. Maximum allowable voltage for control wiring shall be 120 V. If only higher voltages are available, the contractor shall provide step-down transformers.
- M. All wiring shall be installed as continuous lengths, with no splices permitted between termination points.
- N. Install plenum wiring in sleeves where it passes through walls and floors. Maintain fire rating at all penetrations.
- O. Size of raceway and size and type of wire type shall be the responsibility of the contractor in keeping with the manufacturer's recommendations and NEC requirements, except as noted elsewhere.
- P. Include one pull string in each raceway 2.5 cm (1 in.) or larger.
- Q. Use color-coded conductors throughout with conductors of different colors.
- R. Control and status relays are to be located in designated enclosures only. These enclosures include packaged equipment control panel enclosures unless they also contain Class 1 starters.
- S. Conceal all raceways except within mechanical, electrical, or service rooms. Install raceway to maintain a minimum clearance of 15 cm (6 in.) from high-temperature equipment (e.g. steam pipes or flues).
- T. Secure raceways with raceway clamps fastened to the structure and spaced according to code requirements. Raceways and pull boxes may not be hung on flexible duct strap or tie rods. Raceways may not be run on or attached to ductwork.

- U. Adhere to this specification's Division 26 requirements where raceway crosses building expansion joints.
- V. Install insulated bushings on all raceway ends and openings to enclosures. Seal top end of vertical raceways.
- W. The contractor shall terminate all control and/or interlock wiring and shall maintain updated (as-built) wiring diagrams with terminations identified at the job site.
- X. Flexible metal raceways and liquid-tight flexible metal raceways shall not exceed 1 m (3 ft) in length and shall be supported at each end. Flexible metal raceway less than ½ in. electrical trade size shall not be used. In areas exposed to moisture, including chiller and boiler rooms, liquid-tight, flexible metal raceways shall be used.
- Y. Raceway must be rigidly installed, adequately supported, properly reamed at both ends, and left clean and free of obstructions. Raceway sections shall be joined with couplings (according to code). Terminations must be made with fittings at boxes, and ends not terminating in boxes shall have bushings installed.

3.7 COMMUNICATION WIRING

- A. All cabling shall be installed in a neat and workmanlike manner. Follow manufacturer's installation recommendations for all communication cabling
- B. Do not install communication wiring in raceways and enclosures containing Class 1 or other Class 2 wiring.
- C. Maximum pulling, tension, and bend radius for the cable installation, as specified by the cable manufacturer, shall not be exceeded during installation.
- D. Contractor shall verify the integrity of the entire network following cable installation. Use appropriate test measures for each particular cable.
- E. When a cable enters or exits a building, a lightning arrestor must be installed between the lines and ground. The lightning arrestor shall be installed according to manufacturer's instructions.
- F. All runs of communication wiring shall be unspliced length when that length is commercially available.
- G. All communication wiring shall be labeled to indicate origination and destination data.
- H. Grounding of coaxial cable shall be in accordance with NEC regulations article on "Communications Circuits, Cable, and Protector Grounding."
- I. BACnet IP, Arcnet, or MS/TP communications wiring shall be installed in accordance with ASHRAE/ANSI Standard 135. This includes but is not limited to:

1. IP
 - a. The network shall use Cat5e or greater cabling for connections.
 - b. Custom made patch cables must use either the T568A or T568 wiring standard and must use the same standard on both ends of the cable.
2. Arcnet
 - a. The network shall use shielded, twisted-pair cable with characteristic impedance between 100 nominal. Distributed capacitance between conductors shall be less than 12.5 pF per foot (41 pF per meter.)
 - b. The maximum length of an Arcnet segment is 610 meters (2000 ft) with AWG 22 cable.
 - c. The maximum number of nodes per segment shall be 32, as specified in the EIA 485 standard. Additional nodes may be accommodated by the use of repeaters.
 - d. An Arcnet network shall have no T connections
3. MS/TP
 - a. The network shall use shielded, twisted-pair cable with characteristic impedance between 100 and 120 ohms. Distributed capacitance between conductors shall be less than 100 pF per meter (30 pF per foot.)
 - b. The maximum length of an MS/TP segment is 1200 meters (4000 ft) with AWG 18 cable. The use of greater distances and/or different wire gauges shall comply with the electrical specifications of EIA-485.
 - c. The maximum number of nodes per segment shall be 32, as specified in the EIA 485 standard. Additional nodes may be accommodated by the use of repeaters.
 - d. An MS/TP EIA-485 network shall have no T connections.

3.8 FIBER OPTIC CABLE

- A. Maximum pulling tensions as specified by the cable manufacturer shall not be exceeded during installation. Post-installation residual cable tension shall be within cable manufacturer's specifications.
- B. All cabling and associated components shall be installed in accordance with manufacturers' instructions. Minimum cable and unjacketed fiber bend radii, as specified by cable manufacturer, shall be maintained.

3.9 INSTALLATION OF SENSORS

- A. Install sensors in accordance with the manufacturer's recommendations.
- B. Mount sensors rigidly and adequately for environment within which the sensor operates.
- C. Room temperature sensors shall be installed on concealed junction boxes properly supported by wall framing.
- D. All wires attached to sensors shall be sealed in their raceways or in the wall to stop air transmitted from other areas from affecting sensor readings.
- E. Sensors used in mixing plenums and hot and cold decks shall be of the averaging type. Averaging sensors shall be installed in a serpentine manner vertically across the duct. Each bend shall be supported with a capillary clip.
- F. Low-limit sensors used in mixing plenums shall be installed in a serpentine manner horizontally across duct. Each bend shall be supported with a capillary clip. Provide 3 m (10 ft) of sensing element for each 1 m² (1 ft²) of coil area.
- G. Do not install temperature sensors within the vapor plume of a humidifier. If installing a sensor downstream of a humidifier, install it at least 3 m (10 ft) downstream.
- H. All pipe-mounted temperature sensors shall be installed in wells. Install liquid temperature sensors with heat-conducting fluid in thermal wells.
- I. Install outdoor air temperature sensors on north wall, complete with sun shield at designated location.
- J. Smoke detectors, freezestats, high-pressure cut-offs, and other safety switches shall be hard-wired to de-energize equipment as described in the sequence of operation. Switches shall require manual reset. Provide contacts that allow DDC software to monitor safety switch status.
 - 1. Smoke detectors utilized for fan shutdown shall be addressable and signal to the fire-alarm control panel upon activation.

3.10 ACTUATORS

- A. General. Mount and link control damper actuators according to manufacturer's instructions.
 - 1. To compress seals when spring-return actuators are used on normally closed dampers, power actuator to approximately 5° open position, manually close the damper, and then tighten the linkage.
 - 2. Check operation of damper/actuator combination to confirm that actuator modulates damper smoothly throughout stroke to both open and closed positions.

3. Provide all mounting hardware and linkages for actuator installation.
- B. Electric/Electronic
1. Dampers: Actuators shall be direct mounted on damper shaft or jackshaft unless shown as a linkage installation. For low-leakage dampers with seals, the actuator shall be mounted with a minimum 5° travel available for tightening the damper seal. Actuators shall be mounted following manufacturer's recommendations.
 2. Valves: Actuators shall be connected to valves with adapters approved by the actuator manufacturer. Actuators and adapters shall be mounted following the actuator manufacturer's recommendations.

3.11 WARNING LABELS

- A. Permanent warning labels shall be affixed to all equipment that can be automatically started by the control system.
1. Labels shall use white lettering (12-point type or larger) on a red background.
 2. Warning labels shall read as follows.
 - a. C A U T I O N: This equipment is operating under automatic control and may start or stop at any time without warning. Switch disconnect to "Off" position before servicing.
- B. Permanent warning labels shall be affixed to all motor starters and control panels that are connected to multiple power sources utilizing separate disconnects.
1. Labels shall use white lettering (12-point type or larger) on a red background.
 2. Warning labels shall read as follows.
 - a. C A U T I O N: This equipment is fed from more than one power source with separate disconnects. Disconnect all power sources before servicing.

3.12 IDENTIFICATION OF HARDWARE AND WIRING

- A. All wiring and cabling, including that within factory-fabricated panels shall be labeled at each end within 5 cm (2 in.) of termination with control system address or termination number.
- B. All pneumatic tubing shall be labeled at each end within 5 cm (2 in.) of termination with a descriptive identifier.
- C. Permanently label or code each point of field terminal strips to show the instrument or item served.

- D. Identify control panels with minimum 1 cm (½ in.) letters on laminated plastic nameplates.
- E. Identify all other control components with permanent labels. All plug-in components shall be labeled such that label removal of the component does not remove the label.
- F. Identify room sensors related to terminal boxes or valves with nameplates.
- G. Manufacturers' nameplates and UL or CSA labels shall be visible and legible after equipment is installed.
- H. Identifiers shall match record documents.

3.13 CONTROLLERS

- A. Provide a separate controller for each AHU or other HVAC system. A DDC controller may control more than one system provided that all points associated with the system are assigned to the same DDC controller. Points used for control loop reset, such as outside air or space temperature, are exempt from this requirement.
- B. Building Controllers and Custom Application Controllers shall be selected to provide the required I/O point capacity required to monitor all of the hardware points listed in sequences of operation.

3.14 PROGRAMMING

- A. Provide sufficient internal memory for the specified sequences of operation and trend logging.
- B. Point Naming. Coordinate with owner for point naming conventions. Name points as shown on the equipment points list provided with each sequence of operation or as directed by owner. If character limitations or space restrictions make it advisable to shorten the name, abbreviations as coordinated with owner may be used. Where multiple points with the same name reside in the same controller, each point name may be customized with its associated Program Object number. For example, "Zone Temp 1" for Zone 1, "Zone Temp 2" for Zone 2.
- C. Software Programming.
 - 1. Provide programming for the system and adhere to the sequences of operation provided. All other system programming necessary for the operation of the system, but not specified in this document, also shall be provided by the contractor. Embed into the control program sufficient comment statements to clearly describe each section of the program. The comment statements shall reflect the language used in the sequences of operation. Use the appropriate technique based on the following programming types:

- a. Text-based:

1. Must provide actions for all possible situations
 2. Must be modular and structured
 3. Must be commented
- b. Graphic-based:
1. Must provide actions for all possible situations
 2. Must be documented
- c. Parameter-based:
1. Must provide actions for all possible situations
 2. Must be documented.
- D. Operator Interface.
1. Standard Graphics. Provide graphics for all mechanical systems and floor plans of the building. This includes each chilled water system, hot water system, chiller, boiler, air handler, and all terminal equipment. Point information on the graphic displays shall dynamically update. Show on each graphic all input and output points for the system. Also show relevant calculated points such as setpoints. As a minimum, show on each equipment graphic the input and output points and relevant calculated points as indicated on the applicable Points List or sequence of operation.
 2. The contractor shall provide all the labor necessary to install, initialize, start up, and troubleshoot all operator interface software and its functions as described in this section. This includes any operating system software, the operator interface database, and any third-party software installation and integration required for successful operation of the operator interface.

3.15 CONTROL SYSTEM CHECKOUT AND TESTING

- A. Startup Testing. All testing listed in this article shall be performed by the contractor and shall make up part of the necessary verification of an operating control system. This testing shall be completed before the owner's representative is notified of the system demonstration.
1. The contractor shall furnish all labor and test apparatus required to calibrate and prepare for service of all instruments, controls, and accessory equipment furnished under this specification.
 2. Verify that all control wiring is properly connected and free of all shorts and ground faults. Verify that terminations are tight.
 3. Enable the control systems and verify calibration of all input devices individually. Perform calibration procedures according to manufacturers' recommendations.

4. Verify that all binary output devices (relays, solenoid valves, two-position actuators and control valves, magnetic starters, etc.) operate properly and that the normal positions are correct.
5. Verify that all analog output devices (I/Ps, actuators, etc.) are functional, that start and span are correct, and that direction and normal positions are correct. The contractor shall check all control valves and automatic dampers to ensure proper action and closure. The contractor shall make any necessary adjustments to valve stem and damper blade travel.
6. Verify that the system operation adheres to the sequences of operation. Simulate and observe all modes of operation by overriding and varying inputs and schedules. Tune all DDC loops.
7. Alarms and Interlocks:
 - a. Check each alarm separately by including an appropriate signal at a value that will trip the alarm.
 - b. Interlocks shall be tripped using field contacts to check the logic, as well as to ensure that the fail-safe condition for all actuators is in the proper direction.
 - c. Interlock actions shall be tested by simulating alarm conditions to check the initiating value of the variable and interlock action.

3.16 CONTROL SYSTEM DEMONSTRATION AND ACCEPTANCE

A. Demonstration.

1. Prior to acceptance, the control system shall undergo a series of performance tests to verify operation and compliance with this specification. These tests shall occur after the Contractor has completed the installation, started up the system, and performed his/her own tests.
2. The tests described in this section are to be performed in addition to the tests that the contractor performs as a necessary part of the installation, start-up, and debugging process and as specified in the "Control System Checkout and Testing" article in Part 3 of this specification. The engineer will be present to observe and review these tests. The engineer shall be notified at least 10 days in advance of the start of the testing procedures.
3. The demonstration process shall follow that approved in Part 1, "Submittals." The approved checklists and forms shall be completed for all systems as part of the demonstration.
4. The contractor shall provide at least two persons equipped with two-way communication and shall demonstrate actual field operation of each control and sensing point for all modes of operation including day, night, occupied, unoccupied, fire/smoke alarm, seasonal changeover, and power failure

modes. The purpose is to demonstrate the calibration, response, and action of every point and system. Any test equipment required to prove the proper operation shall be provided by and operated by the contractor.

5. As each control input and output is checked, a log shall be completed showing the date, technician's initials, and any corrective action taken or needed.
6. Demonstrate compliance with Part 1, "System Performance."
7. Demonstrate compliance with sequences of operation through all modes of operation.
8. Demonstrate complete operation of operator interface.
9. Additionally, the following items shall be demonstrated:
 - a. DDC loop response. The contractor shall supply trend data output in a graphical form showing the step response of each DDC loop. The test shall show the loop's response to a change in set point, which represents a change of actuator position of at least 25% of its full range. The sampling rate of the trend shall be from 10 seconds to 3 minutes, depending on the speed of the loop. The trend data shall show for each sample the set point, actuator position, and controlled variable values. Any loop that yields unreasonably under-damped or over-damped control shall require further tuning by the Contractor.
 - b. Demand limiting. The contractor shall supply a trend data output showing the action of the demand limiting algorithm. The data shall document the action on a minute-by-minute basis over at least a 30-minute period. Included in the trend shall be building kW, demand limiting set point, and the status of sheddable equipment outputs.
 - c. Optimum start/stop. The contractor shall supply a trend data output showing the capability of the algorithm. The change-of-value or change-of-state trends shall include the output status of all optimally started and stopped equipment, as well as temperature sensor inputs of affected areas.
 - d. Interface to the building fire alarm system.
 - e. Operational logs for each system that indicate all set points, operating points, valve positions, mode, and equipment status shall be submitted to the architect/engineer. These logs shall cover three 48-hour periods and have a sample frequency of not more than 10 minutes. The logs shall be provided in both printed and disk formats.
10. Any tests that fail to demonstrate the operation of the system shall be repeated at a later date. The contractor shall be responsible for any

necessary repairs or revisions to the hardware or software to successfully complete all tests.

B. Acceptance.

1. All tests described in this specification shall have been performed to the satisfaction of both the engineer and owner prior to the acceptance of the control system as meeting the requirements of completion. Any tests that cannot be performed due to circumstances beyond the control of the contractor may be exempt from the completion requirements if stated as such in writing by the engineer. Such tests shall then be performed as part of the warranty.
2. The system shall not be accepted until all forms and checklists completed as part of the demonstration are submitted and approved as required in Part 1, "Submittals."

3.17 CLEANING

- A. The contractor shall clean up all debris resulting from his/her activities daily. The contractor shall remove all cartons, containers, crates, etc., under his/her control as soon as their contents have been removed. Waste shall be collected and placed in a designated location.
- B. At the completion of work in any area, the contractor shall clean all work, equipment, etc., keeping it free from dust, dirt, and debris, etc.
- C. At the completion of work, all equipment furnished under this section shall be checked for paint damage, and any factory-finished paint that has been damaged shall be repaired to match the adjacent areas. Any cabinet or enclosure that has been deformed shall be replaced with new material and repainted to match the adjacent areas.

3.18 TRAINING

- A. Provide training for a designated staff of Owner's representatives. Training shall be provided via self-paced training, web-based or computer-based training, classroom training, or a combination of training methods.
- B. Training shall enable students to accomplish the following objectives.
 1. Day-to-day Operators:
 - a. Proficiently operate the system
 - b. Understand control system architecture and configuration
 - c. Understand DDC system components
 - d. Understand system operation, including DDC system control and optimizing routines (algorithms)

- e. Operate the workstation and peripherals
 - f. Log on and off the system
 - g. Access graphics, point reports, and logs
 - h. Adjust and change system set points, time schedules, and holiday schedules
 - i. Recognize malfunctions of the system by observation of the printed copy and graphical visual signals
 - j. Understand system drawings and Operation and Maintenance manual
 - k. Understand the job layout and location of control components
 - l. Access data from DDC controllers and ASCs
 - m. Operate portable operator's terminals
2. Advanced Operators:
- a. Make and change graphics on the workstation
 - b. Create, delete, and modify alarms, including annunciation and routing of these
 - c. Create, delete, and modify point trend logs and graph or print these both on an ad-hoc basis and at user-definable time intervals
 - d. Create, delete, and modify reports
 - e. Add, remove, and modify system's physical points
 - f. Create, modify, and delete programming
 - g. Add panels when required
 - h. Add operator interface stations
 - i. Create, delete, and modify system displays, both graphical and others
 - j. Perform DDC system field checkout procedures
 - k. Perform DDC controller unit operation and maintenance procedures
 - l. Perform workstation and peripheral operation and maintenance procedures
 - m. Perform DDC system diagnostic procedures

- n. Configure hardware including PC boards, switches, communication, and I/O points
- o. Maintain, calibrate, troubleshoot, diagnose, and repair hardware
- p. Adjust, calibrate, and replace system components
- 3. System Managers/Administrators:
 - a. Maintain software and prepare backups
 - b. Interface with job-specific, third-party operator software
 - c. Add new users and understand password security procedures
- C. Organize the training into sessions or modules for the three levels of operators listed above. (Day-to-Day Operators, Advanced Operators, System Managers and Administrators). Students will receive one or more of the training packages, depending on knowledge level required.
- D. Provide course outline and materials according to the "Submittals" article in Part 1 of this specification. Provide one copy of training material per student.
- E. The instructor(s) shall be factory-trained and experienced in presenting this material.
- F. Classroom training shall be done using a network of working controllers representative of installed hardware.

3.19 CONTROL DAMPER INSTALLATION

- A. Damper submittals shall be coordinated for type, quantity, and size to ensure compatibility with sheet metal design.
- B. Duct openings shall be free of any obstruction or irregularities that might interfere with blade or linkage rotation or actuator mounting. Duct openings shall measure $\frac{1}{4}$ in. larger than damper dimensions and shall be square, straight, and level.
- C. Individual damper sections, as well as entire multiple section assemblies, must be completely square and free from racking, twisting, or bending. Measure diagonally from upper corners to opposite lower corners of each damper section. Both dimensions must be within 0.3 cm (1/8 in.) of each other.
- D. Follow the manufacturer's instructions for field installation of control dampers. Unless specifically designed for vertical blade application, dampers must be mounted with blade axis horizontal.
- E. Install extended shaft or jackshaft according to manufacturer's instructions. (Typically, a sticker on the damper face shows recommended extended shaft location. Attach shaft on labeled side of damper to that blade.)

- F. Damper blades, axles, and linkage must operate without binding. Before system operation, cycle damper after installation to ensure proper operation. On multiple section assemblies, all sections must open and close simultaneously.
- G. Provide a visible and accessible indication of damper position on the drive shaft end.
- H. Support ductwork in area of damper when required to prevent sagging due to damper weight.
- I. After installation of low-leakage dampers with seals, caulk between frame and duct or opening to prevent leakage around perimeter of damper.

3.20 SMOKE DAMPER INSTALLATION

- A. The contractor shall coordinate all smoke and smoke/fire damper installation, wiring, and checkout to ensure that these dampers function properly and that they respond to the proper fire alarm system general, zone, and/or detector trips. The contractor shall immediately report any discrepancies to the engineer no less than two weeks prior to inspection by the code authority having jurisdiction.
- B. Provide complete submittal data to controls system subcontractor for coordination of duct smoke detector interface to HVAC systems.

DUCT SMOKE DETECTION

- A. Submit data for coordination of duct smoke detector interface to HVAC systems as required in Part 1, "Submittals."
- B. This Contractor shall provide a dry-contact alarm output in the same room as the HVAC equipment to be controlled.

3.22 START-UP AND CHECKOUT PROCEDURES

- A. Start up, check out, and test all hardware and software and verify communication between all components.
 - 1. Verify that all control wiring is properly connected and free of all shorts and ground faults. Verify that terminations are tight.
 - 2. Verify that all analog and binary input/output points read properly.
 - 3. Verify alarms and interlocks.
 - 4. Verify operation of the integrated system.

3.23 PROJECT MANAGEMENT

- A. Provide a designated project manager who will be responsible for the following:
 - 1. Construct and maintain project schedule.

2. On-site coordination with all applicable trades, subcontractors, and other integration vendors
3. Authorized to accept and execute orders or instructions from owner/architect.
4. Make necessary field decisions relating to this scope of work.
5. Coordination/Single point of contact

3.24 COMMISSIONING, TESTING AND ACCEPTANCE

- A. Perform commissioning procedure consisting of field I/O commissioning. Document all commissioning information on commissioning data sheets which shall be submitted prior to acceptance testing. Commissioning work which requires shutdown of system or deviation from normal function shall be performed when the operation of the system is not required. The commissioning must be coordinated with the owner and construction manager to ensure systems are available when needed. Notify the operating personnel in writing of the testing schedule so that authorized personnel from the owner and construction manager are present throughout the commissioning procedure.
- B. Prior to system program commissioning, verify that each control panel has been installed according to plans, specifications, and approved shop drawings.
- C. Submit for approval, a detailed acceptance test procedure designed to demonstrate compliance with contractual requirements. This Acceptance test procedure will take place after the commissioning procedure but before final acceptance, to verify that sensors and control devices maintain specified accuracies and the system performance does not degrade over time.
- D. Refer to HVAC commissioning specification for additional information.

3.25 SEQUENCE OF OPERATION – SPLIT SYSTEM HEAT PUMP UNIT (HP)

- A. OCCUPIED Economizer (Outside Air Cooling) Conditions:
 1. Outside air temperature is below the return air temperature.
 2. Outside air is within the acceptable range for free cooling (temperature range shall be 55°F to 75°F and humidity is below a certain threshold).
 3. Supply air temperature is set to a maximum of 75°F.
- B. OCCUPIED Economizer Operation (Outside Air Cooling) Operation:
 1. The economizer will modulate to bring in outside air and bypass mechanical cooling.
 2. The damper position will be adjusted based on the outside air temperature and return air conditions.

3. The compressor and condenser fans will remain off.
 4. The fan will operate at the required speed to deliver the necessary airflow for cooling.
- C. OCCUPIED Cooling Mode Conditions:
1. The building is in occupied mode as determined by either a time schedule or an occupancy sensor signal from the BMS.
 2. The room temperature exceeds the cooling setpoint (typically 75°F or 24°C).
- D. OCCUPIED Cooling Mode Operation:
1. Thermostat Control: The system will maintain the room temperature at the cooling setpoint (typically 75°F or 24°C) as dictated by the thermostat or BMS.
 2. Compressor Operation: The compressor will be activated to provide cooling. The system will run in cooling mode until the room temperature reaches the setpoint.
 3. Fan Operation: The furnace blower motor(s) will run at an appropriate speed based on the required cooling load.
 4. Outdoor Unit (Condenser): The outdoor unit will operate to reject heat, with the condenser fan running as needed to dissipate the heat.
- E. UNOCCUPIED Cooling Operation (When Cooling Mode is Active) Conditions:
1. The building is in unoccupied mode as determined by the BMS occupancy schedule or input from occupancy sensors.
 2. The temperature exceeds the cooling setpoint (e.g., 78°F).
- F. UNOCCUPIED Cooling Operation (When Cooling Mode is Active) Operation:
1. The BMS detects unoccupied status and adjusts the cooling setpoint to a higher temperature (e.g., 78°F).
 2. If cooling is still required (e.g., temperature rises above the new unoccupied setpoint), the heat pump is activated in cooling mode.
 3. The compressor and outdoor unit are energized.
 4. The indoor fan (furnace(s)) may run at a reduced speed to maintain air circulation but consumes less energy.
 5. The system cools the space until the temperature reaches the unoccupied setpoint.
 6. The BMS monitors the operation and can cycle the system to save energy if cooling is not required.

- G. OCCUPIED Mode to UNOCCUPIED Mode:
1. Based on the BMS schedule, the system detects that the space has entered the unoccupied period (e.g., after business hours).
 2. The BMS adjusts the temperature setpoints to the unoccupied mode setpoints.
 3. The system will transition to energy-saving operation: heating and cooling will be reduced, or the system may cycle based on the new setpoint.
 4. The BMS continues to monitor the system's temperature and occupancy signals to ensure comfort during off-hours if necessary.
- H. UNOCCUPIED Mode to OCCUPIED Mode:
1. The BMS detects the end of the unoccupied period (e.g., before business hours or after occupancy sensors detect movement).
 2. The system will revert to the occupied setpoints (e.g., 72°F for cooling, 68°F for heating).
 3. The heat pump will activate as needed based on the indoor temperature and the cooling or heating requirements.
 4. The indoor fan operates at the required speed to maintain the space within the desired comfort zone.
 5. The BMS may send alerts if there are any discrepancies between the temperature setpoints and actual conditions.
- I. System Safety and Alarms
1. High/Low Pressure Monitoring: The BMS continually monitors refrigerant pressures during cooling and heating operation. In the event of a high or low-pressure fault, the compressor will be turned off and an alarm will be sent to the BMS for action.
 2. Filter Status: The BMS will monitor filter status and send alerts if the air filter needs replacement or cleaning, based on runtime or airflow detection.
 3. Compressor Cycle Protection: The system will include cycle protection to prevent short cycling of the compressor, and the BMS will ensure that the compressor starts only after a safe delay between cycles.
 4. Fault Detection: In the event of a system fault (e.g., compressor failure, sensor failure, power issues), the BMS will trigger an alarm and provide diagnostic information for maintenance.

3.26 SEQUENCE OF OPERATION – ROOFTOP HEAT PUMP (RTU-X)

- A. OCCUPIED: Cooling Stage 1: Economizer Operation (Outside Air Cooling) Conditions:

1. Outside air temperature is below the return air temperature.
 2. Outside air is within the acceptable range for free cooling (temperature range shall be 55°F to 75°F and humidity is below a certain threshold).
 3. supply air temperature is set to a maximum of 75°F.
- B. OCCUPIED: Cooling Stage 1: Economizer Operation (Outside Air Cooling) Operation:
1. The economizer will modulate to bring in outside air and bypass mechanical cooling.
 2. The damper position will be adjusted based on the outside air temperature and return air conditions.
 3. The compressor and condenser fans will remain off.
 4. The fan will operate at the required speed to deliver the necessary airflow for cooling.
- C. OCCUPIED: Cooling Stage 2: Direct Expansion (DX) Cooling (Mechanical Cooling) Conditions:
1. The outside air is not within the acceptable range for economizer operation.
 2. The return air temperature exceeds the cooling setpoint.
 3. The economizer damper is closed or partially closed.
- D. OCCUPIED: Cooling Stage 2: Direct Expansion (DX) Cooling (Mechanical Cooling) Operation:
1. The compressor (heat pump) is activated to provide mechanical cooling via direct expansion.
 2. The reversing valve will be energized to allow for cooling mode operation.
 3. The condenser and evaporator fans will operate to facilitate heat exchange.
 4. The system will cycle the compressor on/off as required to maintain the setpoint temperature.
 5. The cooling setpoint can be adjusted (typically 72°F ± 2°F depending on system settings).
- E. OCCUPIED: Single-Stage Heating (gas-fired) Conditions
1. The return air temperature is lower than the heating setpoint (e.g., 68°F).
 2. The gas-fired heat exchanger is capable of providing heating (outside temperature is within operational limits for heating).
 3. Outside air damper shall close to minimum position.

4. Heat exchanger shall fire upon on-board unit controls and modulate as necessary to maintain setpoint.
 5. The fan will operate at the necessary speed to ensure proper airflow.
- F. UNOCCUPIED Cooling Mode (Economizer Operation) Conditions:
1. Outside air temperature is below the return air temperature.
 2. Outside air is within the acceptable range for economizer operation.
- G. UNOCCUPIED Cooling Mode (Economizer Operation) Operation:
1. The economizer will bring in outside air, bypassing mechanical cooling.
 2. The damper will be modulated according to outside air temperature and return air conditions.
 3. The compressor and condenser fans will remain off.
 4. The system will maintain the supply air temperature at the minimum setpoint for cooling (e.g., 75°F).
- H. UNOCCUPIED Cooling Mode (DX Cooling) Conditions:
1. Outside air is not within the acceptable range for economizer cooling.
 2. The return air temperature exceeds the cooling setpoint.
- I. UNOCCUPIED Cooling Mode (DX Cooling) Operation:
1. The compressor will activate, and the system will operate in the same way as in occupied cooling mode (Stage 2), maintaining the return air temperature at the cooling setpoint.
- J. UNOCCUPIED Heating Mode Conditions:
1. The return air temperature is lower than the heating setpoint (e.g., 60°F).
- K. UNOCCUPIED Heating Mode Operation:
1. The system will activate the gas-valve in heating mode.
 2. The outside air damper shall close to minimum position.
 3. The fan will operate as necessary to maintain airflow and heating performance.
- L. CHANGEOVER Occupied Mode to Unoccupied Mode:
1. The system will enter unoccupied mode based on a scheduled time or a signal from the building management system (BMS).

2. In unoccupied mode, the system will maintain a reduced setpoint for heating and cooling (e.g., 60°F for heating, 75°F for cooling) and will rely on the economizer when possible.
- M. CHANGEOVER Unoccupied Mode to Occupied Mode:
1. The system will return to occupied mode based on a scheduled time or occupancy sensor input.
 2. The system will reset the temperature setpoints to the occupied levels and initiate either economizer cooling or mechanical cooling as needed.
- N. ALARMS High-Pressure/Low-Pressure Cutoff:
1. The system will monitor refrigerant pressures during cooling modes.
 2. In the event of high or low pressure exceeding limits, the system will shut down the compressor and generate an alarm.

END OF SECTION 23 09 23

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SECTION 23 23 00 – REFRIGERANT PIPING

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Provide complete piping, specialties, installation and tests in conformity with applicable codes and authorities having jurisdiction for the Work as required by this Section for HVAC equipment indicated on the Contract Drawings and contained herein.
- B. Refrigerant systems include;
 - 1. Field refrigerant piping for direct expansion HVAC system.
- C. All work of this section shall comply with;
 - 1. Division 1 General Requirements
 - 2. Section 23 00 00 HVAC General Requirements
 - 3. ASME B31.5-2020 Refrigeration Piping and Heat Transfer Components

1.2 RELATED WORK

- A. Provide complete piping, specialties, installation and tests in conformity with applicable codes and authorities having jurisdiction for the Work as required by this Section for HVAC equipment indicated on the Contract Drawings and contained herein.

1.3 QUALITY ASSURANCE

- A. Comply with ASHRAE Standard 15, Safety Code for Mechanical Refrigeration. The application of this Code is intended to assure the safe design, construction, installation, operation, and inspection of every refrigerating system employing a fluid which normally is vaporized and liquefied in its refrigerating cycle.
- B. Comply with ASME B31.5: Refrigerant Piping and Heat Transfer Components.
- C. Products shall comply with UL 207 "Refrigerant-Containing Components and Accessories, "Nonelectrical"; or UL 429 "Electrical Operated Valves."

1.4 SUBMITTALS

- A. Submit in accordance with specification Division 01.
- B. Shop Drawings:

1. Complete information for components noted, including valves and refrigerant piping accessories, clearly presented, shall be included to determine compliance with drawings and specifications for components noted below:
 - a. Tubing and fittings
 - b. Valves
 - c. Strainers
 - d. Moisture-liquid indicators
 - e. Filter-driers
 - f. Flexible metal hose
 - g. Liquid-suction interchanges
 - h. Oil separators (when specified)
 - i. Gages
 - j. Pipe and equipment supports
 - k. Refrigerant and oil
 - l. Pipe/conduit roof penetration cover
 - m. Soldering and brazing materials
 2. Layout of refrigerant piping and accessories, including sizing, flow capacities, valves locations, and oil traps slopes of horizontal runs, floor/wall penetrations, and equipment connection details.
- C. Certification: Copies of certificates for welding procedure, performance qualification record and list of welders' names and symbols.
- D. Design Manual: Furnish two copies of design manual of refrigerant valves and accessories.

PART 2 – PRODUCTS

2.1 PIPING AND FITTINGS

- A. Refrigerant Piping: For piping up to 4 inches use Copper refrigerant tube, ASTM B280, cleaned, dehydrated and sealed, marked ACR on hard temper straight lengths. Coils shall be tagged ASTM B280 by the manufacturer.
- B. Fittings, Valves and Accessories:
 - 1. Copper fittings: Wrought copper fittings, ASME B16.22.
 - a. Brazed Joints, refrigerant tubing: Cadmium free, AWS A5.8/A5.8M, 45 percent silver brazing alloy, Class BAg-5.
 - b. Solder Joints, water and drain: 95-5 tin-antimony, ASTM B32 (95TA).
 - 2. Steel fittings: ASTM wrought steel fittings.
 - a. Refrigerant piping – Welded Joints.
 - 3. Flanges and flanged fittings: ASME B16.24.
 - 4. Refrigeration Valves:
 - a. Stop Valves: Brass or bronze alloy, pack-less, or packed type with gas tight cap, frost proof, back seating.
 - b. Pressure Relief Valves: Comply with ASME Boiler and Pressure Vessel Code; UL listed. Forged brass with nonferrous, corrosion resistant internal working parts of high strength, cast iron bodies conforming to ASTM A126, Grade B. Set valves in accordance with ASHRAE Standard 15.
 - c. Solenoid Valves: Comply with ARI 760 and UL 429, UL-listed, two-position, direct acting or pilot-operated, moisture and vapor-proof type of corrosion resisting materials, designed for intended service, and solder-end connections. Fitted with suitable NEMA 250 enclosure of type required by location and normally closed holding coil.
 - d. Thermostatic Expansion Valves: Comply with ARI 750. Brass body with stainless-steel or non-corrosive nonferrous internal parts, diaphragm and spring-loaded (direct-operated) type with sensing bulb and distributor having side connection for hot-gas bypass and external equalizer. Size and operating characteristics as recommended by manufacturer of evaporator and factory set for superheat requirements. Solder-end connections. Testing and rating in accordance with ASHRAE Standard 17.

- e. Check Valves: Brass or bronze alloy with swing or lift type, with tight closing resilient seals for silent operation; designed for low pressure drop, and with solder-end connections. Direction of flow shall be legibly and permanently indicated on the valve body.
5. Strainers: Designed to permit removing screen without removing strainer from piping system, and provided with screens 80 to 100 mesh in liquid lines NPS 1 and smaller, 60 mesh in liquid lines larger than NPS 1, and 40 mesh in suction lines. Provide strainers in liquid line serving each thermostatic expansion valve, and in suction line serving each refrigerant compressor not equipped with integral strainer.
6. Refrigerant Moisture/Liquid Indicators: Double-ported type having heavy sight glasses sealed into forged bronze body and incorporating means of indicating refrigerant charge and moisture indication. Provide screwed brass seal caps.
7. Refrigerant Filter/Dryers: UL listed, angle or in-line type, as shown on drawings. Conform to ARI Standard 730 and ASHRAE Standard 63.1. Heavy gage steel shell protected with corrosion-resistant paint; perforated baffle plates to prevent desiccant bypass. Size as recommended by manufacturer for service and capacity of system with connection not less than the line size in which installed. Filter driers with replaceable filters shall be furnished with one spare element of each type and size.
8. Flexible Metal Hose: Seamless bronze corrugated hose, covered with bronze wire braid, with standard copper tube ends. Provide in suction and discharge piping of each compressor.

2.2 GAUGES

- A. Temperature Gauges: Comply with ASME B40.200. Industrial duty type and in required temperature range for service in which installed. Gages shall have Fahrenheit scale in 2-degree graduations and with black number on a white face. The pointer shall be adjustable. Rigid stem type temperature gages shall be provided in thermal wells located within 5 feet of the finished floor. Universal adjustable angle type or remote element type temperature gages shall be provided in thermal wells located 5 to 7 feet above the finished floor. Remote element type temperature gages shall be provided in thermal wells located 7 feet above the finished floor.
- B. Vacuum and Pressure Gages: Comply with ASME B40.100 and provide with throttling type needle valve or a pulsation dampener and shut-off valve. Gage shall be a minimum of 3-1/2 inches in diameter with a range from 0 psig to approximately 1.5 times the maximum system working pressure. Each gage range shall be selected so that at normal operating pressure, the needle is within the middle-third of the range.
 1. Suction: 30 inches Hg vacuum to 250 psig.

2. Discharge: 0 to 500 psig.

2.3 REFRIGERANTS AND OIL

- A. Provide EPA approved refrigerant and oil for proper system operation.

2.4 PIPE/CONDUIT ROOF PENETRATION COVER

- A. Prefabricated Roof Curb: Galvanized steel or extruded aluminum 12 inches overall height, continuous welded corner seams, treated wood nailer, 1-1/2 inch thick, 3 lb/cu.ft. density rigid mineral fiberboard insulation with metal liner, built-in cant strip (except for gypsum or tectum decks). For surface insulated roof deck, provide raised cant strip (recessed mounting flange) to start at the upper surface of the insulation. Curbs shall be constructed for pitched roof or ridge mounting as required to keep top of curb level.
- B. Penetration Cover: Galvanized sheet metal with flanged removable top. Provide 38 mm (1-1/2 inch) thick mineral fiber board insulation.
- C. Flashing Sleeves: Provide sheet metal sleeves for conduit and pipe penetrations of the penetration cover. Seal watertight penetrations.

2.5 PIPE INSULATION FOR DX HVAC SYSTEMS

- A. Refer to Section 23 07 00 Thermal Insulation for Mechanical Systems.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install refrigerant piping and refrigerant containing parts in accordance with ASHRAE Standard 15 and ASME B31.5
 1. Install piping as short as possible, with a minimum number of joints, elbow and fittings.
 2. Install piping with adequate clearance between pipe and adjacent walls and hangers to allow for service and inspection. Space piping, including insulation, to provide 1 inch minimum clearance between adjacent piping or other surface. Use pipe sleeves through walls, floors, and ceilings, sized to permit installation of pipes with full thickness insulation.
 3. Locate and orient valves to permit proper operation and access for maintenance of packing, seat and disc. Generally locate valve stems in overhead piping in horizontal position. Provide a union adjacent to one end of all threaded end valves. Control valves usually require reducers to connect to pipe sizes shown on the drawing.
 4. Use copper tubing in protective conduit when installed below ground.

5. Install hangers and supports per ASME B31.5 and the refrigerant piping manufacturer's recommendations.
 6. Verify refrigerant pipe sizes and install in accordance with manufacturer's pipe size recommendations.
- B. Joint Construction:
1. Brazed Joints: Comply with AWS "Brazing Handbook" and with filler materials complying with AWS A5.8/A5.8M.
 - a. Use Type BcuP, copper-phosphorus alloy for joining copper socket fittings with copper tubing.
 - b. Use Type BAg, cadmium-free silver alloy for joining copper with bronze or steel.
 - c. Swab fittings and valves with manufacturer's recommended cleaning fluid to remove oil and other compounds prior to installation.
 - d. Pass nitrogen gas through the pipe or tubing to prevent oxidation as each joint is brazed. Cap the system with a reusable plug after each brazing operation to retain the nitrogen and prevent entrance of air and moisture.
 - C. Protect refrigerant system during construction against entrance of foreign matter, dirt and moisture; have open ends of piping and connections to compressors, condensers, evaporators and other equipment tightly capped until assembly.
 - D. Pipe relief valve discharge to outdoors for systems containing more than 100 lbs. of refrigerant.
 - E. Firestopping: Fill openings around uninsulated piping penetrating floors or fire walls, with firestop material.

3.2 PIPE AND TUBING INSULATION

- A. Apply two coats of weather-resistant finish as recommended by the manufacturer to insulation exposed to outdoor weather.

3.3 SIGNS AND IDENTIFICATION

- A. Each refrigerating system erected on the premises shall be provided with an easily legible permanent sign securely attached and easily accessible, indicating thereon the name and address of the installer, the kind and total number of pounds of refrigerant required in the system for normal operations, and the field test pressure applied.
- B. Systems containing more than 110 lb of refrigerant shall be provided with durable signs, in accordance with ANSI A13.1 and ANSI Z535.1, having letters not less than 1/2 inch in height designating:

1. Valves and switches for controlling refrigerant flow, the ventilation and the refrigerant compressor(s).
2. Signs on all exposed high pressure and low pressure piping installed outside the machinery room, with name of the refrigerant and the letters "HP" or "LP."

3.4 FIELD QUALITY CONTROL

- A. Prior to initial operation examine and inspect piping system for conformance to plans and specifications and ASME B31.5. Correct equipment, material, or work rejected because of defects or nonconformance with plans and specifications, and ANSI codes for pressure piping.
- B. After completion of piping installation and prior to initial operation, conduct test on piping system according to ASME B31.5. Furnish materials and equipment required for tests. Perform tests in the presence of Resident Engineer. If the test fails, correct defects and perform the test again until it is satisfactorily done and all joints are proved tight.
 1. Every refrigerant-containing parts of the system that is erected on the premises, except compressors, condensers, evaporators, safety devices, pressure gages, control mechanisms and systems that are factory tested, shall be tested and proved tight after complete installation, and before operation.
 2. The high and low side of each system shall be tested and proved tight at not less than the lower of the design pressure or the setting of the pressure-relief device protecting the high or low side of the system, respectively, except systems erected on the premises using non-toxic and non-flammable Group A1 refrigerants with copper tubing not exceeding DN 18 (NPS 5/8). This may be tested by means of the refrigerant charged into the system at the saturated vapor pressure of the refrigerant at 20 degrees C (68 degrees F) minimum.
- C. Test Medium: A suitable dry gas such as nitrogen or shall be used for pressure testing. The means used to build up test pressure shall have either a pressure-limiting device or pressure-reducing device with a pressure-relief device and a gage on the outlet side. The pressure relief device shall be set above the test pressure but low enough to prevent permanent deformation of the system components.

3.5 SYSTEM TEST AND CHARGING

- A. System Test and Charging: As recommended by the equipment manufacturer or as follows:
 1. Connect a drum of refrigerant to charging connection and introduce enough refrigerant into system to raise the pressure to 70 kPa (10 psi) gage. Close valves and disconnect refrigerant drum. Test system for leaks

with halide test torch or other approved method suitable for the test gas used. Repair all leaking joints and retest.

2. Connect a drum of dry nitrogen to charging valve and bring test pressure to design pressure for low side and for high side. Test entire system again for leaks.
3. Evacuate the entire refrigerant system by the triplicate evacuation method with a vacuum pump equipped with an electronic gage reading in microns. Pull the system down to 2245.6 inches of mercury at 60 degrees F. and hold for four hours then break the vacuum with dry nitrogen (or refrigerant). Repeat the evacuation two more times breaking the third vacuum with the refrigeration to be charged and charge with the proper volume of refrigerant.

2.6 LEAK TESTING

- A. After completion of pressure test in conformance with this section and ASME B31.5-2020, test all new connections and components of system. Conduct test on piping system and components according to ASTM E515 - Standard Method of Testing for Leaks Using Bubble Emission Techniques and Article 10, section V of the ASME Boiler and Pressure Vessel Code or by other methods of equal sensitivity.
- B. Furnish materials and equipment required for tests. Perform tests in the presence of Inspector of Record. If the test fails, correct defects and perform the pressure test again until it is satisfactorily done and all joints are proved tight. Contractor shall utilize Leak-Tec Thin Film 372G formula for all applicable refrigerant formulas or other approved testing medium of equal sensitivity.

END OF SECTION 23 23 00

SECTION 23 31 13 - METAL DUCTS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Provide complete materials, equipment, fabrications, installation and tests in conformity with applicable codes and authorities having jurisdiction for the following:
 - 1. Ductwork and Plenums
 - 2. Fasteners and Sealants
 - 3. Access doors
 - 4. Balancing dampers
 - 5. Backdraft dampers
 - 6. All duct accessories

1.2 DEFINITIONS

- A. In addition to Section 23 00 00 GENERAL REQUIREMENTS - HEATING, VENTILATING, AND AIR-CONDITIONING the following abbreviations apply:
 - 1. Seam: locks or weld applied longitudinally to close section of duct. Examples: longitudinal seam, spiral seam.
 - 2. Joint: abutting connection between duct sections for continuity of air passage. Examples: cross joint, transverse joint, coupling.
 - 3. Reinforcement: hardware applied to strengthen duct. Examples: girth angles, tie rods, fasteners (not connectors).
 - 4. Stiffening: folding, bending, cross-breaking or corrugating of sheets to achieve strength through shape. Examples: pocket lock secures joint and is transverse stiffener, with girth angle and/or fasteners applied (not connectors), joint or stiffener is reinforced.
- B. Duct Classifications:
 - 1. Velocity:
 - a. Low: to 2,000 feet per minute.
 - b. High: above 2000 feet per minute.

2. Pressure classification: except as noted:
 - a. Low: Up to 2 inches water gauge.
 - b. Medium: Above 2 inches to maximum 6" water gauge.
 - c. High: Above 6" water gauge.

1.3 QUALITY ASSURANCE

- A. In addition to Section 23 00 00 GENERAL REQUIREMENTS - HEATING, VENTILATING, AND AIR-CONDITIONING quality assurance requirements the ductwork shall:
 1. Entire ductwork system, including materials and installation shall be installed in accordance with NFPA 90A.
 2. Ductwork and components shall be listed as U.L. 181, Class 1 air duct, flame rating not to exceed 25 and smoke rating not to exceed 50.
 3. Fire Safety Code: Comply with NFPA 90A.
 4. Duct System Construction and Installation: Referenced SMACNA Standards are the minimum acceptable quality.
 5. Duct Sealing, Air Leakage Criteria, and Air Leakage Tests: Ducts shall be sealed as per duct sealing requirements of SMACNA HVAC Air Duct Leakage Test Manual for duct pressure classes shown on the drawings.
 6. Duct accessories exposed to the air stream, such as dampers of all types (except smoke dampers) and access openings, shall be of the same material as the duct or provide at least the same level of corrosion resistance.

1.4 SUBMITTALS

- A. Manufacturer's Literature and Data:
 1. Rectangular ducts:
 - a. Schedules of duct systems, materials and selected SMACNA construction alternatives for joints, sealing, gage and reinforcement.
 - b. Duct liner.
 - c. Sealants and gaskets.
 - d. Access doors.
 2. Round and flat oval duct construction details:
 - a. Manufacturer's details for duct fittings.

- b. Duct liner.
 - c. Sealants and gaskets.
 - d. Access sections.
 - e. Installation instructions.
3. Volume dampers, back draft dampers.
 4. Upper hanger attachments.
 5. Fire dampers, fire doors, and smoke dampers with installation instructions.
 6. Sound attenuators, including pressure drop and acoustic performance.
 7. Flexible ducts and clamps, with manufacturer's installation instructions.
 8. Flexible connections.
 9. Instrument test fittings.
 10. Details and design analysis of alternate or optional duct systems.
- B. Coordination Drawings: Refer to article, SUBMITTALS, in Section 23 00 00.

1.5 APPLICABLE PUBLICATIONS

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. American Society for Testing and Materials (ASTM):
1. A167-99(2009) Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
 2. A653-09 Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy coated (Galvannealed) by the Hot-Dip process.
 3. A1011-09a 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.
 4. B209-07 Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
 5. C1071-05e1 Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material).

6. E84-09a Standard Test Method for Surface Burning Characteristics of Building Materials.
- C. National Fire Protection Association (NFPA):
1. 90A-09 Standard for the Installation of Air Conditioning and Ventilating Systems.
 2. 96-08 Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations.
- D. Sheet Metal and Air Conditioning Contractors National Association (SMACNA):
1. 4th Edition HVAC Duct Construction Standards, Metal and Flexible.
 2. 2012 HVAC Air Duct Leakage Test Manual.
 3. 7th Edition Fibrous Glass Duct Construction Standards.
- E. Underwriters Laboratories, Inc. (UL):
1. 181-08 Factory-Made Air Ducts and Air Connectors.
 2. 555-06 Standard for Fire Dampers.
 3. 555S-06 Standard for Smoke Dampers.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

- A. Spiral round duct: McGill Airflow
- B. Duct Connection Systems: Ductmate Industries
- C. Flexible Connections: Ventfabrics
- D. Flexible Ducts: ATCO Rubber Products, Inc.
- E. Duct Sealants: Foster
- F. Flexible Duct Clamps: ATCO Rubber Products
- G. Spin-in fittings: Buckley Associates, Inc.
- H. Duct Access Doors at ducts: Ventfabrics
- I. Duct Access Doors at plenums: Ventfabrics
- J. Multi-blade volume dampers: Ruskin
- K. Backdraft Dampers: Ruskin
- L. Damper Hardware: Young Regulator Company

2.2 DUCT MATERIALS AND SEALANTS

- A. General: Except for systems specified otherwise, construct ducts, casings, and accessories of galvanized sheet steel, ASTM A653, coating G90; or, aluminum sheet, ASTM B209, alloy 1100, 3003 or 5052.
- B. Specified Corrosion Resistant Systems: Stainless steel sheet, ASTM A167, Class 302 or 304, Condition A (annealed) Finish No. 4 for exposed ducts and Finish No. 2B for concealed duct or ducts located in mechanical rooms.
- C. Joint Sealing: Refer to SMACNA HVAC Duct Construction Standards (3rd Edition), paragraph S1.9.
 - 1. Sealant: Elastomeric compound, gun or brush grade, maximum 25 flame spread and 50 smoke developed (dry state) compounded specifically for sealing ductwork as recommended by the manufacturer. Generally provide liquid sealant, with or without compatible tape, for low clearance slip joints and heavy, permanently elastic, mastic type where clearances are larger. Oil base caulking and glazing compounds are not acceptable because they do not retain elasticity and bond.

2. Tape: Use only tape specifically designated by the sealant manufacturer and apply only over wet sealant. Pressure sensitive tape shall not be used on bare metal or on dry sealant.
 3. Gaskets in Flanged Joints: Soft neoprene.
- D. Approved factory made joints may be used.

2.3 DUCT CONSTRUCTION AND INSTALLATION

- A. Regardless of the pressure classifications outlined in the SMACNA Standards, fabricate and seal the ductwork in accordance with the following pressure classifications:
- B. Duct Pressure Classification:
1. 2 inch
 2. > 2 inch to 3 inch
 3. > 3 inch to 4 inch
- C. Seal Class: All ductwork shall receive Class A Seal
- D. Round and Flat Oval Ducts: Furnish duct and fittings made by the same manufacturer to insure good fit of slip joints. When submitted and approved in advance, round and flat oval duct, with size converted on the basis of equal pressure drop, may be furnished in lieu of rectangular duct design shown on the drawings.
1. Elbows: Diameters 3 through 8 inches shall be two sections die stamped, all others shall be gored construction, maximum 18 degree angle, with all seams continuously welded or standing seam. Coat galvanized areas of fittings damaged by welding with corrosion resistant aluminum paint or galvanized repair compound.
 2. Provide bell mouth, conical tees or taps, laterals, reducers, and other low loss fittings as shown in SMACNA HVAC Duct Construction Standards.
 3. Ribbed Duct Option: Lighter gage round/oval duct and fittings may be furnished provided certified tests indicating that the rigidity and performance is equivalent to SMACNA standard gage ducts are submitted.
 - a. Ducts: Manufacturer's published standard gage, G90 coating, spiral lock seam construction with an intermediate standing rib.
 - b. Fittings: May be manufacturer's standard as shown in published catalogs, fabricated by spot welding and bonding with neoprene base cement or machine formed seam in lieu of continuous welded seams.
 4. Provide flat side reinforcement of oval ducts as recommended by the manufacturer and SMACNA HVAC Duct Construction Standard S3.13.

Because of high pressure loss, do not use internal tie-rod reinforcement unless approved by the Engineer.

- E. Casings and Plenums: Construct in accordance with SMACNA HVAC Duct Construction Standards Section 6, including curbs, access doors, pipe penetrations, eliminators and drain pans. Access doors shall be hollow metal, insulated, with latches and door pulls, 20 inches wide by 48 - 54 inches high. Provide view port in the doors where shown. Provide drain for outside air louver plenum. Outside air plenum shall have exterior insulation. Drain piping shall be routed to the nearest floor drain.
- F. Volume Dampers: Single blade or opposed blade, multi-louver type as detailed in SMACNA Standards. Refer to SMACNA Detail Figure 2-12 for Single Blade and Figure 2.13 for Multi-blade Volume Dampers.
- G. Duct Hangers and Supports: Refer to SMACNA Standards Section IV. Avoid use of trapeze hangers for round duct.

2.4 DUCT LINER (Where indicated on drawings)

- A. Duct sizes shown on drawings for lined duct are clear opening inside lining.
- B. Rectangular Duct or Casing Liner: ASTM C1071, Type I (flexible), or Type II (board), 25 mm (one inch) minimum thickness, applied with mechanical fasteners and 100 percent coverage of adhesive in conformance with SMACNA, Duct Liner Application Standard.

2.5 DUCT ACCESS DOORS, PANELS AND SECTIONS

- A. Provide access doors, sized and located for maintenance work, upstream, in the following locations:
 - 1. Each duct mounted coil and humidifier.
 - 2. Each fire damper (for link service), smoke damper and automatic control damper.
 - 3. Each duct mounted smoke detector.
 - 4. For kitchen hood exhaust duct, locate access doors at 20 feet intervals and at each change in duct direction.
- B. Openings shall be as large as feasible in small ducts, 12 inch by 12 inch minimum where possible. Access sections in insulated ducts shall be double-wall, insulated. Transparent shatterproof covers are preferred for uninsulated ducts.
 - 1. For rectangular ducts: Refer to SMACNA HVAC Duct Construction Standards (Figure 2-12).
 - 2. For round and flat oval duct: Refer to SMACNA HVAC duct Construction Standards (Figure 2-11).

2.6 FIRE DAMPERS

- A. Galvanized steel, interlocking blade type, UL listing and label, 1-1/2 hour rating, 160 degrees F fusible line, 100 percent free opening with no part of the blade stack or damper frame in the air stream.
- B. Fire dampers in wet air exhaust shall be of stainless steel construction, all others may be galvanized steel.
- C. Minimum requirements for fire dampers:
 - 1. The damper frame may be of design and length as to function as the mounting sleeve, thus eliminating the need for a separate sleeve, as allowed by UL 555. Otherwise provide sleeves and mounting angles, minimum 14 gage, required to provide installation equivalent to the damper manufacturer's UL test installation.
 - 2. Submit manufacturer's installation instructions conforming to UL rating test.

2.7 SMOKE DAMPERS

- A. Maximum air velocity, through free area of open damper, and pressure loss: Low pressure and medium pressure duct (supply, return, exhaust, outside air): 1500 fpm. Maximum static pressure loss: 0.13 inch W.G.
- B. Maximum air leakage, closed damper: 4.0 CFM per square foot at 3 inch W.G. differential pressure.
- C. Minimum requirements for dampers:
 - 1. Shall comply with requirements of Table 6-1 of UL 555S, except for the Fire Endurance and Hose Stream Test.
 - 2. Frame: Galvanized steel channel with side, top and bottom stops or seals.
 - 3. Blades: Galvanized steel, parallel type preferably, 12 inch maximum width, edges sealed with neoprene, rubber or felt, if required to meet minimum leakage. Airfoil (streamlined) type for minimum noise generation and pressure drop are preferred for duct mounted dampers.
 - 4. Shafts: Galvanized steel.
 - 5. Bearings: Nylon, bronze sleeve or ball type.
 - 6. Hardware: Zinc plated.
 - 7. Operation: Automatic open/close. No smoke damper that requires manual reset or link replacement after actuation is acceptable. See drawings for required control operation.

- D. Motor operator (actuator): Provide pneumatic or electric as required by the automatic control system, externally mounted on stand-offs to allow complete insulation coverage.

2.8 COMBINATION FIRE AND SMOKE DAMPERS

- A. Combination fire and smoke dampers: Multi-blade type units meeting all requirements of both fire dampers and smoke dampers shall be used where shown and may be used at the Contractor's option where applicable.

2.9 FLEXIBLE AIR DUCT

- A. General: Factory fabricated, complying with NFPA 90A for connectors not passing through floors of buildings. Flexible ducts shall not penetrate any fire or smoke barrier which is required to have a fire resistance rating of one hour or more. Flexible duct length shall not exceed 5 feet. Provide insulated acoustical air duct connectors in supply air duct systems and elsewhere as shown.
- B. Flexible ducts shall be listed by Underwriters Laboratories, Inc., complying with UL 181. Ducts larger than 8 inches in diameter shall be Class 1. Ducts 8 inches in diameter and smaller may be Class 1 or Class 2.
- C. Insulated Flexible Air Duct: Factory made including mineral fiber insulation with maximum C factor of 0.25 at 24 degrees C (75 degrees F) mean temperature, encased with a low permeability moisture barrier outer jacket, having a puncture resistance of not less than 50 Beach Units. Acoustic insertion loss shall not be less than 3 dB per foot of straight duct, at 500 Hz, based on 6 inch duct, of 2500 fpm.
- D. Application Criteria:
 - 1. Temperature range: -0 to 200 degrees F internal.
 - 2. Maximum working velocity: 4000 feet per minute.
 - 3. Minimum working pressure, inches of water gage: 10 inches positive, 2 inches negative.
- E. Duct Clamps: 100 percent nylon strap, 175 pounds minimum loop tensile strength manufactured for this purpose or stainless steel strap with cadmium plated worm gear tightening device. Apply clamps with sealant and as approved for UL 181, Class 1 installation.

2.10 FLEXIBLE DUCT CONNECTIONS

- A. Where duct connections are made to fans and air handling units, install a non-combustible flexible connection of 29 ounce neoprene coated fiberglass fabric approximately 6 inches wide. For connections exposed to sun and weather provide "hypalon" coating in lieu of neoprene. Burning characteristics shall conform to NFPA 90A. Securely fasten flexible connections to round ducts with stainless steel or zinc-coated iron draw bands with worm gear fastener. For rectangular connections,

crimp fabric to sheet metal and fasten sheet metal to ducts by screws 2 inches on center. Fabric shall not be stressed other than by air pressure. Allow at least one inch slack to insure that no vibration is transmitted.

2.11 PREFABRICATED ROOF CURBS

- A. Galvanized steel or extruded aluminum 12 inches above finish roof service, continuous welded corner seams, treated wood nailer, 1-1/2 inch thick, 3 pound/cubic feet density rigid mineral fiberboard insulation with metal liner, built-in cant strip (except for gypsum or tectum decks). For surface insulated roof deck, provide raised cant strip (recessed mounting flange) to start at the upper surface of the insulation. Curbs shall be constructed for pitched roof or ridge mounting as required to keep top of curb level.

2.12 TURNING VANES

- A. Galvanized steel constructed per SMACNA HVAC Duct Construction Standards for:
 - 1. Single wall vanes with $\frac{3}{4}$ inch trailing edges (double wall vanes not acceptable).
 - 2. Provide separate equal size sections for vane length greater than those indicated in SMACNA where occurs.
 - 3. Vane runners shall be Type 1 or 2.
 - 4. Vane radius shall be 2 inch for duct widths up to 36 inches and 4-1/2" for larger ducts.
 - 5. Low pressure round duct take-off fittings in rectangular ductwork:
 - a. Factory fabricated spin-in fitting of die-formed galvanized steel with integral balancing damper (spring loaded with locking regulator) and sealed at both ends to prevent leakage. Use no scoops. Buckley Associates, Inc.

PART 3 – EXECUTION

3.1 GENERAL INSTALLATION

- A. Fabricate and install ductwork and accessories in accordance with referenced SMACNA Standards:
 - 1. Drawings show the general layout of ductwork and accessories but do not show all required fittings and offsets that may be necessary to connect ducts to equipment, boxes, diffusers, grilles, etc., and to coordinate with other trades. Fabricate ductwork based on field measurements. Provide all necessary fittings and offsets at no additional cost to the owner. Coordinate with other trades for space available and relative location of HVAC equipment and accessories on ceiling grid. Duct sizes on the drawings are inside dimensions which shall be altered by Contractor to other dimensions with the same air handling characteristics where necessary to avoid interferences and clearance difficulties.
 - 2. Provide duct transitions, offsets and connections to dampers, coils, and other equipment in accordance with SMACNA Standards, Section II. Provide streamliner, when an obstruction cannot be avoided and must be taken in by a duct. Repair galvanized areas with galvanizing repair compound.
 - 3. Provide bolted construction and tie-rod reinforcement in accordance with SMACNA Standards.
 - 4. Construct casings, eliminators, and pipe penetrations in accordance with SMACNA Standards, Chapter 6. Design casing access doors to swing against air pressure so that pressure helps to maintain a tight seal.
- B. Install duct hangers and supports in accordance with SMACNA Duct Construction Standards (3rd Edition), Chapter 5.
- C. Install fire dampers, smoke dampers and combination fire/smoke dampers in accordance with the manufacturer's instructions to conform to the installation used for the rating test. Install fire dampers, smoke dampers and combination fire/smoke dampers at locations indicated and where ducts penetrate fire rated and/or smoke rated walls, shafts and where required by the Resident Engineer. Install with required perimeter mounting angles, sleeves, breakaway duct connections, corrosion resistant springs, bearings, bushings and hinges per UL and NFPA. Demonstrate re-setting of fire dampers and operation of smoke dampers to the Engineer.
- D. Seal openings around duct penetrations of floors and fire rated partitions with fire stop material as required by NFPA 90A.
- E. Flexible duct installation: Refer to SMACNA Standards, Chapter 3. Ducts shall be continuous, single pieces not over 5 feet long (NFPA 90A), as straight and short as feasible, adequately supported. Centerline radius of bends shall be not less than two duct diameters. Make connections with clamps as recommended by SMACNA. Clamp

per SMACNA with one clamp on the core duct and one on the insulation jacket. Flexible ducts shall not penetrate floors, or any chase or partition designated as a fire or smoke barrier, including corridor partitions fire rated one hour or two hour. Support ducts SMACNA Standards.

- F. Where diffusers, registers and grilles cannot be installed to avoid seeing inside the duct, paint the inside of the duct with flat black paint to reduce visibility.
- G. Control Damper Installation:
 - 1. Provide necessary blank-off plates required to install dampers that are smaller than duct size. Provide necessary transitions required to install dampers larger than duct size.
 - 2. Assemble multiple sections dampers with required interconnecting linkage and extend required number of shafts through duct for external mounting of damper motors.
 - 3. Provide necessary sheet metal baffle plates to eliminate stratification and provide air volumes specified. Locate baffles by experimentation, and affix and seal permanently in place, only after stratification problem has been eliminated.
 - 4. Install all damper control/adjustment devices on stand-offs to allow complete coverage of insulation.
- H. Air Flow Measuring Devices (AFMD): Install units with minimum straight run distances, upstream and downstream as recommended by the manufacturer.
- I. Low Pressure Duct Liner: Install in accordance with SMACNA, Duct Liner Application Standard.
- J. Protection and Cleaning: Adequately protect equipment and materials against physical damage. Place equipment in first class operating condition, or return to source of supply for repair or replacement, as determined by Resident Engineer. Protect equipment and ducts during construction against entry of foreign matter to the inside and clean both inside and outside before operation and painting. When new ducts are connected to existing ductwork, clean both new and existing ductwork by mopping and vacuum cleaning inside and outside before operation.
- K. Ducts exposed to the weather:
 - 1. Make ducts watertight with tops sloped to shed water. Standing pools of water on top of ducts shall not be allowed.
 - a. Arrange seams to not act as dams.
 - b. Place longitudinal seams at bottom of ducts.
 - c. Insure water runoff by sloping entire top of duct down toward sides.

- d. Longitudinal seams and non-bolted joints shall be sealed with SMACNA approved duct sealant for both interior and exterior applications.
 - e. Bolted duct joints: Top of duct shall have a continuous metal cleat from corner to corner to provide a weather cap. The sides, end and bottom shall have intermediate 6" pieces of metal cleats so that any water can drain away.
- L. Construct with gauges, joints, bracing, reinforcing, and other details per latest edition of the CMC, AHSRAE, SMACNA and NFPA. Comply with most stringent requirement. Provide ducts with CMC required gauges when penetrating rated construction.
- M. Provide for duct rigidity by either beading at 12 inches on center, maximum, or crossbreaking outward in ducts with positive pressures and crossbreaking inward for ducts having negative pressures. The exception is for ducts exposed to weather which shall crossbreak outward on top of duct.
- N. At exposed duct penetrations of walls, floors and ceilings provide sheet metal angle type escutcheons with no sharp corners or edges. For round ducts factory angle rings may be used.
- O. Frame, trim, caulk and seal all duct penetrations through acoustical walls and partitions.
- P. Tapers:
- 1. Pitch sides of ducts in diverging or converging airflow with a maximum 1 to 4 taper. Abrupt bushing type fitting shall not be permitted.
- Q. Duct openings:
- 1. Provide openings to accommodate instrumentation, thermometers, smoke detectors, controllers and miscellaneous components. Insert through airtight rubber grommets.
 - 2. Where openings are provided in insulated ductwork for insertion of instruments install insulation material inside metal ring for use as a plug.
 - 3. At fire dampers allow adequate length of duct to install access door.
- R. No exposed sharp metal shall be allowed.
- 1. All exposed pins, screws and sharp objects shall be covered with hardening silicon.
 - 2. All exposed sheet metal edges shall be hemmed with exposed corners rounded smooth.
 - 3. Remove all sheet metal fish hooks.

- S. Flexible duct connectors:
 - 1. Install at connections to fans and air handling units and where indicated on the drawings.
 - 2. Install with 2 inches of slack fabric to allow a minimum movement of 1 inch in each direction.
- T. Elbows:
 - 1. Radius elbows shall have a centerline dimension not less than 1 duct width, unless otherwise noted.
 - 2. Where elbows with turning vanes are shown:
 - a. Install per SMACNA HVAC Duct Construction Standards
- U. Rectangular duct joints:
 - 1. In medium pressure ductwork transverse joints shall be Ductmate. In low pressure ductwork transverse joints shall be Ductmate except that slip and drive may be used at contractor's option for ducts less than 24 inches longest side.
 - 2. Longitudinal seams shall be Pittsburge type. Snaplock shall not be allowed.
- V. Horizontal supports shall be one or two piece clamp band straps or as otherwise detailed on the drawings with one support minimum per sections and additional as required to prevent sagging.
- W. Vertical supports shall consist of a pedestal at base of vertical or clamp bands with knee bracing or clamp bands with extended ends supported by floor.
- X. Connections to air distribution (grilles, registers and diffusers) shall be by full radius elbow or by a straight duct connection for one duct diameter or greater.
 - 1. Where space is tight use side inlet plenums (cans) fabricated of minimum 24 gauge galvanized sheet metal, at least as tall as the connecting duct, with turning vanes.
 - 2. Connections to air distribution shall be insulated just the same as for the ductwork.
 - 3. Connections to air outlets shall be sealed with duct sealant.
- Y. Duct hangers and supports
 - 1. Support horizontal ducts with hangers of size and spacing per SMACNA HVAC Duct Construction Standards with attachments to suit structure type and seismic restraints where required.

- a. See Hangers and Supports Section 23 05 29 for attachments to structure.
- 2. Horizontal supports:
 - a. Install hangers at each change in direction of duct.
 - b. Strap hangers:
 - c. Install in pairs on each side of duct, in symmetry, and extend down each side with turn in on bottom of min 2 inches. Metal screw hangers to ducts on bottom, upper and lower sides and no less than 12 inches on center.
 - d. Angle hangers:
 - 1) Provide angle hangers formed by extended vertical bracing angles or by rods connecting to bottom angles if size or bracing angles conform to SMACNA schedules.
 - e. Vertical supports:
 - 1) Support vertical ducts at every floor with angles or channels riveted to ducts. Set angles or channels on floor slab or structural steel members.
- Z. Volume and Dampers shall be provided at locations shown on the drawings.
 - 1. Volume dampers shall be installed as far away from air outlets as functionally reasonable to avoid noise in the occupied spaces.
 - 2. Provide also in wyes and spin-ins to outlets whether shown on drawings or not, except:
 - a. Where dampers are not shown above inaccessible ceilings.
 - b. To sidewall outlets in exposed ducts (opposed blade dampers in outlets shall be provided).

3.2 DUCT LEAKAGE TESTS AND REPAIR

- A. Ductwork leakage testing shall be performed by the Testing and Balancing Contractor directly contracted by the General Contractor and independent of the Sheet Metal Contractor.
- B. Ductwork leakage testing shall be performed for the entire air distribution system (including all supply, return, exhaust and relief ductwork), section by section, including fans, coils and filter sections. Based upon satisfactory initial duct leakage test results, the scope of the testing may be reduced by the Engineer on ductwork constructed to the 2" WG duct pressure classification. In no case shall the leakage testing of ductwork constructed above the 2" WG duct pressure classification or ductwork located in shafts or other inaccessible areas be eliminated.

- C. Test procedure, apparatus and report shall conform to SMACNA Leakage Test manual. The maximum leakage rate allowed is 4 percent of the design air flow rate.
- D. All ductwork shall be leak tested first before enclosed in a shaft or covered in other inaccessible areas.
- E. All tests shall be performed in the presence of the Engineer and the Test and Balance agency. The Test and Balance agency shall measure and record duct leakage and report to the Resident Engineer and identify leakage source with excessive leakage.
- F. If any portion of the duct system tested fails to meet the permissible leakage level, the Contractor shall rectify sealing of ductwork to bring it into compliance and shall retest it until acceptable leakage is demonstrated to the Resident Engineer.
- G. All tests and necessary repairs shall be completed prior to insulation or concealment of ductwork.
- H. Make sure all openings used for testing flow and temperatures by TAB Contractor are sealed properly.

END OF SECTION 23 31 13

SECTION 23 37 13 - DIFFUSERS, REGISTERS AND GRILLES

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Provide all air outlets, inlets, grilles, registers and diffusers except where integral with manufactured piece of equipment. Outlets and inlets shall have, as a minimum, throw and noise criteria ratings for each size device as listed in manufacturers current data, rated as required by the applicable publications and standards.
- B. All work of this section shall comply with Section 23 00 00 GENERAL REQUIREMENTS - HEATING, VENTILATING, AND AIR-CONDITIONING (HVAC)

1.2 APPLICABLE PUBLICATIONS

The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.

- A. American Society of Heating, Refrigeration and Air Conditioning Engineers:
 - 1. ASHRAE Standard 70 Methods of Testing for Rating the Airflow Performance of Outlets and Inlets.
- B. American Refrigeration Institute:
 - 1. ARI 650 Air Outlets and Inlets
- C. Air Diffusion Council Test Code:
 - 1. 1062 GRD-84 Certification, Rating, and Test Manual 4th Edition.
- D. American Society of Civil Engineers (ASCE):
 - 1. ASCE7-05 Minimum Design Loads for Buildings and Other Structures.
- E. American Society for Testing and Materials (ASTM):
 - 1. A167-99 Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet and Strip.
 - 2. B209-07 Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
- F. National Fire Protection Association (NFPA):
 - 1. 90A-09 Standard for the Installation of Air Conditioning and Ventilating Systems.

- G. Underwriters Laboratories, Inc. (UL):
 - 1. 181-08 UL Standard for Safety Factory-Made Air Ducts and Connectors.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Manufacturer shall examine and approve of application of each item of air distribution.
- B. Noise level at design capabilities: no larger than diffuser selections shown on drawings.
- C. Volume dampers:
 - 1. Do not provide dampers built into air distribution or directly attached to air distribution unless specifically called out on drawings.
 - 2. Volume damper adjustable from face of diffuser on register except as noted.
- D. Air distribution frame shall be suitable for the ceiling construction indicated:
 - 1. Concealed spline type acoustical tile ceiling: flanged for surface mounting.
 - 2. Lay-in acoustical tile ceiling with inverted tee-bar: lay-in type frame for setting on tee-bars.
 - 3. Plaster ceilings: flanged for surface mounting, or plaster frames as indicated.
 - 4. Positive connection of diffuser to all ceiling connections (T-bar, hard lid, etc.)
- E. Match finish color sample as directed by the Owner's Representative.
 - 1. Factory- baked white enamel unless otherwise specified.
 - 2. Other special materials and finished, as scheduled on Drawings.

2.2 AIR OUTLETS AND INLETS

- A. Materials:
 - 1. Steel or aluminum unless specifically indicated within the documents. Provide manufacturer's standard gasket.
 - 2. Exposed Fastenings: The same material as the respective inlet or outlet. Fasteners for aluminum may be stainless steel.
 - 3. Contractor shall review all ceiling drawings and details and provide all ceiling mounted devices with appropriate dimensions and trim for the specific locations.

- B. Air Supply Outlets:
1. Ceiling Diffusers: Suitable for surface mounting, exposed T-bar or special tile ceilings, baked enamel white finish, square or round neck connection as shown on the drawings. Provide plaster frame for units in plaster ceilings.
 - a. Square, louver, fully adjustable pattern: Round neck, surface mounting unless shown otherwise on the drawings. Provide equalizing or control grid and volume control damper.
 - b. Louver face type: Square or rectangular, removable core for one, two, three or four-way directional pattern. Provide equalizing or control grid and opposed blade damper.
 - c. Perforated face type: Manual adjustment for one, two, three, or four-way horizontal air distribution pattern without change of air volume or pressure. Provide equalizing or control grid and opposed blade over overlapping blade damper.
 2. Supply Registers: Double deflection type with horizontal face bars and opposed blade damper with removable key operator.
 - a. Margin: Flat, 1-1/4 inches wide.
 - b. Bar spacing: 3/4 inch maximum.
 - c. Finish: Off white baked enamel for ceiling mounted units. Wall units shall have a prime coat for field painting, or shall be extruded with manufacturer's standard finish.
 3. Supply Grilles: Same as registers but without the opposed blade damper.
- C. Return and Exhaust Registers and Grilles: Provide opposed blade damper without removable key operator for registers.
1. Finish: Off-white baked enamel for ceiling mounted units. Wall units shall have a prime coat for field painting, or shall be extruded aluminum with manufacturer's standard aluminum finish.
 2. Standard Type: Fixed horizontal face bars set at 30 to 45 degrees, approximately 1-1/4 inch margin.
 3. Perforated Face Type: To match supply units.
 4. Grid Core Type: 1/2 inch by 1/2 inch core with 1-1/4 inch margin.
 5. Linear Type: To match supply units.
 6. Door Grilles: Are to be furnished with the doors.

7. Egg Crate Grilles: Aluminum or Painted Steel 1/2 by 1/2 by 1/2 inch grid providing 90% free area.
 - a. Heavy extruded aluminum frame shall have countersunk screw mounting. Unless otherwise indicated, register blades and frame shall have factory applied white finish.
 - b. Grille shall be suitable for duct or surface mounting as indicated on drawings. All necessary appurtenances shall be provided to allow for mounting.
- D. Acoustic Transfer Grille: Aluminum, suitable for partition or wall mounting.

2.3 WIRE MESH GRILLE

- A. Fabricate grille with 2 x 2 mesh 1/2 inch galvanized steel or aluminum hardware cloth in a spot welded galvanized steel frame with approximately 1-1/2 inch margin.
- B. Use grilles where shown in unfinished areas such as mechanical rooms.

PART 3 – EXECUTION

3.1 INSTALLATION

- A. Install air distribution in accordance with manufacturers written installation instructions.
- B. Return and exhaust grilles: install with blades oriented to prevent sight through outlets.
- C. Air distribution cans visible through grilles painted flat black.
- D. Transfer grilles:
 - 1. See drawings.
 - 2. Wall installations, unless otherwise indicated, provide two grilles:
 - a. One on each side of wall, except where open to return air plenums.
 - b. Connecting sheet metal collar with 18" elevation offset for light and sound attenuation.
- E. Provide duct screens at termination ducts as indicated.
- F. Verify mounting, direction and adjustments are installed per the drawings.

3.2 MOUNTING AND ALIGNMENT

- A. All air distribution shall be secured to building:
 - 1. Ceiling distribution shall be secured to prevent falling from ceiling during construction or service with minimum of two 16-gauge ceiling wires, two 22-gauge by 1 inch galvanized sheet metal strap or two #10 sheet metal screws.
 - 2. Comply with CBC.
- B. Mount directional grilles as shown on drawings.
- C. Adjust distribution throw patterns:
 - 1. As shown on drawings.
 - 2. For double deflection grilles, adjust rear blades horizontal and front blades in 45 degree pattern at each end gradually rotating to be almost straight at blades in center of distribution.
 - 3. Prior to test and balance.

END OF SECTION 23 37 13

SECTION 23 80 00 - DECENTRALIZED HVAC EQUIPMENT

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This Section covers the furnishing and installation of Heating, Ventilating and Air Conditioning (HVAC) equipment as indicated on the contract drawings, schedules and as specified herein.
1. Condensing Unit (CU-#)
 2. Heat Pump, VRF (HP-1)
 3. Fan Coil (FC-#)
 4. Energy Recovery Ventilator (ERV-1)
 5. Power Exhaust (PE-1)
 6. Rooftop Packaged Unit (RTU-1)
- B. All work of this section shall comply with Section 23 00 00 GENERAL REQUIREMENTS - HEATING, VENTILATING, AND AIR-CONDITIONING (HVAC).
- C. Definitions:
1. Energy Efficiency Ratio (EER): (Btu hour/Watt) is equal to the measured cooling capacity of the unit by its electrical input.
 2. Unitary (ARI): A Unitary Air Conditioner consists of one or more factory-made assemblies which normally include an evaporator or cooling coil, a compressor and condenser combination, and may include a heating function as well. Where such equipment is provided in more than one assembly the separated assemblies are to be designed to be used together and the requirements of rating are based upon use of matched assemblies.

1.2 QUALITY ASSURANCE

- A. Safety Standards: ASHRAE Standard 15, Safety Code for Mechanical Refrigeration.

1.3 SUBMITTALS

A. Manufacturer's literature and data:

1. Sufficient information, including capacities, pressure drops and piping connections clearly presented, shall be included to determine compliance with drawings and specifications for units noted below:

- a. Equipment Listed on Sheet M0.01:

1. Condensing Unit (CU-#)
 2. Heat Pump, VRF (HP-1)
 3. Fan Coil (FC-#)
 4. Energy Recovery Ventilator (ERV-1)
 5. Power Exhaust (PE-1)
 6. Rooftop Packaged Unit (RTU-1)

2. Unit Dimensions required clearances, operating weights accessories and start-up instructions.
 3. Electrical requirements, wiring diagrams, interlocking and control wiring showing factory installed and portions to be field installed.
 4. Mounting and flashing of the roof curb to the roofing structure with coordinating requirements for the roof membrane system.
- B. Certification: Submit proof of specified ARI Certification.
- C. Performance Rating: Submit catalog selection data showing equipment ratings and compliance with required sensible-to-heat-ratio, energy efficiency ratio (EER), and coefficient of performance (COP).
- D. Operating and Maintenance Manual: Submit three copies of Operating and Maintenance manual to Resident Engineer three weeks prior to final inspection.

1.4 APPLICABLE PUBLICATIONS

The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.

- A. Air-Conditioning and Refrigeration Institute (ARI):
1. 210/240-06 Performance Rating of Unitary Air-Conditioning and Air-Source Heat Pump Equipment
 2. 270-95 Sound Rating of Outdoor Unitary Equipment
 3. 310/380-04 Standard for Packaged Terminal Air-Conditioners and Heat Pumps (CSA-C744-04)
 4. 340/360-04 Commercial and Industrial Unitary Air-Conditioning and Heat Pump Equipment
 5. 520-04 Positive Displacement Condensing Units
- B. Air Movement and Control Association (AMCA):
1. 210-99 Laboratory Methods of Testing Fans for Aerodynamic Performance Rating (ANSI)
 2. 410-96 Recommended Safety Practices for Users and Installers of Industrial and Commercial Fans
- C. American National Standards Institute (ANSI):
1. S12.51-02 Acoustics - Determination of Sound Power Levels of Noise Sources Using Sound Pressure - Precision Method for Reverberation Rooms (same as ISO 3741:1999)

- D. American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE):
 - 1. 2004 Handbook HVAC Systems and Equipment
 - 2. 15-04 Safety Standard for Refrigeration Systems (ANSI)
- E. American Society of Testing and Materials (ASTM):
 - 1. B117-03 Standard Practice for Operating Salt Spray (Fog) Apparatus
- F. National Fire Protection Association (NFPA) Publications:
 - 1. 90A-02 Standard for the Installation of Air-Conditioning and Ventilating Systems

PART 2 - PRODUCTS

- 2.1 Refer to Sheet M0.01 for list of schedules and equipment, relating but not limited to:
 - A. Condensing Unit (CU-#)
 - B. Heat Pump, VRF (HP-1)
 - C. Fan Coil (FC-#)
 - D. Energy Recovery Ventilator (ERV-1)
 - E. Power Exhaust (PE-1)
 - F. Rooftop Packaged Unit (RTU-1)

PART 3 - EXECUTION

- 3.1 INSTALLATION
 - A. Roof Curb: Install where indicated on the Drawings, level and secure, according to ARI Guideline B. Secure rooftop units to upper curb rail, and secure curb base to roof framing or concrete base with anchor bolts.
 - B. Rooftop Unit Support: Install unit level on structural curbs, unless otherwise indicated on the Drawings. Coordinate wall penetrations and flashing with wall construction. Secure rooftop units to structural support with anchor bolts.
 - C. Install units level and plumb maintaining manufacturer's recommended clearances and tolerances.
 - D. Install water-cooled units with thermometer and pressure gage at the water supply and return connection.

- E. Install ground-mounting, compressor-condenser components on 4-inch thick, reinforced concrete base; 4 inches larger on each side than unit.
- F. Install seismic restraints.
- G. Install and connect pre-charged refrigerant tubing to component's quick-connect fittings. Install tubing to allow access to unit.
- H. Install wall sleeves in finished wall assembly and weatherproof. Install and anchor wall sleeves to withstand, without damage seismic forces as required by code.

3.2 CONNECTIONS

- A. Verify condensate drainage requirements.
- B. Install condensate drain, minimum connection size, with trap and indirect connection to nearest roof drain or area drain or as indicated on the Drawings.
- C. Install piping adjacent to units to allow service and maintenance.
- D. Install ducts to termination at top of roof curb. Cut roof decking only as required for passage of ducts. Do not cut out decking under entire roof curb.
- E. Install return-air duct continuously through roof structure.
- F. Connect refrigerant piping to coils with shutoff valves on the suction and liquid lines at the coil and a union or flange at each connection at the coil and condenser.
- G. Install ducts to the units with flexible duct connections.

3.3 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports.
- B. Tests and Inspections: After installing units and after electrical circuitry has been energized, test units for compliance with requirements. Inspect for and remove shipping bolts, blocks, and tie-down straps. After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION 23 80 00

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SECTION 26 05 00 - COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

1.1 SCOPE OF WORK

- A. Work included in this Section: "Provide" indicates all materials, labor, equipment, services, and incidentals necessary to install the Electrical Work indicated on the contract drawings and these specifications. Work includes, but is not limited to the following:
1. Electrical and telephone services stub-outs and coordination.
 2. Distribution feeders, branch circuit wiring, wiring devices and connections to all equipment requiring electrical service.
 3. Interior and exterior building lighting fixtures, controls and connections complete.
 4. Coordination with Vendor's associated with the construction of the project.
 5. All necessary incidental work not specifically mentioned herein or shown on the drawings shall be provided for complete and functioning systems.
- B. Work specified in Division 26, 27, 28:
1. Section 260519: Low-Voltage Electrical Power Conductors and Cables
 2. Section 260526: Grounding and Bonding for Electrical Systems
 3. Section 260529: Hangers and Supports for Electrical Systems
 4. Section 260533: Raceway and Boxes for Electrical Systems
 5. Section 260544: Sleeves and Sleeve Seals for Electrical Raceways and Cabling
 6. Section 260548.16: Seismic Controls for Electrical Systems
 7. Section 260553: Identification for Electrical Systems
 8. Section 260943: Network Lighting Controls
 9. Section 262416: 600-Volt Rated Panelboards & CBs'
 10. Section 262726: Wiring Devices
 11. Section 265119: LED Interior Lighting

1.2 INCORPORATED DOCUMENTS

- A. Requirements of the General Conditions, Supplementary Conditions, and Division 1 Sections apply to all work in this Section, unless modified herein.
- B. Provide equipment and materials which conform to, and perform the installation thereof in accordance with the following codes and industry standards. The applicable version of each shall be that in effect as of the date of the Contract:
1. California Electrical Code, latest edition (CEC).
 2. California Building Code, latest edition (CBC)
 3. Underwriters' Laboratories, Inc. (UL).
 4. NFPA 101, Life Safety Code.
 5. Titles 8, 19 and 24 of the California Code of Regulations (CCR).

6. American National Standards Institute (ANSI).
7. California State Fire Marshal (CSFM).
8. National Electrical Manufacturers' Association (NEMA).
9. Institute of Electrical and Electronics Engineers (IEEE).
 - a. National Electrical Safety Code (NESC).
 - 1) Electrical Safety Orders.
 - 2) Other applicable local codes and ordinances.
10. All local, State and Municipal Codes and Ordinances.

- C. Where the authority-having-jurisdiction makes an interpretation or decision, as is their prerogative in accordance with the Code, such direction shall be considered a part of these Contract Documents as if contained herein. With respect to completing the intent of the Contract Documents, comply with any and all requirements of the authority-having-jurisdiction and utility company field inspectors, at no additional cost.
- D. The above referenced codes and standards are considered to be absolute minimum requirements. The Drawings and Specifications shall take precedence over the above referenced codes and standards where materials or workmanship of higher quality or larger size is indicated. Nothing in these Drawings or Specifications shall be construed to allow work not conforming to the applicable codes and standards

1.3 REVIEW OF CONTRACT DOCUMENTS

- A. Examine all relevant Contract Documents including Drawings, Specifications, and Shop Drawings in order to become acquainted with the Work of other installers whose activities will adjoin or be affected by the Electrical Work.

1.4 PERMITS, LICENSES, AND FEES

- A. Procure and pay for all permits, licenses and fees that are required to carry out and complete the Electrical Work.
- B. Pay for building department imposed inspection fees.
- C. Pay utility company charges for normal or after hours shutdowns, service calls, repairs, and cable locating that are directly related to the installation of the Electrical Work.

1.5 SITE VERIFICATION OF INFORMATION

- A. Visit the project site prior to submitting a bid and verify the condition, location and dimensions of buildings, equipment, and facilities. The act of submitting a bid shall indicate the Contractor to have familiarized themselves with all discernible conditions

and has no exceptions to the existing conditions. There shall be no extra payment approved for work required due to existing conditions, whether specifically mentioned or not.

- B. Verify at the project site, the accuracy of information shown on the Drawings regarding existing equipment, materials, and facilities. This includes but is not limited to: size, type, rating, quality, age, and serviceability. No allowance will be made on behalf of the Contractor for extra expenses resulting from the failure to discover conditions affecting the Work.
- C. Lines of other services that are damaged as a result of this work shall promptly be repaired complete to the satisfaction of the Owner at no additional expense to the contract.

1.6 WORKING SPACE

- A. Maintain adequate work space around, and access to, electrical and mechanical equipment in strict accordance with the applicable Codes. Verify during the course of construction that sufficient space will be available for the installation equipment, fixtures, etc.

1.7 QUALITY ASSURANCE

- A. Conformance:
 - 1. The Contractor shall notify the Owner's Representative, prior to submission of bid, about any part of the design which fails to comply with abovementioned requirements.
 - 2. If after contract is awarded, minor changes and additions are required by aforementioned authorities, even though such work is not shown on drawings or covered in the specifications, they shall be included at Contractor's expense.
- B. Coordination:
 - 1. The Contractor shall become familiar with the conditions at the job site, contract drawings and specifications and plan the installation of the electrical work to conform with the existing conditions and that shown and specified so as to provide the best possible assembly of the combined work of all trades.
 - 2. The Contractor shall work out in advance all "tight" conditions, involving all trades and if found necessary, supplementary drawings shall be prepared by this Contractor, for the Owner's Representative approval before work proceeds in these areas. No additional costs will be considered for work which must be relocated due to conflicts with the work of other trades.

1.8 MATERIALS AND SUBSTITUTIONS

- A. Materials shall be new, high quality, free from defects, of standard make, and of the brand or grade as shown on the Drawings or specified herein. Specific trade names are

used in the Drawings and Specifications in order to establish the standard grade and characteristics of said items. This does not imply the right upon the part of the Contractor to use other materials or methods without the approval of the Owner's Representative.

- B. Electrical materials and equipment shall bear the label of, or be listed by, the Underwriters' Laboratories (UL) wherever standards have been established and label service is regularly furnished by that agency. Comply with the installation and application requirements of UL as documented in their published directories.
- C. Unless specifically noted, equipment and systems shall be the product of a manufacturer who has been in the manufacture of, and has nationally distributed catalogs covering the ratings and specifications of, said equipment or systems, for a period of not less than five (5) years.
- D. Maintain uniformity throughout the Project by making use of only one make or brand of material for each material used.
- E. Substitutions of materials or methods will only be allowed if such items are approved in writing by the Owner's Representative as equal in quality and utility to the specified items. Submit a list of proposed substitutions within thirty (30) days of the award of the Contract. Include on the list the original manufacturer's name and model number, the proposed manufacturer's name and model number, catalog cut sheets, ratings, sizes, performance curves, shop drawings, and other data as may be required to demonstrate equality to the specified item.
- F. The approval of a substitution does not authorize any deviation from the utility, size, function, or durability of the specified item unless specifically pointed out and requested in the proposed substitution list, and said deviation is approved in writing by the Owner's Representative. Responsibility of the Contractor for dimensional considerations or space conflicts is not relieved by the approval of a substitution.
- G. If requested by the Owner's Representative, submit samples of materials and equipment for approval prior to installation.
- H. Any and all additional costs incurred by the substitution of electrical material or equipment, or installation thereof, whether Owner's Representative, structural, plumbing, mechanical or electrical, shall be borne by the Contractor under this Section.
- I. Burden of proof of equality of any substitution for a specified product is the responsibility of this Contractor.
- J. Where required by Owner's Representative to ascertain equality of substitute product, Contractor may be requested to provide the specified item and the submitted substitution for comparison, at no additional cost to the Owner.

1.9 ELECTRICAL SUBMITTALS

- A. See the General Conditions for conditions of submittal approval and general requirements for submission of shop drawings.
- B. Submit electrical shop drawings and manufacturer's cut sheets for equipment and materials as noted in each Division 26 specification section. Bind the submittals as complete volumes according to classification of equipment such as power, lighting, etc. When possible, make all electrical submittals at the same time.
- C. Submit shop drawings and supporting data as instruments of the Contractor. Stamp each item in the submittal documents with the Contractor's stamp, thereby stating that the equipment meets all requirements and conditions of the Drawings and Specifications. In particular, certify that the items shown on the shop drawings conform to the dimensional, environmental, and space restrictions as pertains to all work under this Contract and the work of other parties in conjunction with this Project.
- D. Provide a blank space on the title page of each submittal classification for the Owner's Representative's or Engineers approval stamp and comment field. The minimum size of such space shall be eight inches wide by five inches high.
- E. Arrange panelboard submittals to show bussing, circuit numbering, and branch circuit protective devices similar the schedules on the Drawings. Show elevations of switchboards, motor control centers, and distribution centers indicating the layout of devices, meters, handles, etc. Provide device ratings, circuit numbers, and nameplate descriptions in table form. Include terminal strip mounting arrangements on elevations for terminal cabinets.

1.10 DRAWINGS AND SPECIFICATIONS

- A. The data and information contained on the Drawings is as accurate as was reasonably possible at the time they were produced, but absolute accuracy is not guaranteed. Exact locations, distances, elevations, etc., will be dictated by the actual building and the conditions at the site.
- B. The layout of electrical equipment, wiring, and accessories is shown in a diagrammatic fashion (not pictorially) in order to achieve clarity and legibility. Although the size and location of electrical equipment is drawn to scale wherever possible, refer to all data in the Contract Documents and field verify this information as the project progresses. Examine Owner's Representative, structural, mechanical, and other drawings to determine the exact location of conduits, outlets, fixtures, and equipment and to note any conditions which may affect the electrical work.
- C. The Drawings and Specifications may be superseded by later detail drawings and specifications prepared by the Owner's Representative. Conform to such detail drawings, specifications, addenda, change orders, other reasonable changes as if they are contained herein. See the General Conditions for change order cost considerations.

- D. Because the Electrical Drawings may be distorted for clarity of representation, it may be necessary to field verify the exact location of electrical outlets, lights, switches, etc. in order to conform to the architectural elements. The Owner's Representative reserves the right to make minor changes to the locations of equipment, devices, and wiring shown on the Drawings, at no additional cost, providing the changes are ordered before the rough-in of conduit, boxes, or related items is completed, and no extra material are required.
- E. For dimensional and locational purposes, the Architectural Drawings take precedence over the Electrical Drawings. Determine the appropriate location of lighting fixtures, outlets, wall-mounted devices, etc. by studying the reflected ceiling plans, building sections, and interior elevations. Report conflicting conditions to the Owner's Representative before rough-in for adjustments to the locations.
- F. Conduit quantities, sizes, termination points, and wiring are depicted on the Electrical Drawings. However, not all conduit bends or routing details are necessarily shown. Route conduit so as to conform to the structural conditions, avoid obstructing other trades, maintain space restrictions and keep circulation areas and access openings clear.
- G. Thoroughly examine the Contract Documents prior to submitting a bid in order to determine electrical requirements which are not necessarily indicated on the Electrical Drawings. Include sufficient allowance in the bid sum to cover the costs of these other requirements.
- H. Should the Contractor perceive that the Drawings and Specifications do not sufficiently define the intent of electrical work, contact the Owner's Representative for clarification or additional information. The absence of such contact will be considered as evidence of understanding, on the part of the Contractor, of the intended Electrical Work and the required installation thereof.

1.11 WORKMANSHIP

- A. Constantly supervise the work personally or through an authorized and competent representative. Keep the same foreman or supervisor on the project from commencement through completion.
- B. Perform the Electrical work using the highest caliber craftsman available. Workmanship shall be first class and of the best quality available to insure a long and trouble free service life. Allow only experienced and competent workmen on the job.

1.12 COOPERATION AND COORDINATION

- A. Consult with the other installers and trades in coordinating the Work so as to avoid conflicts, omissions and delays. Cooperate with other contractors, third parties, and the Owner in order to expedite the project and provide for the proper execution of the

building as a whole. Work performed without regard to other trades or the overall project scheme, may necessarily be required to be moved at the Contractor's expense.

1.13 MANUFACTURER'S DIRECTIONS

- A. Adhere to the manufacturer's directions regarding the proper installation and configuration of electrical equipment where those directions cover points not included in these Drawings and Specifications.

1.14 PROTECTION AND STORAGE

- A. Use all means necessary to protect the materials of this Division before, during, and after installation and to protect the work and materials of all trades.
- B. Deliver electrical materials to the site new, and in unbroken packages. Provide for the temporary storage of such materials, equipment, and construction tools in accordance with the General Conditions and in strict accordance with approved manufacturers' recommendations. Protect electrical equipment and materials during transit, storage and handling to prevent damage, soiling and deterioration.
- C. During shipping storage and handling protect electrical materials from damage of any type including dust, water, over-spray, and temperature.
- D. Avoid damage during construction to the work and materials of other trades as well as the electrical work and material. Repair or replace, at the Contractor's expense, defective or damaged items such that the entire Work is completed in a condition satisfactory to the Owner's Representative.
- E. Replacements: In the event of damage, immediately make all repairs and replacements necessary to the approval of the Owner's Representative and at no additional cost to the Owner.
- F. This Contractor shall personally, or through an authorized representative, check all materials upon receipt at jobsite for conformance with approved shop drawings and/or plans and specifications.

1.15 EXCAVATION, CUTTING, PATCHING, AND REPAIR

- A. Perform excavation and backfill required for the installation of electrical sub-structures. Restore grounds, walkways, roadways, curbs, walls, and other existing underground facilities to their original condition.
- B. Conform to the applicable requirements of Division 2, Earthwork for Utilities, in the selection, placement, and compaction of backfill material and finished surfaces.

- C. Cut, core-drill, and demolish existing walls, floors, ceilings and other building surfaces as required for the installation of Electrical Work. Obtain the approval of the Owner's Representative prior to performing any operation which may affect any structural elements of the building.
- D. Patch and repair wood, plaster, tile, or concrete surfaces which have been damaged by the installation of the Electrical Work so that the finished surface matches the surrounding conditions.

1.16 FLASHING, WATERPROOFING AND SEALING

- A. In general, install in an approved watertight manner, Electrical Work which pierces exterior walls or waterproofing membranes. Flash and counter-flash roof and wall penetrations in a manner described in other applicable sections of this Specification and as approved by the Owner's Representative.
- B. Fit conduits passing through finished walls with steel escutcheon plates of brass, chrome, or painted finish as directed by the Owner's Representative. Grout penetrations of floor slabs, concrete or masonry walls with an approved grout or silicone elastomeric caulk.

1.17 CLEANING, ADJUSTING, AND TOUCH-UP

- A. Remove on a daily basis electrical debris, scraps, packaging material and other rubbish. Dispose of such items off-site in an approved manner and debris. Maintain the site free from physical hazards at all times. See the General Conditions for additional requirements.
- B. After installation, completely clean electrical equipment, fixtures, and materials of excess paint, over-spray, plaster, cement, insulating products, and other foreign matter. Leave the Electrical Work in a clean, finished, dry, level, like new condition.
- C. Touch-up paint scratches and scuffs on electrical equipment and lighting fixtures with paint recommended by the manufacturer and matching the original item finish.
- D. Make setting, adjustments, and programming in accordance with the manufactures' operating and installation instructions. Settings and program variables will be issued by the Owner's Representative prior to commissioning of the electrical system.

1.18 AS-BUILT DRAWINGS

- A. Throughout the project, maintain accurate and current record documents. Show on the record drawings deviations from the Electrical Drawings, locations of underground conduits and pull-boxes, and concealed equipment which is not readily apparent. Dimension the record drawings using permanent, readily identified benchmarks such as column or wall lines.

- B. At the completion of the project, present one clearly legible set of the record drawings to the Owner's Representative.

1.19 SCHEDULING/SEQUENCING

- A. Place orders for all equipment in time to prevent any delay in construction schedule or completion of project. If any materials or equipment are not ordered in time, additional charges made by equipment manufacturers to complete their equipment in time to meet the construction schedule, together with any special handling charges, shall be borne by this Contractor.
- B. The Contractor shall coordinate production and delivery schedule for all Owner-supplied equipment with the equipment suppliers to ensure that all Owner-supplied equipment is delivered to site in coordination with the construction schedule and in such a manner as to cause no delays in completion of the Contract as scheduled.

1.20 INSPECTIONS AND TESTING

- A. Arrange for the inspection of the Work at various stages of completion by the Authority Having Jurisdiction, utility company representatives, and the Owner's Representative. Comply with all directions and remedial measures issued thereby. Any objections to these orders on the part of the Contractor must be presented to the Owner's Representative in writing within forty eight (48) hours of the inspection report.
- B. Coordinate the installation of the Work so that observation of all rough-in, concealed, or underground Work can take place by the Owner's Representative. Provide a minimum of seventy two (72) hours notice to the Owner's Representative prior to covering up the work. Uncover Work that has not been properly observed and make repairs to restore the Work and adjoining surfaces to their proper condition at no additional cost.
- C. Perform tests of the electrical system during the course of the project and at project completion to ensure safe and proper function in accordance with the Contract Documents, manufacturers' recommendations, and applicable codes. Provide complete documentation of all test results to the Owner's Representative prior to project completion. Testing shall include, but not necessarily be limited to, the following:
 - 1. Test for short circuits, open circuits, neutral leakage, and improper grounds on feeders and branch circuits. Perform this test with mains in disconnect from feeders, branch circuits closed, fixtures and devices permanently connected, lamps removed from sockets and wall switches closed.
 - 2. Provide insulation resistance tests of all phase and neutral circuit conductors using a 500 Volt Megger for circuits of 240 Volt rating and below, and a 1000 Volt Megger for circuits of 277 volts and above. Minimum acceptable insulation resistance is one (1) megohm.
 - 3. Perform a ground resistance test of each main grounding electrode system, ground rod, and supplemental grounding electrode. Utilize a calibrated, direct

- reading, earth ground test set and make the tests using the "Three-terminal, Fall-of-Potential" method. The maximum allowable earth ground resistance is 25 ohms.
4. Test for proper phase-to-phase and phase-to-neutral operating voltage on the main service and on each separately derived system. Perform this test at full load and at no load. With all circuits at full operating conditions, test the phase and neutral load currents using a clamp-on ammeter.
 5. When series rated circuit breakers are used, provide a letter from the manufacturer of the equipment confirming that U.L. series rating exists for all protective devices. State the available fault current from the Utility Company and indicate that the overcurrent devices exceed the available fault current at the respective point of protection.
 6. Tests as required by other sections of these Specifications.
 7. Tests as prescribed by individual equipment manufacturers whether or not described in these Specifications.
- D. At project completion, demonstrate to the Owner's Representative that the entire installation is complete, in proper operation condition and that the Contract has been properly and fully executed. Activate all circuits, lights, devices, and controls under full load and normal operating conditions. Identify faulty items and immediately replace or repair defective equipment, workmanship, and materials to like new condition and retest in the presence of the Owner's Representative.
- E. At the completion of the Project, demonstrate to the Owner's Representative that the entire electrical system is free from short circuits and improper grounds, or upon request of the Owner's Representative anytime, make necessary tests under the observation of the Owner's Representative which will ensure that electrical equipment, materials and installation methods are as specified.

1.21 IDENTIFICATION

- A. Each branch circuit of panelboards to have a permanently fixed number with one word directory, mounted under celluloid on inside of cabinet door, showing circuit numbers and typewritten description of equipment supplied by breakers, including location.
1. All existing panelboards touched shall be updated with new panel schedules.
 2. All existing equipment on existing panel schedules shall be transferred to new panel schedules.
- B. Provide label on all motors: "*Caution. Automatic equipment. May start at any time.*"
- C. Provide identification of all pull boxes, junction boxes, and conduit stub-ups on the project as outlined below:
1. For Power Feeders:
 - a. Stencil cover with identifying circuit number.
 - b. Lettering 1" high.
 - c. Color of lettering black.
 - d. Place lettering on cover in neat manner; run parallel to long sides of box.

2. For branch circuits, grounding, communication, signal, and control systems boxes and blank conduit stub-outs. Paint inside back of each j-box, front of each cover, and ends of each blank conduit stub-out with identifying system color as listed below:

<u>System</u>	<u>Color</u>
277/480 volt	Orange
120/208 volt	Blue
Telephone/Data	Grey
Ground system	Green
Clock	Brown
Fire Alarm	Red
Audio/Visual	Yellow
Security	White
Low voltage lighting control	Orange/White

1.22 GUARANTEE

- A. In accordance with Division 1 requirements.

1.23 PERMITS AND INSPECTIONS

- A. This Contractor shall obtain and pay for all required permits and arrange for all inspections required.
- B. Do not allow or cause any of the work to be covered or enclosed until it has been tested and/or inspected.

1.24 WARRANTIES, CERTIFICATES, AND OPERATING MANUALS

- A. Properly fill out and deliver to the Owner, all warranties, guarantees, certificates, etc. for equipment and materials that are furnished and installed under this Section of the Work. The effective date on each item shall be the date of acceptance of the work by the Owner.
- B. Deliver to the Owner, a minimum of two (2) copies of the manufacturers' operating and maintenance manuals for major items of equipment.

END OF SECTION 26 05 00

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

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Building wires and cables rated 600 V and less.
 - 2. Connectors, splices, and terminations rated 600 V and less.

1.2 ACTION SUBMITTALS

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

1.3 INFORMATIONAL SUBMITTALS

- A. Field quality-control test reports.

1.4 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in CEC, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with CEC.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Wire and Cable (600V)
 - a. American Wire Company
 - b. Belden
 - c. General Wire and Cable Corporation
 - d. Okonite Company
 - e. Rome Cable Corporation
 - f. Cerrowire
 - g. American Insulated Wire
 - h. AFC Cable Systems

- i. Essex
 - j. Simplex Wire and Cable Company
 - 2. Solderless Lugs and Grounding Connections
 - a. Burndy Engineering Company, Inc.
 - b. O.Z. Gedney Company, Inc.
 - c. Penn Union Electric Corporation
 - d. Thomas and Betts Company, Inc.
- 2.2 CONDUCTORS AND CABLES
 - A. Copper Conductors: Comply with NEMA WC 70.
 - B. Conductor Insulation: Comply with NEMA WC 70 for Types THHN-THWN and XHHW.
- 2.3 CONNECTORS AND SPLICES
 - A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. AFC Cable Systems, Inc.
 - 2. Hubbell Power Systems, Inc.
 - 3. O-Z/Gedney; EGS Electrical Group LLC.
 - 4. 3M; Electrical Products Division.
 - 5. Tyco Electronics Corp.
 - B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

PART 3 - EXECUTION

- 3.1 CONDUCTOR MATERIAL APPLICATIONS
 - A. Feeders: Copper Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
 - B. Branch Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
 - C. 600-volt class, insulation color coded, minimum No. 12 AWG for branch circuits, No. 14 AWG for control circuits.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

- A. All branch circuits for equipment electrical power, receptacles and lighting shall be concealed spaces where possible. Wiring method shall be MC Cable (copper) with home runs routed in EMT conduit.
- B. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-THWN, single conductors in raceway.
- C. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-THWN, single conductors in raceway.
- D. Class 1 Control Circuits: Type THHN-THWN, in raceway.
- E. Class 2 Control Circuits: Type THHN-THWN, in raceway.
- F. Insulation type:
 - 1. Standard locations: #12 to #1 AWG: THWN for wet locations and THHN for dry locations. #1/0 through #4/0 AWG: XHHW (55 Mils). 250MCM and larger: XHHW (65 Mils). All wire sizes used shall be based on a 75 degree insulation rating, unless specifically used with 90 degree rated breakers and devices.
 - 2. High temperature and non-standard locations: Provide wire type and insulation category suitable for area of use as defined in CEC table 310-13.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

- A. Conceal cables in finished walls, ceilings, and floors, unless otherwise indicated.
- B. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
- C. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.
- D. Support cables according to Division 26 Sections "Hangers and Supports for Electrical Systems."
- E. 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.
- F. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.

- G. Install all wiring (low voltage and line voltage) in conduit unless noted otherwise in the drawings, but do not pull into conduit until plastering and taping have been completed and conduits and outlets have been thoroughly cleaned and swabbed as necessary to remove water and debris.
- H. Approximately balance branch circuits about the neutral conductors in panels.
- I. Connections to devices from "thru-feed" branch circuit conductors to be made with pigtails, with no interruption of the branch circuit conductors.
- J. Neutral conductor identified by white outer braid, with different tracers of "EZ" numbering tags used where more than one neutral conductor is contained in a single raceway.
- K. Neatly arrange and "marlin" wires in panels and distribution panelboards with "T and B Ty-rap" or approved equal plastic type strapping.
- L. All wire and cable shall bear the Underwriters' Label, brought to the job in unbroken packages; wire color-coded as follows:

<u>Voltage</u>	<u>Phasing</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>N</u>
120/208	3PH-4W	Black	Red	Blue	White
208	3PH-3W	Black	Red	Blue	--
277/480	3PH-4W	Brown	Orange	Yellow	White
480	3PH-3W	Brown	Orange	Yellow	--
120/240	3PH-4W	Black	Red	Blue	White
240	3PH-3W	Black	Red	Blue	--

- M. The equipment grounding conductor shall be insulated copper; where it is insulated, the insulation shall be colored green.
- N. Label each wire of each electrical system in each pull box, junction box, outlet box, terminal cabinet, and panelboard in which it appears with "EZ" numbering tags indicating the connected circuit numbers.
- O. Properly identify the "high leg" of 4-wire delta connected systems (in each accessible location) as required by CEC 215-8 and 230-56.

3.4 INSTALLATION OF DICONNECTS, CONNECTORS, AND LUGS

- A. Equipment Disconnects: All disconnects shall be located to allow proper code required clearance in each area. Locations shown on drawings are diagrammatic only. The contractor shall coordinate exact locations in the field (with other trades) prior to rough-in to insure proper clearances.
 - 1. Motor Disconnect Switches and Safety Switches: General Electric Company Heavy Duty Type "THD", cover interlocked with operating handle so that cover cannot be opened with switch in closed position and switch cannot be closed with cover

in open position. 240V or 480V rating, single or multi-pole as required or as noted on drawings, in Nema 1 enclosure indoors or Nema 3R enclosure outdoors unless otherwise noted. Provide dual element motor circuit fuses sized as recommended by equipment manufacturer (for final equipment actually installed).

2. Code required disconnects: Provide a local disconnect in addition to the branch circuit protection device for all equipment as required by code (whether shown or not). Disconnects shall consist of a motor rated switch (or disconnect) for all motor loads less than 3/4HP or other suitable disconnect sized to match branch circuit conductors and load current of equipment, with number of poles as required.
- B. Lugs and Connectors: Thomas and Betts "lock-tite", for No. 4 and larger wire; "Scotchlock" fixed spring type with insulator for No. 6 and smaller wire.
1. All splices made up with wire nut connectors shall be solidly twisted together with electricians pliers before connector is installed to ensure a proper connection in the event of wire nut failure. No exceptions.
 2. Connectors listed or labeled for "no wire twisting required" are not an acceptable substitute for actual wire twisting.
 3. Utilize porcelain type connectors in all high temperature environments (above 105 degrees Celsius).
- C. Splice Insulation: "Scotch" electrical tape with vinyl plastic backing or rubber tape with protective friction tape for interior work.
1. Provide watertight cast splices for all conductors in site pull boxes or wet locations.

3.5 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Division 26 Section "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.6 FIRESTOPPING

- A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Division 07 Section "Penetration Firestopping."
- B. Fire stopping: 3M Fire Protection Products or equal.
1. Fire-rated and smoke barrier construction: Maintain barrier and structural floor fire and smoke resistance ratings including resistance to cold smoke at all penetrations, connections with other surfaces or types of construction, at separations required to permit building movement and sound vibration absorption, and at other construction gaps.
 2. Systems or devices listed in the UL Fire Resistance Directory under categories XHCR and XHEZ may be used, providing that it conforms to the construction type, penetration type, annular space requirements and fire rating involved in each

separate instance, and that the system be symmetrical for wall penetrations. Systems or devices must be asbestos free.

3.7 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports.
- B. Tests and Inspections:
 - 1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors for compliance with requirements.
 - 2. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 - 3. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each splice in cables and conductors No. 3 AWG and larger. Remove box and equipment covers so splices are accessible to portable scanner.
 - a. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each splice 11 months after date of Substantial Completion.
 - b. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
 - c. Record of Infrared Scanning: Prepare a certified report that identifies splices checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.
- C. Test Reports: Prepare a written report to record the following:
 - 1. Test procedures used.
 - 2. Test results that comply with requirements.
 - 3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.
- D. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION 26 05 19

SECTION 26 05 26 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes: Grounding systems and equipment.

1.2 ACTION SUBMITTALS

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

1.3 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.4 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in CEC, by a qualified testing agency, and marked for intended location and application.
- B. Comply with UL 467 for grounding and bonding materials and equipment.

PART 2 - PRODUCTS

2.1 CONDUCTORS

- A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.
- B. Bare Copper Conductors:
 - 1. Solid Conductors: ASTM B 3.
 - 2. Stranded Conductors: ASTM B 8.
 - 3. Tinned Conductors: ASTM B 33.
 - 4. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch in diameter.
 - 5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
 - 6. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
 - 7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

2.2 CONNECTORS

- A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.
- B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, pressure type with at least two bolts.
 - 1. Pipe Connectors: Clamp type, sized for pipe.
- C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

2.3 GROUND RODS

- A. Copper clad steel size 5/8 inch in diameter and 96 inches in length.

2.4 Test Wells

- A. Provide handholes "Christy G5" or equal, with cast iron traffic lid and hold down screws.

PART 3 - EXECUTION

3.1 APPLICATIONS

- A. Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger unless otherwise indicated.
- B. Underground Grounding Conductors: Install bare copper conductor, No. 4/0 AWG minimum. Bury at least 24 inches below grade.
- C. Conductor Terminations and Connections:
 - 1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
 - 2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
 - 3. Connections to Ground Rods at Test Wells: Bolted connectors.
 - 4. Connections to Structural Steel: Welded connectors.

3.2 EQUIPMENT GROUNDING

- A. Install insulated equipment grounding conductors with the following items, in addition to those required by CEC:
 - 1. Feeders and branch circuits.
 - 2. Lighting circuits.
 - 3. Receptacle circuits.
 - 4. Single-phase motor and appliance branch circuits.
 - 5. Three-phase motor and appliance branch circuits.
 - 6. Flexible raceway runs.
 - 7. Computer and Rack-Mounted Electronic Equipment Circuits: Install insulated equipment grounding conductor in branch-circuit runs from equipment-area power panels and power-distribution units.

- B. Signal and Communication Equipment: In addition to grounding and bonding required by CEC, provide a separate grounding system complying with requirements in TIA/ATIS J-STD-607-A.
 - 1. For telephone, alarm, voice and data, and other communication equipment, provide No. 4 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.
 - 2. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a 1/4-by-4-by-12-inch grounding bus.
 - 3. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.

3.3 INSTALLATION

- A. Grounding Conductors: Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

- B. Install ground wires in rigid conduit.

- C. All grounding electrode conductor connections "thermite" or "cad-weld" welded.

- D. Use approved pressure type solderless connector or use fusion welding for all connections to and bonding of grounding electrode system. All connections shall be visible, readily accessible for testing purposes. Grounding electrode conductor between the grounding electrode and service equipment.

- E. Terminate grounding conduits at equipment with ground bushing, with ground wire connected through bushing.

- F. Other than for isolated ground receptacles, provide No. 12 stranded (green) THHN conductor from outlet box to ground screw of every receptacle.

- G. Ground all isolated sections of metallic raceways.
- H. Provide #12 minimum stranded (green) THHN conductor sized per CEC, or as noted, connected continuously throughout branch circuit for all circuits, bonded to panel ground bus, and to all electrical devices and equipment enclosures
- I. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.
 - 1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
 - 2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
 - 3. Use exothermic-welded connectors for outdoor locations; if a disconnect-type connection is required, use a bolted clamp.

3.4 LABELING

- A. Comply with requirements in Division 26 Section "Requirements for Electrical Installations" The label or its text shall be green.
- B. Install labels at the telecommunications bonding conductor and grounding equalizer and at the grounding electrode conductor where exposed.
 - 1. Label Text: "If this connector or cable is loose or if it must be removed for any reason, notify the facility manager."

3.5 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections and prepare test reports:
 - 1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
 - 2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
 - 3. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, and at ground test wells. Make tests at ground rods before any conductors are connected.
 - 4. Test system using the three-point fall of potential method only. Record results and submit to Owner's Representative for approval.
- B. Report measured ground resistances that exceed the following values:
 - 1. Power and Lighting Equipment or System with Capacity of 500 kVA and Less: 10 ohms.

2. Power Distribution Units or Panelboards Serving Electronic Equipment: 3ohm(s).
- C. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Owner's Representative promptly and include recommendations to reduce ground resistance.

END OF SECTION 26 05 26

SECTION 26 05 29 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes:
 - 1. Hangers and supports for electrical equipment and systems.

1.2 PERFORMANCE REQUIREMENTS

- A. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.
- B. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of five times the applied force.

1.3 ACTION SUBMITTALS

- A. Product Data: For steel slotted support systems.
- B. Shop Drawings: Show fabrication and installation details and include calculations for the following:
 - 1. Trapeze hangers. Include Product Data for components.
 - 2. Steel slotted channel systems. Include Product Data for components.
 - 3. Equipment supports.

1.4 INFORMATIONAL SUBMITTALS

- A. Welding certificates.

1.5 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Comply with CEC.

PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

- A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Allied Tube & Conduit.
 - b. Cooper B-Line, Inc.; a division of Cooper Industries.
 - c. ERICO International Corporation.
 - d. GS Metals Corp.
 - e. Thomas & Betts Corporation.
 - f. Unistrut; Tyco International, Ltd.
 - g. Wesanco, Inc.
 - h. General Electric Company
 - i. Republic Steel Corporation
 - 2. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
 - 3. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
 - 4. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
 - 5. Channel Dimensions: Selected for applicable load criteria.
- B. Raceway and Cable Supports: As described in NECA 1 and NECA 101.
- C. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- D. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.
- E. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
- F. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
 - 1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.

- a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) Hilti Inc.
 - 2) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
 - 3) MKT Fastening, LLC.
 - 4) Simpson Strong-Tie Co., Inc.; Masterset Fastening Systems Unit.
2. Mechanical-Expansion Anchors: Insert-wedge-type, stainless steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
 - a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) Cooper B-Line, Inc.; a division of Cooper Industries.
 - 2) Empire Tool and Manufacturing Co., Inc.
 - 3) Hilti Inc.
 - 4) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
 - 5) MKT Fastening, LLC.
 3. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
 4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
 5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
 6. Toggle Bolts: All-steel springhead type.
 7. Hanger Rods: Threaded steel.

2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

- A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.
- B. Materials: Comply with requirements in Division 05 Section "Metal Fabrications" for steel shapes and plates.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.

- B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as required by CEC. Minimum rod size shall be 1/4 inch in diameter.
- C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
 - 1. Secure raceways and cables to these supports with two-bolt conduit clamps.
- D. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

3.2 SUPPORT INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.
- B. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.
- C. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
 - 1. To Wood: Fasten with lag screws or through bolts.
 - 2. To New Concrete: Bolt to concrete inserts.
 - 3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
 - 4. To Existing Concrete: Expansion anchor fasteners.
 - 5. To Steel: Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts
 - 6. To Light Steel: Sheet metal screws.
 - 7. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate by means that meet seismic-restraint strength and anchorage requirements.
- D. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

- A. Comply with installation requirements in Division 05 Section "Metal Fabrications" for site-fabricated metal supports.

- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
- C. Field Welding: Comply with AWS D1.1/D1.1M.

3.4 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 minimum dry film thickness of 2.0 mils.
- B. Touchup: Comply with requirements in Division 09 Section "Exterior Paints" for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 26 05 29

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SECTION 26 05 33 - RACEWAYS AND BOXES

PART 1 - GENERAL

1.1 SUMMARY

- A. All branch circuits for electrical equipment, receptacles and lighting shall be copper wiring routed in EMT conduit home runs. MC cable may only be used within 6 feet of light fixture.

1.2 RELATED SECTIONS

- A. Section 260500: Common Work Results for Electrical
- B. Section 260519: 600-Volt Power Conductors and Cables
- C. Section 260526: Grounding and Bonding for Electrical Systems
- D. Section 260553: Identification for Electrical Systems

1.3 REFERENCES - CODES AND STANDARDS

- A. ANSI C80.1 Rigid Steel Conduit, Zinc Coated.
- B. ANSI C80.3 Electrical Metallic Tubing, Zinc Coated.
- C. ANSI C80.6 American National Standard for Electrical Intermediate Metal Conduit.
- D. ASTM A 48 Standard Specification for Grey Iron Castings.
- E. NECA (National Electrical Contractor's Association) – "Standard of Installation."
- F. NEMA FB 1 (National Electrical Manufacturers Association) – Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit and Cable Assemblies.
- G. NEMA OS 1 (National Electrical Manufacturers Association) – Sheet-steel Outlet Boxes, Device Boxes, Covers, and Box Supports.
- H. NEMA OS 2 (National Electrical Manufacturers Association) – Nonmetallic Outlet Boxes, Device Boxes, Covers and Box Supports.
- I. NEMA RN 1 (National Electrical Manufacturers Association) – Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit.

- J. NEMA TC 2 – Electrical Polyvinyl Chloride (PVC) Conduit.
- K. NEMA TC 3 (National Electrical Manufacturers Association) – PVC Fittings for Use with Rigid PVC Conduit and Tubing.
- L. NEMA TC 6 - Non-Metallic Conduit.
- M. NEMA 250 (National Electrical Manufacturers Association) – Enclosures for Electrical Equipment (1,000 Volts Maximum).
- N. CEC California Electrical Code (CEC). Latest approved edition
- O. UL 1 Flexible Metal Conduit
- P. UL 6 Rigid Metal Conduit
- Q. UL 514B Conduit, Tubing and Cable Fittings.
- R. UL 651 Rigid Non-Metallic Conduit
- S. UL 797 Electrical Metallic Tubing
- T. UL 1242 Intermediate Metal Conduit

1.4 SYSTEM DESCRIPTION

- A. Raceway, boxes and manholes located as indicated on drawings and at other locations required for splices, taps, wire pulling, equipment connections, and compliance with regulatory requirements. Raceway, boxes and manholes are shown in approximate locations unless dimensioned. Provide raceway for complete wiring system.
- B. All branch circuits for equipment electrical power, receptacles and lighting shall be concealed spaces where possible. Wiring method shall be EMT conduit.
- C. In or Under Slab: Provide Schedule 40 non-metallic conduit.
- D. Underground more than 5 feet (1,500 mm) outside foundation wall: Provide Schedule 40 non-metallic conduit.
- E. Underground within 5 feet from foundation wall: Provide rigid steel or Schedule 80 non-metallic conduit.
- F. Provide Schedule 80 or Galvanized Steel with tape wrap rigid steel factory bends greater than 22.5 degrees and for stub-ups through concrete slabs.
- G. Outdoor Locations, Above Grade: Provide EMT conduit painted to match surface(s). Provide cast metal gasketed outlet, pull, and junction boxes.

- H. Concealed Dry Locations: Provide electrical metallic tubing for sizes less than 2-inches. Provide galvanized rigid steel or intermediate steel conduit in sizes 2-inches or larger. Provide cast or sheet metal boxes.

1.5 DESIGN REQUIREMENTS

- A. Minimum Raceway Size: 3/4 inch (19 mm) unless otherwise specified.

1.6 SUBMITTALS

- A. Manufacturer's Installation Instructions: Submit application conditions and limitations of use stipulated by product testing agency having jurisdiction. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- B. Submit detailed conduit routing plan, for review and approval, prior to installation as follows:
 - 1. Exposed and/or concealed in building walls for conduits larger than 2-inch outside diameter.
 - 2. All underground conduits (3/4-inch and larger) in duct bank; concealed in floor slabs, equipment pads and concrete slabs.
- C. Product Data: Submit for the following:
 - 1. Rigid Steel Conduit.
 - 2. Electrical Metallic Tubing (EMT).
 - 3. Liquid tight flexible metal conduit.
 - 4. Nonmetallic conduit.
 - 5. Raceway fittings.
 - 6. Conduit bodies.
 - 7. Surface raceway.
 - 8. Pull boxes, junction boxes.
- D. Manufacturer's Installation Instructions:
 - 1. Submit application conditions and limitations of use stipulated by product testing agency specified under Regulatory Requirements.
 - 2. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

1.7 CLOSEOUT SUBMITTALS

- A. Project Record Documents:
 - 1. Record actual routing of conduits. Provide record (as-built) drawings marked in red to show actual routing of the underground raceway and cable when different from the original contract drawings. Prepare on new, clean set of contract drawings.
 - 2. Record actual locations and mounting heights of outlet, pull boxes, junction boxes and manholes.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Protect conduit from corrosion and entrance of debris by storing above grade. Provide appropriate covering.
- B. Protect PVC and PVC-coated metallic conduit from sunlight.

PART 2 - PRODUCTS

2.1 CONDUIT

- A. Galvanized Rigid Steel Conduit (GRSC or RGS), couplings and elbows shall be hot-dip galvanized, rigid mild steel in accordance with ANSI C80.1 and UL 6. The conduit interior and exterior surfaces shall have a continuous zinc coating with a transparent overcoat of enamel, lacquer, or zinc chromate. Conduit shall be formed with continuous welded seams with a uniform wall thickness, in minimum 10-foot lengths, with threaded ends.
- B. Electrical Metallic Tubing (EMT). Electrical metallic tubing, including elbows and bends, shall be zinc coated, mild steel in accordance with the requirements of ANSI C80.3 and UL 797. The interior and exterior surfaces of the tubing shall have a continuous zinc coating. Conduit shall be formed with a continuous welded seam, with a uniform wall thickness, in minimum 10-foot lengths.
- C. Liquid-Tight Flexible Metal Conduit shall be plastic-jacketed, galvanized steel, "Sealtite" Type EF for general service areas or Type HC for high-temperature when used under raised floor or in air plenums. Conduit shall be UL listed.
- D. Non-Metallic Conduit shall be as follows:
 - 1. Schedule 40: Conduit shall be 90 degree Celsius, polyvinyl chloride in conformance with NEMA TC-2 and UL 651 requirements.
 - 2. Spacers used in duct bank installations shall be high impact plastic, interlocking bases, and intermediate type spacers. Place spacers between 6 and 10 feet apart.

2.2 RACEWAY FITTINGS

- A. Couplings and Thread Protectors. Each length of threaded conduit shall be provided complete from the manufacturer with a coupling on one end and a thread protector on the other. The thread protector shall have sufficient mechanical strength to protect the threads during normal handling and storage.
- B. Metal Conduit Fittings shall conform to the requirements of UL 514B where this standard applies. Galvanized steel fittings shall be used with steel conduit. Threaded fittings shall engage a minimum of five threads made up wrench-tight and be compatible with conduit. EMT fittings shall be compression type, UL approved for rain tight applications.

- C. Liquid-Tight Flexible Conduit Fittings shall be galvanized steel, T&B 53XX series insulated throat, and shall bear the UL label. Die-cast malleable fittings are not acceptable.
- D. Non-Metallic Conduit Fittings shall be of same material and strength characteristics as the conduit and shall be solvent welded as recommended by manufacturer. End bells shall be plastic, high impact, tapered to fit. Where conduit transition from non-metallic to metallic is required, provide non-metallic female "terminal" adapter. Non-metallic "male" adapters are not acceptable.
- E. Bushings shall be provided for the termination of all conduits not terminated in hubs, couplings or insulated throat connectors. Grounding type insulated bushings with insulating inserts in metal housings shall be provided for conduit 1-1/4 inches and larger. Standard bushings shall be galvanized steel or malleable iron in all sizes.
- F. Locknuts. One interior and one exterior locknut shall be provided for all conduit terminations not provided with threaded hubs and couplings. Locknuts shall be designed to securely bond with the conduit to the box when tightened. Locknuts shall be so constructed that they will not be loosened by vibration.

2.3 CONDUIT BODIES

- A. Malleable iron conduit bodies shall be cast malleable iron with tensile strength meeting ASTM A 48, Class 30A requirements. Malleable conduit bodies shall be finished with an epoxy powder coating. Cover shall be malleable iron with captive screws.
- B. All conduit bodies' entrances shall be machined NPT threads with a smooth, rounded, internal conduit stop bushing.
- C. All conduit bodies shall be equipped with a sealed and gasketed cover. Cover shall be secured using stainless steel machine screws.
- D. Conduit bodies shall be manufactured by Crouse-Hinds, Appleton, or approved equal.

2.4 CONDUIT SUPPORTS

- A. Conduit supports shall be furnished and installed in accordance with other section of these specifications. Conduits shall be supported so that fittings are accessible. Support systems shall be limited to electrical conduits only.
- B. Hanger rods shall be 3/8-inch diameter galvanized threaded steel rods, minimum. Conduit racks over 18-inch wide, over one level, or supporting 2-inch RSC or larger, shall be 1/2-inch diameter rod minimum.

- C. Conduit Clamps. Conduits in single runs or groups of two shall be supported by steel clamps and clamp backs. They shall be galvanized malleable iron or approved equal cast ferrous metal for steel conduit or tubing.
- D. Support Channels. Supports for banks of three or more conduits shall be constructed of formed steel support channels (Unistrut, Kindorf, Superstrut, B-Line or approved equal) with associated conduit or tubing clips. Support channels shall be steel, hot-dip galvanized after fabrication with galvanized steel clips for steel conduit or tubing.
- E. Wall Penetrations. All conduits, raceways, cables and sleeve penetrations through fire rated and hazardous location walls, shafts, floor, ceilings, etc., shall be sealed with a UL-approved fire stopping system, in accordance with specification Section 16060 – Basic Electrical Materials and Methods.

2.5 OUTLET BOXES AND SWITCH BOXES

- A. Manufacturers: Firms regularly engaged in the manufacturing of electrical raceways of the types and capacities required, whose products have been in satisfactory use in similar service for not less than 3 years.
- B. Sheet Metal Outlet Boxes: ANSI/NEMA OS 1, galvanized flat rolled sheet steel outlet wiring boxes of types, shapes and sizes, including box depths, to suit each respective location and installation; construct with stamped knockouts in back and sides, and with threaded screw holes with corrosion-resistant screws for securing box covers and wiring devices.
- C. Outlet boxes used in wet outdoor locations, surface mounted shall be cast metal (FS or FD type) with mounting lugs and gasketed covers.
- D. Luminaire and Equipment Supporting Boxes: Rated for weight of equipment supported, per CEC requirements.
- E. Outlet Box Accessories: Provide outlet box accessories as required for each installation, including mounting brackets, wallboard hangers, extension rings, fixture studs, cable clamps and metal straps for supporting outlet boxes, which are compatible with outlet boxes being used and meeting requirements of individual wiring situations.

2.6 PULL BOXES, JUNCTION BOXES, HANDHOLES AND MANHOLES

- A. Sheet Metal Boxes shall be NEMA OS 1, NEMA rating as indicated on drawings. Minimum 16 gauge galvanized steel construction with stainless steel hinged cover and neoprene gasket. Cover shall be secured to the body with a continuous, full length, piano type hinge and stainless steel pin on one side and captive screw on the other side. Door shall be equipped with padlock hasp with sealing hole provisions.
 - 1. Provide #10-32 tapped hole provisions for optional ground lug kit.
 - 2. Provide 0.375-16 collar studs for mounting optional panel.

3. Provide external mounting feet for secure wall mounting.
 4. Finish: Wash and phosphate undercoat with ANSI 61 gray polyester power finish.
- B. Surface-Mounted Cast Metal Box: NEMA 250, NEMA Type 3R or 4 as indicated, flat-flanged, surface-mounted junction box:
1. Material: Cast Iron.
 2. Cover: Furnish with ground flange, neoprene gasket, and stainless steel cover screws.
- 2.7 CLOSURE FOAM
- A. All conduit, raceways, cables and sleeves penetrations through fire rated and hazardous location walls, shafts, floor, ceilings, etc., shall be sealed by closure foam as in Dow Corning #3-6548 silicone RTV, GE RTV 850 silicone foam, or approved equal.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify outlet locations and routing and termination locations of raceway prior to rough in.

3.2 INSTALLATION OF RACEWAYS

- A. Routing
1. Install raceway and boxes in accordance with NECA "Standard of Installation."
 2. Conduit routing shown on drawings is diagrammatic only. Contractor shall field route conduit and raceways between equipment and devices as required to obtain a complete wiring system.
 3. Conduit shall not be exposed unless specifically mentioned on the drawings or accepted by the architect.
 4. All exposed conduits shall be installed parallel or perpendicular to dominant surfaces with right-angle turns made of symmetrical bends or fittings.
 5. Conduit shall not be installed on the outside face of exposed columns, but shall be routed on the web or on the inside of a flange of the column.
 6. Except where prevented by the location of other work, a single conduit or a conduit group shall be centered on structural members.
 7. Conduit shall be located at least 6 inches from hot water or steam pipes and from other hot surfaces
- B. Moisture Pockets
1. Moisture pockets shall be eliminated from conduits. If water cannot drain to the natural opening in the conduit system, a hole shall be drilled in the bottom of a

pull box or a "C-type" conduit fitting provided in the low point of the conduit run.

- C. Couplings and Unions
 - 1. Metal conduit shall be joined by threaded conduit couplings, with the conduit ends butted.
 - 2. The use of running threads, Erickson type couplings, split couplings or similar unions are not permitted.
- D. Conduit Bodies
 - 1. Conduit bends shall meet the requirements of CEC, minimum bend radius of the cable installed or as indicated on the drawings, whichever is greater.
 - 2. Conduits or tubing deformed or crushed in any way shall be removed from the job site.
- E. Bends and Offsets
 - 1. Changes in direction of conduits shall be made with fittings or bends.
 - 2. Conduit bends shall meet the requirements of CEC, minimum bend radius of the cable installed or as indicated on the drawings, whichever is greater.
 - 3. Bends shall be made using appropriate tools or mechanical equipment. The use of a pipe tee or vise for bending conduit or tubing will not be permitted.
 - 4. For non-metallic conduit or plastic coated steel, approved factory bends and offsets shall be used.
 - 5. Conduits or tubing deformed or crushed in any way shall be removed from the job site.
 - 6. Install no more than the equivalent of three 90 degree bends between boxes or outlets
- F. Cutting and Threading
 - 1. The plane of all conduit ends shall be square with the centerline.
 - 2. Where threads are required, they shall be cut and cleaned prior to conduit reaming.
 - 3. The ends of all conduit and tubing shall be reamed to remove all rough edges and burrs.
 - 4. Cutting oil shall be used in threading operations; the dies shall be kept sharp, and provisions shall be made for chip clearance.
 - 5. Threads on conduits and fittings shall be lubricated with conducting and sealing compound.
 - 6. All steel conduits shall be coated after threading with cold-galvanized zinc coating. The Contractor shall supply this protective material and shall apply it in the field prior to installing conduit or fittings.
- G. All steel conduit, exposed to weather or in contact with earth, shall be re-galvanized after threading with "Galvanizing Powder M-321" as manufactured by the American Solder and Flux Company of Philadelphia, Pennsylvania; "Zincilate 810" as manufactured by Industrial Metal Protectives, Inc., of Dayton, Ohio; "Zinc Rich" coating as manufactured by ZRC Chemical Products Company, Quincy, Massachusetts; or

approved equal. The Contractor shall supply this protective material and shall apply it in the field.

- H. Connections to Boxes and Cabinets
 1. Conduit shall be securely fastened to all boxes and cabinets.
 2. Threads on metallic conduit shall project through the wall of the box to allow the bushing to butt against the end of the conduit.
 3. The locknuts, both inside and outside, shall then be tightened sufficiently to bond the conduit securely to the box.
 4. Locknuts on connectors shall be tightened securely to bond the connectors.

- I. All conduits entering enclosures outdoors or in wet areas shall enter through Meyer's hubs, or approved equal, or threaded openings.

- J. Cleaning
 1. Precautions shall be taken to prevent the accumulation of water, dirt, or concrete in the conduit.
 2. Conduit in which water or other foreign materials have been permitted to accumulate shall be thoroughly cleaned or, where such accumulation cannot be removed by methods acceptable to the Owner /Engineer, the conduit shall be replaced.
 3. For conduits sizes 3 inches and larger, draw a flexible testing mandrel approximately 12 inches long with a diameter less than the inside diameter of the conduit through the conduit. After which, draw a stiff bristle brush through until conduit is clear of particles of foreign materials. For conduits less than 3 inches, draw a stiff bristle brush through until conduit is clear of particles and foreign material.

- K. Empty Conduit
 1. All conduits installed for future use shall have a polypropylene pull line with a minimum tensile strength of 200 lbs., Jet Line, Cat. No. 232, polyolefin, or approved equal. Pull line shall be secured at both ends to ensure future accessibility.

- L. Rooftop Conduits
 1. Provide redwood sleepers on waterproof mastic base for all conduit runs exposed on roofs.

- M. Identification
 1. All conduits shall be identified in accordance with other section of these specifications.

- N. Grounding
 1. All conduits shall be grounded in accordance with specification Section 16050 – Basic Electrical Materials and Methods.
 2. A solid or stranded bare copper or green insulated copper solid or stranded ground wire shall be provided in all conduits and raceways.

- O. Galvanized Rigid Steel Conduit
 1. Galvanized rigid steel conduit shall be installed in areas exposed to weather, vehicle traffic, in hazardous classified areas, for penetrations through foundations, and 10 feet before transition from below grade to 8 feet above grade, unless otherwise noted on the drawings.
 2. Steel conduit in contact with earth shall be protected by "Scotchwrap" 10 mil tape applied in double thickness using 50 percent lap turns to 6 inches above grade and 6 inches beyond transition.
 3. Expansion joints shall be used where required.

- P. Polyvinyl Chloride (PVC) Coated Galvanized Rigid Steel Conduits and Intermediate Steel Conduit
 1. PVC -coated, steel conduit and fittings shall be installed where highly corrosive conditions exist, indoors or outdoors.
 2. The Contractor shall patch any damaged coating according to the manufacturer's instructions.

- Q. Electrical Metallic Tubing
 1. Electrical metallic tubing shall be installed for all circuits, indoors above concrete slab, where not subject to conditions outlined for rigid galvanized steel conduits.

- R. Liquid-Tight Flexible Metal Conduit
 1. Liquid-tight flexible metal conduit shall be used in place of regular flexible conduit for connections to motors and transformers, in areas exposed to weather, moisture or oil, and under raised floors.
 2. Liquid-tight flexible metal conduit may be used in place of flexible metal conduit where not otherwise required.

- S. Non-Metallic Conduit
 1. Schedule 40 shall be used for all power, signal feeders and branch circuits, in earth or enclosed in concrete, unless otherwise noted on the drawings. Conduits must be buried in earth in accordance with the CEC.

- T. Conduit Support
 1. Fasten conduit supports to building structures and surfaces in accordance with Section 16050 – Basic Electrical Materials and Methods.
 2. Support raceway using coated steel or malleable iron straps, lay-in adjustable hangers, clevis hangers, and split hangers.
 3. Do not use wire, ceiling support wires or perforated pipe straps to support conduit. Remove any temporary installation support wire.

- U. Spacing of Supports
 1. All conduit runs shall be rigidly supported, except where buried in concrete,.
 2. Each conduit shall be supported within one (1) foot of junction boxes and fittings.
 3. Spacers used in duct bank installations shall be placed no more than 6 to 10 feet apart.

4. Support spacing along conduit runs shall be as follows.

Conduit Size	Maximum Distance Between Supports
½ inch through 1-1/4 inch	5 feet
1-1/2 inch and larger	8 feet

- V. Ground and bond raceway and boxes in accordance with Section 16050 – Basic Electrical Materials and Methods.

3.3 CABINET AND BOX INSTALLATION

- A. Install electrical boxes as shown on drawings, and as required for splices, taps, wire pulling, equipment connections and compliance with regulatory requirements.
- B. Locate boxes and conduit bodies so as to ensure ready accessibility of electrical wiring, maintain headroom and to present neat mechanical appearance.
- C. Install pull boxes and junction boxes above accessible ceilings and in unfinished areas only. In inaccessible ceiling areas, install outlet and junction boxes no more than 6 inches from ceiling access panel or from removable recessed luminaire.
- D. Align adjacent wall mounted outlet boxes for switches, thermostats, and similar devices with each other.
- E. Use flush mounting outlet boxes in finished areas.
1. Do not install flush mounting boxes back-to-back in walls.
 2. Provide minimum 6-inch separation between adjacent boxes.
 3. Provide minimum 24-inch separation in acoustic rated walls.
 4. Use stamped steel bridges to fasten flush mounting outlet box between studs.
 5. Secure flush mounting box to interior wall and partition studs.
 6. Accurately position to allow for surface finish thickness.
 7. Install flush mounting box without damaging wall insulation or reducing its effectiveness.
 8. Use adjustable steel channel fasteners for hung ceiling outlet box.
- F. Support boxes independently of conduits.
- G. Use code sized gang box where more than one device is mounted together. Do not use sectional box. Use code sized gang box with plaster ring for single device outlets.
- H. Use cast outlet box in exterior locations where exposed to the weather and wet locations (interior or exterior).

- I. Coordinate installation of electrical boxes and fittings with cable and raceway installation work. Provide knockout closures to cap unused knockout holes where blanks have been removed.
- J. Avoid using round boxes where conduit must enter box through side of box, which would result in difficult and insecure connections where fastened with a locknut or bushing on rounded surface.
- K. Fasten boxes rigidly to substrate or structural surfaces to which they are being mounted, or solidly embed electrical boxes in concrete or masonry as appropriate.
- L. Except as prevented by the location of other work, all junction boxes and outlet boxes shall be centered on structures.
- M. Conduit openings in boxes shall be made with a hole saw or shall be punched.
- N. Cabinets and boxes shall be rigidly mounted.
 - 1. Mounting on concrete shall be secured by self-drilling anchors.
 - 2. Mounting on steel shall be by drilled and tapped screw holes, or by special support channels welded to the steel, or by both.
 - 3. Cabinets shall be leveled and fastened to the mounting surface with not less than ¼-inch air space between the enclosure and mounting surface.
 - 4. All mounting holes in the enclosure shall be used.
- O. Large Pull Boxes - Boxes larger than 100 cubic inches in volume or 12 inches in any dimension.
 - 1. Interior Dry Locations - Use hinged enclosure.
 - 2. Other Locations - Use surface mounted box of appropriate location classification.

3.4 ANCHORS

- A. Where supports for raceways, boxes, and cabinets are mounted on concrete surfaces, they shall be fastened with self-drilling tubular expansion shell anchors with externally split expansion shells, single-cone expanders, and annular break-off grooved chucking cones. Anchors shall be Phillips "Red Head" or approved equal.

3.5 ADJUSTING

- A. Install knockout closures in unused openings in boxes.

3.6 CLEANING

- A. Clean interior of boxes to remove dust, debris, and other material.
- B. Clean exposed surfaces and restore manufacturer's finish.

END OF SECTION 26 05 33

SECTION 26 05 44 - SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Sleeves for raceway and cable penetration of non-fire-rated construction walls and floors.
2. Sleeve-seal systems.
3. Sleeve-seal fittings.
4. Grout.
5. Silicone sealants.

B. Related Requirements:

1. Division 07 Section "Penetration Firestopping" for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.

PART 2 - PRODUCTS

2.1 SLEEVES

A. Wall Sleeves:

1. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, plain ends.
2. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

B. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies: Galvanized-steel sheet; 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.

C. Sleeves for Rectangular Openings:

1. Material: Galvanized sheet steel.
2. Minimum Metal Thickness:
 - a. For sleeve cross-section rectangle perimeter less than 50 inches and with no side larger than 16 inches thickness shall be 0.052 inch.
 - b. For sleeve cross-section rectangle perimeter 50 inches or more and one or more sides larger than 16 inches, thickness shall be 0.138 inch.

2.2 SLEEVE-SEAL SYSTEMS

- A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.
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. Metraflex Company (The).
 - d. Pipeline Seal and Insulator, Inc.
 - e. Proco Products, Inc.
 2. Sealing Elements: Nitrile (Buna N) rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
 3. Pressure Plates: Carbon steel.
 4. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, of length required to secure pressure plates to sealing elements.

2.3 SLEEVE-SEAL FITTINGS

- A. Description: Manufactured plastic, sleeve-type, waterstop assembly made for embedding in concrete slab or wall. Unit shall have plastic or rubber waterstop collar with center opening to match piping OD.
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. Presealed Systems.

2.4 GROUT

- A. Description: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.
- B. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- C. Design Mix: 5000-psi, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

2.5 SILICONE SEALANTS

- A. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below.

1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.
 2. Sealant shall have VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 3. 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."
- B. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

- A. Comply with NECA 1.
- B. Comply with NEMA VE 2 for cable tray and cable penetrations.
- C. Sleeves for Conduits Penetrating Above-Grade Non-Fire-Rated Concrete and Masonry-Unit Floors and Walls:
1. Interior Penetrations of Non-Fire-Rated Walls and Floors:
 - a. Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint.
 - b. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect material while curing.
 2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
 3. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway or cable unless sleeve seal is to be installed or unless seismic criteria require different clearance.
 4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
 5. Install sleeves for floor penetrations. Extend sleeves installed in floors 2 inches above finished floor level. Install sleeves during erection of floors.
- D. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies:
1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
 2. Seal space outside of sleeves with approved joint compound for gypsum board assemblies.
- E. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.

- F. Aboveground, Exterior-Wall Penetrations: Seal penetrations using cast-iron pipe 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.
- G. Underground, Exterior-Wall and Floor Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch annular clear space between raceway or cable and sleeve for installing sleeve-seal system.

3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

- A. Install sleeve-seal systems in sleeves in exterior/interior concrete walls and slabs-on-grade at raceway entries into building or as shown on drawings.
- B. Install type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.3 SLEEVE-SEAL-FITTING INSTALLATION

- A. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.
- B. Secure nailing flanges to concrete forms.
- C. Using grout, seal the space around outside of sleeve-seal fittings.

END OF SECTION 26 05 44

SECTION 26 05 48.16 - SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Restraint channel bracings.
 - 2. Restraint cables.
 - 3. Seismic-restraint accessories.
 - 4. Mechanical anchor bolts.
 - 5. Adhesive anchor bolts.
- B. Related Requirements:
 - 1. Section 260529 "Hangers and Supports for Electrical Systems" for commonly used electrical supports and installation requirements.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. 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.
- B. Delegated-Design Submittal: For each seismic-restraint device.
 - 1. Include design calculations and details for selecting seismic restraints complying with performance requirements, design criteria, and analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
 - 2. Design Calculations: Calculate static and dynamic loading caused by equipment weight, operation, and seismic forces required to select seismic restraints and for designing vibration isolation bases.
 - a. Coordinate design calculations with wind load calculations required for equipment mounted outdoors. Comply with requirements in other Sections for equipment mounted outdoors.

3. 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. 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).

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Show coordination of seismic bracing for electrical components with other systems and equipment in the vicinity, including other supports and seismic restraints.
- B. Welding certificates.
- C. Field quality-control reports.

1.5 QUALITY ASSURANCE

- A. Comply with seismic-restraint requirements in the CBC unless requirements in this Section are more stringent.
- B. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- C. Seismic-restraint devices shall have horizontal and vertical load testing and analysis. They shall bear anchorage preapproval from OSHPD in addition to preapproval, 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.
- D. Comply with CEC.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Building Classification Category: III.

- B. Seismic-Restraint Loading:
 - 1. Site Class as Defined in the CBC: D.
 - 2. Assigned Seismic Use Group or Building Category as Defined in the CBC: III.
 - a. Component Importance Factor: 1.0.
 - b. Component Response Modification Factors:
 - 1) Panel boards, instrumentation cabinets: 6.0.
 - 2) Lighting fixtures: 1.5.
 - 3) Communication equipment: 2.5.
 - 4) Electrical conduit and cable trays: 6.0
 - c. Component Amplification Factors:
 - 1) Panel boards, instrumentation cabinets: 2.5.
 - 2) Lighting fixtures: 1.0.
 - 3) Communication equipment: 1.0.
 - 4) Electrical conduit and cable trays: 2.5
 - 3. Design Spectral Response Acceleration at Short Periods (0.2 Second).
 - 4. Design Spectral Response Acceleration at 1.0-Second Period.

2.2 RESTRAINT CHANNEL BRACINGS

- A. Description: 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.

2.3 RESTRAINT CABLES

- A. Restraint Cables: 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.

2.4 SEISMIC-RESTRAINT ACCESSORIES

- A. Hanger-Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections to hanger rod.

- B. Hinged and Swivel Brace Attachments: Multifunctional steel connectors for attaching hangers to rigid channel bracings and restraint cables.
- C. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings and matched to type and size of anchor bolts and studs.
- D. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings and matched to type and size of attachment devices used.
- E. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

2.5 MECHANICAL ANCHOR BOLTS

- A. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

2.6 ADHESIVE ANCHOR BOLTS

- A. Adhesive Anchor Bolts: Drilled-in and capsule anchor system containing PVC 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.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and equipment to receive seismic-control devices for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for reinforcement and cast-in-place anchors to verify actual locations before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

- A. Multiple Raceways or Cables: Secure raceways and cables 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 caused by 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.

3.3 SEISMIC-RESTRAINT DEVICE INSTALLATION

- A. Equipment and Hanger Restraints:
 - 1. Install resilient, bolt-isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch (3.2 mm).
 - 2. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction providing required submittals for component.
- B. Install cables so they do not bend across edges of adjacent equipment or building structure.
- C. 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.
- D. 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.
- E. 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 prestressed tendons, electrical and telecommunications conduit, and gas lines.
 - 2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
 - 3. 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.

3.4 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

- A. Install flexible connections in runs of raceways, cables, wireways, cable trays, and busways where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where connection is terminated to equipment that is anchored to a different structural element from the one supporting them as they approach equipment.

3.5 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Perform the following 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 postconnection 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 to 90 percent of rated proof load of device.
- C. Seismic controls will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports.

3.6 ADJUSTING

- A. Adjust restraints to permit free movement of equipment within normal mode of operation.

END OF SECTION 26 05 48.16

SECTION 26 05 53 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. The extent of the electrical systems and equipment requiring identification is shown on the drawings, and the extent of identification required is specified herein and in individual sections of work requiring identification. The types of electrical identification specified in this section include the following:
1. Exposed conduit color banding.
 2. Cable/conductor identification.
 3. Operational instructions and warnings.
 4. Equipment/system identification signs.

1.2 REFERENCES - CODES AND STANDARDS

- A. ANSI Z535.1 - Safety Color Code
- B. APWA ULCC - Uniform Color Code for Buried Utilities.
- C. CEC California Electrical Code (CEC). Latest approved edition.

1.3 SYSTEM DESCRIPTION

- A. Label the following electrical equipment with nameplates which clearly identify each item, the function or use of the item, and the circuit identification of the feed to the item:
1. All transformers shall be identified by 1-inch high block letters cut in stencil and applied with yellow paint on a flat-black background. The transformer number, primary and secondary voltages, and the kVA shall be shown.
 2. All Distribution Panelboards, Power and Lighting Panels, Local Control Panels, Terminal Cabinets and all electrical equipment enclosure shall be identified using laminated plastic nameplates. The equipment number, voltage rating, current rating, number of phases, connection type, short circuit interrupting rating, and circuit number shall be shown
 3. All motors, starters, disconnect switches, Time Switches, Special Function Pushbuttons and Switches, and miscellaneous control devices shall be identified by function and circuit number, with 1/4-inch high black characters on a 1/2-inch wide white stick-on tape where installed indoors and engraved plastic nameplates where installed outdoors.
 4. All underground raceway or cable shall be marked with buried warning tape along its entire length.
 5. All exposed raceway longer than 10 feet in length shall be identified.

6. Panelboard Directories: Furnish all panelboards with a complete typewritten directory mounted in the inner door under a clear plastic cover set in a metal frame.

B. Branch circuits and devices:

1. Label all individual receptacle outlets and light switches at their faceplate to indicate the panelboard of origin and branch circuit number, as shown on drawings. Labels shall be self adhesive, thermal machine printed type such as Brothers, Panduit, or T&B and shall be clear plastic with black lettering.
2. All branch circuits in outlet boxes shall be identified with circuit number using wrap-around labels (T&B, BRADY or 3M).
3. As an alternative to separate nameplates, device plates may be engraved directly with lettering filled with black enamel.

1.4 SUBMITTALS

- A. Catalog data for nameplates, labels, and markers.
- B. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency specified under regulatory requirements. Include instructions for storage, handling, protection, examination, preparation and installation of product.

1.5 REGULATORY REQUIREMENTS

- A. Conform to requirements of CEC – California Electrical Code.
- B. Furnish products listed and classified by Underwriters' Laboratories, Inc. (UL), Electrical Testing Laboratories, Inc. (ETL), or other recognized, approved testing and listing agencies as suitable for the purpose specified and shown.

PART 2 - PRODUCTS

2.1 NAMEPLATES AND LABELS

A. Nameplates

1. Engraved three-layer laminated plastic, white letters on black background for normal power and white letters on red background for emergency power. Communications and control cabinets shall be labeled with white letters on green background.
2. Locations
 - a. Each electrical distribution board, panelboard and control equipment enclosure.
 - b. Communication cabinets.

3. Letter Size

- a. Use 1/8-inch letters for identifying individual equipment and loads.
- b. Use 1/4-inch letters for identifying grouped equipment, loads, panelboards, and transfer switches.
- c. Use 1/2-inch letters for identifying the main switchboard, motor control centers, transformers and large distribution switchboards.

B. Labels

1. Embossed adhesive tape, with 3/16-inch white letters on colored background to match color scheme of plastic laminate labels in 2.1.1. Use only for identification of individual wall switches and receptacles, control device stations, and multi-outlet devices.
2. Thickness
 - a. 1/16-inch for units up to 20 square inches or 8-inch length; 1/8-inch for larger units.

2.2 WIRE MARKERS

A. Manufacturers

1. Brady
2. Thomas & Betts
3. 3-M Co.

B. Description: Cloth, tape, split sleeve, or tubing type wire markers, self-adhesive.

C. Locations: Each conductor at panelboard gutters, pull boxes, outlet and junction boxes, control panels, motor controllers and starters, and each load connection.

D. Legend

1. Power and Lighting Circuits: Branch circuit or feeder feed from.
2. Control Circuits: Control wire number indicated on shop drawings.
3. Neutral Conductors: Clearly indicate the branch circuit or feeder number the neutral serves. In multi-wire circuits where the neutral is shared, mark the neutral with the circuit number of the "A" phase.

2.3 CONDUIT MARKERS

- A. Provide manufacturer's standard preprinted, flexible or semi-rigid, permanent, plastic-sheet conduit markers, minimum of 3 mils thick and 1-1/2-inch wide extending 360 degrees around conduits; designed for self-adhesive attachment to conduit. Except as otherwise indicated, provide lettering that indicates the voltage of the conductor(s) in the conduit. Provide 8-inch minimum length for 2-inch and smaller conduit, 12-inch minimum length for larger conduit.

- B. Location: Furnish markers for each conduit longer than 10 feet.
- C. Spacing: 20 feet on center.
- D. Color: Unless otherwise indicated or required by governing regulation, provide orange markers with black letters.
 - 1. Fire Alarm System: Red w/black letters.
 - 2. Telephone System: Green w/yellow letters.
 - 3. Data/Communication. System: White w/black letters.
 - 4. Emergency System: Orange w/black letters.
- E. Legend:
 - 1. 208 Volt System: Normal 208/120-volts.
 - 2. Fire Alarm System: Fire alarm.
 - 3. Telephone System: Telephone.
 - 4. Data/Communication System: Data/communications.

2.4 FASTENERS

- A. Secure all labels and nameplates with self-tapping stainless steel screws. Use contact type permanent adhesive where screws cannot or should not penetrate the substrate.

2.5 LETTERING AND GRAPHICS

- A. Coordinate names, abbreviations and other designations used in the electrical identification work, with the corresponding designations shown, specified or scheduled. Provide numbers, lettering and wording as indicated or, if not otherwise indicated, as recommended by manufacturers or as required for proper identification and operation/maintenance of the electrical systems and equipment.

2.6 UNDERGROUND WARNING TAPE

- A. Three-inch minimum width, 5 mil thickness, foil bonded polyethylene tape, detectable type, with suitable continuous warning legend describing buried electrical lines. Tape color shall conform to APWA uniform color code using ANSI Z535.1 safety colors. Text shall be black, 2-inch minimum letters.
- B. Identify underground conduits using underground warning tape. Install one tape per trench at 3 inches below finished grade.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Degrease and clean surfaces to receive nameplates and labels.
- B. Coordination: Where identification is to be applied to surfaces that require finish, install identification after completion of painting.
- C. Regulations: Comply with governing regulations and the requests of governing authorities for the identification of electrical work.

3.2 APPLICATION

- A. Install nameplate and label parallel to equipment lines.
- B. Secure nameplate to equipment front using screws, rivets, or adhesive.
- C. Secure nameplate to outside moveable surface of door on panelboard.
- D. Conduit Identification:
 - 1. Where electrical conduit is exposed in spaces with exposed mechanical piping, which is identified by a color-coded method, apply color-coded identification on the electrical conduit in a manner similar to the piping identification. Except as otherwise indicated, use orange as the coded color for conduit.
 - 2. Paint red band or provide red tape on each fire alarm conduit longer than 10 feet, minimum 20 feet on center.
- E. Cable/Conductor Identification:
 - 1. Apply cable/conductor identification on each cable and conductor in each box/enclosure/cabinet where the wires of more than one circuit or communication/signal system are present, except where another form of identification (such as color-coded conductors) is provided.
 - 2. Match identification with marking system used in panelboards, shop drawings, contract documents, and similar previously established identification for project electrical work.
- F. Operational Identification and Warnings
 - 1. Wherever reasonably required to ensure safe and efficient operation and maintenance of the electrical systems, and electrically connected mechanical systems and general systems and equipment, including the prevention of misuse of electrical facilities by unauthorized personnel, install self-adhesive plastic signs or similar equivalent identification, instruction or warnings on switches, outlets and other controls, devices and covers of electrical enclosures. Where detailed instructions or explanations are needed, provide plasticized tags with clearly written messages adequate for the intended purposes.

END OF SECTION 26 05 53

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SECTION 26 09 23 - LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Outdoor, wireless photoelectric switches, solid state.
2. Outdoor, wireless smart-control sensors, flexible mounting.
3. Daylight-harvesting dimming controls.
4. Indoor occupancy and vacancy sensors.
5. Digital wall control stations.
6. Extreme-temperature, wireless occupancy sensors.
7. Outdoor motion sensors.
8. Lighting contactors.
9. Emergency shunt relay.
10. Conductors and cables.

B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 260011 "Facility Performance Requirements" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.
3. Section 262726 "Wiring Devices" for wall-box dimmers, non-networkable wall-switch occupancy sensors, and manual light switches.

1.2 ACTION SUBMITTALS

A. Product Data:

1. Outdoor, wireless photoelectric switches, solid state.
2. Outdoor, wireless smart-control sensors, flexible mounting.
3. Daylight-harvesting dimming controls.
4. Indoor occupancy and vacancy sensors.
5. Digital wall control stations.
6. Extreme-temperature, wireless occupancy sensors.
7. Outdoor motion sensors.
8. Lighting contactors.
9. Emergency shunt relay.
10. Conductors and cables.

B. Shop Drawings:

1. Provide installation details for the following:

- a. Occupancy sensors.
- b. Vacancy sensors.
2. Interconnection diagrams indicating field-installed wiring.
3. Include diagrams for power, signal, and control wiring.
- C. Field quality-control reports.

1.3 INFORMATIONAL SUBMITTALS

- A. Sample Warranty: For manufacturer's warranties.

1.4 WARRANTY

- A. Special Extended Warranty: Manufacturer and Installer warrant that installed lighting control devices perform in accordance with specified requirements and agree to repair or replace, including labor, materials, and equipment, devices that fail to perform as specified within extended warranty period.
 1. Failures include, but are not limited to, the following:
 - a. Faulty operation of lighting control software.
 - b. Faulty operation of lighting control devices.
 2. Extended Warranty Period: 5 year(s) from date of shipment.

PART 2 - PRODUCTS

2.1 OUTDOOR, WIRELESS PHOTOELECTRIC SWITCHES, SOLID STATE

- A. Basis-of-Design Product: Subject to compliance with requirements, provide nLight; Acuity Brands Lighting, Inc.; rSBOR or comparable product by one of the following:
 1. Cooper Industries, Inc.
 2. Leviton Manufacturing Co., Inc.
- B. Description: Solid state, with SPST dry contacts rated for 800 W at 120 V(ac), to operate connected load, complying with UL 773, and compatible with CFL and LED lamps.
 1. Listed and labeled in accordance with NFPA 70, by a qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
 2. Light-Level Monitoring Range: 0.1.5 to 200 fc (1 to 2152 lx), with an adjustment for turn-on and turn-off levels within that range.
 3. Time Delay: Thirty-second minimum, to prevent false operation.
 4. Lightning Arrester: Air-gap type.
 5. Mounting: Directly to a 1/2 inch (16 mm) knockout.

6. Failure Mode: Luminaire stays ON.

2.2 OUTDOOR, WIRELESS SMART-CONTROL SENSORS, FLEXIBLE MOUNTING

- A. Basis-of-Design Product: Subject to compliance with requirements, provide nLight; Acuity Brands Lighting, Inc.; rSBOR series or comparable product by one of the following:

1. Cooper Industries, Inc.
2. Leviton Manufacturing Co., Inc.

- B. Description: Digital sensor capable of motion- and daylight-based switching and dimming control of connected load complying with UL 916, UL 924, and compatible with CFL and LED lamps.

- C. General Requirements:

1. Listed and labeled in accordance with NFPA 70, by a qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
2. Capable of group control when paired with compatible devices in wireless network.
3. Operating Voltage: 120 to 277 V(ac).
4. Operating Temperature: Minus 40 to plus 149 deg F (Minus 40 to plus 65 deg C).
5. Ingress Protection: IP66.
6. Mounting: Direct to 1/2 inch (16 mm) knockout.

- D. Features:

1. Mounting Height: Low, 8 to 15 ft. (2.4 to 4.5 m), See drawings for specifics.
2. Motion Sensing Range: 360-degree field of view with a coverage area equal to [**twice**] mounting height.
3. Motion Sensing Technology: PIR tuned for walking motion.
4. Light-Level Monitoring Range: 0.1 to 200 fc (1 to 2152 lx), with an adjustment for turn-on and turn-off levels within that range.
5. Wireless Communication:
 - a. Dual 900 MHz IEEE 802.15.4 based and 2.4 GHz, Version 4.0+ Bluetooth.
 - b. Security: AES-128 bit.
6. Power Monitoring: Output current monitoring with 3 percent accuracy and calculates power usage.

2.3 DAYLIGHT-HARVESTING DIMMING CONTROLS

- A. Description: Sensing daylight and electrical lighting levels, the system adjusts the indoor electrical lighting levels. As daylight increases, lights are dimmed.

1. Lighting control set point is based on the following two lighting conditions:

- a. When no daylight is present (target level).
 - b. When significant daylight is present.
 2. System programming is done with integral push button or dedicated software package.
- B. Wireless Ceiling-Mounted Dimming Controls:
 1. Basis-of-Design Product: Subject to compliance with requirements, provide nLight; Acuity Brands Lighting, Inc.; Model rCMS or comparable product by one of the following:
 - a. Cooper Industries, Inc.
 - b. Leviton Manufacturing Co., Inc.
 2. Description: Solid-state, low-voltage, battery-powered, light-level sensor unit, with separate power pack, that detects changes in indoor lighting levels that are perceived by the eye, suitable for ceiling or surface mounting.
 3. Operating Temperature: 14 to 122 deg F (Minus 10 to plus 50 deg C).
 4. Maximum Humidity: 90 percent, non-condensing.
 5. Sensor Output: Digital signal compatible with power pack.
 6. Sensor Type: Closed loop.
 7. Zone: See plans
 8. Wireless Communication:
 - a. Dual 900 MHz IEEE 802.15.4 based and 2.4 GHz, Version 4.0+ Bluetooth.
 - b. Security: AES-128 bit.
- C. Wireless Knockout-Mounted Dimming Controls:
 1. Basis-of-Design Product: Subject to compliance with requirements, provide nLight; Acuity Brands Lighting, Inc.; rLSXR series with automatic dimming or comparable product by one of the following:
 - a. Cooper Industries, Inc.
 - b. Leviton Manufacturing Co., Inc.
 2. Description: Solid-state, low-voltage, light-level sensor unit, with separate power pack, that detects changes in indoor lighting levels that are perceived by the eye, suitable for mounting on luminaire or on any standard 1/2-inch (6-mm) knockout.
 3. Operating Temperature: 14 to 122 deg F (Minus 10 to plus 50 deg C).
 4. Maximum Humidity: 90 percent, non-condensing.
 5. Sensor Output: Digital signal compatible with power pack.
 6. Sensor Type: Closed loop.
 7. Zone: See plans.
 8. Wireless Communication:
 - a. Dual 900 MHz IEEE 802.15.4 based and 2.4 GHz, Version 4.0+ Bluetooth.
 - b. Security: AES-128 bit.

D. Wireless, Battery-Powered, Ceiling-Mounted Dimming Controls:

1. Basis-of-Design Product: Subject to compliance with requirements, provide nLight; Acuity Brands Lighting, Inc.; Model rCMSB or comparable product by one of the following:
 - a. Cooper Industries, Inc.
 - b. Leviton Manufacturing Co., Inc.
2. Solid-state, wireless, battery-powered, light-level sensor unit that detects changes in indoor lighting levels that are perceived by the eye, suitable for surface mounting.
3. Sensor Output: Wireless, digital signal compatible with power pack and other compatible sensors.
4. Power Source: Three replaceable, type AA lithium batteries.
5. Operating Temperature: Minus 40 to plus 140 deg F (Minus 40 to plus 60 deg C).
6. Wireless Communication:
 - a. Dual 900 MHz IEEE 802.15.4 based and 2.4 GHz, Version 4.0+ Bluetooth.
 - b. Security: AES-128 bit.

E. Power Pack:

1. Basis-of-Design Product: Subject to compliance with requirements, provide nLight; Acuity Brands Lighting, Inc.; rPP20 D series or comparable product by sensor manufacturer.
2. Dry contacts Rating: 120 to 277 V(ac), 16 A tungsten, standard ballast electronic ballast and 1/2 hp at 120 V(ac) with integrated overcurrent protection for load side faults.
3. Relay Type: Latching.
4. Dimming Control Output: 100 mA, zero to 10 V(dc).
5. Compatible with digital addressable lighting interface.
6. Plenum rated.
7. Class 2 Power Supply: 15 V(dc), 40 mA power source for sensors.
8. Operating Temperature: 14 to 122 deg F (Minus 10 to plus 50 deg C).
9. Maximum Humidity: 90 percent, non-condensing.
10. Wireless Communication:
 - a. Dual 900 MHz IEEE 802.15.4 based and 2.4 GHz, Version 4.0+ Bluetooth.
 - b. Security: AES-128 bit.

2.4 INDOOR OCCUPANCY AND VACANCY SENSORS

A. General Requirements for Sensors:

1. Ceiling-mounted, solid-state indoor occupancy and vacancy sensors.
2. Dual technology.
3. Separate power pack.
4. Wireless connection to switch.

5. Listed and labeled in accordance with NFPA 70, by a qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
 6. Operation:
 - a. Occupancy Sensor: Unless otherwise indicated, turn lights on when coverage area is occupied, and turn them off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
 - b. Vacancy Sensor: Unless otherwise indicated, lights are manually turned on and sensor turns lights off when the room is unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
 - c. Combination Sensor: Unless otherwise indicated, sensor must be programmed to turn lights on when coverage area is occupied and turn them off when unoccupied, or to turn off lights that have been manually turned on; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
 7. Sensor Output: Sensor is powered from the power pack.
 8. Mounting:
 - a. Sensor: Suitable for mounting in any position in a standard device box or outlet box.
 - b. Relay: Externally mounted through a 1/2 inch (13 mm) knockout in a standard electrical enclosure.
 - c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
 9. Bypass Switch: Override the "on" function in case of sensor failure.
 10. Automatic Light-Level Sensor: Adjustable from 0.1 to 200 fc (1 to 2152 lx); turn lights off when selected lighting level is present.
 11. Maximum Humidity: 90 percent, non-condensing.
- B. PIR Type, Wireless, Battery Powered, Ceiling Mounted: Detect occupants in coverage area by their heat and movement.
1. Basis-of-Design Product: Subject to compliance with requirements, provide nLight; Acuity Brands Lighting, Inc.; Model rCMSB series or comparable product by one of the following:
 - a. Cooper Industries, Inc.
 - b. Leviton Manufacturing Co., Inc.
 2. Detector Sensitivity: Detect occurrences of 6 inch (150 mm) minimum movement of any portion of a human body that presents a target of not less than 36 sq. inch (23 200 sq. mm).
 3. Detection Coverage (Low Mount): Detect occupancy anywhere within a circular area of 700 sq. ft. (65 sq. m) when mounted on a 108 inch (2740 mm) high ceiling.
 4. Sensor Output: Wireless, digital signal compatible with power pack and other compatible sensors.

5. Power Source: Three replaceable, type AA lithium batteries.
 6. Operating Temperature: Minus 40 to plus 140 deg F (Minus 40 to plus 60 deg C).
- C. Dual-Technology Type, Wireless, Battery Powered, Ceiling Mounted: Detect occupants in coverage area using PIR and microphonic detection methods. The particular technology or combination of technologies that control on-off functions is selectable in the field by operating controls on unit.
1. Basis-of-Design Product: Subject to compliance with requirements, provide nLight; Acuity Brands Lighting, Inc.; Model rCMSB series with microphonics series or comparable product by one of the following:
 - a. Cooper Industries, Inc.
 - b. Leviton Manufacturing Co., Inc.
 2. Detector Sensitivity: Detect occurrences of 6 inch (150 mm) minimum movement of any portion of a human body that presents a target of not less than 36 sq. inch (23 200 sq. mm).
 3. Detection Coverage (Low Mount): Detect occupancy anywhere within a circular area of 700 sq. ft. (65 sq. m) when mounted on a 108 inch (2740 mm) high ceiling.
 4. Sensor Output: Wireless, digital signal compatible with power pack and other compatible sensors.
 5. Power Source: Three replaceable, type AA lithium batteries.
 6. Operating Temperature: Minus 40 to plus 140 deg F (Minus 40 to plus 60 deg C).
- D. Power Pack:
1. Basis-of-Design Product: Subject to compliance with requirements, provide nLight; Acuity Brands Lighting, Inc.; rPP20 series or comparable product by sensor manufacturer.
 2. Dry contacts Rating: 120 to 277 V(ac), 16 A tungsten, standard ballast electronic ballast and 1/2 hp at 120 V(ac) with integrated overcurrent protection for load side faults.
 3. LED status lights to indicate load status.
 4. Plenum rated.
 5. Relay Type: Latching.
 6. Class 2 Power Supply: 15 V(dc), 40 mA power source for sensors.
 7. Operating Temperature: 14 to 122 deg F (Minus 10 to plus 50 deg C).
 8. Maximum Humidity: 90 percent, non-condensing.
 9. Wireless Communication:
 - a. Dual 900 MHz IEEE 802.15.4 based and 2.4 GHz, Version 4.0+ Bluetooth.
 - b. Security: AES-128 bit.

2.5 DIGITAL WALL CONTROL STATIONS

- A. Description: Manual controls for on/off, dimming and lighting scene selection compatible with Occupancy and Photosensor control power packs allowing user override of indoor electrical lighting levels.

B. Wireless, Line Voltage Wall Controls:

1. Basis-of-Design Product: Subject to compliance with requirements, provide nLight; Acuity Brands Lighting, Inc.; Model rPODLA or comparable product by one of the following:
 - a. Cooper Industries, Inc.
 - b. Leviton Manufacturing Co., Inc.
2. Switch Configuration: Single pole.
3. Operating Temperature: 32 to 140 deg F (Zero to 60 deg C).
4. Supply Voltage: 120 to 277 V(ac).
5. Maximum Humidity: 75 percent, non-condensing.
6. Switch Output: Wireless, digital signal compatible with power pack.
7. Wireless Communication:
 - a. Dual 900 MHz IEEE 802.15.4 based and 2.4 GHz, Version 4.0+ Bluetooth.
 - b. Security: AES-128 bit.
8. Color: White.

C. Wireless, Battery-Powered Wall Controls:

1. Basis-of-Design Product: Subject to compliance with requirements, provide nLight; Acuity Brands Lighting, Inc.; Model rPODBA or comparable product by one of the following:
 - a. Cooper Industries, Inc.
 - b. Leviton Manufacturing Co., Inc.
2. Switch Configuration: See Drawings
3. Operating Temperature: Minus 40 to plus 140 deg F (Minus 40 to plus 60 deg C).
4. Battery Type: Three, AAA lithium.
5. Expected Battery Life: Ten years.
6. Maximum Humidity: 75 percent, non-condensing.
7. Switch Output: Wireless, digital signal compatible with power pack.
8. Wireless Communication:
 - a. Dual 900 MHz IEEE 802.15.4 based and 2.4 GHz, Version 4.0+ Bluetooth.
 - b. Security: AES-128 bit.
9. Color: White.

2.6 EXTREME-TEMPERATURE, WIRELESS OCCUPANCY SENSORS

A. Basis-of-Design Product: Subject to compliance with requirements, provide nLight; Acuity Brands Lighting, Inc.; rSBOR or comparable product by one of the following:

1. Cooper Industries, Inc.
2. Sensor Switch, Inc.

- B. Description: Solid-state, extreme-temperature, wireless occupancy sensors.
1. Listed and labeled in accordance with NFPA 70, by a qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended application in damp locations.
 2. Operation: Turn lights on when coverage area is occupied, and turn them off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 30 minutes.
 3. Operating Voltage: 120 to 277 V(ac).
 4. Integral dry contacts rated for 800 W at 120 V(ac), 1200 W at 277 V(ac), 1000 W at 208 V(ac), 1500 W at 347 V(ac), 1200 W at 240 V(ac), and 2160 W at 480 V(ac) or 1/4 HP.
 5. Operating Temperature: Minus 40 to plus 149 deg F (Minus 40 to plus 65 deg C).
 6. Mounting: Direct to 1/2 inch (16 mm) knockout.
 7. Wireless Communication:
 - a. Dual 900 MHz IEEE 802.15.4 based and 2.4 GHz, Version 4.0+ Bluetooth.
 - b. Security: AES-128 bit.
- C. Detector Technology: PIR. Ceiling mounted; detect occupants in coverage area by their heat and movement.
1. Detector Sensitivity: Detect occurrences of 6 inch (150 mm) minimum movement of any portion of a human body that presents a target of not less than 36 sq. inch (23 200 sq. mm).
 2. Detection Coverage: Detect occupancy anywhere in a circular area 60 ft. (18.2 m) in diameter when mounted 10 ft. (3 m) high.

2.7 OUTDOOR MOTION SENSORS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide nLight; Acuity Brands Lighting, Inc.; rSBOR or comparable product by one of the following:
1. Cooper Industries, Inc.
 2. Leviton Manufacturing Co., Inc.
- B. Description: Solid-state outdoor motion sensors.
1. Listed and labeled in accordance with NFPA 70, by a qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application, and must comply with California Title 24.
 2. PIR type, weatherproof. Detect occurrences of 6 inch (150 mm) minimum movement of any portion of a human body that presents a target of not less than 36 sq. inch (23 200 sq. mm). Comply with UL 773A.
 3. Switch Rating: 800 W, at 120 V(ac) or 1/4 hp.
 4. Detector Coverage:
 - a. Mounting Height: See Drawings.

- b. Standard Range: 270-degree field of view, with a minimum coverage area of 314 sq. ft. (21 sq. m).
5. Ambient-Light Override: Concealed, field-adjustable, light-level sensor from 0.1 to 200 fc (1 to 2150 lx). The switch prevents the lights from turning on when the light level is higher than the set point of the sensor.
6. Concealed, field-adjustable, "off" time-delay selector at up to 30 minutes.
7. Concealed, "off" time-delay selector at 30 seconds and 5, 10, and 20 minutes.
8. Adaptive Technology: Self-adjusting circuitry detects and memorizes usage patterns of the space and help eliminate false "off" switching.
9. Operating Ambient Conditions: Suitable for operation in ambient temperatures ranging from minus 40 to plus 130 deg F (minus 40 to plus 54 deg C), rated as "raintight" in accordance with UL 773A.

2.8 LIGHTING CONTACTORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. ABB, Electrification Business.
 2. Eaton.
 3. Square D; Schneider Electric USA.
- B. Description: Electrically operated and mechanically held, combination-type lighting contactors with Specify Connection, complying with NEMA ICS 2 and UL 508.
 1. Current Rating for Switching: Listing or rating consistent with type of load served, including tungsten filament, inductive, and high-inrush ballast (ballast with 15 percent or less THD of normal load current).
 2. Fault Current Withstand Rating: Equal to or exceeding the available fault current at the point of installation.
 3. Enclosure: Comply with NEMA 250.
 4. Provide with control and pilot devices as indicated on Drawings, matching the NEMA type specified for the enclosure.
- C. Interface with DDC System for HVAC: Provide hardware interface to enable the DDC system for HVAC to monitor and control lighting contactors.
 1. Monitoring: On-off status.
 2. Control: On-off operation.

2.9 EMERGENCY SHUNT RELAY

- A. Basis-of-Design Product: Subject to compliance with requirements, provide nLight; Acuity Brands Lighting, Inc.; PP16 SHUNT or comparable product by one of the following:
 1. Lighting Control and Design.

2. WattStopper; Legrand North America, LLC.
 - B. Description: NC, electrically held relay, arranged for wiring in parallel with manual or automatic switching contacts; complying with UL 924.
 1. Input Rating: 120 to 277 V.
 2. Output Rating: 277 V(ac), 50/60 Hz, 16 A tungsten, standard ballast, electronic ballast, or general purpose; 120 V(ac), 50/60 Hz, 1/2 HP motor load.
 3. Mounting: 1/2-inch (12-mm) knockout on box or fixture.
- 2.10 CONDUCTORS AND CABLES
- A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
 - B. Classes 2 and 3 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 24 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
 - C. Class 1 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 18 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine lighting control devices before installation. Reject lighting control devices that are wet, moisture damaged, or mold damaged.
- B. Examine walls and ceilings for suitable conditions where lighting control devices will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF SENSORS

- A. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression systems, and partition assemblies.
- B. Install and aim sensors in locations to achieve not less than 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's instructions.

3.3 INSTALLATION OF CONTACTORS

- A. Mount electrically held lighting contactors with elastomeric isolator pads to eliminate structure-borne vibration unless contactors are installed in an enclosure with factory-installed vibration isolators.

3.4 INSTALLATION OF WIRING

- A. Wiring Method: Comply with Section 260519 "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size is 1/2 inch (13 mm).
- B. Wiring within Enclosures: Separate power-limited and nonpower-limited conductors in accordance with conductor manufacturer's instructions.
- C. Size conductors in accordance with lighting control device manufacturer's instructions unless otherwise indicated.
- D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, device, and outlet boxes; terminal cabinets; and equipment enclosures.

3.5 IDENTIFICATION

- A. Identify components and power and control wiring in accordance with Section 260553 "Identification for Electrical Systems."
 - 1. Identify controlled circuits in lighting contactors.
 - 2. Identify circuits or luminaires controlled by photoelectric and occupancy sensors at each sensor.
- B. Label time switches and contactors with a unique designation.

3.6 FIELD QUALITY CONTROL

- A. Field tests must be witnessed by authorities having jurisdiction.
- B. Tests and Inspections:
 - 1. Operational Test: After installing time switches and sensors, and after electrical circuitry has been energized, start units to confirm proper unit operation.
 - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Nonconforming Work:
 - 1. Lighting control devices will be considered defective if they do not pass tests and inspections.
 - 2. Remove and replace defective units and retest.

- D. Prepare test and inspection reports.
- E. Manufacturer Services:
 - 1. Engage factory-authorized service representative to support field tests and inspections.

3.7 ADJUSTING

- A. Occupancy Adjustments: When requested within 1 months from date of Substantial Completion, provide on-site assistance in adjusting lighting control devices to suit actual occupied conditions. Provide up to 2 visits to Project during other-than-normal occupancy hours for this purpose.
 - 1. For occupancy and motion sensors, verify operation at outer limits of detector range. Set time delay to suit Owner's operations.
 - 2. For daylighting controls, adjust set points and deadband controls to suit Owner's operations.
 - 3. Align high-bay occupancy sensors using manufacturer's laser aiming tool.

3.8 MAINTENANCE

- A. Software and Firmware Service Agreement:
 - 1. Technical Support: Beginning at Substantial Completion, verify that software and firmware service agreement include software support for 5 years.
 - 2. Upgrade Service: At Substantial Completion, update software and firmware to latest version. Install and program software upgrades that become available within 5 years from date of Substantial Completion. Verify upgrading software includes operating system and new or revised licenses for using software.
 - a. Upgrade Notice: No fewer than 30 days to allow Owner to schedule and access the system and to upgrade computer equipment if necessary.
 - 3. Upgrade Reports: Prepare written report after each update, documenting upgrades installed.

END OF SECTION 26 09 23

SECTION 26 09 43.19 - WIRELESS-NETWORK LIGHTING CONTROLS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. System Software Interfaces.
2. System Backbone and Integration Equipment.
3. Wireless Networked Devices.

B. Related Requirements:

1. Div. 26: Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 260011 "Facility Performance Requirements for Electrical" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.

1.2 DEFINITIONS

- A. Data Bus: A wired interface used to communicate with connected devices.
- B. Device: A collective term for bus or wireless connected devices, including fluorescent ballasts, LED drivers, incandescent luminaires, manual switches, switching relays, sensors, and similar.
- C. Global: Communication between devices in otherwise separate spaces using a bridging device or system controller.
- D. Group: A set of devices that communicate together.
- E. Monitoring: Acquisition, processing, communication, and display of equipment status data, metered electrical parameter values, power quality evaluation data, event and alarm signals, tabulated reports, and event logs.
- F. RF: Radio-frequency.
- G. Scene: Digital light level associated with a preset.
- H. System Backbone: Devices used to connect and manage otherwise separate spaces, including bridging devices and gateways or system controllers. Used to expose devices to software configuration via TCP/IP.

1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at **Enter Project Location**.
- B. Preinstallation Coordination Meeting(s): For digital-network lighting controls. Conduct meeting(s) **Enter Meeting Venue** before **Insert construction activity**.
 - 1. Attendees: Installers, fabricators, representatives of manufacturers, and administrators for field tests and inspections. Notify Architect **and <enter other required attendees>** of scheduled meeting dates.
 - 2. Engage factory-authorized service representative to attend preinstallation conference and review the submittal drawing, sequence of operation, and device installation best practices with the Project team.
 - 3. Engage factory-authorized service representative to perform cellular signal strength measurements during site walk through and compare to Project plans to verify the placement of cellular antennas and quantity of lighting control system RF access points.

1.4 ACTION SUBMITTALS

- A. Product Data:
 - 1. Bill of Materials necessary to install the networked lighting control system.
 - 2. Product Specification Sheets indicating general device descriptions, dimensions, electrical specifications, wiring details, and nomenclature.
 - 3. Information Technology (IT) connection information pertaining to interconnection with facility IT networking equipment and third-party systems.
 - 4. Other Diagrams and Operational Descriptions - as needed to indicate system operation or interaction with other system(s).
- B. Shop Drawings:
 - 1. Riser Diagrams showing device wiring connections of system backbone and typical per room/area type.

1.5 INFORMATIONAL SUBMITTALS

- A. Contractor Startup/Commissioning Worksheet.
- B. Service Specification Sheets indicating general service descriptions, including startup, training, post-startup support, and service contract terms.
- C. Field quality-control reports.
- D. Sample Warranty: For manufacturer's special warranty.

1.6 CLOSEOUT SUBMITTALS

- A. Maintenance Contracts:
 - 1. Hardware and Software Operation Manuals.
 - 2. Maintenance service agreement.
 - 3. Software service agreement.
- B. Warranty documentation.

1.7 QUALITY ASSURANCE

- A. Manufacturer Qualifications:
 - 1. Phone Support: Toll-free technical support available from manufacturer through an online tool to schedule a technical support appointment and provide 24/7 emergency support.
 - 2. Remote Support: Manufacturer capable of providing remote support and ability to virtually connect with customers to address issues with visual guidance overlaid on images of real-world objects.
 - 3. Cellular Connectivity: Manufacturer capable of cellular connectivity to a networked lighting control system available to provide remote support within the continental United States.
 - 4. On Site Support: Manufacturer capable of providing a 72-hour, onsite response time within the continental United States.
 - 5. Service Contracts: Manufacturer capable of providing service contracts for continued onsite and remote support of the lighting control system post installation for terms up to 10 years from substantial completion, including:
 - a. Remote and on-site emergency response.
 - b. Remote system performance checks.
 - c. Remote diagnostics.
 - d. Replacement parts.

1.8 WARRANTY

- A. Warranty: Manufacturer and Installer warrant that installed lighting control devices perform in accordance with specified requirements and agree to repair or replace, including labor, materials, and equipment, devices that fail to perform as specified within extended warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Faulty operation of lighting control hardware.
 - b. Faulty operation of lighting control firmware.
 - c. **Insert failure modes.**
 - 2. Minimum Warranty Period: Five years from date of shipment.
 - 3. Extended Warranty Period: **Insert number** year(s) from date of shipment.

PART 2 - PRODUCTS

2.1 SYSTEM COMPLIANCE

- A. System components manufactured in accordance with UL 916 and UL 924 standards where applicable.
- B. System components manufactured in accordance with CFR Title 47, Part 15 standards where applicable.
- C. System components manufactured in accordance with ISED Canada RSS-247 standards where applicable.
- D. System components manufactured in accordance with IFT-008-2015 and NOM-208-SCFI-2016 standards where applicable.
- E. System listed as qualified under DesignLights Consortium Networked Lighting Control System Specification v5.0.
- F. Performance Criteria:
 - 1. Regulatory Requirements:
 - a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

2.2 SYSTEM PERFORMANCE REQUIREMENTS

- A. System Architecture:
 - 1. System architecture based upon the following concepts:
 - a. Networkable intelligent lighting control devices.
 - b. Standalone lighting control zones using distributed intelligence.
 - c. Optional system backbone for remote, time-based, and global operation.
 - 2. Intelligent lighting control devices with individually addressable network communication capability and having one or more basic lighting control components including: occupancy sensor, photosensor, relay, dimming output, contact closure input, analog 0-10 V(dc) input, and manual wall station capable of indicating switching, dimming, and/or scene control. Combining one or more of these components into a single device enclosure permissible to minimize overall system device count.
 - 3. System capable of interfacing directly with networked luminaires such that either low-voltage network cabling or wireless RF communication is used to interconnect networked luminaires with control components such as sensors, switches, and system backbone.

4. Networked luminaires and intelligent lighting control devices support individual (unique) configuration of device settings and properties, with such configuration residing within the networked luminaires and intelligent control devices.
 5. Lighting control zones consisting of one or more networked luminaires and intelligent lighting control devices capable of providing automatic control from sensors (occupancy and/or photosensor) and manual control from local wall stations without requiring connection to a higher-level system backbone.
 - a. Lighting control zones support at least 128 devices per zone.
 - b. Capable of being networked with a higher-level system backbone to provide time-based control, control from inputs or systems external to control zone, and remote configuration and monitoring through a software interface.
 6. Networked luminaires and intelligent lighting control devices with distributed intelligence programming stored in non-volatile memory, such that following any loss of power the lighting control zones operate according to their defined default settings and sequence of operations.
 7. System to include one or more system controllers that provide time-based control.
 8. System controller provides means of connecting the lighting control system to a system software interface and building management systems (BMS) via BACnet/IP or BACnet MS/TP protocol.
 9. System controller supports both low-voltage wired and wireless RF communication within a single controller device.
 10. System devices support firmware update, either remotely or from within the application space, for purposes of upgrading functionality at a later date.
 11. System capable of reporting lighting system events and performance data to management software for display and analysis.
- B. Wireless Networked Control Zone Characteristics:
1. No wired connections between networked devices required for the purposes of system communications.
 2. Multiple wireless networking protocols supported:
 - a. Standards-based, distributed star topology type of protocol for 900 MHz communication, to support lighting control applications and IoT applications.
 - b. Bluetooth standard protocol for 2.4 GHz communication that supports direct connection to smartphone or tablet, to support device configuration, control applications, and IoT without requiring the use of a system backbone.
 3. Wireless network must be self-healing, such that the loss of backbone or local communication between devices does not result in the loss of local control of lights in the space.
 4. Wireless network communication must support uniform and instant response such that all luminaires in a lighting control zone respond immediately and synchronously in response to a sensor or wall station signal.

5. Communication of control signals from sensors and wall stations to networked luminaires and wireless load-control devices occurs directly, without any communication, interpretation, or translation of information through a backbone device such as a wireless access point, communication bridge, or gateway.
6. All wireless communication between lighting control components supports the following five tiers of security measures.
 - a. Data encryption.
 - b. Firmware protection.
 - c. Tamper-proof hardware.
 - d. Authenticated user access.
 - e. Mutual device authentication.
7. Wireless devices use Advanced Encryption Standard (AES) encryption to secure communication with a unique encryption key generated for each programmed site.
8. Wireless devices use signed firmware to ensure that unmodified, authentic software is always installed.
9. Wireless networked devices capable of communicating a minimum distance of 150 ft. (45 m) between devices under typical site conditions accounting for typical environmental conditions and building construction materials encountered within commercial indoor lighting environments.
10. Minimum Line-of-Sight Communication Range: 1000 ft. (304 m) under ideal environmental conditions.
11. Wireless devices self-identify when communication to system controller cannot be accomplished or when communication to the system controller is lost.
 - a. Self-identification not required for wireless switches or battery-powered devices.
12. Wireless devices self-establish connection to system controller through other devices if direct communication cannot be accomplished or when communication to system controller is lost.
 - a. Communication path formation to utilize existing, wireless networked devices located between system controller and respective end devices.
 - b. No additional hardware for formation of networked communication path between a system controller and end devices required.
 - c. Automatic connection not required for wireless switches or battery-powered devices.
13. Networked control devices suitable for control of egress or emergency light sources without additional, externally mounted UL 924 shunting or 0-10 V(dc) disconnect devices, to provide a compliant sequence of operation while reducing the overall installation and wiring costs of the system. Capable of supporting the following sequence of operation:
 - a. Line-Voltage Power Sensing: Devices listed as UL 924 emergency relays that automatically close load-control relay and provide 100 percent light

- output upon detection of loss of power sensed via line voltage connection to normal power.
- b. Normal-Power-Broadcast Sensing: Devices listed as UL 924 emergency relays that automatically close load-control relay and provide 100 percent light output upon loss of a wireless normal-power broadcast from devices connected to normal power.
- C. System Integration Capabilities:
1. Capable of interface with third-party BMS to support two-way communication using BACnet/IP protocol, BACnet MS/TP protocol, and RESTful API including the following system integration capabilities:
 - a. "Write" messages for control of individual devices, including control of relay and dimming output.
 - b. "Write" messages for control of groups of devices through a single command, including control of relay and dimming output of all devices.
 - c. "Read" messages for individual device status information.
 - 1) Available status will vary based on device type and capabilities, which may include relay state, dimming output, power measurement, occupancy sensor status, and photosensor light measurement.
 - d. "Read" messages for group status information for occupancy, relay state, and dimming output.
 - e. Activation of pre-defined system Global Profiles.
 2. Activation of Global Profiles from third-party systems via dry contact closure output signals or digital commands via RS-232 or RS-485.
 3. Activation of demand response levels from Demand Response Automation Servers (DRAS) via OpenADR 2.0a protocol.
- D. Supported Sequence of Operations:
1. Control Zones:
 - a. Local Control Zones: Networked luminaires and intelligent lighting control devices installed in an area (also referred to as a group of devices) capable of transmitting and tracking occupancy sensor, photosensor, and manual switch information within at least 48 unique control zones to support different and reconfigurable sequences of operation within area. These will also be referred to as local control zones.
 - b. Adjacent Control Zones: Networked luminaires and intelligent lighting control devices capable of tracking occupancy broadcasts from adjacent zones. When this feature is enabled, luminaire output for a vacant zone will reduce to a configurable dimmed state if one or more adjacent zones are occupied. Luminaires will turn off when both primary and adjacent zones are vacant.

- c. Global Control Zones: Networked luminaires and intelligent lighting control devices located in different areas able to transmit and track information within at least 128 system-wide control zones to support required sequences of operation that may span across multiple areas. Occupancy, photosensor inhibit, and switch commands available across multiple controllers.
2. Wall Station Capabilities:
 - a. Wall stations support the following capabilities:
 - 1) On/Off of a local or global control zone.
 - 2) Continuous dimming control of light level of a local or global control zone.
 - b. Multi-Way Control: Multiple wall stations capable of controlling the same local or global control zones, to support "multi-way" switching and dimming control.
3. Occupancy Sensing Capabilities:
 - a. Occupancy sensors configurable to control a local or global zone.
 - b. Multiple occupancy sensors capable of controlling the same local or global zones. This capability combines occupancy sensing coverage from multiple sensors without consuming multiple control zones.
 - c. Occupancy sensing sequence of operation modes:
 - 1) On/Off Occupancy Sensing.
 - 2) Partial-On Occupancy Sensing.
 - 3) Partial-Off Occupancy Sensing.
 - 4) Vacancy Sensing (Manual-On/Automatic-Off).
 - d. On/Off, Partial-On, and Partial-Off Occupancy Sensing Modes Sequence of Operation:
 - 1) Occupancy automatically turn lights on to a designated level when occupancy is detected. Designated occupied light level support at least 100 dimming levels.
 - 2) Occupancy sensors automatically turn lights off or to a dimmed state (Partial-Off) when vacancy occurs or if sufficient daylight is detected. Designated unoccupied dim level support at least 100 dimming levels.
 - 3) System capable of combining Partial-Off and Full-Off operation by dimming lights to a designated level when vacant and turning the lights off completely after an additional time delay.
 - 4) Photosensor readings, if enabled in occupancy sensing control zone, automatically adjust light levels during occupied or unoccupied conditions as necessary.
 - 5) Wall station activation changes the dimming level or turns lights off as selected by the occupant. Lights optionally remain in this manually

specified light level until the zone becomes vacant. Upon vacancy, normal sequence of operation resumes.

- e. Vacancy Sensing or Manual-On/Automatic-Off Mode Sequence of Operation:
 - 1) Activation of a wall station is required turn lights on. System capable of programming the zone to turn on to either a designated light level or a previous user-set light level. Initially occupying the space without using a wall station must not result in lights turning on.
 - 2) Occupancy sensors automatically turn lights off or to a dimmed state (Partial-Off) when vacancy occurs or if sufficient daylight is detected. Designated unoccupied dim level support at least 100 dimming levels.
 - 3) System capable of dimming the lights when vacant and then turning the lights off completely after an additional time delay.
 - 4) System capable of an "automatic grace period" immediately following detection of vacancy, during which time any detected occupancy results in the lights reverting to the previous level. After the grace period has expired, the use of a wall station is required to turn lights on.
 - 5) Photosensor readings, if enabled in the Occupancy Sensing control zone, capable of automatically adjusting the light level during occupied or unoccupied conditions as necessary.
 - 6) Wall station interaction changes the dimming level or turns lights off as selected by occupant. Lights remain at manually specified light level until zone becomes vacant; normal sequence of operation resumes upon vacancy.
 - f. Occupancy time delays before dimming or shutting off lights separately programmable for all control zones from 15 seconds to two hours.
4. Photosensor Sensing Capabilities (Automatic Daylight Sensing):
- a. Photosensor devices configurable to control a local zone.
 - b. Photosensor-Based Control:
 - 1) Continuous Dimming: Control zone automatically adjusts dimming output in response to photosensor readings, to maintain a minimum light level consisting of both electric light and daylight sources. Photosensor response configurable to adjust set point and dimming rates.
5. Schedule Capabilities:
- a. System capable of time schedules for time-of-day to override devices including offsets from dusk and dawn.
 - b. System capable of providing a visible "blink warning" five minutes prior to the end of the schedule.

- c. Wall stations may be programmed to provide timed extensions/overrides that turn the lights on for an additional time period.
 - 1) Timed override/extension duration programmable for each individual device, zone of devices, or customized group of devices, from five minutes to 12 hours.

- 6. Global Profile Capabilities:
 - a. System capable of automatically modifying the sequence of operation for selected devices in response to any of the following:
 - 1) Time-of-day schedule.
 - 2) Contact closure input state.
 - 3) Manually triggered wired wall station input.
 - 4) RS-232/RS-485 command to wired input device.
 - 5) BACnet input command.

 - b. Global Profile Capabilities:
 - 1) Global Profiles stored within and executed from the system controller (via internal time clock). Dedicated software host or server is not required to be online to support automatic scheduling and/or operation of Global Profiles.
 - 2) Global Profile time-of-day schedules capable of recurrence settings including daily, specific days of week, every "n" number of days, weekly, monthly, and yearly. Lighting control global profile schedules support definition of start date, end date, end after "n" recurrences, or never ending.
 - 3) Daylight savings time adjustments capable of being performed automatically, if desired.
 - 4) Global Profile holiday schedules follow recurrent settings for specific U.S. holiday dates regardless if they always occur on a specific date or are determined by day/week of the month.
 - 5) Global Profiles capable of being scheduled to run according to timed offsets relative to sunrise or sunset. Sunrise/sunset times automatically derived from location information using an astronomical clock.
 - 6) Software management interface capable of displaying a graphic calendar view of profile schedules for each control zone.
 - 7) Global Profiles capable of manual activation directly from system controller, specially programmed wireless input devices, scene-capable wireless wall stations, and software management interface.
 - 8) Global Profiles selectable to apply to a single device, zone of devices, or customized group of devices.
 - 9) Global Profile Configurable Parameters:
 - a) Fixture light level.
 - b) Occupancy time delay.

- c) Response to occupancy sensors (including enabling/disabling response).
 - d) Response to daylight sensors (including enabling/disabling response).
 - e) Enabling/disabling of wall stations.
- c. Local and Global Profiles backed up and stored on software's host server such that Profile backup can be applied to a replacement system controller or wireless wall station.
7. System supports automated demand response capabilities with automatic reduction of light level to at least three levels of demand response, configurable for each output device.

2.3 SYSTEM SOFTWARE INTERFACES:

A. Management Interface:

1. Web-based management interface for remote system control, live status monitoring, and configuration of lighting control settings and schedules.
2. Compatible with industry-standard web browser clients.
3. Minimum of 100 unique password-protected user accounts.
4. Minimum of three user permission levels: read-only, read and change settings, and full administrative system access.
5. Capable of restricting access for user accounts to specific devices within the system.
6. All system devices capable of being given user-defined names.
7. Device identification information displayed in the Management interface including:
 - a. Model number.
 - b. Model description.
 - c. Serial number or network ID.
 - d. Manufacturing date code.
 - e. Custom label.
 - f. Parent network device.
8. Management interface capable of displaying live status of a networked luminaire or intelligent control device including:
 - a. Luminaire on/off status.
 - b. Dim level.
 - c. Power consumption.
 - d. Device temperature.
 - e. Passive infrared (PIR) occupancy sensor status.
 - f. Microphonic occupancy sensor status.
 - g. Remaining occupancy time delay.
 - h. Photosensor reading.
 - i. Active Profiles.

9. Management interface capable of displaying and modifying the current active settings of a networked luminaire or intelligent control device including:
 - a. Dimming trim levels.
 - b. Occupancy sensor and photosensor enable/disable.
 - c. Occupancy sensor time delay and light level settings.
 - d. Occupancy sensor response (normal or vacancy).
 - e. Photosensor setpoints and transition time delays.
 10. Management interface capable of applying settings changes for a zone of devices or a group of selected devices using a single action that does not require the user to apply settings changes for each individual device.
 11. Management interface capable of compiling a printable network inventory report.
 12. Management interface capable of compiling a printable report detailing all system profiles.
 13. All sensitive information stored encrypted.
 14. System software updates available for automatic download and installation via the Internet.
- B. System Energy Analysis and Reporting:
1. Intuitive graphical screens to facilitate simple viewing of system energy performance.
 2. Energy Scorecard: Summarized display that indicates calculated energy savings in dollars or KWh.
 3. Software calculates allocation of energy savings by control measures including occupancy sensors, photosensors, and manual switching.
 4. Energy savings data calculated for the system as a whole.
 5. Time-scaled graph showing all relay transitions.
 6. Time-scaled graph showing zone occupancy time delays.
 7. Time-scaled graph showing the total light level.
 8. Software capable of storing information remotely onto an open-source, object-relational database, such as PostgreSQL.
 9. Data stored in the database will be accessed utilizing an open standard, application programming interface, such as Open Database Connectivity (ODBC).
- C. Visualization and Programming Interfaces
1. System provides an optional web-based visualization interface that displays a graphical floor plan.
 2. Graphical floor plan will offer the following types of system visualization:
 - a. Full Device Option: Master graphic of entire building, by floor, showing each control device installed with zones outlined including:
 - 1) Controls embedded light fixtures.
 - 2) Controls devices not embedded in light fixtures.
 - 3) Daylight sensors.
 - 4) Occupancy sensors.
 - 5) Wall switches and dimmers.

- 6) Scene controllers.
 - 7) Networked relays.
 - 8) System Controllers.
 - 9) Group outlines.
 - b. Group-Only Option: Master graphic of the entire building, by floor, showing only control groups outlined.
 - c. Pan and zoom commands supported to allow smaller areas to be displayed on a larger scale simply by panning and zooming each floor's master graphic.
 - d. Selecting any control device displays the following as applicable:
 - 1) Device catalog number.
 - 2) Device name and custom label.
 - 3) Device diagnostic information.
 - 4) Link to further information on device including status or current configuration.
3. Programming capabilities through the application will include the following:
 - a. Switch, occupancy sensor, and photosensor zone configuration.
 - b. Manual-on or automatic-on modes.
 - c. Turn-on and dim to dimming levels.
 - d. Occupancy sensor time delays and PIR sensitivity.
 - e. Dual-technology occupancy sensor sensitivity.
 - f. Photosensor calibration adjustment and auto-setpoint.
 - g. Multiple photosensor zone offset.
 - h. Trim level settings.
 - i. Preset scene creation and copy for scene-capable devices.
 - j. Application of custom device labels to the Bluetooth Low Energy Programming Devices and individual connected lighting control devices.
 - k. Fade rate settings.
- D. Smartphone Programming Interface for Wireless Devices:
 1. Interface provided for both Apple iOS and Android operating systems that allows configuration of lighting control settings.
 2. Application supports configuration of wireless networked control devices.
 - a. Application access granted with valid user name and password.
 - b. Access to program information governed by permission system that allows users to share access with other users and restrict access to those who should not be able to reconfigure the equipment.
 - c. Indication of signal strength where multiple Bluetooth Low-Energy Programming Devices are available for configuration.
 3. Programming Capabilities:
 - a. Switch, occupancy sensor, and photosensor group configuration.
 - b. Manual-on or automatic-on modes.

- c. Turn-on and dim to dimming levels.
- d. Occupancy sensor time delays and PIR sensitivity.
- e. Dual-technology occupancy sensor sensitivity.
- f. Photosensor calibration adjustment and auto-setpoint.
- g. Multiple photosensor zone offset.
- h. Trim level settings.
- i. Preset scene creation.
- j. Application of custom device labels for individual connected lighting control devices.
- k. Fade rate settings.

2.4 SYSTEM BACKBONE AND SYSTEM INTEGRATION EQUIPMENT:

- A. System Controller: Multi-tasking, real-time digital control processor consisting of modular hardware with plug-in enclosed processors, communication controllers, and power supplies.
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide nLight; Acuity Brands Lighting, Inc.; nECY or comparable product by one of the following:
 - a. Cooper Industries, Inc.
 - b. Leviton Manufacturing Co., Inc.
 - c. **Insert manufacturer's name.**
 - 2. System Controller Processor: 32-bit microprocessor operating at a minimum of 1 GHz.
 - 3. System Controller Memory: Minimum of 512MB memory, with a minimum of 4GB non-volatile flash, to support operating system and databases.
 - 4. System Controller Functions:
 - a. Time-based control of downstream wireless network devices.
 - b. Linking into an Ethernet network.
 - c. Integration with BMS and Heating, Ventilation and Air Conditioning (HVAC) equipment.
 - d. Connection to various software interfaces, including management interface, historical database and analytics interface, and visualization interface.
 - 5. Integral web server to support system controller configuration and diagnostics **with control and visualization of connected devices.**
 - a. Web Server Control Interface:
 - 1) Display associated devices within the context of a graphical floor plan.
 - 2) Provide control of output-capable devices through virtual sliders, toggle buttons, preset level widgets, and transparent layers on floor plan.

- 3) Control Capabilities:
 - a) Control of individual output devices, including control of relay state and analog dimming level where applicable.
 - b) Control of local lighting control zones, including control of relay state and analog dimming level where applicable.
 - c) Control of global lighting control zones, including control of relay state and analog dimming level where applicable.
 - d) Control of Global Profiles.
- b. Visualization Interface:
 - 1) Customizable display with the ability to superimpose colored, transparent layers representing real-time property values, including occupancy status, dimming level status, light level status, and online or offline status where applicable.
 - 2) Ad hoc display of trended information via an intuitive values-over-time graph.
 - 3) Report Creation:
 - a) Reports accept and graphically display trended status datasets for creator-selected devices or zones of devices.
 - b) Report information displayed over a user-defined interval and date range.
 - c) Reports exportable to a standard comma-separated values (CSV) format.
6. Graphical touch screen to support configuration and diagnostics.
7. Minimum of three RJ-45 networked lighting control ports for connection to any of the following:
 - a. Graphical touch screen.
 - b. Direct connection to networked luminaires and intelligent lighting control devices (up to 128 total devices per port).
8. Device will automatically detect all network-connected devices.
9. Capable of managing and operating a minimum of 750 networked devices per system controller.
10. Multiple System Controllers capable of connection via local area network (LAN) for scalability to a minimum of 20,000 networked devices.
11. Supports BACnet/IP and BACnet MS/TP protocols to directly interface with BMS and HVAC equipment without additional protocol translation gateways.
 - a. BACnet MS/TP Connection Speed: 9600 to 115200 baud rate.
 - b. BACnet Testing Laboratory (BTL listed) using Device Profile BACnet Building Controller (B-BC) with outlined enhanced features.
12. Integral FIPS 140-2, Level 1 cryptographic module.
13. Supports RESTful API for control of BACnet objects, user management, date and time, and file management.

14. NEMA 1 enclosure with Class 1 and Class 2 separation.
 - a. Power Supply Voltage: Specify Voltage V(ac).
15. Automatic algorithm to eliminate redundant, wireless networked paths to streamline communication between the system controller and end devices.
16. System Controller Security Provisions:
 - a. Disallow the use of default passwords and require passwords to be updated prior to use.
 - b. Support user role-based access, such as administrator, user, and viewer.
 - c. Signed firmware to ensure that unmodified, authentic software is always installed.
 - d. IP-based communication protected with strong encryption algorithms such as AES or TLS1.2+.
 - e. Prevent rollback of firmware to firmware versions with known, critical vulnerabilities.
 - f. Valid cybersecurity listing through a third party.
17. Cellular Remote Access: Cellular router and modem for remote access.
 - a. Router supports remote access to at least five system controllers on its LAN or network subnet.
 - b. Remote access capable of device setting updates, schedule updates, system performance optimization, and diagnostics.
 - c. Remote access enabled through outbound communication from router to an outside source. Solutions that begin communication via inbound requests for network access are unacceptable.
 - d. Router supports outbound communication to manufacturer-hosted portal using TLS1.2 or greater in-transit encryption over a cellular or Ethernet connection.
 - e. Router with integral firewall to prevent unauthorized access to devices connected to its LAN port.
 - f. Router includes cellular SIM capable of connection to AT&T, T-Mobile, Sprint, US Cellular, Alaska Wireless, Telefonica, Tellus, Bell, or Sasktel networks where carrier service is available.
 - g. Outbound communication from the router limited to whitelisted endpoints. Devices that allow unrestricted communication are unacceptable.
 - h. Outbound communication from router includes only lighting control system information.

2.5 WIRELESS NETWORKED DEVICES:

A. Wireless Networked Wall Switches, Dimmers:

1. Basis-of-Design Product: Subject to compliance with requirements, provide nLight; Acuity Brands Lighting, Inc.; rPOD series or comparable product by one of the following:

- a. Cooper Industries, Inc.
 - b. Leviton Manufacturing Co., Inc.
 - c. **Insert manufacturer's name.**
2. Mounting: Suitable for installation in single-gang switch box.
 3. Wireless Communication:
 - 1) Dual 900 MHz IEEE 802.15.4 based and 2.4 GHz, Version 4.0+ Bluetooth.
 - 2) Security: AES-128 bit.
 4. Power Supply: **Power source.**
 5. Mechanical push buttons provide tactile and LED user feedback during button press.
 6. Mechanical push buttons available with custom button labeling.
 7. Wall Switches and Dimmer Options:
 - a. Number of Control Zones: **Enter Number of zones per switch.**
 - b. Control Types Supported: On/Off and On/Off/Dimming.
 8. Scene Switch Options:
 - a. Number of Scenes: **Enter Number of scenes per switch.**
 - b. Control Types Supported: On/Off, On/Off/Dimming, and Preset Level Scene Type.
 9. Color: **Enter switch color.**
- B. Wireless Networked Embedded Fixture Control Devices:
1. Basis-of-Design Product: Subject to compliance with requirements, provide nLight; Acuity Brands Lighting, Inc.; rIO or comparable product by one of the following:
 - a. Cooper Industries, Inc.
 - b. Leviton Manufacturing Co., Inc.
 - c. **Insert manufacturer's name.**
 2. Wireless Communication:
 - a. Dual 900 MHz IEEE 802.15.4 based and 2.4 GHz, Version 4.0+ Bluetooth.
 - b. Security: AES-128 bit.
 3. Power Supply: Standard low-voltage wiring typically associated with an LED driver.
 4. Suitable for installation within a luminaire such that the control device is not visible on the luminaire face.
 5. Devices available with integrated and remote antennas such that devices can be installed within sealed container without detriment to wireless strength.
 6. Antenna Color: **Enter antenna color.**

7. Dimming Output: **Enter dimming protocol.**
8. Power loss detection, where unit powers and controls the emergency circuit. Loss of wireless broadcasts from a dedicated normal-power-connected device forces unit to shunt closed, go to full bright, and ignore all system commands until main power is restored.

C. Wireless Networked Indoor Load Controller with Occupancy and Photosensors:

1. Basis-of-Design Product: Subject to compliance with requirements, provide nLight; Acuity Brands Lighting, Inc.; rLSXR or comparable product by one of the following:
 - a. Cooper Industries, Inc.
 - b. Leviton Manufacturing Co., Inc.
 - c. **Insert manufacturer's name.**
2. Wireless Communication:
 - a. Dual 900 MHz IEEE 802.15.4 based and 2.4 GHz, Version 4.0+ Bluetooth.
 - b. Security: AES-128 bit.
3. Detects the presence of human activity within space and fully control the on/off function of lights.
4. Utilizes PIR technology, which detects occupant motion, to initially turn lights on from an off state, thus preventing false on conditions. Ultrasonic and Microwave-based sensing technologies are unacceptable.
5. Dual-technology sensors used in locations where a second method of sensing is necessary to adequately detect maintained occupancy (such as in rooms with obstructions).
6. Dual-technology sensors must have one sensing technology not motion dependent to detect occupancy. Acceptable dual technology includes PIR/Microphonics (also known as Passive Dual Technology or PDT), which detects both occupant motion and sounds indicating occupants. Sensors where both technologies detect motion (PIR/Ultrasonic) are unacceptable.
7. All sensing technologies are acoustically passive, meaning they do not transmit sound waves of any frequency (for example in the Ultrasonic range), as these technologies have the potential for interference with other electronic devices within the space (such as electronic white board readers and hearing devices). Acceptable detection technologies include PIR and/or Microphonic technology. Ultrasonic and Microwave-based sensing technologies are unacceptable.
8. Sensor programming parameters available and configurable remotely.
9. Ceiling-, fixture-, and junction-box-mounted sensors available, with multiple lens options available customized for specific applications.
10. Dry Contact Output: One integrated dry contact switching relay, capable of switching 100 mA at 24 V, resistive only.
11. Integral daylight photosensor for programmable daylight harvesting.
12. Photosensor includes adjustable illumination set point and dead band to prevent the artificial light from cycling. Set point and dead band capable of automatically

calibrating through an "Automatic Set-Point Programming" procedure. Min and max dimming settings and set point may be manually entered or modified.

13. Dead-band setting verified and modified by the sensor automatically every time the lights cycle to accommodate physical changes in the space (i.e., furniture layouts, lamp depreciation, or lamp outages).
14. Power loss detection, where unit powers and controls the emergency circuit. Loss of wireless broadcasts from a dedicated normal-power-connected device forces unit to shunt closed, go to full bright, and ignore all system commands until main power is restored.
15. Power Monitoring: Integral current measurements on output with 3 percent accuracy when measuring loads 225 mA or greater.

D. Wireless Networked Indoor Occupancy and Photosensors:

1. Basis-of-Design Product: Subject to compliance with requirements, provide nLight; Acuity Brands Lighting, Inc.; **Enter sensor choice** or comparable product by one of the following:
 - a. Cooper Industries, Inc.
 - b. Leviton Manufacturing Co., Inc.
 - c. **Insert manufacturer's name.**
2. Wireless Communication:
 - a. Dual 900 MHz IEEE 802.15.4 based and 2.4 GHz, Version 4.0+ Bluetooth.
 - b. Security: AES-128 bit.
3. Detects the presence of human activity within space and fully control the on/off function of lights.
4. Utilizes PIR technology, which detects occupant motion, to initially turn lights on from an off state, thus preventing false on conditions. Ultrasonic and Microwave-based sensing technologies are unacceptable.
5. Dual-technology sensors used in locations where a second method of sensing is necessary to adequately detect maintained occupancy (such as in rooms with obstructions).
6. Dual-technology sensors must have one sensing technology not motion dependent to detect occupancy. Acceptable dual technology includes PIR/Microphonics (also known as PDT, which detects both occupant motion and sounds indicating occupants. Sensors where both technologies detect motion (PIR/Ultrasonic) are unacceptable.
7. All sensing technologies acoustically passive, meaning they do not transmit sound waves of any frequency (for example in the Ultrasonic range), as these technologies have the potential for interference with other electronic devices within the space (such as electronic white board readers and hearing devices). Acceptable detection technologies include PIR and/or Microphonic technology. Ultrasonic and Microwave-based sensing technologies are unacceptable.
8. Sensor programming parameters available and configurable remotely.
9. Ceiling-, fixture-, and junction-box-mounted sensors available, with multiple lens options available customized for specific applications.
10. Dry Contact Output: One integrated dry contact switching relay, capable of switching 100 mA at 24 V, resistive only.

11. Integral daylight photosensor for programmable daylight harvesting.

12. Photosensor includes adjustable illumination set point and dead band to prevent the artificial light from cycling. Set point and dead band capable of automatically calibrating through an "Automatic Set-Point Programming" procedure. Min and max dimming settings and set point may be manually entered or modified.
13. Dead-band setting verified and modified by the sensor automatically every time the lights cycle to accommodate physical changes in the space (i.e., furniture layouts, lamp depreciation, or lamp outages).

E. Wireless Networked Outdoor Occupancy and Photosensors:

1. Basis-of-Design Product: Subject to compliance with requirements, provide nLight; Acuity Brands Lighting, Inc.; rSBOR or comparable product by one of the following:
 - a. Cooper Industries, Inc.
 - b. Leviton Manufacturing Co., Inc.
 - c. **Insert manufacturer's name.**
2. Wireless Communication:
 - a. Dual 900 MHz IEEE 802.15.4 based and 2.4 GHz, Version 4.0+ Bluetooth.
 - b. Security: AES-128 bit.
3. Mounting: **Enter required mounting.**
4. Supply Voltage: **Enter voltage V(ac).**
5. Detects the presence of human activity within space and fully control the on/off function of lights.
6. Utilizes PIR technology, which detects occupant motion, to initially turn lights on from an off state, thus preventing false on conditions. Ultrasonic and Microwave-based sensing technologies are unacceptable.
7. Sensors detect valid communication and blink a unique LED pattern to visually indicate a potential issue.
8. Sensor programming parameters available and configurable remotely.
9. Available with multiple lens options available for various mounting heights.
10. Power Monitoring: Integral current measurements on output with 3 percent accuracy when measuring loads 225 mA or greater.
11. Integral daylight photosensor for programmable daylight harvesting.
12. Photosensor includes adjustable illumination set point and dead band to prevent the artificial light from cycling. Set point and dead band capable of automatically calibrating through an "Automatic Set-Point Programming" procedure. Min and max dimming settings and set point may be manually entered or modified.
13. Dead-band setting verified and modified by the sensor automatically every time the lights cycle to accommodate physical changes in the space (i.e., furniture layouts, lamp depreciation, or lamp outages).
14. Power loss detection, where unit powers and controls the emergency circuit. Loss of wireless broadcasts from a dedicated normal-power-connected device forces unit to shunt closed, go to full bright, and ignore all system commands until main power is restored.

F. Wireless Networked Indoor Embedded Sensors:

1. Basis-of-Design Product: Subject to compliance with requirements, provide nLight; Acuity Brands Lighting, Inc.; **Enter sensor choice** or comparable product by one of the following:
 - a. Cooper Industries, Inc.
 - b. Leviton Manufacturing Co., Inc.
 - c. **Insert manufacturer's name.**
 2. Wireless Communication:
 - a. Dual 900 MHz IEEE 802.15.4 based and 2.4 GHz, Version 4.0+ Bluetooth.
 - b. Security: AES-128 bit.
 3. Sensors consisting of occupancy sensors and dimming photosensor suitable for installation within a luminaire such that only the lens is visible on luminaire face.
 4. Power Supply: Standard low-voltage wiring typically associated with an LED driver.
 5. Devices available with integrated and remote antennas such that devices can be installed within sealed container without detriment to wireless strength.
 6. Antenna Color: **Enter antenna color.**
 7. Dimming Output: **Enter dimming protocol.**
 8. Detects the presence of human activity within space and fully control the on/off function of lights.
 9. Utilizes PIR technology, which detects occupant motion, to initially turn lights on from an off state, thus preventing false on conditions. Ultrasonic and Microwave-based sensing technologies are unacceptable.
 10. Sensors detect valid communication and blink a unique LED pattern to visually indicate a potential issue.
 11. Sensor programming parameters available and configurable remotely.
 12. Available with multiple lens options available for various mounting heights.
 13. Integral daylight photosensor for programmable daylight harvesting.
 14. Photosensor includes adjustable illumination set point and dead band to prevent artificial light from cycling. Set point and dead band capable of automatically calibrating through an "Automatic Set-Point Programming" procedure. Min and max dimming settings and set point may be manually entered or modified.
 15. Dead-band setting verified and modified by sensor automatically every time lights cycle to accommodate physical changes in space (i.e., furniture layouts, lamp depreciation, or lamp outages).
 16. Power loss detection, where unit powers and controls the emergency circuit. Loss of wireless broadcasts from a dedicated normal-power-connected device forces unit to shunt closed, go to full bright, and ignore all system commands until main power is restored.
- G. Wireless Networked Outdoor Embedded Sensors:
1. Basis-of-Design Product: Subject to compliance with requirements, provide nLight; Acuity Brands Lighting, Inc.; **Enter Sensor Choice** or comparable product by one of the following:

- a. Cooper Industries, Inc.
 - b. Leviton Manufacturing Co., Inc.
 - c. **Insert manufacturer's name.**
2. Wireless Communication:
 - a. Dual 900 MHz IEEE 802.15.4 based and 2.4 GHz, Version 4.0+ Bluetooth.
 - b. Security: AES-128 bit.
 3. Sensors consisting of occupancy sensors and dimming photosensor suitable for installation within a luminaire such that only the lens is visible on luminaire face.
 4. Power Supply: Standard low-voltage wiring typically associated with an LED driver.
 5. Color: **Enter color.**
 6. Ingress Protection: Minimum IP66.
 7. Devices available with remote antennas such that devices can be installed within sealed container without detriment to wireless strength.
 8. Detects the presence of human activity within space and fully control the on/off function of lights.
 9. Utilizes PIR technology, which detects occupant motion, to initially turn lights on from an off state, thus preventing false on conditions. Ultrasonic and Microwave-based sensing technologies are unacceptable.
 10. Sensors detect valid communication and blink a unique LED pattern to visually indicate a potential issue.
 11. Sensor programming parameters available and configurable remotely.
 12. Available with multiple lens options available for various mounting heights.
 13. Integral daylight photosensor for programmable daylight harvesting.
 14. Photosensor includes adjustable illumination set point and dead band to prevent artificial light from cycling. Set point and dead band capable of automatically calibrating through an "Automatic Set-Point Programming" procedure. Min and max dimming settings and set point may be manually entered or modified.
 15. Dead-band setting verified and modified by the sensor automatically every time the lights cycle to accommodate physical changes in the space (i.e., furniture layouts, lamp depreciation, or lamp outages).
 16. Power loss detection, where unit powers and controls the emergency circuit. Loss of wireless broadcasts from a dedicated normal-power-connected device forces unit to shunt closed, go to full bright, and ignore all system commands until main power is restored.
- H. Wireless Networked Power Packs:
1. Basis-of-Design Product: Subject to compliance with requirements, provide nLight; Acuity Brands Lighting, Inc.; rPP series or comparable product by one of the following:
 - a. Cooper Industries, Inc.
 - b. Leviton Manufacturing Co., Inc.
 - c. **Insert manufacturer's name.**

2. Wireless Communication:

- a. Dual 900 MHz IEEE 802.15.4 based and 2.4 GHz, Version 4.0+ Bluetooth.
- b. Security: AES-128 bit.
3. Plenum rated.
4. Supply Voltage: **Enter voltage** V(ac).
5. Relay Output: Class 1 relay rated for 20 A and 1.5 HP at 120 to 277 V(ac) and 5 A and 0.5 HP at 480 V(ac).
6. Dimming Output: 0-10 V(dc) dimming output.
7. Sink Current: 150 mA at 0-10 V(dc).
8. Antenna Type: **Antenna**.
9. Programming parameters available and configurable remotely.
10. Mounting: Integral 1/2-inch (16-mm) chase nipple. Plastic clips into junction box are unacceptable.
11. Power Pack Options:
 - a. Power Pack capable of full 20-Amp switching of all normal power lighting load types, with optional 0-10V dimming output capable of up to 150mA of sink current.
 - b. Power Packs capable of full 20-Amp switching of general purpose receptacle (plug-load) control.
 - c. Listing: UL 924 for control of emergency lighting circuits, field configurable for two distinct sequence of operation:
 - 1) Power sense of normal power feed, where unit powers and controls emergency circuit, and loss of the normal power sense circuit forces the power pack to shunt closed, go to full bright, and ignore all system commands until normal power is restored.
 - 2) Power loss detection, where unit powers and controls the emergency circuit. Loss of wireless broadcasts from a dedicated normal-power-connected device forces unit to shunt closed, go to full bright, and ignore all system commands until main power is restored.
 - d. Power Monitoring: Integral current measurements on output with 3 percent accuracy when measuring loads **Enter current** mA or greater.
 - e. Chicago Plenum External Antenna:
 - 1) Mounting: 1/2-inch (16-mm).
 - 2) Ingress Protection: IP67.
- I. Wireless Networked Communication Adapter:
 1. Basis-of-Design Product: Subject to compliance with requirements, provide nLight; Acuity Brands Lighting, Inc.; nECYD or comparable product by one of the following:
 - a. Cooper Industries, Inc.
 - b. Leviton Manufacturing Co., Inc.
 - c. **Insert manufacturer's name**.

2. Wireless Communication:

- a. Dual 900 MHz IEEE 802.15.4 based and 2.4 GHz, Version 4.0+ Bluetooth.
 - b. Security: AES-128 bit.
3. Capable of supporting a minimum of 750 networked wireless devices per adapter.
 4. Interface: USB connection.
 5. Ingress Protection: Minimum IP66.
 6. Mounting: Integral 1/2-inch (16-mm) chase nipple. Minimum 16 ft. (4.8 m) USB cable and optional cable extenders for remote mounting.

PART 3 - EXECUTION

3.1 INSTALLATION OF WIRING

- A. Wiring Method: Comply with Section 260519 "Low-Voltage Electrical Power Conductors and Cables" and Section 260523 "Control-Voltage Electrical Power Cables." Minimum conduit size is 1/2 inch (13 mm).
 1. Comply with requirements for cable trays specified in Section 260536 "Cable Trays for Electrical Systems."
 2. Comply with requirements for raceways and boxes specified in Section 260533.13 "Conduits for Electrical Systems," and Section 260533.16 "Boxes and Covers for Electrical Systems,"
- B. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

3.2 IDENTIFICATION

- A. Identify system components, wiring, cabling, boxes, cabinets, and terminals. Comply with identification requirements specified in Section 260553 "Identification for Electrical Systems."
- B. Identify field-installed conductors, interconnecting wiring, and components; install warning signs complying with Section 260553 "Identification for Electrical Systems."
- C. Identify all controls with device address.
- D. Label each device cable within 6 inch (152 mm) of connection to bus power supply or termination block.

3.3 FIELD QUALITY CONTROL

- A. Acceptance Testing Preparation:
 1. Test continuity of each circuit.

- B. Field tests and inspections must be witnessed by **Enter witnesses**.
- C. Tests and Inspections: **Enter responsible party** test inspections.
 - 1. Test each zone using local and remote control hardware.
 - 2. Perform each visual and mechanical inspection and electrical test stated in NETA ATS. Certify compliance with test parameters.
- D. Nonconforming Work:
 - 1. Lighting controls will be considered defective if they do not pass tests and inspections.
 - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
- E. Field Test Reports: **Enter responsible party** field test reports.
 - 1. Prepare functionality and inspection reports, including a certified report that identifies controls included and describes test results. Include notation of deficiencies detected, remedial action taken, and observations made after remedial action.
 - 2. Include list of all points created from actual tests of all addressed control points for lamps, ballasts, manual controls, and sensors.

3.4 REMOTE ACCESS

- A. Digital network lighting control system capable of remote access by manufacturer with the following features:
 - 1. System diagnostics including detection of fault condition in hardware or connected devices.
 - 2. Access to all connected devices for complete programming including scheduling of time-of-day events and device parameters necessary to meet required sequence of operations.
 - 3. Browser-based interface to verify system functionality.
 - 4. On-demand access to manufacturer technical support for remote troubleshooting, diagnostics, configuration, and programming.
 - 5. Owner training on the digital network lighting control system available remotely.
- B. Remote access system fully functional over commercial cellular connection or Internet-connected Ethernet network.
- C. All hardware associated with remote access including cellular modem and cellular antenna are to remain on-site regardless of warranty or cellular contract status.

3.5 SYSTEM STARTUP

- A. **Enter responsible party** startup service.

1. Complete installation and startup checks in accordance with manufacturer's published instructions.
2. Activate luminaires and verify that all maximum output levels match output levels detailed in an Owner-approved sequence of operations.
3. Confirm correct communications wiring, initiate communications between control devices and controller/gateways, and program the lighting control system in accordance with approved configuration schedules, time-of-day schedules, and input override assignments.
4. Program network devices to meet required sequence of operations.
5. Program and verify all sequence of operations.
6. Create backup of system programming.
7. Assist in installation of system software on customer-provided workstation or server.

8. Verify bidirectional communication of manufacturer-provided cellular router with manufacturer-managed remote access portal.
9. **Insert startup steps if any.**
10. Commissioning Walkthrough: **Enter responsible party** to demonstrate lighting control system functionality and verify the system meets the specified Project requirements.

3.6 CLOSEOUT ACTIVITIES

- A. Enhanced Documentation: Engage lighting system manufacturer to provide comprehensive system documentation including detailed programming, sequence of operation data per Project specifications, and related code requirements.
- B. Training: Engage lighting system manufacturer to provide comprehensive system overview, software overview, and documentation relating to system operation and maintenance.

3.7 PROTECTION

- A. After installation, protect digital network lighting controls from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

3.8 MAINTENANCE

- A. Engage a factory-authorized service representative to perform on-site system adjustments.
 1. On-Site Occupancy Adjustments: When requested within **Insert number** months from date of Substantial Completion, provide on-site settings adjustments to suit actual occupied conditions. Provide up to **Insert number** visits to Project during other-than-normal occupancy hours for this purpose.

2. Prepare and submit report after each visit that details activities performed.
- B. Engage a factory-authorized service representative to perform remote system adjustments.
1. Remote Occupancy Adjustments: When requested within **Insert number** months from date of Substantial Completion and project registration with lighting control system manufacturer, provide remote settings adjustments to suit actual occupied conditions. Provide up to **Insert number** sessions to Project during other-than-normal occupancy hours for this purpose.
 - a. System to include manufacturer-provided cellular communication hardware and connection to the system for a minimum of **Insert number** months after substantial completion to allow for factory representative assistance with settings adjustments and system sustainment.
 - b. For the remaining duration of the maintenance term, or in the event cellular connectivity is not available, manufacturer assistance must be available through an Owner-provided, Internet-connected network.
 2. Prepare and submit report after each session that details activities performed.
- C. Maintenance Service Agreement:
1. Beginning at Substantial Completion, verify that maintenance service agreement includes 12 months' full maintenance by manufacturer's authorized service representative.
 2. Include **Enter frequency Enter location** preventive maintenance.
 3. Preventative maintenance to include:
 - a. System diagnostic reports.
 - b. System performance checks.
 - c. Device firmware updates.
 - d. Programming adjustment as required for proper lighting system operation.
 - e. Expedited factory direct warranty processing, replacement, and programming of defective components.
 4. Verify that parts and supplies are manufacturer's authorized replacement parts and supplies.

END OF SECTION 26 09 43.19

SECTION 26 24 16 - 600-VOLT RATED PANELBOARDS & CB

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes distribution and branch circuit panelboards and circuit breakers.

1.2 RELATED SECTIONS

- A. Section 260500: Common Work Results for Electrical
- B. Section 260526: Grounding and Bonding for Electrical Systems
- C. Section 260553: Identification for Electrical Systems

1.3 REFERENCES - CODES AND STANDARDS

- A. ANSI C2 National Electrical Safety Code.
- B. NECA Standard of Installation
- C. NEMA AB 1 Molded Case Circuit Breakers.
- D. NEMA ICS 6 Enclosures
- E. NEMA PB 1 Panelboards.
- F. NEMA PB 1.1 Instructions for Safe Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less.
- G. NETA ATS (National Electrical Testing Association) - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems
- H. NFPA 70 National Electrical Code

1.4 SUBMITTALS

- A. Shop Drawings: Indicate outline and support point dimensions, voltage, main bus ampacity, integrated short circuit ampere rating, circuit breaker and fusible switch arrangement and sizes.
- B. Product Data: Submit catalog data showing specified features of standard products.
- C. Test Report:

1. Factory Tests:
 - a. Certified factory test reports shall be submitted for manufacturer performed routine factory tests, including tests required by standards listed in paragraph "References". Results of factory tests performed shall be certified by the manufacturer, or an approved testing laboratory, and submitted within 7 days following successful completion of the tests. The manufacturer's pass-fail criteria for tests specified in paragraph "Field Testing" shall be included.

1.5 CLOSEOUT SUBMITTALS

- A. Project Record Documents: Record actual locations of panelboards and record actual circuiting arrangements.
- B. Operation and Maintenance Data: Submit spare parts listing; source and current prices of replacement parts and supplies; and recommended maintenance procedures and intervals.

1.6 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum five (5) years experience.

1.7 MAINTENANCE MATERIALS

- A. Furnish two (2) of each panel board key. Panelboards keyed alike to Owner's current keying system.

PART 2 - PRODUCTS

2.1 DISTRIBUTION AND BRANCH CIRCUIT PANELBOARDS

- A. Manufacturers:
 1. Allen Bradley
 2. Cutler Hammer
 3. General Electric Co.
 4. Siemens.
 5. Square D Co.
 6. Or Approved Equal.
- B. Product Description
 1. NEMA PB 1, circuit breaker type distribution, lighting and appliance branch circuit panelboard.
- C. Service Conditions:

1. Temperature: 104 degrees F (40 degrees C) ambient
 2. Altitude: 100 feet (35 m) above sea level.
- D. Panelboard Bus
1. Silver plated copper current carrying components, ratings as indicated on drawings.
 2. Main bus ampacity shall be equal to the main circuit breaker frame size rating.
 3. Furnish copper ground bus in each panelboard.
- E. Minimum integrated short circuit rating
1. Panelboards rated 240-Volts - 10,000 amperes RMS symmetrical
 2. Panelboards rated 480-Volts - 42,000 amperes RMS symmetrical
 3. Circuit Breaker rating shall match or exceed the panel interrupting rating
 4. Series rated circuit breakers are not acceptable
- F. Enclosure:
1. Indoor Installation:
 - a. NEMA PB 1, Type 1, gasketed, steel construction, minimum 6 inches (153 mm) deep, 20 (503 mm) inches wide suitable for flush or surface mounting as indicated on drawings.
 - b. Flush or surface cabinet front with concealed trim clamps, concealed hinge, metal directory frame, and flush lock keyed alike. Finish in manufacturer's standard gray enamel.
 - c. Fully hinged door with flush lock and metal directory frame.
 - d. Finished in manufacturer's standard gray enamel (ANSI 61).
 2. Outdoor Installation:
 - a. Panel shall be housed inside an outer weatherproof, corrosion resistant, NEMA 4X, 316 stainless steel enclosure constructed as follows:
 - b. Steel support frame with body stiffeners for added strength and minimum 12 gauge 316 stainless steel panels all around.
 - c. Steel panels shall have seams that are continuously welded and ground smooth with no holes or knockouts.
 - d. The outer door shall provide two-door protection, isolation of electrical equipment and easy access to the interior section doors and devices.
 - e. Provide rolled lip around three sides of each outer door and along the top of enclosure opening to channel away liquids and contaminants.
 - f. Provide oil-resistant door gasket attached with oil resistant adhesive and held in place with steel retaining strips.
 - g. Provide heavy gauge steel continuous piano hinged, 3-point latch, hasp and staple for pad-locking.
 - h. Provide continuous external support channels for floor mounting, leveling and anchoring the assembly.
 - i. Provide heavy duty removable lifting angles and/or lugs.
 - j. Provide suitable grounding stud on door and body.

- k. Provide adequate cable entry space and conduit fittings approved for NEMA Type 4X enclosure for top or bottom conduit entry as indicated on the drawings.
- l. Provide space heaters with thermostat control in each section to prevent condensation.

2.2 MOLDED CASE CIRCUIT BREAKERS

- A. NEMA AB 1, bolt-on type thermal magnetic and instantaneous magnetic trip circuit breaker. Circuit breaker thermal elements shall be of the bimetallic type and shall be capable of withstanding sustained overload and short-circuit currents without injury and without affecting the calibration of the bimetallic element. The thermal element shall have inverse time characteristics. The instantaneous elements shall trip the circuit breaker at the minimum standard trip setting.
- B. Provide common trip handle for multiple pole circuit breakers.
- C. Provide type SWD for lighting circuits and type HACR circuit breakers for air conditioning equipment circuits.
- D. Provide Class A ground fault interrupter circuit breakers as indicated on drawings.
- E. Trip rating shall be as indicated on drawings.
- F. Minimum integrated short circuit rating
 1. Circuit Breakers rated 240-Volts - 10,000 amperes RMS symmetrical
 2. Circuit Breakers rated 480-Volts - 42,000 amperes RMS symmetrical
 3. Circuit Breaker rating shall match or exceed the panel interrupting rating
 4. Series rated breakers are not acceptable

PART 3 - EXECUTION

3.1 EXISTING WORK

- A. Disconnect and remove abandoned panelboards. Verify all branch circuits are no longer in use before disconnecting.
- B. Maintain access to existing panelboard that remain active and require access. Modify installation or provide access panel.
- C. Clean and repair existing panelboards to remain or to be reinstalled.

3.2 INSTALLATION

- A. Install panelboards in accordance with NEMA PB 1.1 and NECA "Standard of Installation", NFPA 70 and IEEE C2.

- B. Install panelboards plumb.
- C. Install recessed panelboards flush with wall finishes.
- D. Mounting height: 6 feet (1,800 mm) to top of panelboard. Install panelboards taller than 6 feet (1,800 mm) with bottom no more than 4 inches (100 mm) above floor.
- E. Install filler plates for unused spaces in panelboards.
- F. Provide typed circuit directory for each panelboard. Revise directory to reflect circuiting changes to balance phase loads.
- G. Install engraved plastic nameplates in accordance with Section 260553.
- H. Ground and bond panelboard enclosure according to Section 260526. Connect equipment ground bars of panels in accordance with NEC.

3.3 FIELD QUALITY CONTROL

- A. Field Inspect and testing shall be in performer under the provisions of NETA ATS 7.6 (1) (1) – Circuit Breaker, Low Voltage, Insulated Case/Molded Case, as outlined below:
 - 1. Visual and Mechanical Inspection:
 - a. Compare equipment nameplate data with drawings and specifications.
 - b. Inspect physical and mechanical condition.
 - c. Inspect circuit breaker for correct mounting.
 - d. Operate circuit breaker to insure smooth operation.
 - e. Inspect case for cracks or other defects.
 - f. Verify appropriate anchorage, required area clearances, physical damage, and correct alignment.
 - g. Inspect all doors, panels, and sections for corrosion, dents, scratches, fit, and missing hardware.
 - h. Verify that fuse and/or circuit breaker sizes and types correspond to drawings.
 - i. Perform circuit breaker inspections and operation test.

3.4 ADJUSTING

- A. Rearrange circuits in panelboard to balance phase loads to within 20 percent of each other.
- B. Maintain proper phasing for multi-wire branch circuits.

END OF SECTION 26 24 16

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SECTION 262726 - WIRING DEVICES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Wiring devices are defined as single discrete units of electrical distribution systems that are intended to carry but not utilize electric energy. The types of general purpose wiring devices required for the project include, but are not limited to the following line voltage devices:
 - 1. Connectors
 - 2. Plugs
 - 3. Receptacles
 - 4. Wall plates

1.2 RELATED SECTIONS

- A. Section 260500: Common Work Results for Electrical
- B. Section 260519: 600-Volt Power Conductors and Cables
- C. Section 260526: Grounding and Bonding
- D. Section 260553: Identification for Electrical Systems

1.3 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

- A. IEC 529 Degrees of Protection provided by Enclosures.
- B. NEMA WD 1 General Purpose Wiring Devices
- C. NEMA WD 6 Wiring Device Configurations.

1.4 CONTRACTOR SUBMITTALS

- A. Product Information:
 - 1. Catalog cut of each device showing Manufacturer name, catalog number, voltage and current rating and dimensions.

1.5 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum five (5) years experience.

- B. Installer: A firm with at least five (5) years of successful installation experience on projects with electrical installation work similar to that required for the project.

1.6 REGULATORY REQUIREMENTS

- A. Furnish products listed and classified by Underwriters Laboratories, Inc. (UL), Electrical Testing Laboratories, Inc. (ETL), or other recognized, acceptable testing and listing agencies as suitable for the purpose specified and shown.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Provide factory fabricated wiring devices in the type, color, electrical rating for service indicated, and/or as shown on the drawings.

2.2 MANUFACTURERS

- A. Provide products produced by one of the following, or acceptable alternate:
 - 1. Appleton
 - 2. Arrow-Hart, Inc.
 - 3. Bryant Electric Co.
 - 4. Crouse-Hinds Co.
 - 5. General Electric Co.
 - 6. Hubbell Wiring Device Division
 - 7. Leviton
 - 8. Pass & Seymour
 - 9. Pyle National
 - 10. Russell & Stoll
 - 11. Slater
 - 12. Wiremold (multi-outlet assemblies)

2.3 RECEPTACLES

- A. Provide specification grade, grounding type, heavy-duty receptacles with ivory plastic body, green hexagonal equipment ground screw terminal and grounding poles internally connected to mounting yoke; metal plaster ears; side wiring NEMA WD-6 as follows:
 - 1. Duplex Receptacle: Two pole, 3 wire, 20-ampere, 125-volt duplex receptacle, NEMA configuration 5-20R unless otherwise indicated.
 - 2. GFCI Receptacle: Two pole, 3 wire, 20-ampere, 125-volt duplex receptacle with integral ground fault circuit interrupter to meet regulatory requirements.
 - 3. Special Purpose: Two pole, 3 wire, 20-ampere, 125-volt single receptacle, twist-lock, NEMA configuration L5-20R as indicated.

4. Two pole, 3 wire, 20-ampere, 250-volt single receptacle, twist-lock, NEMA configuration L6-20R as indicated.
5. Two pole, 3 wire, 20-ampere, 277-volt single receptacle, twist-lock, NEMA configuration L7-20R as indicated.
6. Two pole, 3 wire, 30-ampere, 125-volt single receptacle, twist-lock, NEMA configuration L5-30R as indicated.
7. Two pole, 3 wire, 30-ampere, 250-volt single receptacle, twist-lock, NEMA configuration L6-30R as indicated.
8. Two pole, 3 wire, 30-ampere, 277-volt single receptacle, twist-lock, NEMA configuration L7-30R as indicated.
9. Three phase, 4 wire, 20-ampere, 125/250-volt single receptacle, twist-lock, NEMA configuration L14-20R as indicated.
10. Three phase, 4 wire, 20-ampere, 250-volt single receptacle, twist-lock, NEMA configuration L15-20R as indicated.
11. Three phase, 4 wire, 20-ampere, 480-volt single receptacle, twist-lock, NEMA configuration L16-20R as indicated.
12. Three pole, 4 wire, 30-ampere, 125/250-volt single receptacle, twist-lock, NEMA configuration L14-30R as indicated.
13. Three pole, 4 wire, 30-ampere, 250-volt single receptacle, twist-lock, NEMA configuration L15-30R as indicated.
14. Special Purpose Receptacle: Type as required meeting the requirements of this Section and the equipment shown on the drawings and elsewhere specified.

2.4 PLUGS AND CONNECTORS

- A. Comply with NEMA Standards Publication No. WD-1. Provide 20 ampere, 125-volts, bakelite body connectors, 3-wire grounding, parallel blades, double wipe contact, with cord clamp.
- B. Matching Insulgrip, corrosion resistant nylon plugs, IP20, shall be provided for each twist-lock type receptacles unless indicated otherwise.

2.5 WALL PLATES

- A. Stainless steel cover plate.
- B. For areas where two separate power sources are provided, each power source receptacle shall have a different color cover plate such as black, gray, or brown. Emergency power source receptacles shall have a red cover plate.
- C. Weatherproof Cover Plate: Gasketed cast metal with hinged gasketed device cover. Cover for duplex devices shall be designed such that each device is independently covered.

2.6 MULTI-OUTLET ASSEMBLIES

- A. Provide fixed multi-outlet assemblies consisting of #5362 grounding type, 20 ampere, 125-volt, two poles, three wire receptacles as an integral part, on 12-inch centers, unless otherwise noted.

- B. Where more than one circuit is indicated, do not connect adjacent receptacles to the same circuit. Include raceway snap-on covers with punched holes to accurately align receptacles.

2.7 HAZARDOUS RATED AREAS

- A. Switches, receptacles and other devices installed in hazardous areas shall be explosion-proof type in accordance with NFPA 70 and as shown on drawings.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify outlet boxes are installed at proper height.
- B. Verify wall openings are neatly cut and will be completely covered by wall plates.
- C. Verify branch circuit wiring installation is completed, tested, and ready for connection to wiring devices.
- D. Inspect each item of materials or equipment immediately prior to installation, and reject damaged and defective items.

3.2 PREPARATION

- A. Provide extension rings to bring outlet boxes flush with finished surface, if necessary.
- B. Clean debris from all boxes.

3.3 INSTALLATION

- A. Install wiring devices where indicated, in accordance with the manufacturer's written instructions, the applicable requirements of the NEC and the NECA "Standard of Installation", and in accordance with recognized industry practices to ensure that products serve the intended function.
- B. Comply with the manufacturer's applicable instructions and recommendations for installation, to whatever extent these are more explicit or more stringent than applicable requirements indicated in the contract documents.
 - 1. Install devices plumb and level. Install switches with OFF position down
 - 2. Install vertically oriented grounded receptacles with grounding pole on top
 - 3. Connect wiring device grounding terminal to equipment grounding conductor.
 - 4. Connect isolated ground (IG) receptacle equipment (yoke) grounding terminal only at metallic box with bonding jumper
 - 5. Install decorative plates on switch, receptacle, and blank outlets in finished areas

6. Install galvanized steel plates on outlet boxes and junction boxes in unfinished areas, above accessible ceilings, and on surface mounted outlets in utility areas. (Does not include multi-outlet assemblies, other similar locations.).
7. Identify wiring devices as specified in Section 260553 – Electric Equipment Identification.
8. If single outlet in a duplex assembly is switched, that outlet shall be upside down in order for owners to easily identify.

3.4 INTERFACE WITH OTHER PRODUCTS

- A. Coordinate locations of outlet boxes to obtain mounting heights compliant with ADA.
- B. Install wall switch at 42 inches to top of the maximum reach above finished floor for forward reach applications, 48 inches to top of reach for side reach applications. The lower reach shall be at or above 18 inches for forward reach and for side reach, unless otherwise noted.
- C. Install convenience receptacle 18 inches to center above finished floor, unless otherwise noted.
- D. Install convenience receptacle 6 inches to center above backsplash of counter, unless otherwise noted.
- E. Install dimmer 42 inches to center above finished floor, unless otherwise noted.
- F. Install telephone and/or data jacks 18 inches to center above finished floor, unless otherwise noted.
- G. Install telephone jack for wall telephone 42 inches to top of reach above finished floor for forward reach applications, and 48 inches above finished floor to top of reach for side reach applications to comply with the ADA. Receiver hook shall not be above 54 inches to its highest point above finished floor.
- H. Provide GFCI receptacles at all locations within 6-feet of a sink.

3.5 FIELD QUALITY CONTROL

- A. Inspect each wiring device for defects.
- B. Operate each wall switch with circuit energized and verify proper operation.
- C. Verify that each receptacle device is energized.
- D. Test each receptacle device for proper polarity.
- E. Test each GFCI receptacle device for proper operation.
- F. Verify that each telephone and data jack is properly connected and circuit is operational.

3.6 CLEANING

- A. Clean all material per specification Section 260500 Common Work Results for Electrical and General Conditions requirements.

3.7 ADJUSTING

- A. Adjust devices and wall plates to be flush, plumb and level.

END OF SECTION 262726