

SECTION C

CITY OF DIXON FIRE DEPARTMENT DIXON FIRE STATION 82

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EROSION CONTROL

PART 1 – GENERAL

1.01 SCOPE OF WORK

- A. General: Provide all materials, equipment and labor necessary to furnish and install BMPs and required maintenance as shown on the Drawings and on the Storm Water Pollution Prevention Plan.
- B. Comply with State Water Resources Control Board requirements. The Contractor shall provide the following, but not limited to:
 - 1. Cut and fill operations.
 - 2. Temporary stockpiles.
 - 3. Vehicle and equipment storage, maintenance and fueling operations.
 - 4. Concrete, plaster, mortar and paint disposal.
 - 5. Dust control.
 - 6. Tracking of dirt, mud on off-site streets.
 - 7. Pipe flushing.
 - 8. Appropriate Erosion Controls

1.02 QUALITY ASSURANCE

- A. General: Comply with governing codes and regulations.

PART 2 – PRODUCTS

2.01 MATERIALS

- A. Straw Wattles: Shall be new manufactured straw roles in compliance with state requirements for sediment control.
- B. Filter Bag: Shall be as required by local jurisdiction.

PART 3 – EXECUTION

3.01 INSTALLATION

- A. Straw Wattles: Shall be installed per the drawings and/or as required.
- B. Filter Bags: Shall be installed as required by manufactures requirements.

3.02 MAINTENANCE AND REMOVAL:

- A. General: Maintain and repair existing and new erosion control facilities throughout the construction period. Remove silt build up at straw wattles and/or silt fences as needed. Repair damage to earth slopes and banks. Erosion control measures shall be left in place until final paving and landscaping are complete.

- B. Monitoring: Contractor shall provide all site monitoring and recommendations to meet current NPDES requirements during construction.
- C. Cleaning: Keep area clean of debris.
- D. Remove erosion control measures prior to placing finish landscaping.

END OF SECTION

SECTION 02 30 00
SUBSURFACE INVESTIGATION

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Geotechnical Engineering Report:

1. A Geotechnical Engineering Report has been prepared for the site of this Project by Geocon Consultants, Inc., 3160 Gold Valley Drive, Suite 800, Rancho Cordova, CA 95742.
2. The report is titled as: Geotechnical Investigation, Dixon Fire Station 82, Pitt School Road and Lavender Lane, Dixon, California.
3. The report number is: S9731-05-37, dated March 10, 2023.

B. Use of Data:

1. This report was obtained for use in Project design and is referenced for Contractor's information only.
2. Contents of the report referenced in this Section do not constitute a warranty of subsurface conditions.
3. Copies of this report can be obtained, upon request, at Architect's office.
4. Contractor shall visit the site to verify existing conditions.

1.2 QUALITY ASSURANCE

A. A Geotechnical Engineer/Testing Laboratory will be retained and paid by Owner to observe performance of work in connection with excavating, trenching, placing of compacted fill and backfilling operations and at the conclusion of the excavations to provide the following services:

1. Determine if the soil at the bottom of the excavations is suitable as a base for the structure.
2. Determine if compacted fill, backfill or any other required fill meets the requirements of the Specifications.
3. Determine if imported fill materials comply with the specified requirements.
4. Determine necessary adjustments in moisture content of soil, size of equipment, thickness of layers, and any tests as may be required to ensure a properly placed fill conforming to applicable requirements of Specifications.
5. Observation and testing by Geotechnical Engineer/Testing Laboratory shall be provided during filling and compacting operations. Contractor shall give at least two working days' notice prior to beginning such operations, to allow proper scheduling of observation and testing work.
6. Field density tests shall be performed by Geotechnical Engineer/Testing Laboratory after compaction of each layer of fill. Where compaction equipment has disturbed the surface to a depth of several inches, density tests shall be taken in the compacted material below the disturbed surface. Additional layers of fill shall not be placed until the field density tests indicate that the specified density has been obtained.

- B. If Contractor fails to meet technical or design requirements of the Contract Drawings and requirements/recommendations of Geotechnical Engineering Report, necessary readjustments shall be made until all work is deemed satisfactory by Geotechnical Engineer/Testing Laboratory, and Architect.
 - 1. No deviation from Specifications shall be permitted without written acceptance from Architect.
- C. Differing Site Conditions: Report differences observed between actual conditions at the site and the conditions indicated in Geotechnical Engineering Report immediately upon discovery. Report the nature and extent of differences to Owner and Architect orally to permit early verification of the conditions, and concurrently submit it in writing.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

END OF SECTION

SECTION 03 10 00
CONCRETE FORMING AND ACCESSORIES

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SECTION INCLUDES

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

1.3 RELATED REQUIREMENTS

- A. Section 03 20 00 - Concrete Reinforcing.
- B. Section 03 30 00 - Cast-in-Place Concrete.
- C. Section 05 12 00 - Structural Steel Framing.

1.4 REFERENCE STANDARDS

- A. Utilize the edition of the listed document as identified in the "Design Criteria Notes" in the structural drawings. If not listed in the "Design Criteria Notes", use the edition adopted or referenced by the listed governing building code or material standard. If no specific edition is adopted, use the latest edition.
 - 1. ACI 117 - Specification for Tolerances for Concrete Construction and Materials.
 - 2. ACI 301 - Specifications for Concrete Construction.
 - 3. ACI 303R - Guide to Cast-In-Place Architectural Concrete Practice.
 - 4. ACI 318 - Building Code Requirements for Structural Concrete.
 - 5. ACI 347R - Guide to Formwork for Concrete.
 - 6. ACI 347.2R – Guide for Shoring/Reshoring of Concrete Multi-story Buildings.

1.5 SUBMITTALS

- A. See Division 01 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide data and installation requirements for the following:
 - 1. Tie rods and spreaders.
 - 2. Formwork for exposed concrete.
 - 3. Form coatings and release agents.

1.6 QUALITY ASSURANCE

- A. Perform work of this section in accordance with all requirements of ACI 347R and ACI 318 Chapter 26.
- B. Delegated Designer Qualifications: Design formwork and shoring under direct supervision of a Professional Engineer experienced in design of concrete formwork and licensed in the State in which the Project is located.
- C. Concrete formwork and shores shall be designed and constructed to safely support fluid concrete and superimposed construction loads without excessive deflection or concrete leakage. Provide bracing to maintain accurate alignment and to resist all anticipated lateral loads. Forms shall conform with drawings as to shape, line, and dimension. Design, engineering, and construction of forms, shoring, and reshoring shall be the Contractor's responsibility. The Contractor shall also be responsible for determining when temporary supports, shores, reshores, backshores and other bracing may be safely removed.
- D. Formwork for exposed concrete shall be constructed to the tolerances specified in ACI 303R.
- E. Cooperate and coordinate with other trades who furnish and/or install piping, conduit, reglets, anchors, inserts, sleeves, hangers, etc., as their work requires, including provisions for recesses and chases.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver prefabricated forms and installation instructions in manufacturer's packaging.
- B. Deliver and store packaged materials in original containers with seals unbroken and labels intact until time of use.
- C. Store prefabricated forms off ground in ventilated and protected manner to prevent deterioration from moisture.
- D. Protect plastic foam products from damage and exposure to sunlight.

PART 2 PRODUCTS

2.1 FORMWORK – GENERAL

- A. Provide concrete forms, accessories, shoring, and bracing as required to accomplish cast-in-place concrete work.
- B. Design and construct concrete that complies with design with respect to shape, lines, and dimensions.
- C. Chamfer outside corners of beams, joists, columns, and walls, unless otherwise noted.
- D. Comply with applicable state and local codes with respect to design, fabrication, erection, and removal of formwork.
- E. Comply with relevant portions of ACI 347R, ACI 301, and ACI 318.
- F. Use the following form types:
 - 1. Concrete not exposed to view: APA Plyform, steel, or clean and sound 1x8 sawn lumber.

2. Smooth Concrete exposed to view: APA Plyform or steel
3. Fiber Forms: Tubular column type spirally constructed of laminated plies of fiber
4. Elevated Floor/Roof Slabs: At discretion of the Contractor.
5. Extruded Polystyrene Foam: board or shaped as required.
6. Form types for concrete exposed to view shall be submitted to and reviewed by the Architect.

2.2 WOOD FORM MATERIALS

- A. Plywood: 5/8-inch minimum APA Plyform.
- B. Lumber: Douglas-Fir species; Standard grade; with grade stamp clearly visible.

2.3 FIBER FORMS

- A. Manufacturers:
 1. Sonoco Products Company, Sonotube.
 2. Burke Company, Burke Smoothtube.
 3. Substitutions: See Division 01 – Product Requirements.
- B. Material shall be of round, spirally wound laminated fiber using a non-water sensitive adhesive and surface wax impregnated for moisture protection, surface treated with release agent, non-reusable, of sizes indicated. Forms shall give a smooth and seamless appearance to the cast concrete. Provide reveals as shown on the Drawings.

2.4 EXTRUDED POLYSTYRENE FOAM FORMWORK

- A. Manufacturers: Comply with ASTM C578 type IV
 1. Dow Chemical Corp., Styrofoam.
 2. UC Industries, Foamular.
 3. Substitutions: See Division 01 – Product Requirements.

2.5 FORMWORK ACCESSORIES

- A. Form Ties:
 1. Concrete exposed to view: Snap ties allowing full 1-inch back break.
 2. Concrete not exposed to view: Snap ties or wire.
 3. Verify special spacing requirements with architectural drawings at exposed concrete.
- B. Form Clamps:
 1. Assembly to have cone washers allowing full 1-inch back break; 3/8" center rod.
- C. Spreaders: metal (no wood)
- D. Form Release Agent: Capable of releasing forms from hardened concrete without staining or discoloring concrete or forming bugholes and other surface defects, compatible with concrete and form materials, and not requiring removal for satisfactory bonding of coatings to be applied.

1. Do not use materials containing diesel oil or petroleum-based compounds. Form coating containing mineral oils or other non-drying materials will not be permitted for any concrete work.
2. Composition: Colorless, reactive, water-based compound.
3. Products:
 - a. Kaufman Products Inc., FormKote Emulsion.
 - b. Nox-Crete Inc., BIO-NOX.
 - c. SpecChem, LLC, Bio Strip WB (water-based).
 - d. W. R. Meadows, Inc., Duogard II (water-based).
 - e. Substitutions: See Division 01 – Product Requirements.
- E. Dowel Sleeves: Plastic sleeve and nailable plastic base for smooth, round, steel load-transfer dowels.
 1. Manufacturers:
 - a. BoMetals, Inc.
 - b. Substitutions: See Division 01 – Product Requirements.
- F. Filler Strips for Chamfered Corners: Rigid plastic or wood type; $\frac{3}{4}$ x $\frac{3}{4}$ inch size unless noted otherwise on the Drawings.
- G. Joint tape: Plastic film tape 3 inches wide.
 1. Manufacturers:
 - a. 3M Company, No. 471 plastic film tape.
- H. Expansion Joint Filler (preformed): $\frac{1}{2}$ " thick
 1. Manufacturers:
 - a. W.R. Meadows, Inc., Sealtight Fiber Expansion Joint.
- I. Nails, Spikes, Lag Bolts, Through Bolts, Anchorages: Sized as required, of sufficient strength and character to maintain formwork in place while placing concrete.
- J. Embedded Anchor Shapes, Plates, Angles and Bars: As specified in Section 05 12 00.
- K. Waterstops:
 1. Configuration: As indicated on the Drawings.
 2. Size: As indicated on the Drawings.

PART 3 EXECUTION

3.1 EXAMINATION

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

3.2 EARTH FORMS

- A. Earth forms are not permitted, except as specifically indicated on approved drawings and as indicated below.

1. Concrete footings may be poured directly against cut earth where excavations are deemed stable by a representative of the geotechnical engineer.
2. See Structural drawings for requirements for placing concrete footings directly against earth without forms.

B. Hand trim sides and bottom of earth forms. Remove loose soil prior to placing concrete.

3.3 ERECTION – FORMWORK

- A. Erect and maintain formwork, shoring and bracing to achieve design requirements, in accordance with requirements of ACI 301.
- B. Construct forms to sizes, shapes, lines, and dimensions shown, and to obtain accurate alignment, locations, grades, level and plumb work in finished structures. Provide for openings, offsets, keyways, recesses, moldings, rustications, reglets, chamfers, blocking, screeds, bulkheads, anchorages, inserts, and other features required in work. Use selected materials to obtain required finishes. Solidly butt joints and provide back-up at joints to prevent leakage of concrete.
- C. Provide bracing to ensure stability of formwork. Shore or strengthen formwork subject to overstressing by construction loads. Ensure forms are tied, clamped, and braced to prevent spreading, shifting, or settling.
- D. Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces. Provide and secure units to support screed strips; use strike-off templates or compacting-type screeds.
- E. Install permanent insulated foam panel formwork per manufacturer's recommendations.
- F. Arrange and assemble formwork to permit dismantling and stripping. Do not damage concrete during stripping. Permit removal of remaining principal shores.
- G. Align joints and make water-tight. Keep form joints to a minimum.
- H. Obtain approval before framing openings in structural members that are not indicated on drawings.
- I. Install void forms in accordance with manufacturer's recommendations. Protect forms from moisture or crushing.
- J. Coordinate this section with other sections of work that require attachment of components to formwork.
- K. If formwork is placed after reinforcement, resulting in insufficient concrete cover over reinforcement, request instructions from Architect before proceeding.

3.4 APPLICATION - FORM RELEASE AGENT

- A. Apply form release agent on formwork in accordance with manufacturer's recommendations.
- B. Apply prior to placement of reinforcing steel, anchoring devices, and embedded items.

- C. Do not apply form release agent where concrete surfaces will receive special finishes or applied coverings that are affected by agent. Soak inside surfaces of untreated forms with clean water. Keep surfaces coated prior to placement of concrete.

1.1 CONSTRUCTION JOINTS

- A. Refer to Specification 03 30 00 Section 3.05.

3.5 INSERTS, EMBEDDED PARTS, AND OPENINGS

- A. Provide formed openings where required for items to be embedded in passing through concrete work.
- B. Locate and set in place items that will be cast directly into concrete. All such items shall be secured into position before the concrete is placed.
- C. Coordinate with work of other sections in forming and placing openings, slots, reglets, recesses, sleeves, bolts, anchors, other inserts, and components of other work.
 - 1. The Contractor shall ensure that sleeves have been installed and other provisions have been made for the installation of mechanical, electrical and other equipment.
 - 2. Coordinate with all trades to ensure proper placement of all items in forms and to provide proper blockouts wherever required.
- D. Position recessed anchor slots for brick veneer masonry anchors to spacing and intervals as required for the specified product.
- E. Install accessories in accordance with manufacturer's instructions so they are straight, level, and plumb. Ensure items are not disturbed during concrete placement.
- F. Install waterstops in accordance with manufacturer's instructions, so they are continuous without displacing reinforcement. Heat seal joints so they are water-tight.
- G. Provide temporary ports or openings in formwork where required to facilitate cleaning and inspection. Locate openings at bottom of forms to allow flushing water to drain.
- H. Close temporary openings with tight fitting panels flush with inside face of forms and neatly fitted so joints will not be apparent in exposed concrete surfaces.

3.6 FORM CLEANING

- A. Clean forms as erection proceeds, to remove foreign matter within forms.
- B. Clean and protect permanent foam panel formwork per manufacturer's recommendations.
- C. Clean formed cavities of debris prior to placing concrete.
 - 1. Flush with water or use compressed air to remove remaining foreign matter. Ensure that water and debris drain to exterior through clean-out ports.
 - 2. No wooden ties or blocking shall be left in concrete except where indicated for attachment of other work.

3.7 FORMWORK TOLERANCES

- A. Construct formwork to maintain tolerances required by ACI 117, unless otherwise indicated.

- B. Construct permanent insulated foam panel formwork to maintain tolerances required by ACI 301.
- C. Construct and align formwork for elevator hoistway in accordance with ASME A17.1.
- D. Camber slabs and beams in accordance with ACI 301.
- E. The Owner shall hire an independent qualified surveyor to verify the proper form, line, position, and elevation of the finished concrete work. The results of each survey shall be sent to the Owner, Architect, Engineer of Record, and Contractor and shall identify any deviation from specified tolerances. All work not in conformance with specified tolerances shall be removed at the Contractor's sole expense if so specified by the Owner.

3.8 FIELD QUALITY CONTROL

- A. An independent testing agency will perform field quality control tests, as specified in Division 01 - Quality Requirements.
- B. Inspect erected formwork, shoring, and bracing to ensure that work is in accordance with formwork design, and to verify that supports, fastenings, wedges, ties, and items are secure.
 - 1. Notify the Architect at least 48 hours in advance of the beginning of pouring operations and at the completion of formwork and location of all construction joints. An inspection of forms and joints will be made for approval of finished work and general layout only. The foregoing inspection shall in no way relieve the Contractor of responsibility of design and safety of formwork, bulkheads and shoring.
 - a. Concrete work out of alignment, level or plumb will be cause for rejection of the whole work affected and, if so rejected, such work shall be removed and replaced, as directed by Architect, with no additional cost to the Owner.
- C. Thoroughly clean and patch all holes in formwork and re-coat as required before reusing. Forms not suited to obtain concrete surfaces and tolerances in conformity with Contract requirements will be rejected by Architect.
 - 1. Reuse of forming materials shall be limited only as required to produce the finishes as specified, free from blemishes and other defects unless covered by other building materials in which case blemish free concrete is not required.

3.9 SHORES AND RESHORES

- A. Comply with ACI 318, ACI 347.2R, and ACI 301 for design, installation, and removal of shoring and reshoring.
- B. In multistory construction, extend shoring or reshoring over a sufficient number of stories to distribute loads in such a manner that no floor or member will be excessively loaded or will induce tensile stress in concrete members without sufficient steel reinforcement.
- C. Plan sequence of removal of shores and reshore to avoid damage to concrete. Locate and provide adequate reshoring to support construction without excessive stress or deflection.

3.10 FORM REMOVAL

- A. Do not remove forms or bracing until concrete has gained sufficient strength to carry its own weight and imposed loads.

1. Formwork and shoring shall remain in place until concrete has cured sufficiently to avoid damage during form removal. The Contractor or their representative in charge of concrete construction shall be present during removal of forms and shores and shall be personally responsible for safety of this operation at all times and under all conditions.
 2. Shores must be immediately replaced with reshores in a sequence designed to avoid inducing stress in the concrete member.
- B. Loosen forms carefully. Do not wedge pry bars, hammers, or tools against finish concrete surfaces scheduled for exposure to view.
- C. Store removed forms to prevent damage to form materials or to fresh concrete. Discard damaged forms.
- D. Surfaces to be painted shall be smooth and free of substances such as dirt, wax, excessive laitance, grease or materials that would prevent proper bonding of finishes.
1. Removal of foregoing contaminants and complete removal of parting and curing compounds affecting proper paint bond, shall be responsibility of this Section of Work. Sandblast cleaning shall not be employed without specific approval of Structural Engineer.
- E. Upon completion of this Work, clean up and remove from Site all equipment and debris resulting from this work.

END OF SECTION

SECTION 03 20 00
CONCRETE REINFORCING

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 SECTION INCLUDES

- A. Reinforcing steel for cast-in-place concrete and/or concrete unit masonry.
- B. Supports and accessories for steel reinforcement.

1.3 RELATED REQUIREMENTS

- A. Section 03 10 00 - Concrete Forming and Accessories.
- B. Section 03 30 00 - Cast-in-Place Concrete.
- C. Section 04 22 00 – Concrete Unit Masonry.

1.4 REFERENCE STANDARDS

- A. Utilize the edition of the listed document as identified in the “Design Criteria Notes” in the structural drawings. If not listed in the “Design Criteria Notes”, use the edition adopted or referenced by the listed governing building code or material standard. If no specific edition is adopted, use the latest edition.
 - 1. ACI 117 – Specification for Tolerances for Concrete Construction and Materials
 - 2. ACI 301 - Specifications for Concrete Construction.
 - 3. ACI 315R - Guide to Presenting Reinforcing Steel Design Details.
 - 4. ACI 318 - Building Code Requirements for Structural Concrete.
 - 5. ACI SP-66 - ACI Detailing Manual.
 - 6. ASTM A82 - Cold Drawn Wire for Concrete Reinforcement.
 - 7. ASTM A184 - Standard Specification for Welded Deformed Steel Bar Mats for Concrete Reinforcement.
 - 8. ASTM A615 - Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
 - 9. ASTM A704 - Standard Specification for Welded Steel Plain Bar or Rod Mats for Concrete Reinforcement.
 - 10. ASTM A706 - Standard Specification for Deformed and Plain Low-Alloy Steel Bars for Concrete Reinforcement.
 - 11. ASTM A767 - Standard Specification for Zinc-Coated (Galvanized) Steel Bars for Concrete Reinforcement.

12. ASTM A775 - Standard Specification for Epoxy-Coated Steel Reinforcing Bars.
13. ASTM A884 - Standard Specification for Epoxy-Coated Steel Wire and Welded Wire Reinforcement.
14. ASTM A1035 - Standard Specification for Deformed and Plain, Low-Carbon, Chromium, Steel Bars for Concrete Reinforcement.
15. ASTM A1064 - Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.
16. ASTM D3963 - Standard Specification for Fabrication and Jobsite Handling of Epoxy-Coated Steel Reinforcing Bars.
17. AWS B2.1 - Specification for Welding Procedure and Performance Qualification.
18. AWS D1.4 - Structural Welding Code - Steel Reinforcing Bars.
19. CRSI (DA4) - Manual of Standard Practice.
20. CRSI (P1) - Placing Reinforcing Bars.
21. TMS 402/602 - Building Code Requirements and Specification for Masonry Structures.

1.5 SUBMITTALS

- A. See Division 01 - Administrative Requirements, for submittal procedures.
- B. Shop Drawings: Prepare in accordance ACI 315 and ACI SP-66 and CRSI standards. Indicate bending diagrams, assembly diagrams, splicing and laps of bars and shapes, dimensions and details of bar reinforcing and assemblies.
 1. The correctness of all reinforcing requirements and work is the responsibility of the Contractor.
 - a. Identify such shop drawings with reference thereon to sheet and detail numbers from Contract Drawings.
 - b. Direct copies of the contract documents are not acceptable as a submission from the Contractor.
 - c. Do not use scaled dimensions from Contract Drawings in determining the lengths of reinforcing bars.
 - d. No reinforcing steel shall be fabricated without approved shop drawings.
 - e. Any deviations from the contract documents must be clearly indicated as a deviation on the shop drawings.
 - f. Include bar sizes, lengths, material, grade, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, splices and laps, mechanical connections, tie spacing, hoop spacing, and supports for concrete reinforcement. Include any welding to be done.
 - g. Shop drawings shall make it clear where each bar is located. Beams, grade beams and walls shall be shown in elevation. On elevations show locations of sleeves and penetrations.
 - h. Check architectural, structural, mechanical, and electrical and other contract documents for anchor bolt schedules and locations, anchors, inserts, conduits, sleeves, and any other items which are required to be cast in concrete, and make necessary provisions as required so that reinforcing steel will not interfere with the placement of such embedded items.

- i. Show all areas of congestion. Identify where reinforcing steel will interfere with the placement of embedded items such as anchor bolts, anchors, inserts, conduits, sleeves and any other items which are required to be cast in concrete.
- C. Submit shop drawings indicating which members will use fusion welding process for assembly. Shop drawings shall show complete structural details indicating the size of stirrups, the size of holding wires, and welding requirements.
- D. Submit International Code Council (ICC) Evaluation Service Reports indicating approval from ICC Evaluation Service, Inc. for mechanical splices, hooked anchorage systems, large-headed stud punching shear reinforcement and dowel bar replacement systems.
- E. Manufacturer's Certificate: Certify that reinforcing steel and accessories supplied for this project meet or exceed specified requirements.
 - 1. Reinforcing Bars
 - 2. Welded Wire Fabric
 - 3. Welding Electrodes
- F. Product Data:
 - 1. Manufacturer's specifications and installation instructions for splice devices.
 - 2. Bar Supports.
- G. Welders' Qualification Statement: Welders' certificates in accordance with AWS B2.1 and dated no more than 12 months before start of scheduled welding work.
- H. Reports: Submit certified copies of mill test report of reinforcement material chemical and physical analysis.
 - 1. Tensile and bend tests shall be performed by the mill in accordance with ASTM A615 or A706, as applicable to reinforcing type.
- I. Samples: Only as required by Architect.

1.6 QUALITY ASSURANCE

- A. Perform work of this section in accordance with ACI 301.
 - 1. Maintain one copy of each document on project site.
- B. Tests and Inspections:
 - 1. Provide Architect and Special Inspection Agency with access to fabrication plant to facilitate inspection of reinforcement. Provide notification of commencement and duration of shop fabrication in sufficient time to allow inspection.
 - 2. A testing program is required prior to the start of construction. Testing program to be done in compliance with the CBC requirements and in collaboration with Testing Laboratory, Design team, contractor, owner and submitted for review by the agency in charge of building enforcement. Requirements below are minimum requirements; additional requirements may be required in final testing program.
 - 3. All reinforcing steel whose properties are not identifiable by mill test reports shall be tested in accordance with ASTM A615. One Series of tests for each missing report to be borne

by the Contractor.

4. When inspections are indicated for reinforcement placement on the Structural drawings, a special inspector shall be employed to inspect reinforcing placement per CBC Chapter 17.
5. When tests are indicated for reinforcing steel on the structural drawings, the reinforcing steel used shall be tested in accordance with ASTM A615. One tensile and one bend test for each 2-1/2 tons of steel or fraction thereof, shall be made.
6. Inspect shop and field welding in accordance with AWS D1.4, including checking materials, equipment, procedure, and welder qualification as well as the welds. Inspector will use non-destructive testing or any other non-destructive aid to visual inspection that Inspector deems necessary to assure the adequacy of the weld.
7. Tests and inspection shall be performed by Owners testing agency except when needed to justify rejected work, in which case the cost of retests and reinspection shall be paid by the Owner and back-charged to the Contractor.

C. Installer Qualifications:

1. Reinforcing Steel: Installation shall be done only by an installation firm normally engaged in this business. All work shall be performed by qualified mechanics working under an experienced supervisor.

D. Manufacturer Qualifications:

Reinforcing Steel: A firm regularly engaged in the manufacture of steel bar and welded wire fabric reinforcing.

E. Mechanical Bar Couplers shall have a current ICC-ES or IAPMO Evaluation Report that indicates compliance with the requirements of these specifications.

F. Steel Reinforcing Allowable Tolerance (ACI 117):

1. Fabrication:
 - a. Sheared length: 1 inch.
 - b. Depth of truss bars: Plus or minus 1/2-inch.
 - c. Ties: Plus or minus 1/2-inch.
 - d. All other bends: Plus or minus 1 inch.
2. Placement:
 - a. Concrete cover to form surfaces: Plus or minus 1/4-inch.
 - b. Minimum spacing between bars: Plus or minus 1/4-inch.
 - c. Crosswise of members: Spaced evenly within 2 inches of stated separation.
 - d. Lengthwise of members: Plus or minus 2 inches.
3. Maximum bar movement to avoid interference with other reinforcing steel, conduits, or embedded items: 2 bar diameters.

G. Unidentifiable Reinforcing Steel: Tested by testing agency; paid for by Contractor:

1. Test reinforcing delivered to site which cannot be properly identified by heat number and mill mark for compliance with ASTM A615 as follows:
 - a. No. 8 Bar and Smaller: One tensile test and one bend test of each size per 7-1/2 tons, or portion thereof.

- b. No. 9 Bar and Larger: One tensile test of each size per 10 tons, or portion thereof.
- H. Welding: Qualify procedures and personnel according to AWS D1.4, "Structural Welding Code--Reinforcing Steel."
 - 1. Welders whose work fails to pass inspection shall be requalified before performing further welding.
 - 2. Firm specializing in furnishing and installing reinforcement shall have a minimum of 5 years' experience on projects with requirements similar to this project and shall have sufficient production capacity.
 - 3. All welding shall be performed by operators who are qualified for the types of welds used. Each operator shall have been qualified within the preceding one year as prescribed by AWS.
 - 4. Require welders to retake the qualification test if, as determined by the Architect, there is a reasonable doubt as to the proficiency of the welder. If the welder does not requalify, they shall not perform any welding on the project.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Steel Reinforcement

- 1. Deliver, store, and handle steel reinforcement to prevent bending and damage. Avoid damaging coatings on steel reinforcement where occur.
- 2. Deliver reinforcing to Site properly bundled and tagged. Use tags that indicate bar size, lengths and marks corresponding to markings shown on shop drawings. Bundles shall be identified as to heat number and manufacturer and be accompanied by mill and analysis test reports and affidavit from the supplier stating that the material conforms to the requirements of the ASTM specification listed therein. Segregate to maintain identification after bundles are broken.
- 3. Store reinforcement in a manner that will prevent excessive rusting or fouling with/ grease, oil, dirt, and other bond weakening materials.
- 4. Do not use damaged, reworked, or deteriorated material.

B. Deliver and store welding electrodes in accordance with AWS D1.4.

PART 2 PRODUCTS

2.1 STEEL REINFORCEMENT

- A. Reinforcing Steel: ASTM A615, Grade 60 (60,000 psi) for all bars unless otherwise indicated.
 - 1. Plain billet-steel bars.
 - 2. Unfinished.
- B. Reinforcing Steel: ASTM A706, deformed low-alloy steel bars for bars to be welded.
 - 1. Unfinished.
- C. Reinforcing Steel: Dual grade ASTM A615/A706, Grade 60 (60,000 psi) may be used in lieu of A615 or A706, Grade 60 (60,000 psi).
 - 1. Unfinished.

- D. Reinforcing Steel: ASTM A706, Grade 60 (60,000 psi) for bars used in special seismic systems as indicated in drawings.
 - 1. Unfinished.
 - 2. ASTM A615 Grade 60 bars meeting the following requirements of ACI 318 may be used in lieu of A706 Grade 60 in special seismic systems.
 - a. Actual yield strength based on mill tests does not exceed more than 78,000 psi.
 - b. The ratio of the actual tensile strength to the actual yield strength is at least 1.25.
 - c. Minimum fracture elongation in 8 in. shall be at least 14% for bar sizes #3 through #6, at least 12% for bar sizes #7 through #11, and at least 10% for bar sizes #14 and #18.
- E. Minimum uniform elongation shall be at least 9% for bar sizes #3 through #10, and at least 6% for bar sizes #11 through #18. reinforcing Steel: Plain or deformed bars; ASTM A1035, Grade 100 (100,000 psi), Type CL.
- F. Stirrup and Tie Steel: ASTM A615 grade 60 for all bars, unfinished.
- G. Reinforcing steel used as spiral reinforcing as noted on the drawings shall conform to ASTM A615 unless noted otherwise.
- H. Deformed Bar Anchors: AWS Type D studs manufactured in conformance with ASTM A 496 with a minimum tensile strength of 80,000 PSI. ASTM A 615 reinforcing bars may not be substituted for deformed bar anchors. Reinforcement shall be approved by the ICC-Evaluation Service, Inc and shall have the Evaluation Service Report submitted for Engineer review. The following are acceptable products, provided that their Evaluation Service Reports are still valid at the time of intended use on the project:
 - 1. Nelson Stud Welding, Inc.; Nelson D2L Deformed Bar Anchor Studs (ESR-2907).
 - 2. Tru-Weld Division, TFP Corporation; Deformed Bar Anchors (ESR-2823).
- I. Epoxy-Coated Reinforcing Steel: Provide epoxy coated reinforcing bars at the locations indicated on the drawings. Epoxy coated reinforcing bars shall conform to ASTM A 775. Bars that are to be epoxy coated shall conform to the type of steel required for the given situation as noted on the drawings.
- J. Steel Dowels: Same grade as bars to which dowels are connected.
- K. Steel Welded Wire Reinforcement (WWR): Plain type; ASTM A1064 with a yield strength of 65,000 psi. Provide flat sheets only. Spacing and size of wire as indicated in drawings.
- L. Reinforcement Accessories:
 - 1. Tie Wire: FS-QQ-W-461, annealed, minimum 16-gauge, 0.0508 inch.
 - 2. Chairs, Bolsters, Bar Supports, Spacers: Sized and shaped for adequate support of reinforcement during concrete placement.
 - a. Wire support: CRSI class 2.
 - b. Do not use wood, brick, or other objectionable materials.
 - c. Do not use galvanized supports.
 - d. Supports placed against ground: Pre-cast concrete blocks not less than 4 inches square with embedded wire.
 - 3. Provide stainless steel components for placement within 1-1/2 inches of weathering

surfaces.

M. Welding Electrodes: AWS D1.4, low hydrogen, E70XX series.

N. Headed Steel Stud Punching Shear Reinforcement: Punching shear reinforcement using headed studs welded to flat bars shall be manufactured in conformance with ASTM A 1044 and approved by the ICC Evaluation Service, Inc. as expressed in an ICC Evaluation Report for use as punching shear reinforcement for slabs and footings designed in accordance with ACI 421.1.

1. Studs

- a. Nelson Stud Welding Inc.; Nelson Punching Shear Resistor Studs (ESR-1170).
- b. Tru-Weld Division, TFP Corporation; Tru-Weld Punching Shear Resistor Studs (ESR-2822).

2. Assemblies

- a. Dayton Superior Corporation; Dayton Shear Resistance System (ESR-2696).
- b. Decon, Inc.; Decon Studrails (ESR 2494).
- c. Dywidag Systems International USA, Inc.; Dywidag Shear System (ESR-2534).
- d. Jobsite Stud Welding, Inc.; Jobsite Stud Welding Punching Shear Resistor Shear Rail Assemblies (ESR-3264).
- e. Simpson Strong-Tie Company, Inc.; Simpson Strong-Tie Punching Shear Resistor Rail (ESR-2992).
- f. SRL Industries LTD.; SRL Punching Shear Resistor Shear Rails (ESR-2938).

A. Hooked Anchorage Replacement: Reinforcing bar terminations shall be manufactured out of ASTM A 576, ASTM A 615, or A 706 material and shall develop the full tensile strength of the bar when installed at the manufacturer's recommended depth.

- 3. The anchorage shall be approved by the ICC Evaluation Service Inc. as expressed in an ICC Evaluation Service Report which shall be submitted for review.
- 4. The following are acceptable products (for use only with grade 60 bars), provided that their Evaluation Service Reports are still valid at the time of intended use on the project:
 - a. Dextra Manufacturing Co., Ltd; Bartec Mechanical Anchorages for Steel Reinforcing Bars in Concrete (ESR-2166).
 - b. Headed Reinforcement Corporation; HRC 555 Headed Reinforcing Bars (ESR-2935).
 - c. Erico Products, Inc.; Lenton Terminator (ER-3967).

2.2 REINFORCING BAR SPLICING:

A. Coupler Systems: Mechanical devices for splicing reinforcing bars; Comply with ACI 318 Chapter 25.

- 1. Mechanical splices shall conform to Type 1 or Type 2 splices. Where not specifically indicated, use type 2 splices.
 - a. Type 1 splice shall develop, in tension and compression, 1.25 times the specified yield strength of the splice bar.
 - b. Type 2 splice shall meet the requirements of Type 1 splice and, in addition, develop the full tensile strength of the splice bar.

- c. Splices shall be approved by the ICC-Evaluation Service, Inc and shall have the Evaluation Service Report submitted for Engineer review.
- 2. Manufacturers:
 - a. Headed Reinforcement Corporation (HRC)
 - b. nVent Lenton
 - c. Dayton Superior Corporation
 - d. Splice Sleeve North America, Inc; NMB Splice Sleeve System
 - e. Substitutions: See Division 01 - Product Requirements.
- B. Form Savers: Mechanical devices for connecting dowels and reinforcing bars at construction joints; capable of developing full steel reinforcing design strength in tension and compression.
 - 1. Manufacturers:
 - a. nVent Lenton
 - b. Substitutions: See Division 01 - Product Requirements.
- C. Taper Tie Hole Plug: Mechanical device for plugging tie holes; anchors optional flush or recessed grout.
 - 1. Manufacturers:
 - a. Dayton Superior Corporation
 - b. Substitutions: See Division 01 - Product Requirements.
- D. Grout: Cementitious, non-metallic, non-shrink grout for use with manufacturer's grout sleeve reinforcing bar coupler system.
 - 1. Manufacturers:
 - a. Dayton Superior Corporation
 - b. Substitutions: See Division 01 - Product Requirements.

2.3 FABRICATION

- A. Fabricate concrete reinforcing in accordance with CRSI (DA4) - Manual of Standard Practice and to meet requirements of Drawings.
- B. Fabricate reinforcement in accordance with the requirements of ACI 315R where specific details are not shown or where Drawings and Specifications are not more demanding.
- C. Steel reinforcement shall not be bent or straightened in a manner that will injure the material. Bars with kinks or bends not shown on the Drawings shall not be used. Heating of bars for bending will not be permitted.
- D. Reinforcing shall not be field bent or straightened without structural engineer's review.
- E. Provide offsets in rebar (1:6 maximum) where required to maintain clearances.
- F. Fusion welding of preassembled cages shall be permitted only under the following conditions:
 - 1. Fusion welding of holding wires to ties, stirrups, and hoops in beams, columns, and grade beams to preassemble reinforcing cages is permissible. The holding wire area shall not exceed 5% of the beam, column, or grade beam cross sectional longitudinal steel area. Fusion welding is not allowed to longitudinal reinforcing steel in any beam, column, or

grade beam.

2. Fusion welding of holding wires to the ends of the reinforcing steel placed in mats (spread footings, slab reinforcement, etc.) is permitted provided the fusion weld occurs within 6 bar diameters of the free end of the bar (e.g. no allowed at the end of coupled, T-headed, or weld splice bars).
3. Fusion welding of holding wires shall not occur on a bent portion of a reinforcing bar. Bars may not be bent where a fusion weld occurs.
4. Holding wires shall conform to ASTM A496.
5. All reinforcing steel to be welded shall comply with ASTM A706.
6. Submit complete structural plans indicating which members will use fusion welding process for assembly. Provide complete structural details indicating the size of stirrups and holding wires and welding requirements. Submit a complete shop welding program which includes the following:
 - a. Type of the specific fusion welding machine
7. Periodic inspection protocol of the in-plant welding. This information shall be submitted to the Structural Engineer (SEOR) and the Owner's Testing Agency for approval. Fusion welding and fabrication is not permitted until approved by the SEOR.

PART 3 EXECUTION

3.1 PLACEMENT

- A. Place, support and secure reinforcement against displacement. Do not deviate from the required position. All reinforcement shall be accurately set in place, lapped, spliced, spaced rigidly and securely held in place and tied with specified wire at all splices and crossing points. All wire tie ends shall point away from the form. Carefully locate all dowel steel to align with wall and column steel.
 1. Comply with CRSI recommended practice for "Placing Reinforcing Bars", for details and methods of reinforcement placement and supports and as herein specified.
 2. Bars shall be in long lengths with laps and splices as shown. Offset laps in adjacent bars. Place steel with clearances and cover as shown. Bar laps shall be as indicated on the Drawings. Tie all laps and intersections with the specified wire.
 3. For horizontal reinforcement, maintain clear space between parallel bars not less than 1 times nominal reinforcement diameter, but in no case shall clear space be less than 4/3 times maximum size concrete aggregate.
 4. For vertical reinforcement, maintain clear space between parallel bars not less than 1-1/2 times nominal reinforcement diameter, but in no case shall clear space be less than 4/3 times maximum size concrete aggregate.
 5. Reinforcing dowels for slabs shall be placed as detailed. Sleeves may be used if reviewed by the Structural Engineer before installation. Install dowel through all construction and expansion joints for all slabs on grade. Support slab-on-grade joint dowel bars independently of support for slab reinforcement on soil supported slab bolsters or specially manufactured cradles such that dowel bar remains parallel to slab surface and at right angles to joint during concreting operations. Lightly coat the exposed end of the dowel with a paraffin-base lubricant, asphalt emulsion, form oil, or grease or use a dowel bar

sleeve.

6. Provide and place additional reinforcing steel at all sleeves and openings in beams, slabs, and walls as specified on the drawings. Where sleeves or openings not shown on the drawings interrupt the reinforcement, consult with Engineer for instructions for placing and splicing of bars. Provide the required additional reinforcing steel at no additional cost to the Owner.
7. Epoxy-Coated Reinforcement: Use epoxy-coated steel tie wires to fasten epoxy-coated reinforcement. Repair cut and damaged epoxy coatings with epoxy repair coating according to ASTM D 3963.
8. Do not bend reinforcement that is embedded partially in concrete except in locations noted on the drawings or approved by the Engineer.

B. Reinforcement in Composite Metal Deck Slab

1. Composite steel deck slabs shall be reinforced as indicated on the drawings.
2. Extra Reinforcement over Girders: Provide additional reinforcing steel over interior girders as shown on the drawings.
3. Placement of Slab Reinforcement: Provide bolsters, high chairs, and/or additional reinforcing as shown in details on the drawings to support the reinforcing with the clear cover shown on the drawings.

C. Reinforcement in Topping Slabs

1. Provide welded smooth wire reinforcement minimum 6 x 6 W1.4 x W1.4 in all topping slabs unless specified otherwise on the drawings.

D. Bar Supports: Support and securely fasten bars with chairs, spacers and ties to prevent displacement by construction loads or placement of concrete beyond the tolerances specified. Conform to CRSI as a minimum standard.

E. Steel Adjustment:

1. Move within ACI 117 specified allowable tolerances to avoid interference with other reinforcing steel, conduits, or embedded items.
2. Do not move bars beyond allowable without concurrence of Structural Engineer.
3. Do not heat, bend, or cut bars without concurrence of Structural Engineer.
4. Reinforcement shall not be bent after being embedded in hardened concrete.

F. Splices:

1. Provide splices as indicated on the drawings. Splice reinforcing bars only at locations shown on the structural drawings and approved shop drawings. Unauthorized or unscheduled splices not approved by the Engineer in writing will not be accepted.
2. All lap splices in reinforcing steel shall be contact lap splices unless detailed otherwise on the drawings.
3. Maintain proper cover and spacing between reinforcing bars at splices.
4. Lap unscheduled reinforcing bars not otherwise specified with a Class B lap splice.
5. Lap Splices: Tie securely with wire to prevent displacement of splices during placement of concrete.
6. Mechanical Splice Devices: Install in accordance with manufacturer's written instructions.

- Obtain Structural Engineer's review before using. The manufacturer of mechanical splice shall be present for first day's installation.
7. Do not splice bars except at locations shown without concurrence of Structural Engineer.
 - a. Where splices in addition to those indicated are required, indicate location on shop drawings clearly and highlight "for Engineer's approval".
 - G. Repair of Epoxy-Coated Reinforcing: Repair cut and damaged epoxy coatings on fabricated reinforcing before delivery with epoxy repair coating according to ASTM D 3963.
 - H. Do not displace or damage vapor barrier.
 - I. Accommodate placement of formed openings.
 - J. Refer to Structural Drawings for concrete cover requirements over reinforcement.
 - K. Concrete shown without reinforcing shall be reinforced as similar parts shown with reinforcing except where concrete is specifically noted to be unreinforced.
 - L. Examine surfaces and conditions receiving or affecting the work. Do not proceed until unsuitable conditions have been corrected.
 - M. Welding:
 1. Welding is only permitted where specifically detailed on Drawings or approved by Engineer.
 2. Employ shielding metal-arc method and meet requirements of AWS D1.4.
 3. Welding is not permitted on bars where the carbon equivalent is unknown or is determined to exceed 0.55.
 4. Welding shall not be done within two bar diameters of any bent portion of a bar which has been bent cold.
 5. Tack welding of reinforcement is not permitted, unless specifically requested by the Contractor and approved by the Structural Engineer of Record.
 6. Welding of crossing bars is not permitted.
 - N. Welded Wire Fabric: Install in long lengths, lapping 24 inches at end splices and one mesh at side splices. Offset laps in adjacent widths. Place fabric in approximately the middle of the slab thickness unless shown otherwise on the Drawings by dimension. Wire tie lap joints at 12-inch centers. Use concrete blocks to support mesh in proper position.
 - O. Reinforcement shall be free of mud, oil or other materials that may reduce bond at the time concrete is placed. Reinforcement with tightly adhered rust or mill scale will be accepted without cleaning provided that rusting has not reduced dimensions and weights below applicable standards. Remove loose rust.
 - P. Protection against rust:
 1. Where there is danger of rust staining adjacent surfaces, wrap reinforcement with impervious tape or otherwise prevent rust staining.
 2. Remove protective materials and clean reinforcement as required before proceeding with concrete placement.

- Q. Refer to notes on Drawings for additional reinforcement requirements.
- R. Refer to Mechanical and Electrical Drawings for formed concrete requiring reinforcing steel.
All such steel shall be included under the work of this Section.

3.2 FIELD QUALITY CONTROL

- A. An independent testing agency, as specified in Division 01 - Quality Requirements, will inspect installed reinforcement for compliance with contract documents before concrete placement.
- B. Reinforcing Steel
 - 1. Notify the testing agency and the Architect at least 48 hours before concrete is to be poured or reinforcing is covered up.
 - 2. Before any concrete is poured on any portion of the building, the reinforcing steel and form dimensions will be inspected by the Testing Agency. Any errors or discrepancies shall be corrected before concrete is placed.
 - 3. A testing program is required prior to the start of construction. Testing program to be done in compliance with the CBC requirements and in collaboration with Testing Laboratory, Design team, contractor, owner and submitted for review by the agency in charge of building enforcement. Requirements below are minimum requirements; additional requirements may be required in the final testing program.
 - 4. All reinforcing steel whose properties are not identifiable by mill test reports shall be tested in accordance with ASTM A615. One Series of tests for each missing report shall be made and costs shall be borne by the Contractor.
 - 5. When tests are indicated for reinforcing steel on the structural drawings, the reinforcing steel used shall be tested in accordance with ASTM A615. One tensile and one bend test for each 2-1/2 tons of steel or fraction thereof, shall be made.
 - 6. In addition to other required inspections, the following are subject to Special Inspection as per the CBC:
 - a. Placement of Reinforcing Steel
 - b. Welding of Reinforcing Steel
 - 7. A special inspector from the Testing Agency shall be present during all field bending of reinforcement.
 - 8. Installation of deformed bar anchors to be tested in accordance with Section 7.1 of AWS D1.1.
 - 9. Welding of Reinforcement: There shall be continuous inspection during all welding of reinforcement. All butt welds are to be inspected using radiographic testing. At the Owners option recognized non-destructive tests such as resistance, Magnetic Particle Examination, and Liquid Penetrant Inspection may be used to inspect the welds. Inspect shop and field welding in accordance with AWS D1.4, including checking materials, equipment, procedure, and welder qualification as well as the welds. The inspector will use non-destructive testing or any other aid to visual inspection that he deems necessary to assure the adequacy of the weld.
 - 10. Comply with ICC-ES or IAPMO approvals with respect to special inspection required during installation.
 - 11. Testing and inspection of mechanical splices and reinforcing couplers to conform to manufacturer's recommendations and ICC-ES or IAPMO approval.

END OF SECTION

SECTION 03 30 00
CAST-IN-PLACE CONCRETE

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 SECTION INCLUDES

- A. Cast-in-place concrete building elements.
- B. Slabs on grade.
- C. Concrete foundations.
- D. Grouting of steel base plates.
- E. Joint devices associated with concrete work.
- F. Concrete curing.

1.3 RELATED REQUIREMENTS

- A. Section 03 10 00 - Concrete Forming and Accessories.
- B. Section 03 20 00 - Concrete Reinforcing.
- C. Section 04 22 00 – Concrete Unit Masonry
- D. Section 05 12 00 – Structural Steel
- E. Section 05 50 00 – Metal Fabrications

1.4 REFERENCE STANDARDS

- A. Utilize the edition of the listed document as identified in the “Design Criteria Notes” in the structural drawings. If not listed in the “Design Criteria Notes”, use the edition adopted or referenced by the listed governing building code or material standard. If no specific edition is adopted, use the latest edition.
 - 1. ACI 117 - Specification for Tolerances for Concrete Construction and Materials.
 - 2. ACI 211.1 – Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete.
 - 3. ACI 211.2 – Standard Practice for Selecting Proportions for Structural Lightweight Concrete.
 - 4. ACI 301 - Specifications for Concrete Construction.
 - 5. ACI 302.1R - Guide to Concrete Floor and Slab Construction.

6. ACI 304R - Guide for Measuring, Mixing, Transporting, and Placing Concrete.
7. ACI 305R – Guide to Hot Weather Concreting.
8. ACI 306R – Guide to Cold Weather Concreting.
9. ACI 308R - Guide to External Curing of Concrete.
10. ACI 318 - Building Code Requirements for Structural Concrete.
11. ACI 360R – Guide to Design of Slabs-On-Ground.
12. ASTM C31 – Standard Practice for Making and Curing Concrete Test Specimens in the Field.
13. ASTM C33 - Standard Specification for Concrete Aggregates.
14. ASTM C39 – Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
15. ASTM C42 – Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
16. ASTM C94 - Standard Specification for Ready-Mixed Concrete.
17. ASTM C109 – Standard Test Method for Compressive Strength of Hydraulic Cement Mortars.
18. ASTM C143 – Standard Test Method for Slump of Hydraulic Cement Concrete.
19. ASTM C150 - Standard Specification for Portland Cement.
20. ASTM C172 – Standard Practice for Sampling Freshly Mixed Concrete by the Volumetric Method.
21. ASTM C192 – Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory.
22. ASTM C260 - Standard Specification for Air-Entraining Admixtures for Concrete.
23. ASTM C309 - Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
24. ASTM C330 - Standard Specification for Lightweight Aggregates for Structural Concrete.
25. ASTM C494 - Standard Specification for Chemical Admixtures for Concrete.
26. ASTM C567 – Standard Test Method for Determining Density of Structural Lightweight Concrete.
27. ASTM C618 – Standard Specification for Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete.
28. ASTM C685 – Standard Specification for Volumetric Batching and Continuous Mixing.
29. ASTM C989 – Standard Specification for Slag Cement for Use in Concrete and Mortars.
30. ASTM C1116 - Standard Specification for Fiber-Reinforced Concrete.
31. ASTM C1157 – Standard Performance Specification for Hydraulic-Cement.
32. ASTM C1582 - Standard Specification for Admixtures to Inhibit Chloride-Induced Corrosion of Reinforcing Steel in Concrete.

33. ASTM E1155 - Standard Test Method for Determining FF Floor Flatness and FL Floor Levelness Numbers.

1.5 SUBMITTALS

A. See Division 01 - Administrative Requirements for submittal procedures.

B. General:

1. Review of submittals is of a general nature only, and the responsibility for conformance with intent of drawings shall remain with the Contractor. Review does not imply or state that the fabricator has correctly interpreted the construction documents.
2. All submissions shall be in accordance with the submission schedule developed and agreed between the Architect and Contractor at the commencement of the project. Submission shall include dates of order and delivery of materials to the shop and the site.
3. Shop drawing schedule shall allow adequate time for reviews. Reinforcing steel shall not be fabricated or placed before the shop drawings have been reviewed by the Architect and returned.

A. Concrete Design Mixtures: Each concrete mix design to be used on the project shall be reviewed and approved by the Testing Agency prior to concrete being delivered to site. Owner's Testing Agency shall review all mix designs prior to submittal. Submit proposed mix designs for each class of concrete listed on drawings. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

1. For each concrete mixture, the following information shall be included: where the mix is to be used, all materials and admixtures including their source and proportions in the mix; Water content, water-to-cement ratio, slump, and aggregate grading; whether the mixture is appropriate for pumping; and total chloride content.
2. Indicate compressive strength and method used to determine strength. The compressive strength of the concrete shall be proportioned per ACI. Include all calculations and tests required by ACI 318 Chapter 5. Laboratory test data must be submitted along with calculations that show each mix design meets the strength requirement. Mix design number must match the mix design number shown on the test data. Include all test results or past history back up data specific as part of the submittal. Test results within the past two years shall be used to indicate performance in accordance with past history.
3. Indicate amounts of mixing water to be withheld for later addition at Project site.

B. Transit-mix delivery slips.

1. Keep record at the Site showing time and place of each pour of concrete, together with transit mix delivery slip certifying contents of the pour per ASTM C94. Include the time water was added to dry mix.
2. Make the record available for inspection at the Site and to the Architect for his review upon request.
3. Upon completion of this portion of the Work, deliver the record and the delivery

slips to the Architect.

- C. Reinforcement: Comply with submittal requirements in Section 03 20 00.
- D. Formwork and Shoring: Comply with submittal requirements in Section 03 10 00.
- E. Layout drawings for construction, control, and expansion joints for Engineer and Architect review.
- F. Certificates of Compliance from manufacturer or supplier:
 - 1. Material Test Reports:
 - a. Cement Certificates per CBC Chapter 17.
 - 1) Cement without a certificate shall not be used.
 - b. Aggregates: Material test reports for the following, from a qualified testing agency, indicating compliance with requirements:
 - 1) Light weight aggregate (per ASTM C330).
 - 2) Normal weight aggregate (per ASTM C33). Include service record data indicating absence of deleterious expansion of concrete due to alkali aggregate reactivity. Include evaluation of reactivity.
 - 2. Product Test Reports and Certificates: Include ICC-ES or IAPMO reports where available. Provide for each of the following, signed by manufacturers.:
 - a. Cementitious materials, per ASTM C150, ASTM C595, ASTM C618, ASTM C989, and/or ASTM C1240, as applicable.
 - b. Admixtures. Where more than one admixture is used, include certification that admixtures are compatible. Per ASTM C494 for each type used; include chloride ion content.
 - c. Fiber reinforcement.
 - d. Curing compounds. Also include data on method of removal in the event of incompatibility with floor covering adhesives.
 - e. Floor and slab treatments.
 - f. Non-shrink grout, per ASTM C1107 Grade B.
 - g. Bonding agents.
 - h. Vapor retarders.
 - i. Semirigid joint filler and joint-filler strips
 - j. Waterstops.
 - k. Post-installed concrete anchors.
 - l. Repair materials.
- G. Hardeners and sealers: Provide manufacturer's data.
- H. Grout samples for sacked surface textures and colors upon Architect's request only.
- I. Field quality-control test and inspection reports.

- J. Project Record Documents: Accurately record actual locations of embedded utilities and components that will be concealed from view upon completion of concrete work.

1.6 QUALITY ASSURANCE

- A. Perform work of this section in accordance with ACI 301 and ACI 318 and applicable standards listed in the Reference Standards section.
 - 1. Maintain one copy of ACI 301 and ACI 318 on site.
- B. Follow recommendations of ACI 305R when concreting during hot weather.
- C. Follow recommendations of ACI 306R when concreting during cold weather.
- D. For slabs required to include moisture vapor reducing admixture (MVRA), do not proceed with placement unless manufacturer's representative is present for every day of placement except when waived by owner.
- E. For slabs indicated to receive membrane-forming, moisture emission-reducing, curing and sealing compound, do not proceed with application unless manufacturer's representative is present for every day of placement except when waived by owner.
- F. Installer Qualifications:
 - 1. Concrete: A qualified installer who employs Project personnel qualified as ACI-certified Flatwork Technician and Finisher and a supervisor who is an ACI-certified Concrete Flatwork Technician.
- G. Manufacturer Qualifications:
 - 1. Concrete: A firm experienced in manufacturing ready-mixed concrete products that complies with ASTM C94 requirements for production facilities and equipment.
 - a. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities."
- H. Testing Agency Qualifications: An independent agency, acceptable to authorities having jurisdiction, qualified according to ASTM C1077 and ASTM E329 for testing indicated, as documented according to ASTM E548.
 - 1. Personnel conducting field tests shall be qualified as ACI Concrete Field-Testing Technician, Grade 1, according to ACI CP-01 or an equivalent certification program.
 - 2. Personnel performing laboratory tests shall be ACI-certified Concrete Strength Testing Technician and Concrete Laboratory Testing Technician - Grade I. The Testing Agency laboratory supervisor shall be an ACI-certified Concrete Laboratory Testing Technician - Grade II.
 - 3. Shop and field testing and inspection of steelwork shall be performed by an inspector currently certified as an AWS Certified Welding Inspector.
- I. Testing Agency: Shall be selected and paid for by the Owner, unless otherwise specified; re-testing paid for by the Contractor.

- J. Contractor's Quality Control Plan: Quality Control includes the functions performed by the Contractor to ensure that the material and workmanship of concrete construction meets the project specifications and applicable standards. The Contractor shall submit a Quality Control Plan that addresses all inspection issues, including testing and inspection per ACI. The verification testing and inspection carried out by the Testing Agency does not relieve the contractor of the responsibility for conducting their own quality control/inspection program to ensure the requirements of the Contract Documents have been met. The Contractor's Quality Control Plan will be reviewed by the Testing Agency.
- K. Quality Control Inspector Qualifications: Along with Quality Control Plan, Contractor shall submit written qualifications for all inspectors to be assigned Quality Control functions for concrete work.
- L. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, obtain aggregate from one source, and obtain admixtures through one source from a single manufacturer.
- M. Mechanical Bar Couplers shall have a current ICC-ES or IAPMO Evaluation Report that indicates compliance with the requirements of these specifications.
- N. Steel Reinforcing Allowable Tolerances: Comply with ACI 117 and requirements in Section 03 20 00.
 - 1. Refer to Section 03 20 00.
- O. Concrete Testing Service: Engage a qualified independent testing agency to perform material evaluation tests and to test concrete mixtures. When mixes are proportioned by trial batch method, engage a Laboratory conforming to ASTM E329 and under direction of a Professional Engineer licensed in the State in which the Project is located.
- P. Formwork:
 - 1. See Section 03 10 00.
- Q. Prefabrication and Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 01.
 - 1. Before submitting design mixtures, review concrete design mixture and examine procedures for ensuring quality of concrete materials. Require representatives of each entity directly concerned with cast-in-place concrete to attend, including the following:
 - a. Contractor's superintendent.
 - b. Independent testing agency responsible for concrete design mixtures.
 - c. Ready-mix concrete manufacturer.
 - d. Concrete subcontractor.
 - 2. Review special inspection and testing and inspecting agency procedures for field quality control, concrete finishes and finishing, cold- and hot-weather concreting procedures, curing procedures, construction contraction and isolation joints, and joint-fillers, forms and form removal limitations, shoring and reshoring procedures,

vapor-retarder installation, anchor rod and anchorage device installation tolerances, steel reinforcement installation, floor and slab flatness and levelness measurement, concrete repair procedures, and concrete protection.

R. Tests and Inspections:

1. Provide special inspections and testing as described in the "Statement of Structural Special Inspections and Testing" within the structural drawings, and/or TIO form, and as required by this section.
2. A testing program is required prior to start of construction. Testing program to be done in Compliance with the CBC requirements and in collaboration with Testing Laboratory, Design team, contractor, owner and submitted for review by the agency in charge of building enforcement. Requirements below are minimum requirements; additional requirements may be required in final testing program.
3. The following tests shall be made by a recognized testing laboratory selected by the Owner and approved by the governing agency. All tests shall be in accordance with the previously mentioned standards and ACI 318 Section 26.12. A complete record of all tests and inspections shall be kept per CBC Section 1704.5.
 - a. Compressive Strength: Make and cure in accordance with ASTM C-31. Test in accordance with ASTM C-39 and ACI 318 Section 26.12. Standard cure testing shall be utilized. Supplementary field cure testing shall occur where required by SEOR and/or AHJ.
 - 1) A record shall be made of time and of locations of concrete from which samples were taken.
 - 2) A minimum of five identical cylinders shall be taken from each pour of 150 cubic yards or 5000 square feet or part thereof, being placed each day per ACI 318 Section 26.12.2. One cylinder shall be tested at age 7 days, and a minimum of three at age 28 days unless otherwise specified. Preserve a minimum of one remaining cylinder for future use.
 - b. Drying Shrinkage: (applies always for lightweight concrete; also applies for other mixes if specified as such in drawings or specifications).
 - 1) A record shall be made of time cylinders and of locations of concrete from which samples were taken.
 - 2) Three identical 4" x 4" x 11" specimens shall be made from same concrete as used in structure. Percent of shrinkage shall be reported at 21 days after 7 day moist curing period. Average results of 3 specimens shall be used as the accepted value. The value for laboratory cast specimens shall not exceed .075%. If field test specimens are used in lieu of laboratory specimens, a tolerance of +33% may be used.
 - 3) Test specimens in accordance with ASTM C157.
 - c. Concrete consistency (slump) shall be tested in accordance with ASTM C143.
4. Provide full time inspection per CBC Section 1705.3 during the taking of test specimens and during the placing of all concrete and embedded steel.
5. See Section 03 20 00 for reinforcing steel tests and inspections.

6. Provide concrete batch plant inspections per ASTM C685.

1.7 DELIVERY, STORAGE AND HANDLING

A. Steel Reinforcement:

1. See Section 03 20 00.

B. Deliver and store welding electrodes in accordance with AWS D1.4.

C. Formwork: Deliver and store packaged materials in original containers with seals unbroken and labels intact until time of use.

D. Concrete Materials:

1. Protect cement from moisture and rotate stock to ensure fresh materials.
2. Protect aggregates as necessary to maintain saturated condition when batched.
3. Storage methods should comply with ACI 301 4.1.4.

E. Contractor to coordinate with owner and/or testing laboratory to provide facilities for job curing of test cylinders and transporting to Testing Laboratory.

F. Comply with all local building and fire codes for fire safety during construction.

PART 2 PRODUCTS

2.1 CONCRETE MIXES

A. Concrete mixes shall be as stated in the Structural Documents with strength, maximum aggregate size, weight, maximum water to cement ratio, and location of usage.

1. Cement content as required by mix design (ACI 318 Section 26.4.3).
2. Admixtures: Water Reducing
3. Weight
 - a. Normal Weight Concrete (NWC): 150 lbs. per cubic foot maximum
4. Air Entrainment
 - a. As required for UL rating (4%-7% for LWC)
 - b. As required for Durability Requirements per ACI 318 Chapter 19
 - c. As required in Construction Documents

2.2 FORMWORK

A. Comply with requirements of Section 03 10 00.

2.3 REINFORCEMENT MATERIALS

A. Comply with requirements of Section 03 20 00.

2.4 CONCRETE MATERIALS

- A. Cementitious Material: Use the following cementitious materials, of the same type, brand, and source, throughout Project:
1. Portland Cement: ASTM C150, Type II, II/V, Type V, or ASTM C595 Type 1L. One brand of cement shall be used throughout to maintain uniform color for all exposed concrete.
 2. Supplement Portland Cement with the following Supplementary Cementitious Materials (SCM):
 - a. Fly Ash Pozzolan: ASTM C618, F as required.
 - b. Blast-Furnace Slag: ASTM C989-10
 - c. Silica Fume: ASTM C1240, proportioned in accordance with ACI 211.1.
 3. The SCM producer shall have a minimum of 5 years' experience in the production of acceptable SCM and shall practice an effective quality control program to guard against contamination of the SCM.
 4. Cementitious material used shall have at least 2 years of use with proposed aggregates without detrimental reaction.
 5. Alkali content shall not exceed 0.6% when tested in accordance with ASTM C114.
 6. The temperature of cement delivered to the plant shall not exceed 150 degrees F.
- B. Normal-Weight Aggregates: ASTM C33, fine and coarse aggregate, graded. Provide aggregates from a single source with documented service record data of at least 10 years' satisfactory service in similar applications and service conditions using similar aggregates and cementitious materials. Aggregate shall be crushed granite or Perkins type.
1. Select coarse-aggregate size from three options in subparagraph below; add gradation requirements if preferred. Aggregate size limits relate to spacing of steel reinforcement, depth of slab, or thickness of concrete member.
 2. Coarse Aggregate:
 - a. Aggregate shall contain no thin or elongated pieces. Any piece having a major dimension more than 2-1/2 times the average thickness shall be considered thin or elongated.
 - b. If shrinkage-controlled concrete, Coarse Aggregate shall be crushed limestone, granite, or accepted equal.
 - c. The maximum size used in a particular location shall be consistent with the form and dimensions of the section being placed, with the location and spacing of the reinforcing steel and with the method of vibration. The aggregate sizes shall be such as will produce dense, uniform concrete, free of rock pockets, honeycombs, or other irregularities.
 - d. Combined aggregate gradation for slabs and other designated concrete shall be 8% to 18% for large top size aggregates (1-1/2-inch) or 8% - 22% for smaller top size aggregates (1-inch or 3/4-inch) retained on each sieve below the top size and above the No. 100.
 3. Fine Aggregate: Uniformly graded, clean sand, free from excessive fines, organic materials or other deleterious materials. Free of materials with deleterious

reactivity to alkali in cement.

- C. Water: Clean and free from injurious amounts of oil, acids, alkali, organic matter and other deleterious substances; suitable for domestic consumption.

2.5 ADMIXTURES

- A. General: Where more than one is used, admixtures shall be compatible. Use of admixtures shall be consistent throughout Work.

1. Use of alternate admixtures may only be used with the written acceptance of the Architect. See Substitutions Division 01 – Product Requirements.
2. Admixtures to be in accordance with ACI 318 Section 26.4.1.4.
3. Prohibited Admixtures: Admixtures containing more than 0.05 percent chloride ions, fluorides, sulphites, thiocyanates, and/or nitrates are not permitted. Do not use admixtures that will negatively impact the visual finish of concrete exposed to view. Calcium chloride is not permitted.

- B. Air-Entraining Admixture: ASTM C 260, certified by manufacturer to be compatible with other admixtures.

1. Available Products:
 - a. Grace Construction Materials; Darex AEA or Daravair.
 - b. Master Builders, Inc.; MB-VR or Micro Air.
 - c. Euclid Chemical Company (The); Air Mix.

- C. Chemical Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures and that will not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.

1. Water-Reducing (Plasticizing) Admixture: ASTM C494, Type A for use in cool weather. Available Products:
 - a. Grace Construction Products, W. R. Grace & Co.; "WRDA with Hycol".
 - b. Master Builders, Inc.; "Pozzoloth 220N".
 - c. Euclid Chemical Company (The); "WR-75, WR-91 or Eucon MR".
2. Retarding Admixture: ASTM C494, Type B.
3. Water-Reducing and Retarding Admixture: ASTM C494, Type D for use in hot weather. Available Products:
 - a. Sika Corporation; "Sikament 30".
 - b. Euclid Chemical Company (The); "Eucon Retarder-75".
4. Mid-Range, Water-Reducers ASTM C494. Available Products:
 - a. Master Builders "Polyheed."
5. Plasticizing and Retarding Admixture: ASTM C1017, Type II.
6. Non-Chloride, Non-Corrosive Accelerating Admixture: ASTM C494, Type C or E. Manufacturer must have long-term non-corrosive test data from an independent

testing laboratory (of at least a year's duration) using an acceptable accelerated corrosion test method. Available Products:

- a. Euclid Chemical Company (The); "Accelguard 80, 90, or NCA".
7. Shrinkage Reducing Admixture: ASTM C494, Type S.
 - a. Euclid Chemical Company; Eucon SRA Floor; Eucon SRA-XT.
 - b. GCP Applied Technologies; Eclipse Floor 200; Eclipse 4500.
8. Waterproofing Admixture: Admixture formulated to reduce permeability to liquid water, with no adverse effect on concrete properties.
 - a. Admixture Composition: Crystalline, functioning by growth of crystals in capillary pores.
 - b. Admixture Composition: Hydrophobic polymer waterproofing and corrosion inhibitor, functioning by closing concrete pores and chemical bonding.
 - c. Permeability of Cured Concrete: No measurable leakage when tested in accordance with COE CRD-C 48 at 200 psi (1.38 MPa); provide test reports.
 - d. Potable Water Contact Approval: National Science Foundation (NSF) certification for use on structures holding potable water, based on testing in accordance with NSF 61 and NSF 372.
 - e. Available Products:
 - 1) Euclid Chemical Company; Eucon Vandex AM-10.
 - 2) W. R. Meadows, Inc; ADI-CON CW Plus.
 - 3) Xypex Chemical Corporation; XYPEX Admix C-500.
9. Set-Accelerating Corrosion-Inhibiting Admixture: Commercially formulated, anodic inhibitor or mixed cathodic and anodic inhibitor; capable of forming a protective barrier and minimizing chloride reactions with steel reinforcement in concrete and complying with ASTM C494, Type C.
10. Available Products:
 - a. Euclid Chemical Company (The); Eucon CIA.
 - b. Grace Construction Products, W. R. Grace & Co.; DCI.
 - c. Master Builders, Inc.; Rheocrete CNI.
 - d. Sika Corporation; Sika CNI.
- D. Color Pigment: ASTM C979, synthetic mineral-oxide pigments or colored water-reducing admixtures; color stable, free of carbon black, nonfading, and resistant to lime and other alkalis.
 1. Color: As selected by Architect from manufacturer's full range.
 2. Concentration: Base dosage rates on weight of Portland cement, fly ash, silica fume, and other cementitious materials but not aggregate or sand.

2.6 ACCESSORY MATERIALS

A. Underslab Vapor Retarder:

1. Sheet Material: ASTM E 1745, Class A, not less than 15 mils thickness. Suitable for installation in contact with soil or granular fill under concrete slabs. Single-ply polyethylene is prohibited. Include manufacturer's recommended adhesive or pressure-sensitive tape. Plastic Vapor Retarder shall have a water-vapor transmission rate (WVTR) no greater than .008 perms (grain/h xft² in x Hg) when tested in accordance with ASTM E96. Include manufacturer's recommended tape with water vapor transmission rate no greater than 0.3 perms when tested in accordance with ASTM E96. Tape shall be: a minimum of 6-mils thick, a minimum of 3 ¾ inches wide, manufactured from high density polyethylene, and have pressure sensitive adhesive. Include manufacturer's recommended vapor resistant mastic.
 - a. Sheet Products:
 - 1) Alumiseal Corporation; Zero Perm Vapor Barrier.
 - 2) Henry Company (Fortifiber); Moistop Ultra 15.
 - 3) Raven Industries Inc.; Vapor Block 15.
 - 4) Reef Industries, Inc.; Griffolyn Type-65G or 105.
 - 5) W.R. Meadows, Inc.; PERMINATOR Class A - 15 mils.
 - 6) STEGO Industries LLC; Stego Wrap Vapor Barrier.
 - 1) Substitutions: See Section 01 60 00 - Product Requirements.
 - b. Accessory Products: Vapor retarder manufacturer's recommended tape, adhesive, mastic, prefabricated boots, etc., for sealing seams and penetrations.
 - 1) Vapor Retarder Tape:
 - a) Water Vapor Transmission Rate: ASTM E 96, 0.3 perms or lower
 - b) Minimum 6-mils thick
 - c) Minimum 3 ¾ inches wide
 - d) Manufactured from High Density Polyethylene
 - e) Pressure Sensitive Adhesive
- B. Non-Shrink Cementitious Grout: Premixed compound consisting of non-metallic aggregate, cement, water reducing and plasticizing agents. Acceptance by Architect required before using.
1. Grout: Comply with ASTM C1107.
 2. Height Change, Plastic State; when tested in accordance with ASTM C827:
 3. Maximum: Plus 4 percent.
 4. Minimum: Plus 1 percent.
 5. When placed at a flowable consistency there shall be at least 95% bearing under an 18 inches x 36 inches base plate.
 6. Minimum Compressive Strength at 48 Hours: 3,000 pounds per square inch.
 7. Minimum Compressive Strength at 28 Days, ASTM C109: 7,000 pounds per square inch

8. Flowable Products:
 - a. Euclid Chemical Company; Hi-Flow Grout.
 - b. W. R. Meadows, Inc; 588-10K; 1428 HP.
 - c. BASF Construction Products; Masterflow 713 or 928.
 - d. Sika Corporation; Sika Grout 328.
 - e. SpecChem; SC Precision Grout
 - f. Metallic grout equivalent to Master Builders "Embeco" may be used only where covered by earth, concrete, or masonry.
 - g. Substitutions: See Division 01 - Product Requirements.
9. Low-Slump, Dry Pack Products:
 - a. Dry Pack products may only be used where approved by Architect or otherwise indicated in Drawings.
 - 1) Euclid Chemical Company; DRY PACK GROUT.
 - 2) Five Star Products, Inc; Five Star Grout.
 - 3) L&M Construction Chemicals, Inc, a subsidiary of Laticrete International, Inc; Duragrout.
 - 4) SpecChem, LLC; SC Multipurpose Grout.
 - 5) W. R. Meadows, Inc; PAC-IT.
 - 6) Substitutions: See Division 01 - Product Requirements.
- C. Non-Shrink Epoxy Grout: For anchor reinforcing steel or threaded rods in concrete. Moisture-insensitive, two-part; consisting of epoxy resin, non-metallic aggregate, and activator.
 1. Composition: High solids content material exhibiting positive expansion when tested in accordance with ASTM C827.
 - a. Maximum Height Change: Plus 4 percent.
 - b. Minimum Height Change: Plus 1 percent.
 2. Minimum Compressive Strength at 7 days, ASTM C579: 12,000 pounds per square inch (82.7 MPa).
 3. Products:
 - a. BASF Construction Products; Masterflow MP
 - b. Sika Corporation; Sikadur 32 Hi-Mod
 - c. Euclid Chemical Company; Epoxy 452 or E3G.
 - d. Five Star Products, Inc; Five Star DP Epoxy Grout.
 - e. SpecChem, LLC; SpecPoxy Grout.
 - f. Substitutions: See Division 01 - Product Requirements.
- D. Floor Leveling and Fill Materials
 1. Epoxy Concrete Mortar (where areas to fill are less than ¼-inch thick): Floor

leveling, non-shrink trowel applied epoxy concrete mortar.

2. Concrete Mortar (where areas to fill are greater than ¼-inch thick): Floor leveling, patching and repair, non-shrink trowel applied concrete mortar.
3. Cementitious Floor Leveling Material: Shall be self-leveling or trowelable with a minimum 28 day compressive strength of 3000 psi in accordance with ASTM C-109.
 - a. The Quikrete Companies; Quikrete No. 1249.
 - b. Ardex; V-1200.
 - c. Mapei; "UltraFlex".
 - d. Substitutions: See Division 01 - Product Requirements.

2.7 BONDING AND JOINTING PRODUCTS

- A. Latex Bonding Agent: Non-redispersable acrylic latex, complying with ASTM C1059, Type II acrylic emulsion or styrene butadiene.
 - a. Euclid Chemical Company; AKKRO-7T; Wuco-Weld.
 - b. W. R. Meadows, Inc; ACRY-LOK.
 - c. Sonneborn; Sonobond.
 - d. Larsen Products; Weld-Crete.
 - e. Substitutions: See Division 01 - Product Requirements.
- B. Epoxy Bonding System:
 1. Complying with ASTM C881 and of Type required for specific application. Two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class suitable for application temperature and of grade to suit requirements, and as follows:
 - a. Types I and II, non-load bearing or IV and V, load bearing, for bonding hardened or freshly mixed concrete to hardened concrete.
 - 1) CTS Cement Manufacturing Corporation; Fast Anchoring and Repair Adhesive.
 - 2) Euclid Chemical Company; DURAL FAST SET LV.
 - 3) Mapei Corporation; Planibond AE, Planibond 3C.
 - 4) Substitutions: See Division 01 - Product Requirements.
- C. Waterproofing Admixture Slurry: Slurry coat of Portland cement, sand, and crystalline waterproofing additive, mixed with water in proportions recommended by manufacturer to achieve waterproofing at cold joints in concrete.
 1. Products:
 - a. W. R. Meadows, Inc; ADI-CON CW Plus.
 - b. Xypex Chemical Corporation; XYPEX Concentrate.
 - c. Substitutions: See Division 01 - Product Requirements.

D. Waterstops:

1. Rubber, complying with COE CRD-C 513.
2. PVC, complying with COE CRD-C 572.
3. Bentonite and butyl rubber, complying with NSF 61 and NSF 372.
4. Synthetic rubber; swells to 1000 percent of original size in clean water.
5. Configuration: As indicated on drawings.
6. Size: As indicated on drawings.
7. Products:
 - a. Penetron; Penebar SW-55.
 - b. CETCO, a division of Minerals Technologies Inc; WATERSTOP RX.
 - c. Kryton International, Inc; Krytonite Swelling Waterstop.
 - d. Substitutions: See Division 01 - Product Requirements.

E. Reglets: Formed steel sheet, galvanized, not less than 26 gauge, with temporary filler to prevent concrete intrusion during placement.

F. Slab Expansion and Isolation Joint Filler: Preformed non-extruded resilient filler.

1. Material:
 - a. ASTM D1751, cellulose fiber.
 - b. ASTM D1752, sponge rubber (Type I).
 - c. ASTM D8139, semi-rigid, closed-cell polypropylene foam.
2. Products:
 - a. Burke; Fiber Expansion Joint.
 - b. W.R. Meadows; Fibrated Expansion Joint Filler with Snap-Cap; Deck-O-Foam Joint Filler with pre-scored top strip.
 - c. Nomaco, Inc; Nomaflex Expansion Joint Filler with Void Cap Option.
 - d. Substitutions: See Division 01 - Product Requirements.

G. Slab Contraction Joint Device: Preformed linear strip intended for pressing into wet concrete to provide straight route for shrinkage cracking.

H. Slab Construction Joint Devices: Combination keyed joint form and screed, galvanized steel, with rectangular or round knockout holes for conduit or rebar to pass through joint form at 6 inches on center; ribbed steel stakes for setting.

1. Provide removable plastic cap strip that forms wedge-shaped joint for sealant installation.
2. Height: To suit slab thickness.

2.8 CURING MATERIALS

1. Evaporation Reducer: Liquid thin-film-forming compound that reduces rapid moisture loss caused by high temperature, low humidity, and high winds; intended

for application immediately after concrete placement.

2. Conform with State of California Air Resources Board VOC Regulations.
3. Products:
 - a. Euclid Chemical Company ; EUCOBAR.
 - b. Kaufman Products Inc; VaporAid.
 - c. W. R. Meadows, Inc ; Evapre or Evapre-RTU.
 - d. Substitutions: See Division 01 - Product Requirements.
- B. Curing Compound, Naturally Dissipating: Clear, water-based, liquid membrane-forming compound; complying with ASTM C309:
 1. Type 1, Class A and B, and AASHTO Specification M-148;
 2. Type 1, Class A and B requirements, and State of California Air Resources Board VOC Regulations.
 3. Sodium Silicate compounds are prohibited.
 4. Certified by curing compound manufacturer to not interfere with bonding of floor covering.
 5. Product dissipates within 4 to 6 weeks.
 6. Products:
 - a. Euclid Chemical Company; COLOR-CRETE CURE AND SEAL VOC.
 - b. W. R. Meadows, Inc; 1100-Clear.
 - c. Substitutions: See Division 01 - Product Requirements.
- C. Curing Agent, Water-Cure Equivalent Type: Clear, water-based, non-film-forming, liquid-water cure replacement agent.
 1. Compressive Strength of Treated Concrete: Equal to or greater than strength after 14-day water cure when tested according to ASTM C39.
 2. Conform with State of California Air Resources Board VOC Regulations.
- D. Resin Curing Compound: Solvent-based liquid, white pigmented, membrane-forming.
 1. For use on exterior slabs. When slab will be painted, sealed, topped, or receive other applied finish, completely remove curing compound after curing is complete and before finish coatings are applied.
 2. Comply with ASTM C309, Type 2, Classes A and B.
 3. Conform with State of California Air Resources Board VOC Regulations.
 4. VOC Content: Less than 200 g/L.
 5. Solids Content: 20 percent, minimum.
 6. Products:
 - a. Euclid Chemical Company; KUREZ DR-VOX; KUREZ DR-100.
 - b. Kaufman Products Inc; Thinfilm 450 Resin Base.
 - c. Substitutions: See Division 01 - Product Requirements.

- E. Curing and Sealing Compound, Moisture Emission-Reducing, Membrane-Forming: Clear, liquid sealer for application to newly-placed concrete; capable of providing adequate bond for flooring adhesives, initially and over the long term; with sufficient moisture vapor impermeability to prevent deterioration of flooring adhesives due to moisture emission.
1. Use this product to cure and seal all slabs to receive adhesively applied flooring or roofing.
 2. Comply with ASTM C309 and ASTM C1315 Type I Class A.
 3. Conform with State of California Air Resources Board VOC Regulations.
 4. VOC Content: Less than 100 g/L.
 5. Solids Content: 25 percent, minimum.
 6. Sodium silicate compounds prohibited.
 7. Products:
 - a. Euclid Chemical Company; Diamond-Clear VOX
 - b. Floor Seal Technology, Inc; VaporSeal 309 System.
 - c. Spec Chem; Cure & Seal WB.
 - d. ShawContract; Moisture Shield
 - e. Substitutions: See Division 01 - Product Requirements.
- F. Curing and Sealing Compound, Moisture Emission-Reducing, Penetrating: Clear, water-based, non-film-forming curing agent; capable of providing adequate bond for flooring adhesives, initially and over the long term; with sufficient moisture vapor impermeability to prevent deterioration of flooring adhesives due to moisture emission, moisture vapor emission, and alkalinity.
1. Use this product to cure and seal all slabs to receive adhesively applied flooring or roofing.
 2. Compressive Strength of Treated Concrete: Equal to or greater than strength after 28-day water cure when tested according to ASTM C39.
 3. Chloride Ion Resistance of Treated Concrete: Equal to or greater than strength after 28-day water cure when tested according to ASTM C1202.
 4. Comply with ASTM C309 and ASTM C1315 Type I Class A.
 5. Conform with State of California Air Resources Board VOC Regulations.
 6. Products:
 - a. W.R. Meadows; Pentreat 244.
 - b. Substitutions: See Division 01 - Product Requirements.
- G. Curing and Densifying Compound, Membrane-Forming: Lithium polysilicate-based, clear, liquid densifier for application to newly-placed concrete.
1. Comply with ASTM C309.
 2. Conform with State of California Air Resources Board VOC Regulations.
 3. Solids Content: 25 percent, minimum.

- 4. Products:
 - a. BASF; Sonosil.
 - b. Euclid Chemical Company; Eucosil.
 - c. Substitutions: See Division 01 - Product Requirements.
 - H. Moisture-Retaining Sheet/Cover: ASTM C171.
 - 1. Provide in a thickness of 42 mils; standard weight of 53 lbs./1000 ft²; tensile strength (machine direction) of 36 lbs./in.; and puncture resistance of 70 lbs.
 - a. Fiber reinforced asphaltic vapor barrier building paper, regular.
 - b. Polyethylene film, white opaque.
 - c. White-burlap-polyethylene sheet.
 - I. Absorptive Cover: AASHTO M182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. when dry.
 - J. Water: Potable, not detrimental to concrete.
- 2.9 FLOOR AND SLAB TREATMENTS
- A. Abrasive Aggregate for non-slip finish: Fused aluminum oxide grits, graded 12/30. Use factory graded rustproof and non-glazing material that is unaffected by freezing, moisture and cleaning materials.
 - B. Concrete Hardener/Sealer: Clear, water soluble, sprayable in-organic silicate-based hardener/sealer or acrylic co-polymer resin. Shall conform to State of California Air Resources Board VOC Regulations.
 - C. Concrete Sealer: Conforming to ASTM C-309, Type I, Class B requirements, and conforming to State of California Air Resources Board VOC Regulations.
 - D. Sealer for Colored Concrete: Clear, penetrating, water-based, low-luster sealer recommended by the pigment manufacturer. It shall be compatible with colored concrete components and will not adversely affect concrete color or slip resistance.
- 2.10 POST-INSTALLED CONCRETE ANCHORS
- A. Expansion Anchors:
 - 1. As indicated on Drawings.
 - B. Adhesive Anchors:
 - 1. As indicated on Drawings.
 - C. Screw Anchors:
 - 1. As indicated on Drawings.
 - D. Grouted Dowels / Grouted Anchors: High strength non-shrink grout to anchor reinforcing steel or threaded rods in concrete.
 - 1. Master Builders; Masterflow 928.

2. Sika Corporation; Sika Grout 212.
3. Substitutions: See Division 01 - Product Requirements.

2.11 REPAIR MATERIALS

- A. High Strength Flowing Repair Mortar: For forming and pouring structural members, or large horizontal repairs, provide the flowable one-part, high strength microsilica modified repair mortar with 3/8" aggregate. The product shall achieve 9000 psi @ 28-days at a 9-inch slump.
- B. Concrete Patching Mortar:
 1. Horizontal repairs, ASTM C1059, Type II. Available Products:
 - a. Euclid Chemical Co.; Euco Thin Coat, Concrete Coat.
 - b. Sika Chemical Corp.; Sikatop 121 or 122.
 - c. Substitutions: See Section 01 60 00 - Product Requirements.
 2. Vertical or Overhead repairs, ASTM C1059, Type II. Available Products:
 - a. Euclid Chemical Co.; Verticoat.
 - b. Sika Chemical Corp.; Sikatop 123.
 - c. Master Builders; Emaco R300, 310 or R350.
 - d. Substitutions: See Division 01 - Product Requirements.
- C. Repair Underlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/8 inch and that can be feathered at edges to match adjacent floor elevations.
 1. Cement Binder: ASTM C150, portland cement or hydraulic or blended hydraulic cement as defined in ASTM C219.
 2. Primer: Product of underlayment manufacturer recommended for substrate, conditions, and application.
 3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch or coarse sand as recommended by underlayment manufacturer.
 4. Compressive Strength: Not less than specified strength at 28 days when tested according to ASTM C109.
 5. Bond Strength: Not less than specified strength at 28 days when tested according to ASTM C1042.
 6. Available Products:
 - a. Euclid Chemical Co.; Flo-Top.
 - b. Master Builders; UnderLayment 110.
 - c. Substitutions: See Division 01 - Product Requirements.
- D. Repair Overlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/8 inch and that can be feathered at edges to match adjacent floor elevations.
 1. Cement Binder: ASTM C150, Portland cement or hydraulic or blended hydraulic

cement as defined in ASTM C219.

2. Primer: Product of topping manufacturer recommended for substrate, conditions, and application.
3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch or coarse sand as recommended by topping manufacturer.
4. Compressive Strength: Not less than specified strength at 28 days when tested according to ASTM C109.
5. Product shall exhibit the following properties: Chaplin Abrasion Test – 0.0079-inches maximum at 28 days.
6. Available Products:
 - a. Euclid Chemical Co.; Thin Top SL.
 - b. Master Builders; Topping 112.
 - c. Substitutions: See Division 01 - Product Requirements.

2.12 CONCRETE MIX DESIGN

A. General:

1. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, according to ACI 301.
 - a. Procurement of concrete mix design is responsibility of Contractor.
 - b. Use a qualified independent testing agency for preparing and reporting proposed mixture designs based on laboratory trial mixtures.
 - c. Contractor shall notify the Testing Laboratory and Architect of intent to use concrete pumps to place concrete so that mix designs can be modified accordingly.
2. Supplementary Cementitious Materials (SCM): Fly ash shall not exceed 25% of the total cementitious material, unless otherwise indicated by Architect and Structural Engineer. Where slag is used to replace cement, slag shall not exceed 25% of the total cementitious material by mass. Ternary systems where more than one supplementary cementitious material is used are prohibited without consent of SEOR.
3. Limit water-soluble, chloride-ion content in hardened concrete to specified percent by weight of cement.
4. Admixtures: Use admixtures according to manufacturer's written instructions.
 - a. Use admixtures in concrete, as required, for placement and workability.
 - b. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
 - c. Use water-reducing admixture in pumped concrete, concrete for heavy-use industrial slabs and parking structure slabs, concrete required to be watertight, and concrete with a water-cementitious materials ratio below 0.50.
 - d. Use corrosion-inhibiting admixture in concrete mixtures where required.
5. Color Pigment: Add color pigment to concrete mixture according to manufacturer's

written instructions and to result in hardened concrete color consistent with approved mockup.

B. Mixtures:

1. Initial mix design shall be prepared for all concrete in accordance with ACI 318 Section 26.4.3. Mix proportions shall be determined in accordance with ACI 318 Section 26.4.3 or 26.4.4. In the event that additional mix designs are required due to depletion of aggregate sources, aggregate not conforming to Specifications or at request of Contractor, these mixes shall be prepared as above.
2. Definition of Mix Properties to be specified for each mix:
 - a. Concrete density, either normal or light weight concrete.
 - b. Concrete strength (f'_c) as the minimum compressive strength at a specified number of days, tested in accordance with ASTM C39.
 - c. Aggregate size as the largest of the coarse aggregate.
 - d. Slump limit. Slump shall be measured at the point of delivery in accordance with ASTM C143 prior to the addition of superplasticizer (if used). Slump tolerance shall meet the requirements of ACI 117 and shall be 4 inch plus or minus 1 inch for general concrete placement. Mixes employing the specified mid-range water reducer shall provide a measured slump not to exceed 7 inch ± 1 inch after dosing, 2 inch ± 1 inch before dosing. Use water reducing admixtures as required to provide a workable consistency for pump mixers. Water shall not be added at the jobsite without written review by the structural engineer.
 - e. Air entrainment: Provide 6% air entrainment typical for exterior concrete exposed to freeze-thaw cycles.
 - f. Air content by volume and may be plus or minus 1.5 percent at point of delivery.
 - g. Water/cement ratio is a maximum and specified by weight.
 - h. SCM cement replacement ratio as a %.
 - i. Drying shrinkage limit (where required) as a percentage change in length after 21 days of drying when tested as per ASTM C157 with 4 inches x 4 inches x 11 inches specimen moist cured 7 days prior to drying.
 - j. Fiber reinforcement (where used) specified as weight/volume of concrete.

2.13 MIXING

- A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94 or ASTM C685 and ASTM C 1116 (fiber reinforced concrete when applicable), and furnish batch ticket information.
1. The batching plant shall be equipped with an electric metering device capable of determining moisture content of sand.
 2. Begin the mixing operation within thirty minutes after the cement has been intermingled with the aggregates.
 3. After mix water has been added, concrete shall be mixed not less than 1-1/2 minutes nor more than 1-1/2 hours. Concrete shall be rejected if not deposited

within the time specified.

- B. Project-Site Mixing: Use only if method of storing material, mixing of material and type of mixing equipment is approved by Architect. Approval of site mixing does not relieve Contractor of any other requirements of Specifications. Measure, batch, and mix concrete materials and concrete according to ASTM C 94. Mix concrete materials in appropriate drum-type batch machine mixer.
 - 1. For mixer capacity of 1 cu. yd. or smaller, continue mixing at least 1-1/2 minutes, but not more than 5 minutes after ingredients are in mixer, before any part of batch is released.
 - 2. For mixer capacity larger than 1 cu. yd., increase mixing time by 15 seconds for each additional 1 cu. yd.
 - 3. Provide batch ticket for each batch discharged and used in the Work, indicating Project identification name and number, date, mixture type, mixture time, quantity, and amount of water added. Record approximate location of final deposit in structure.
- C. Lightweight Concrete: Mix lightweight concrete in accordance with the directions of the approved lightweight aggregate manufacturer.
- D. Admixtures:
 - 1. Air entrained and chemical admixtures shall be charged into mixer as a solution and shall be dispensed by an automatic dispenser or similar metering device. Powdered admixtures shall be weighed or measured by volume as recommended by manufacturer. Accuracy of measurement of any admixture shall be within plus or minus 3%.
 - 2. Two or more admixtures may be used in same concrete, provided such admixtures are added separately during batching sequence, and provided further that admixtures used in that combination retain full efficiency and have no deleterious effect on concrete or on properties of each other.
 - 3. All admixtures are to be approved by Structural Engineer prior to commencing this work.
- E. Re-tempering:
 - 1. Concrete shall be mixed only in quantities for immediate use. Concrete which has set shall be discarded, not re-tempered.
 - 2. Indiscriminate addition of water to increase slump is prohibited.
 - 3. When concrete arrives at project with slump below that suitable for placing, water may be added only if neither maximum permissible water-cement ratio nor maximum slump is exceeded. Water shall be incorporated by additional mixing equal to at least half of total mixing time required. Any addition of water above that permitted by limitation of water-cement ratio shall be accompanied by a quantity of cement sufficient to maintain proper water-cement ratio. Such additions shall only be used if approved by Architect. In any event, with or without addition of cement, not more than 2 gallons of water per cubic yard of concrete, over that specified in design mix, shall be added.

F. Cold Weather Batching:

1. When average of the highest and lowest air temperature falls below 40 degrees F for more than three consecutive days, provide adequate equipment for heating concrete materials. No frozen materials or materials containing ice shall be used. When placed in forms, concrete placed in these temperatures shall have a minimum temperature based on dimensions of concrete sections placed per ACI 301.

G. Hot Weather Batching:

1. Concrete deposited in hot weather shall have a placing temperature below 95 degrees F per ACI 301. If necessary, ingredients shall be cooled to accomplish this.

- H. Do not use shrinkage-reducing admixture (SRA) in same concrete batch with a moisture vapor reduction admixture (MVRA) or porosity inhibiting admixture (PIA).

PART 3 PEXECUTION

3.1 EXAMINATION

- A. Verify lines, levels, and dimensions before proceeding with work of this section.

3.2 PREPARATION

- A. Prior to Work specified in this Section, carefully inspect the installed Work of other trades and verify that such Work is complete to the point where this installation may properly commence.
- B. Formwork: Comply with requirements of Section 03 10 00.
- C. Reinforcement: Comply with requirements of Section 03 20 00.
- D. Coordinate placement of embedded items with erection of concrete formwork and placement of form accessories.
- E. Notify the Architect at least 48 hours in advance of the beginning of pouring operations and at the completion of formwork and location of all construction joints. An inspection of forms and joints will be made for approval of finished work and general layout only. The foregoing inspection shall in no way relieve the Contractor of responsibility of design and safety or formwork, bulkheads and shorings.
- F. Ensure Excavations are sufficient to permit placement, inspection, and removal of forms. The entire place of deposit shall have been cleaned of wood chips, sawdust, dirt, debris, hardened concrete and other foreign matter. No wooden ties or blocking shall be left in the concrete except where indicated for attachment of other work.
- G. Concrete surfaces to which fresh concrete is to be bonded shall be brush cleaned to remove all dust and foreign matter and to expose the aggregate, and then coated with the bonding adhesive herein specified.

- H. Prior to placing concrete for any slabs on grade, the moisture content of the subgrade below the slabs shall be adjusted to at least optimum moisture.
- I. Verify geotechnical engineer has approved all foundation excavations.
- J. No concrete shall be placed until formwork and reinforcement has been approved by Architect. Clean forms of all debris and remove standing water. Thoroughly clean reinforcement and all handling equipment for mixing and transporting concrete. Concrete shall not be placed against reinforcing steel that is hot to the touch.
- K. Coordinate:
 - 1. Obtain necessary information for coordination of formwork with items to be embedded in concrete.
 - 2. Coordinate size and location of openings in concrete. Obtain Architect's approval for openings not shown on Structural Drawings.
- L. Discrepancies:
 - 1. Notify the Architect of any discrepancies or inconsistencies.
 - 2. Do not proceed with installation in areas of discrepancy until such discrepancies have been fully resolved.
- M. Where new concrete is to be bonded to previously placed concrete, prepare existing surface by cleaning and applying bonding agent in according to bonding agent manufacturer's instructions.
 - 1. Use epoxy bonding system for bonding to damp surfaces, for structural load-bearing applications, and where curing under humid conditions is required.
 - 2. Use latex bonding agent only for non-load-bearing applications.
- N. Where new concrete with integral waterproofing is to be bonded to previously placed concrete, prepare surfaces to be treated in accordance with waterproofing manufacturer's instructions. Saturate cold joint surface with clean water, and remove excess water before application of coat of waterproofing admixture slurry. Apply slurry coat uniformly with semi-stiff bristle brush at rate recommended by waterproofing manufacturer.
- O. Concrete Slabs on Grade:
 - 1. Bases below exterior and interior slabs on grade shall be accurately leveled and compacted prior to placing of concrete.
 - 2. Unless otherwise indicated, interior slabs on grade shall be poured over a minimum of four (4 inch) inches of compacted crushed rock, over a vapor retarder. Install vapor retarder under interior slabs on grade. Comply with ASTM E1643. Lap joints minimum 6 inches. Seal joints, seams and penetrations watertight with manufacturer's recommended products and follow manufacturer's written instructions. Repair damaged vapor retarder before covering.
 - 3. Protect slab on grade subbase from moisture prior to placing concrete. Avoid wetting rock layer to allow adequate concrete curing and avoid future vapor transmission. If the subbase has been wet excessively, verify that water has been

eliminated prior to placement of concrete.

3.3 EMBEDDED ITEMS

- A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded. Ensure that embedded items are placed and held, during placing of concrete, to tolerances consistent with other items that will be attached to them.
 - 1. Install anchor rods, accurately located, to elevations required and complying with tolerances in AISC's "Code of Standard Practice for Steel Buildings and Bridges."
 - 2. Install reglets to receive waterproofing and to receive through-wall flashings in outer face of concrete frame at exterior walls, where flashing is shown at lintels, shelf angles, and other conditions.
 - 3. Install dovetail anchor slots in concrete structures as indicated.
 - 4. Install concrete accessories in accordance with manufacturer's recommendations: straight, level, and plumb.
- B. Provide pipe sleeves when pipes pass through concrete. Fill voids in sleeves, inserts and anchor slots with readily removable material to prevent entry of concrete into voids. The Contractor shall also see that sleeves have been installed and other provisions have been made for the installation of mechanical, electrical and other equipment.
- C. No conduit shall be cast in concrete unless specifically indicated on the Structural Drawings.
- D. Coring of concrete after placement is not permitted without prior approval by the Engineer of Record.

3.4 MISCELLANEOUS CONCRETE ITEMS

- A. Filling In: Fill in holes and openings left in concrete structures, unless otherwise indicated, after work of other trades is in place. Mix, place, and cure concrete, as specified, to blend with in-place construction. Provide other miscellaneous concrete filling indicated or required to complete the Work.
- B. Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and by steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.
- C. Equipment Bases and Foundations: Provide machine and equipment bases and foundations as shown on Drawings. Set anchor bolts for machines and equipment at correct elevations, complying with diagrams or templates from manufacturer furnishing machines and equipment.
- D. Steel Pan Stairs: Provide concrete fill for steel pan stair treads, landings, and associated items. Cast-in inserts and accessories as shown on Drawings. Screed, tamp, and trowel-finish concrete surfaces.

E. Post-Installed Concrete Anchors

1. Install in accordance with the manufacturer's recommendations and ICC-ES (or IAPMO) reports.
2. Use washers on all bolts.
3. Use care to avoid cutting or damaging reinforcing bars.
4. When exposed to view in the final structure, bolts shall be of a length that will extend entirely through but not more than 1/4-inch beyond the nuts unless otherwise shown on the Drawings.

3.5 JOINTS

A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.

B. Existing Concrete to New Concrete Joints

1. Chip keys and roughen existing concrete surfaces where new concrete abuts. Roughen surface by bush-hammering, chipping or sandblasting to remove surface mortar and expose clean aggregate.
2. Drill and install dowels using epoxy grout in accordance with manufacturer's printed recommendations.
3. Prime surface with 10-mil layer of epoxy adhesive using a stiff brush. Place concrete while the epoxy adhesive is still tacky. Re-prime if necessary.

C. Construction Joints: Comply with ACI 318 and install only as indicated and noted on Drawings. Joints not indicated on Drawings shall be so located, when approved, as to least impair strength of structure, and shall conform to typical details. Construction joints shall have level tops, vertical sides. Horizontal construction joints shall be thoroughly cleaned and roughened by removing entire surface film and exposing clean aggregate solidly embedded in mortar matrix. Joints between concrete and masonry shall be considered construction joints. Vertical construction joints need not be roughened unless noted otherwise. See Drawings for doweling and required keys. Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.

1. Place joints perpendicular to main reinforcement unless otherwise indicated. Continue reinforcement across construction joints, unless otherwise indicated. Do not continue reinforcement through sides of strip placements of floors and slabs.
2. In walls, do not space construction joints more than 60 feet apart in horizontal direction and maximum 20 feet apart in vertical direction unless otherwise shown. In framed slabs and beams, and on metal deck slabs, do not space construction joints more than 120 feet apart. Place construction joints perpendicular to main reinforcement except as otherwise shown. Continue reinforcement across construction joints except as otherwise shown.
3. Form keyed joints at indicated locations. Embed keys at least 1-1/2 inches into concrete.
4. Locate joints for beams, slabs, joists, and girders in the middle third of spans. Offset joints in girders a minimum distance of twice the beam width from a beam-

girder intersection.

5. Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders and at the top of footings or floor slabs.
6. Space vertical joints in walls as indicated. Locate joints beside piers integral with walls, near corners, and in concealed locations where possible.
7. Roughen surface at all construction joints where key is not used and under baseplates. Roughen concrete surface while concrete is still green where possible. Do not leave laitance, loosened particles of aggregate or damaged concrete at surface. Forms and reinforcing shall be cleaned of drippings. Dampen contact surfaces of construction joints, leaving them free of standing water, before placing fresh concrete. Roughen construction joints by any of following methods:

D. By sand-blasting joint.

- a. By thoroughly washing joint, using a high-pressure hose, after concrete has taken initial set. Washing shall be done not less than 2 hours nor more than 4 hours after concrete has been poured, depending upon setting time.
- b. By chipping and wire brushing.
2. All decisions pertaining to adequacy of construction joint surfaces and to compliance with requirements pertaining to construction joints shall be reviewed with the Structural Engineer.
3. Use a bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
4. Before placing regular concrete mix, horizontal construction joint surfaces shall be covered with a layer of mortar composed of cement and fine aggregate of same proportions as that used in prescribed mix but omitting coarse aggregate.

E. Control Jointing in Slabs-on-Grade: Joints shall be in locations indicated on Drawings, or as directed by Architect. Form weakened-plane control joints, sectioning concrete into areas as indicated. Construct control joints as follows:

1. Construct interior slab control joints as follows:
 - a. By use of construction joints laid out in checkerboard pattern; pour and allow alternate slabs to set; fill out balance of checkerboard pattern with second pour.
 - b. By use of dummy groove joints at least 1/4 depth of slab, and at least 1/8 inch wide. These joints may be sawcut as soon as wet concrete can support the weight of the equipment and operator. Delaying saw-cutting past this point will make jointing ineffective. Use power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch- wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before concrete develops random contraction cracks.
2. Slab reinforcing need not be terminated at control joints.
3. Construction and expansion joints shall be counted as control joints.

C. Isolation/Expansion Joints in Slabs-on-Grade: After removing formwork, install joint-filler strips at slab junctions with vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.

4. Unless otherwise indicated, use 3/8 inch thick expansion joint filler.
 5. Joints in interior slabs on grade shall be only in locations indicated.
 6. Edges of concrete at joints shall be edger finished to approximately 3/8 inch radius.
 7. Interrupt reinforcing at all expansion joints.
 8. Extend joint-filler strips full width and depth of joint, terminating flush with finished concrete surface, unless otherwise indicated.
 9. Terminate full-width joint-filler strips not less than 1/2 inch or more than 1 inch below finished concrete surface where joint sealants, specified in Division 07 are indicated.
 10. Install joint-filler strips in lengths as long as practicable. Where more than one length is required, lace or clip sections together.
- F. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or asphalt coat one-half of dowel length to prevent concrete bonding to one side of joint.
- G. Joint Filling:
1. Prepare, clean, and install joint filler according to manufacturer's written instructions.
 - a. Defer joint filling until concrete has aged at least a specified length of month(s). Do not fill joints until construction traffic has permanently ceased.
 2. Remove dirt, debris, saw cuttings, curing compounds, and sealers from joints; leave contact faces of joint clean and dry.
 3. Install semirigid joint filler full depth in saw-cut joints and at least 2 inches deep in formed joints. Overfill joint and trim joint filler flush with top of joint after hardening.

3.6 PLACING CONCRETE

- A. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections have been performed. Ensure that all foreign material has been removed from surfaces, including reinforcement and embedded items, against which concrete will be placed.
- B. Contractor shall notify the Testing Laboratory and Architect of intent to use concrete pumps to place concrete. Mix designs shall be modified accordingly as required.
- C. The addition of water to the mix after leaving the plant is permitted only when the added water would not cause the mix design water/cement ratio to be exceeded. The addition of water at the site is contingent upon full-time inspection of the process by the owners testing laboratory and the acceptance of the Inspector. Comply with ACI 301, section 4.3.2.1.
- D. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301.
- E. Method: Convey concrete as rapidly and directly as practicable to preserve quality and to prevent segregation. Deposit concrete in forms as nearly as practicable at its final

position in a manner which will ensure that required quality is obtained. Chutes shall slope not less than 4 inches and not more than 6 inches per foot of horizontal run.

1. Do not deposit concrete that has initially set. Retempering of concrete, which has partially set, is not permitted.
 2. The maximum time for discharge of concrete shall be per ASTM C94.
- F. Sequence: Pour all walls and columns full height to designated construction joints. Pour all beams, and horizontal structures to designated construction joints. Construction joints to be made in walls only where indicated on the Drawings.
- G. Placement: Deposit and consolidate concrete for floors and slabs in a continuous operation, within limits of construction joints, until placement of a panel or section is complete. Deposit concrete to avoid segregation.
1. Once placing is started, carry it on as a continuous operation until placement of the panel or section is complete. Construction joints to be made only where indicated on the Drawings or on approved shop drawings. Prevent the formation of cold joints at other locations.
 2. Deposit concrete in one layer or in horizontal layers of such thickness that no new concrete will be placed on concrete that has hardened enough to cause seams or planes of weakness. Deposit concrete in a manner to avoid inclined construction joints.
 3. Particular care shall be used when starting a concrete pour to maintain the continuity of appearance. Use all means necessary to avoid blemishes, imperfections, or changes in the finish.
 4. Maintain reinforcement in position on chairs during concrete placement.
 5. Deposit concrete into forms in horizontal layers not exceeding 24 inches in thickness around building, proceeding along forms at a uniform rate and consolidating into previous pour. In no case shall concrete be poured into an accumulation of water ahead of pour, nor shall concrete be flowed along forms to its final place of deposit. Fresh concrete shall not be permitted to fall from a height greater than 6 feet without use of adjustable length pipes or, in narrow walls, of adjustable flexible hose sleeves. Concrete shall be scheduled so that placing is a continuous operation for the completion of each section between predetermined construction joints. If any concreting operation, once planned, cannot be carried on in a continuous operation, concreting shall stop at temporary bulkheads, located where resulting construction joints will least impair the strength of the structure. Location of construction joints shall be as shown on the drawings or as approved by Structural Engineer. The rate of rise in walls shall not be less than 2 feet per hour.
- H. Consolidation: Consolidate concrete during placement operations so concrete is thoroughly worked around reinforcement and other embedded items and into corners. Concrete shall be thoroughly compacted and worked to all points with solid continuous contact to forms and reinforcement to eliminate air pockets and honeycombing.
1. Consolidate placed concrete with mechanical vibrating equipment according to ACI 301. Use and type of vibrator shall conform to ACI 309, Guide for Consolidation of Concrete.

2. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least 6 inches into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity. Place vibrating element directly in concrete and not attached to either inside or outside of forms or to reinforcing steel.
 3. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing mixture constituents to segregate. Do not over-vibrate concrete.
- I. Initial Finishing:
1. Screed slab surfaces with a straightedge and strike off to correct elevations.
 2. Where floor drains or floor slopes are indicated, slope slabs uniformly to provide even fall for drainage.
 3. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, before excess bleedwater appears on the surface. Do not further disturb slab surfaces before starting finishing operations.
- J. Concrete Slabs on Grade:
1. Exterior and interior concrete slabs on grade shall be poured as required under this Section. Base shall be accurately leveled and compacted prior to placing of concrete.
 2. Typically, interior slabs on grade shall be poured over a minimum of four (4 inch) inches of clean crushed rock, unless otherwise indicated, over a vapor retarder. Base section shall meet the requirements within the Geotechnical Engineering report.
 3. Protect slab on grade subbase from moisture prior to placing concrete. Avoid wetting rock layer to allow adequate concrete curing and avoid future vapor transmission. If the subbase has been wet excessively, verify that water has been eliminated prior to placement of concrete.
 4. Screed slab surfaces with a straightedge and strike off to correct elevations.
- K. Concrete Over Metal Deck:
1. At floor slabs, increase fill thickness as required to compensate for deflection of beams and deck at no additional cost to Owner. Obtain specified fill thickness at high points of the deck. Finish floor to specified tolerances for floor flatness, including at concrete over metal deck floors. Refer to 05 30 00 Metal Decking Specification.
 2. At roof, maintain specified thickness of concrete uniformly over deck. Slab need not conform to flatness and levelness tolerances
- L. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Concrete placed in these temperatures shall have a minimum temperature based on dimensions of concrete sections placed as shown in ACI 301. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
1. When concrete is expected to be placed at air temperatures of less than 40 deg F,

contractor shall review with Architect all special procedures that will be used including mix design modifications and methods of protection. This review shall occur prior to the expected extreme temperatures.

2. Provide sufficient protection material and equipment on the Project site in advance of the time when the mean daily temperatures are expected to drop below 40 degrees F.
3. When average high and low temperature is expected to fall below 40 deg F for three successive days, maintain delivered concrete mixture temperature within the temperature range required by ACI 301. In addition, take precautions including, but not limited to:
 - a. Use non-chloride, non-corrosive accelerating admixture in accordance with previously accepted submittals.
 - b. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
 - c. Do not use calcium chloride, salt, or other materials containing antifreeze agents unless otherwise specified and approved in mixture designs.

M. Hot-Weather Placement: Comply with ACI 301 and ACI 305.1 and as follows:

1. When concrete is expected to be placed at air temperatures of greater than 75 deg F, contractor shall review with Architect all special procedures that will be used including mix design modifications and methods of protection. This review shall occur prior to the expected extreme temperatures.
2. Provide sufficient protection material and equipment on the Project site in advance of the time when the mean daily temperatures are expected to rise above 75 degrees F.
3. When air temperature exceeds 75 deg F, take special precautions to prevent slump loss, rapid setting, and plastic shrinkage; including but not limited to:
 - a. Maintain concrete temperature below 95 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
 - b. Keep aggregate piles continuously moist by sprinkling with water. Temperature of Concrete: The temperature of the concrete mix at the time it is being placed in the forms shall not exceed 95 degrees F per ACI 301. The method employed to provide this temperature shall in no way alter or endanger the design mix or the design strength required.
 - c. Use set retarding admixture in accordance with previously accepted submittals.
 - d. Convey, deposit, finish and commence curing of concrete as rapidly as practicable.

N. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.

- O. Minimize evaporation from concrete in place by providing shade and windbreaks. Maintain such protection in place for 14 days minimum.

3.7 FINISHING FORMED SURFACES

- A. Rough-Formed Finish: Surfaces shall be reasonably true to line and plane with no specified requirements for selected facing materials. Tie holes and defects shall be patched and fins exceeding 1/4 inch in height shall be rubbed down with wooden blocks. Fins and other rough spots at surfaces to receive membrane waterproofing shall be completely removed and the surfaces rubbed smooth. Otherwise, remove fins and other projections exceeding a specified height agreed with Architect. Rough finish shall be used for the following areas:
 - 1. Below grade and unexposed surfaces.
- B. Smooth-Formed Finish: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch tie holes and defects. Remove fins and other projections that exceed specified limits on formed-surface irregularities.
- C. Smooth Plywood Form Finish: Finish shall be true to line and plane. Tie holes and defects shall have been patched and ground with surface fins removed. Arrangement of plywood sheets shall be orderly, symmetrical, as large as practical and free of torn grain or worn edges. Surface concrete shall be treated with 1 part muriatic acid, in three parts water solution, followed immediately by a thorough rinsing with clear water. Surfaces which are glazed, have efflorescence, or traces of form oil, curing compounds or parting compounds shall be cleaned or treated to match other formed surfaces, except as otherwise indicated or specified.
 - 1. Smooth Plywood Form Finish shall be used for the following areas:
 - a. All surfaces above grade unless otherwise specified.
 - b. At Contractor's option, may also be used in lieu of rough form finish.
- D. Smooth Plastic Liner Finish: Surface shall be smooth, concrete free of honeycombing, air pockets larger than 1/8 inch in diameter, and fins.
 - 1. This finish shall be used only where indicated on the Drawings.
- E. Rubbed Finish: Apply the following to smooth-formed finished as-cast concrete where indicated:
 - 1. Smooth-Rubbed Finish: Not later than one day after form removal, moisten concrete surfaces and rub with carborundum brick or another abrasive until producing a uniform color and texture. Do not apply cement grout other than that created by the rubbing process.
 - 2. Grout-Cleaned Finish: Wet concrete surfaces and apply grout of a consistency of thick paint to coat surfaces and fill small holes. Mix one part portland cement to one and one-half parts fine sand with a 1:1 mixture of bonding admixture and water. Add white portland cement in amounts determined by trial patches so color of dry grout will match adjacent surfaces. Scrub grout into voids and remove excess grout. When grout whitens, rub surface with clean burlap and keep surface damp by fog spray for at least 36 hours.

3. Cork-Floated Finish: Wet concrete surfaces and apply a stiff grout. Mix one part portland cement and one part fine sand with a 1:1 mixture of bonding agent and water. Add white portland cement in amounts determined by trial patches so color of dry grout will match adjacent surfaces. Compress grout into voids by grinding surface. In a swirling motion, finish surface with a cork float.
- F. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces, unless otherwise indicated.
- G. Sacked Surfaces: Exposed surfaces that are unacceptable in appearance to the Architect shall be sacked.
 1. Prepare concrete surfaces in accordance with the referenced standards. Remove any form release materials by stoning by hand, power grinding or other method approved by the Architect.
 2. Prepare concrete surfaces to receive sack finishing with a light sand blasting.
 3. For best results, grout application and rubbing should be performed when areas to be treated are shaded and during cool, damp weather. When work is to be performed in hot and dry weather, a fog spray should be available for continuous use.
 4. Prepare grout samples for matching of concrete surfaces for approval by the Architect. These shall be made in the following proportions of gray cement to white cement to sand: 1:1:2, 1:2:3, and 2:1:3, etc. until the correct matching color is obtained on the test areas. Sand should be fine enough to pass the Number 30 sieve. Mixes should be made to a good workable consistency in a clean container and the mix with the best color chosen, or modified if needed.
 5. Provide sufficient quantities of sand and cement from the same source for the complete work at the job site.
 6. Mixing Application:
 - a. Mixing of grout on the job should be timed for it to be used up within 1 to 1-1/2 hours.
 - b. Let the grout stand 20 to 30 minutes after mixing, and then remixed before applying.
 - c. Soak the concrete surface thoroughly with water at least 15 minutes before applying grout and again just before application so that the surface is adequately wet during the operation.
 - d. Apply grout with plasterer's trowel or sponge rubber float in sweeping strokes from the bottom up. Brush or spray gun applications may be used when approved by the Architect.
 - e. Work in freshly applied grout vigorously with a sponge rubber float, then let sit until some of its plasticity is gone but not until it loses its damp appearance. At this point it shall be rubbed with clean, dry burlap to remove the excess grout, leaving no visible film on the surface but filling all air holes.
 - f. Keep the surface wet for a day after grouting and sack rubbing are completed.

7. Alternate methods of application and materials shall be subject to the approval of the Architect.
- H. Schedule of Concrete Finish Types shall be coordinated with the Architect and indicated on Drawings.

3.8 FINISHING FLOORS AND SLABS (FLATWORK)

- A. Comply with ACI 302.1R recommendations for screeding, restraighening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.
- B. Unless otherwise indicated or specified, flatwork shall have an integral monolithic finish.
- C. Integral Monolithic Finish: Apply as soon as freshly poured concrete slabs will bear weight of workers. Pour slabs full thickness to finish floor elevations indicated. At proper time, tamp surface repeatedly with a wire mesh or grid tamper in a manner to force aggregate down below surface and to bring sufficient mortar to surface to provide for a smooth coating of cement mortar over entire surface. Allow surface mortar to partially set, then float with wooden floats and finish with one of following, as required.
 1. Broom Finish: Steel trowel surface to a smooth dense surface free of lines, tool marks, cat faces and other imperfections. After troweling, and before final set, give surface a broom finish, brushing in direction noted on Drawings, or as directed. Broom finish shall be used typically on exterior flatwork except as otherwise indicated or specified and shall be "medium" texture as approved by Architect.
 2. Smooth Steel Trowel Finish: Apply 2 steel trowelings to obtain hard, smooth surface. All lips, irregularities, uneven levels, etc. shall be worked out before last troweling. All interior flatwork shall have a smooth steel trowel finish unless specified otherwise.
- D. Slip-Resistive Finish: Before final floating, apply slip-resistive finish. Apply according to manufacturer's written instructions.
- E. Dry-Shake Floor Hardener Finish: After initial floating, apply dry-shake floor hardener to surfaces according to manufacturer's written instructions.

3.9 FLOOR FLATNESS AND LEVELNESS TOLERANCES

- A. For tolerances not indicated, refer to ACI 117.
- B. Slabs on grade – Comply with FF Floor Flatness & FL Floor Levelness as specified by Architect or Structural Engineer. Where not otherwise indicated, slab shall meet the a Specified overall flatness, $SOFF = 35$ and Specified overall levelness, $SOLF = 25$ minimum. Coordinate with Architect flatness and levelness requirements for flooring to be installed prior to placing concrete.
- C. Comply with flatness and levelness tolerances per ASTM E 1155 for randomly trafficked floor surfaces. Measure FF Floor Flatness and FL Floor Levelness within 48 hours after slab installation; report both composite overall values and local values for each measured section.

- D. Slabs supporting modular office partitions, adhered flooring systems, or compact storage shelving must also comply with the manufacturer's tolerance requirements.
- E. Slabs scheduled to receive wood flooring must also comply with tolerances required for installation of wood flooring.
- F. Finished surfaces of exterior integral finished flatwork shall not vary more than 1/4 inch from a 10' long straightedge, except at grade changes.
- G. Fill or grind completed slabs as necessary to achieve specified finish tolerances. Fill shall be with a self-leveling cementitious product capable of being tapered to a feathered edge.
 - 1. Repair any slab section measuring below either the minimum local F-number or the minimum local L-number.

3.10 SHORES AND RESHORES

- A. Comply with ACI 318 and ACI 301 for design, installation, and removal of shoring and reshoring.
 - 1. Do not remove shoring or reshoring until measurement of slab tolerances is complete.
 - 2. As a minimum, shoring shall remain in place for the following periods:
 - a. Walls and Columns: 2 days
- B. In multistory construction, extend shoring or reshoring over a sufficient number of stories to distribute loads in such a manner that no floor or member will be excessively loaded or will induce tensile stress in concrete members without sufficient steel reinforcement.
- C. Plan sequence of removal of shores and reshore to avoid damage to concrete. Locate and provide adequate reshoring to support construction without excessive stress or deflection.

3.11 CONCRETE SURFACE REPAIRS

- A. Repair and patch defective areas when approved by Architect. Remove and replace concrete that cannot be repaired and patched to Architect's approval. Repair and replacement work will be done at Contractor's expense.
- B. Patching Mortar: Mix dry-pack patching mortar, consisting of one part portland cement to two and one-half parts fine aggregate passing a No. 16 sieve, using only enough water for handling and placing.
- C. Slabs on Grade: After entire slab is finished, shrinkage cracks that may appear shall be patched as follows:
 - 1. Where slab is not exposed or where appearance is not important, cracks larger than 1/32 inch wide shall be filled with cement grout and struck off level with surface.
 - 2. Where slab is exposed and appearance is important, unsightly cracks shall be

repaired in a manner satisfactory in appearance to Architect. If this cannot be accomplished, concrete shall be considered defective.

- D. Repairing Formed Surfaces: Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycombs, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning.
3. Immediately after form removal, cut out honeycombs, rock pockets, and voids more than 1/2 inch in any dimension in solid concrete, but not less than 1 inch in depth. Make edges of cuts perpendicular to concrete surface. Clean, dampen with water, and brush-coat holes and voids with bonding agent. Fill and compact with patching mortar before bonding agent has dried. Fill form-tie voids with patching mortar or cone plugs secured in place with bonding agent.
 4. Honeycombed areas shall be removed down to sound concrete, coated with a bonding grout or approved compound and patched using a low shrinkage high bond mortar. Patched areas shall be cured by being kept damp for at least 5 days.
 5. Repair defects on surfaces exposed to view by blending white portland cement and standard portland cement so that, when dry, patching mortar will match surrounding color. Patch a test area at inconspicuous locations to verify mixture and color match before proceeding with patching. Compact mortar in place and strike off slightly higher than surrounding surface.
 6. Repair defects on concealed formed surfaces that affect concrete's durability and structural performance as determined by Architect.
 7. Repairing Unformed Surfaces: Test unformed surfaces, such as floors and slabs, for finish and verify surface tolerances specified for each surface. Correct low and high areas. Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template.
 8. Repair finished surfaces containing defects. Surface defects include spalls, popouts, honeycombs, rock pockets, crazing and cracks in excess of 0.01 inch wide or that penetrate to reinforcement or completely through unreinforced sections regardless of width, and other objectionable conditions.
 9. After concrete has cured at least 14 days, correct high areas by grinding.
 10. Correct localized low areas during or immediately after completing surface finishing operations by cutting out low areas and replacing with patching mortar. Finish repaired areas to blend into adjacent concrete.
 11. Correct other low areas scheduled to receive floor coverings with a repair underlayment. Prepare, mix, and apply repair underlayment and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface. Feather edges to match adjacent floor elevations.
 12. Correct other low areas scheduled to remain exposed with a repair topping. Cut out low areas to ensure a minimum repair topping depth of 1/4 inch to match adjacent floor elevations. Prepare, mix, and apply repair topping and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.
 13. Repair defective areas, except random cracks and single holes 1 inch or less in diameter, by cutting out and replacing with fresh concrete. Remove defective

areas with clean, square cuts and expose steel reinforcement with at least a 3/4-inch clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding agent. Mix patching concrete of same materials and mixture as original concrete except without coarse aggregate. Place, compact, and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.

14. Repair random cracks and single holes 1 inch or less in diameter with patching mortar. Groove top of cracks and cut out holes to sound concrete and clean off dust, dirt, and loose particles. Dampen cleaned concrete surfaces and apply bonding agent. Place patching mortar before bonding agent has dried. Compact patching mortar and finish to match adjacent concrete. Keep patched area continuously moist for at least 72 hours.

- D. Perform structural repairs of concrete, subject to Architect's approval, using epoxy adhesive and patching mortar.
- E. Repair materials and installation not specified above may be used, subject to Architect's approval.

3.12 CURING AND PROTECTION

- A. Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and ACI 305.1 for hot-weather protection during curing. Concrete shall be maintained at not less than 50 degrees F nor more than 100 degrees F for a period of 72 hours after being deposited.
- B. Protection: Contractor shall be responsible for protection of finished concrete against injury by rain, cold, vibration, animal tracks, marking by visitors, vandalism, etc.
- C. Provide additional curing agents or compounds, not necessarily listed herein, but as recommended and or required for use with shake type hardeners or other special coatings and coverings by their manufacturers for a complete and proper installation.
- D. Where supplementary cementitious materials are used, extra precautions shall be taken to prevent premature drying.
- E. Evaporation Retarder: Apply evaporation retarder to unformed concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.
- F. Formed Surfaces: Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces. If forms remain during curing period, moist cure after loosening forms. If removing forms before end of curing period, continue curing for the remainder of the curing period. Forms heated by sun shall be kept moist during curing period.
- G. Unformed Surfaces: Begin curing immediately after finishing concrete. Cure unformed surfaces, including floors and slabs, concrete floor toppings, and other surfaces.

- H. Cure concrete according to ACI 308.1, by one or a combination of the following methods:
1. Moisture Curing: Keep surfaces continuously moist for not less than seven (7) days with the following materials:
 - a. Water.
 - b. Continuous water-fog spray.
 - c. Absorptive cover, water saturated, and kept continuously wet. Cover concrete surfaces and edges with 12-inch lap over adjacent absorptive covers.
 2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive. Cure for not less than seven (7) days. Immediately repair any holes or tears during curing period using cover material and waterproof tape.
 - a. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive floor coverings.
 - b. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive penetrating liquid floor treatments.
 - c. Cure concrete surfaces to receive floor coverings with either a moisture-retaining cover or a curing compound that the manufacturer certifies will not interfere with bonding of floor covering used on Project.
 3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.
 - a. After curing period has elapsed, remove curing compound without damaging concrete surfaces by method recommended by curing compound manufacturer unless manufacturer certifies curing compound will not interfere with bonding of floor covering used on Project.
 4. Curing and Sealing Compound: Apply uniformly to floors and slabs indicated in a continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Repeat process 24 hours later and apply a second coat. Maintain continuity of coating and repair damage during curing period.
 5. Interior slabs to receive adhesive-applied or resilient flooring: Cure only with moisture retaining cover. Do not cure with curing compound.
 6. Interior slabs to receive thin set of tile: Cure only with moisture retaining cover. Do not cure with curing compound.
- I. Flatwork: Flatwork to be exposed, stained, or painted shall have curing process submitted and approved by the architect prior to construction.
1. Initial Curing Process:
 - a. Mist Spraying: As soon as troweling of concrete surfaces is completed, exposed concrete shall be sprayed continuously with a special atomizer spray nozzle, capable of producing a fine mist. Spraying shall be done without any

dripping of water from nozzle. Amount of spraying shall be such as to maintain surface of concrete moist without any water accumulating on surface. Maintain spraying for a minimum of 12 hours, or until such time as hereinafter described curing process is applied. Mist spraying will not normally be required when the ambient air temperature is below 90 degrees F.

2. Final Curing Process:

- a. Water Curing: Concrete shall be kept wet by mechanical sprinklers or by any other approved method which will keep surfaces continuously wet.
 - b. Saturated Burlap Curing: Finished surfaces shall be covered with a minimum of two layers of heavy burlap which shall be kept saturated during the curing period.
 - c. Curing Compounds: Membrane curing compounds of chlorinated rubber or resin type conforming to ASTM C309 may be used only if specifically approved by Architect. Use of membrane curing compound will not be permitted on surfaces to be painted, or to receive ceramic tile, membrane water-proofing or hardeners and sealers. Membrane curing compound may be used in areas to receive resilient floor tile, provided it is wax-free, compatible with adhesive used and approved by adhesive manufacturer. Agitate curing compounds thoroughly by mechanical means continuously during use and spray or brush uniformly in accordance with manufacturer's recommendations. Apply immediately following final finishing operation. All curing compounds shall conform to State of California Air Resources Board VOC Regulations.
 - d. Waterproof paper conforming to ASTM C 171, or opaque polyethylene film, may be used. Concrete shall be covered immediately following final finishing operation. Anchor paper or film securely and seal all edges in such a manner as to prevent moisture escaping from concrete.
- J. Refer to Drawings for areas of concrete slab not to receive curing compounds or hardening compounds. Where concrete floors are to receive heavy duty coatings, waterproof coatings and the like, verify with coating installer the type of finish required for specified coating.

3.13 SURFACE HARDENER AND SEALER

- A. Seal all interior exposed flatwork with clear sealer, except surfaces receiving ceramic tile, quarry tile, poured flooring or other special finishes specified, or as scheduled on the Drawings.
1. Apply sealer in 2 or 3 coats, in accordance with manufacturer's directions, using the maximum quantity recommended.
 - a. Concrete floors must be thoroughly cured for a minimum of 30 days and completely dry before treatment.
 - b. Surfaces to be treated must be clean, free of membrane curing compounds, dust, oil, grease and other foreign matter.
 - c. Upon completion, concrete surfaces shall be clean and without discoloration or traces of excess hardener left on the surface.

- B. Apply sprayable hardener/sealer at locations as scheduled or as indicated on the Drawings. Apply in accordance with the manufacturer's favorably reviewed application instructions and recommendations.

3.14 GROUTING

- A. Prepare and place grout materials at locations as indicated on the Drawings in accordance with the manufacturer's recommendations and installation instructions.
- B. Pack grout materials solidly between bearing surfaces and bases or plates as indicated and to ensure no voids.

3.15 DEFECTIVE CONCRETE

- A. Defective concrete shall mean any of the following:
 - 1. Concrete not meeting 100 percent of the specified 28 day compressive strength.
 - 2. Concrete exhibiting rock pockets, voids, spalls, streaks, cracks, honeycombing, that has any sawdust, wood, or debris embedded in it, or is otherwise defective, and in the Architect's judgment these defects impair the proper strength or appearance of the work
 - 3. Exposed reinforcing to extent that strength, durability, or appearance is adversely affected.
 - 4. Concrete significantly out of place, line, or level.
 - 5. Concrete not containing the required embedded items.
 - 6. Any concrete work not in accordance with the Specification and Drawings.
- B. Upon determination that concrete strength is defective:
 - 1. Should cylinder tests fall below minimum strength specified, concrete mix for remainder of work shall be adjusted to produce required strength. Core samples shall be taken and tested from cast-in-place concrete where cylinders and samples indicate inferior concrete with less than minimum specified strength.
 - a. Cores of hardened concrete shall be taken and tested in accordance with ASTM C 42 and C 39. Number and location of such cores shall be subject to the approval of Architect.
 - b. Cost of core sampling and testing will be paid for by the Contractor.
 - c. "85 percent" reduction in ACI 318 Section 26.12.4 will not justify low cylinder tests.
- C. Upon determining that concrete surface is defective, Contractor may restore concrete to acceptable condition by cutting, chipping, pointing, patching, grinding, if this can be done without significantly altering strength of structure. Permission to patch defective areas will not be considered a waiver of the right to require removal if patching does not, in the opinion of the Architect, satisfactorily restore quality and appearance.
- D. If core tests indicate that concrete is below the strength specified, or if patching does not restore concrete to specified quality and appearance, the concrete shall be

deemed defective, and shall be removed and replaced without additional cost to the Owner.

- E. No repair work shall begin until the procedure has been reviewed by the Architect and Structural Engineer.

3.16 FIELD QUALITY CONTROL

- A. Testing and Inspecting: Owner will engage a special inspector and qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.

B. Inspections:

1. Steel reinforcement placement.
2. Steel reinforcement welding.
3. Headed bolts and studs.
4. Post-installed concrete anchors, per ICC-ES or IAPMO recommendations.
5. Verification of use of required design mixture.
6. Concrete placement, including conveying and depositing.
7. Curing procedures and maintenance of curing temperature.
8. Verification of concrete strength before removal of shores and forms from beams and slabs.

- C. Concrete Tests: Provide special inspections and testing as described in the "Statement of Structural Special Inspections and Testing" within the structural drawings and as required by this section.

1. A testing program is required prior to start of construction. Testing program to be done in Compliance with the CBC requirements and in collaboration with Testing Laboratory, Design team, contractor, owner and submitted for review by the agency in charge of building enforcement. Requirements below are minimum requirements; additional requirements may be required in final testing program.
2. The following tests shall be made by a recognized testing laboratory selected by the Owner and approved by the governing agency. All tests shall be in accordance with the previously mentioned standards and ACI 318 Section 26.12. A complete record of all tests and inspections shall be kept per CBC Section 1903.1.
 - a. Compressive Strength: Make and cure in accordance with ASTM C31. Test in accordance with ASTM C39 and ACI 318 Section 26.12.
 - 1) A record shall be made of time and of locations of concrete from which samples were taken.
 - 2) Four identical cylinders shall be taken from each pour of 150 cubic yards or 5000 square feet or part thereof, being placed each day per ACI 318 Section 26.12.2. One cylinder shall be tested at age 7 days, and two at age 28 days unless otherwise specified. Preserve remaining cylinder for future use.
 - b. Drying Shrinkage: (applies to lightweight concrete only unless noted otherwise).

- 1) A record shall be made of time cylinders and of locations of concrete from which samples were taken.
 - 2) Three identical 4" x 4" x 11" specimens shall be made from same concrete as used in structure. Percent of shrinkage shall be reported at 21 days after 7 day moist curing period. Average results of 3 specimens shall be used as the accepted value. The value for laboratory cast specimens shall not exceed .075%. If field test specimens are used in lieu of laboratory specimens, a tolerance of +33% may be used.
 - 3) Test specimens in accordance with ASTM C157.
- c. Concrete consistency (slump) shall be tested in accordance with ASTM C143. Perform one slump test for each set of test cylinders taken.
3. Provide full time inspection per CBC Section 1704.3 during the taking of test specimens and during the placing of all concrete and embedded steel.
- D. Reinforcing Steel
1. See Section 03 20 00.
- E. Survey and Adjustment: Continuously observe formwork operations, record such observations on a daily basis, and submit reports of the results. Instrument check forms before and during concrete placement to assure no movement has taken place. Make appropriate corrections to reposition displaced forms.
1. Measure floor and slab flatness and levelness as specified in "Floor Flatness and Levelness Tolerances" Section.
 2. Certify, by written report submitted on a weekly basis, for each level and story that the elevations, finish lines and building lines of the hardened concrete are within tolerances, as substantiated by transit survey; also that all embeds and inserts have been installed within tolerance.
- F. Slab Testing: Cooperate with manufacturer of specified moisture vapor reducing admixture (MVRA) to allow access for sampling and testing concrete for compliance with warranty requirements.
- G. Permeability Test: Test concrete with waterproofing admixture according to COE CRD-C 48.

3.17 ADJUSTING AND CLEANING

- A. Remove all debris, excess materials, tools and equipment resulting from or used in this operation at completion of this work.
- B. Surfaces to be painted shall be smooth and free of substances such as dirt, wax, excessive laitance, grease or materials that would prevent proper bonding of finishes.
1. Removal of foregoing contaminants, and complete removal of parting and curing compounds affecting proper paint bond, shall be responsibility of this Section of Work. Sandblast cleaning shall not be employed without specific approval of Structural Engineer.

END OF SECTION

SECTION 03 35 43.13
DYED CONCRETE FINISHING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Concrete dying.
- B. Concrete sealer/hardener treatment.
- C. Concrete sealer treatment.

1.2 RELATED SECTIONS

- A. Section 03 30 00 – Cast-in-Place Concrete.
- B. Section 03 35 46 – Sealed Concrete Finishing.
- C. Section 07 92 00 – Joint Sealants.

1.3 REFERENCES

- A. The publications listed below form a part of this Section to the extent referenced. The publications are referred to in the text by the basic designation only. Refer to Division 01 for definitions, acronyms, and abbreviations.
- B. Standards, manuals, and codes refer to the latest edition of such standards, manuals, and codes in effect as of the date of issue of this Project Manual, unless indicated otherwise in CBC Chapter 35 and CFC Chapter 80.
- C. Referenced Standards:
 - 1. ANSI B101.1 – Test Method for Measuring Wet Static Coefficient of Friction of Common Hard-Surface Floor Materials.
 - 2. ANSI B101.3 – Test Method for Measuring Wet Dynamic Coefficient of Friction of Common Hard-Surface Floor Materials.
 - 3. ASTM C805 – Standard Test Method for Rebound Number of Hardened Concrete.
 - 4. ASTM G152 – Standard Practice for Operating Open Flame Carbon Arc Light Apparatus for Exposure of Nonmetallic Materials.
 - 5. ASTM G153 – Standard Practice for Operating Enclosed Carbon Arc Light Apparatus for Exposure of Nonmetallic Materials.
 - 6. CPC – Concrete Polishing Council.

1.4 SUBMITTALS

- A. General: Submit in accordance with Division 01.
- B. Product Data: Submit manufacturer's descriptive literature, product specification, and installation instructions for each product.

- C. Certification: Submit letter of Certification from finish system manufacturer stating that the system installer is a Certified Applicator of their products and finishes, and is familiar with proper procedures and installation requirements required by the manufacturer.
- D. Sustainable Building Design Submittals:
 - 1. MSDS.
 - 2. VOC content.
- E. Closeout Submittals:
 - 1. Cleaning and maintenance data.

1.5 PERFORMANCE REQUIREMENTS

- A. Concrete finish system slip resistance: Comply with CBC Chapter 11B.
 - 1. Coefficient of Friction:
 - a. Achieve a minimum of 0.42 for level floor surfaces per ANSI B101.1 Static Coefficient of Friction.
 - b. Achieve a minimum of 0.35 for level floor surfaces per ANSI B101.3 Dynamic Coefficient of Friction.
- B. Concrete sealer/hardener treatment:
 - 1. Impact Strength: Minimum 21 percent increase as tested per ASTM C805.
 - 2. Weathering: No adverse effect to ultraviolet light and water spray as tested per ASTM G152 and ASTM G153.

1.6 QUALITY ASSURANCE

- A. Qualifications:
 - 1. Manufacturer Qualifications: Company specializing in manufacturing products specified in this Section with a minimum five years' experience.
 - 2. Installer Qualifications:
 - a. Installer shall be a Manufacturer Certified Applicator with an adequate number of skilled workmen who are thoroughly trained and experienced in the grinding, polishing, and application of the concrete floor finishing system. Polishing work shall be performed by workmen who are currently certified as Concrete Polishing Tradesman by CPC.
 - b. The product manufacturer shall certify the applicator.
 - c. Applicator shall be experienced in performing specified work similar in design, products, and extent to scope of this Project; with a record of successful in-service performance; and with sufficient production capability, facilities, and personnel to produce specified work.
 - 1) Supervision: Maintain competent supervisor who is at Project during times specified work is in progress, and is currently certified as a Concrete Polishing Craftsman - Level I or higher by CPAA.
 - d. The Certified Applicator shall have successfully installed dyed and polished concrete floor finishing system on a minimum of five projects similar in scope to this project.
- B. Products: All products used on this project shall be VOC compliant in the State of California.

C. Concrete Substrate Requirements:

1. Tolerances: The tolerances listed below shall be achieved under the work of Section 03 30 00.
 - a. Concrete shall have an overall Floor Flatness rating of at least 50 and a local Floor Flatness rating of at least 40.
 - b. Concrete shall have a Floor Levelness rating of at least 30.
2. Cure Time: Prior to application of floor finish system, concrete shall be cured a minimum of 45 days, or as directed by finish system manufacturer.
3. Protection: Petroleum stains are not allowed at areas where floor finish system is to be applied. Provide the following protective measures:
 - a. Diaper all hydraulic equipment.
 - b. Keep all vehicles off concrete slab or provide non-porous drop cloths where vehicles are parked on concrete slab.
 - c. Do not cut metal materials on concrete slab including, but not limited to, piping, conduit, metal studs, or other materials where metal shavings may rust and stain concrete.
 - d. Do not place steel directly on concrete slab.
 - e. All equipment shall be equipped with non-marking tires.
 - f. Cover floor with floor protection product specified in this Section.

D. Mock-Up Requirements:

1. Construct an in-place mock-up at a location where the concrete is scheduled to receive a floor covering demonstrating specified color, pattern, finish sheen, and slip resistance; minimum ten feet by ten feet. Concrete, finishing equipment, and work crew used for the mock-up shall be the same as that used for the building concrete slab pour.
2. Construct mock-ups to demonstrate aesthetic effects, to set quality standards for materials and execution, and to set quality standards for dyed concrete finishing. Test mock-up to ensure slip-resistance compliance as specified in this Section.
3. Use products and procedures as intended for final work as performed by experienced applicators specialized in the work of this Section.
4. Accepted mock-ups will serve as the standard of quality by which the remainder of the work of this Section will be judged.
5. Protect mock-up from damage.
6. Do not cover mock-up with floor covering until dyed concrete installation has been completed and accepted.

E. Pre-Installation Meetings:

1. Conduct pre-installation meeting in accordance with Division 01.
2. Convene pre-installation meeting prior to concrete slab pour and prior to commencing work of this Section.
3. Coordinate work in this Section with work in related Sections.

F. Walkway Auditor: Certified by CPAA or NFSI to test bonded abrasive polished concrete floors for static coefficient of friction according to ANSI B101.1 and dynamic coefficient of friction according to ANSI B101.3.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Comply with requirements of Division 01.
- B. Deliver products in manufacturer's original containers, dry and undamaged, with seals and labels intact.
- C. Storage and Protection: Store materials in a dry secure place.

1.8 PROJECT/SITE CONDITIONS

- A. Environmental Requirements:
 - 1. Comply with manufacturer's written instructions for substrate temperature and moisture content, ambient temperature and humidity, ventilation, and other conditions affecting concrete finishing performance.
 - 2. Close areas to traffic during and after floor application as specified in this Section.

1.9 MAINTENANCE

- A. Cleaning and Maintenance Data: Submit in accordance with Division 01. Provide cleaning and maintenance information.

PART 2 PRODUCTS

2.1 MANUFACTURERS AND PRODUCTS

- A. Manufacturers and products specified are the Basis of Design for the dyed concrete finishing system and are listed to establish minimum requirements as to quality and performance. Comply with requirements of Division 01 for substitutions.
- B. Concrete Dyes:
 - 1. AmeriPolish Dye distributed by RetroPlate System; www.retroplatesystem.com.
 - 2. Or accepted equal.
- C. Concrete Polishing and Sealer/Hardener Treatment:
 - 1. Curecrete Distribution, Inc.; www.ashfordformula.com. Northern California Representative – Stephen Gamble; phone: 916-215-6819. Product: Ashford Formula.
 - 2. Helix Concrete Dyes distributed by RetroPlate System, a division of Advanced Floor Products, Provo, UT; 801-812-3420, www.retroplatesystem.com.
 - 3. or accepted equal.
- D. Concrete Sealer:
 - 1. RetroGuard as manufactured by Advanced Floor Products.
 - 2. Or accepted equal.
- E. Floor Protection:
 - 1. The System with EZ Cover as manufactured by McTech Group, Inc., Loganville, GA; 866-913-8363, www.mctechgroup.com or accepted equal.
 - 2. System shall be breathable and biodegradable.
 - 3. System shall not be used as a curing sheet.

2.2 RELATED MATERIALS

- A. Water: Potable.

2.3 FINISH

- A. Hard steel troweled concrete slab.
- B. Colors: As indicated on Drawings.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine substrate in the presence of installer for conditions affecting performance of finish.
- B. Alkalinity Testing: Measure pH according to method indicated in ASTM F710.
 - 1. Acceptable Results: pH between 8 and 12.
- C. Verify that the concrete slab meets the special requirements for dyed and polished floor finish as specified in Section 03 30 00.
- D. Inspect and verify that the floor does not have curled joints, large cracks, spalling or lippage. If lippage or curled joints are present, correct conditions as recommended by system manufacturer.
- E. Report unacceptable conditions to Architect. Begin installation only when unacceptable conditions have been corrected.

3.2 PREPARATION

- A. Protect adjacent surfaces such as walls, cabinets, doors, frames, and equipment using 3M Blue Masking Tape and polyethylene sheet.
- B. Clean concrete surface, free from oil, grease, and other surface contaminants that may affect surface treatment. Employ methods and procedures that will prevent dust, airborne contaminants, and damage to adjacent surfaces.

3.3 APPLICATION

- A. General:
 - 1. Apply products of dyed concrete system strictly in accordance with manufacturer's instructions.
 - 2. Comply with manufacturer's written instructions for substrate temperature and moisture content, ambient temperature and humidity, ventilation, and other conditions affecting finish system performance.
- B. Concrete Dyes:
 - 1. Prepare and clean concrete surface free from oil, grease, and other surface contaminants. Pressure rinse with clean water. Power scrub with water and neutralizer, rinse thoroughly and vacuum dry.
 - 2. Mask concrete surface to create pattern as shown on Drawings.

3. Apply color dye in the locations indicated on Drawings in accordance with manufacturer's instructions.
4. Maintain wet edge, working newly applied solution into edges of adjacent wet edges of previously treated surfaces.
5. Maintain consistent saturation throughout application.
6. Complete dye treatment for each color pattern before proceeding with next color pattern.
7. Avoid splashing, dripping, or puddling of solution on adjacent substrates. Clean and remove residue by spraying with clean water and scrubbing. Rinse until rinse water runs clean. Control and collect water run-off to keep from discoloring surface not designated for dye.

C. Concrete Sealer/Hardening Treatment:

1. Apply penetrating sealer/hardener (Ashford Formula) at coverage rates as recommended by manufacturer. Use a power scrubber with a stiff nylon-bristled brush to work the sealer into the pores of the concrete surface. Rinse treated surfaces with potable water at least three times to ensure that all sealer/hardener residue has been removed.

D. Concrete Sealer Treatment:

1. Apply sealer (Retro Guard) at coverage rates as recommended by manufacturer. Use a high speed buffer machine to work the sealer into the pores of the concrete surface.
2. After scrubbing, use a mop and ringer bucket with clean water to rinse the surface of remaining residue.
3. Apply a second coat two hours to four hours after the first coat.
4. Let dry minimum 24 hours before opening to light traffic.

E. Concrete Slab Joint Treatment:

1. Fill slab joints with clear sealant under provisions of Section 07 92 00.

3.4 FIELD QUALITY CONTROL

- A. Field Testing: Engage a qualified walkway auditor to perform field testing to determine if polished concrete floor finish complies with specified coefficient of friction.
1. Test per ANSI B101.1 for static coefficient of friction.
 2. Test per ANSI B101.3 for dynamic coefficient of friction.

3.5 PROTECTION

- A. At all areas of concrete floor finish system, protect finished work until Project Completion in accordance with manufacturer's recommendations using floor protection system specified in this Section.

3.6 CLEANING

- A. Remove protective covering. Repair damage to adjacent surfaces at no additional cost to Owner.
- B. Clean as recommended by manufacturer. Do not use materials or methods which may damage finish surface or surrounding construction.

END OF SECTION

SECTION 03 35 46
SEALED CONCRETE FINISHING

PART 1 GENERAL

1.1 SECTION INCLUDES W1

- A. Concrete sealer/hardener treatment.
- B. Concrete sealer treatment.

1.2 RELATED SECTIONS

- A. Section 03 30 00 – Cast-In-Place Concrete.
- B. Section 03 35 43.13 – Dyed Concrete Finishing.

1.3 REFERENCES

- A. The publications listed below form a part of this Section to the extent referenced. The publications are referred to in the text by the basic designation only. Refer to Division 01 for definitions, acronyms, and abbreviations.
- B. Standards, manuals, and codes refer to the latest edition of such standards, manuals, and codes in effect as of the date of issue of this Project Manual, unless indicated otherwise in CBC Chapter 35 and CFC Chapter 80.
- C. Referenced Standards:
 - 1. ANSI B101.1 – Test Method for Measuring Wet Static Coefficient of Friction of Common Hard-Surface Floor Materials.
 - 2. ANSI B101.3 – Test Method for Measuring Wet Dynamic Coefficient of Friction of Common Hard-Surface Floor Materials.
 - 3. ASTM C805 – Standard Test Method for Rebound Number of Hardened Concrete.
 - 4. ASTM G23 – Standard Practice for Operating Light-Exposure Apparatus (Carbon-Arc Type) With and Without Water for Exposure of Nonmetallic Materials.

1.4 SUBMITTALS

- A. General: Submit in accordance with Division 01.
- B. Product Data: Submit manufacturer's descriptive literature, product specification, and installation instructions for each product.
- C. Certification: Submit letter of Certification from finish system manufacturer stating that the system installer is a Certified Applicator of their products and finishes, and is familiar with proper procedures and installation requirements required by the manufacturer.
- D. Sustainable Building Design Submittals:
 - 1. MSDS.
 - 2. VOC content.

E. Closeout Submittals:

1. Maintenance and cleaning data.

1.5 PERFORMANCE REQUIREMENTS

A. Concrete finish system slip resistance: Comply with CBC Chapter 11B.

1. Coefficient of Friction:

- a. Achieve a minimum of 0.42 for level floor surfaces per ANSI B101.1 Static Coefficient of Friction.
- b. Achieve a minimum of 0.35 for level floor surfaces per ANSI B101.3 Dynamic Coefficient of Friction.

B. Concrete polishing and sealer/hardener treatment:

1. Impact Strength: Minimum 21 percent increase as tested per ASTM C805.
2. Weathering: No adverse effect to ultraviolet light and water spray as tested per ASTM G23.

1.6 QUALITY ASSURANCE

A. Qualifications:

1. Manufacturer Qualifications: Firm specializing in manufacturing products specified in this Section with a minimum five years' experience.
2. Applicator Qualifications: Firm specializing in installing work specified in this Section acceptable to manufacturer with experience on at least five projects of similar nature in the past three years. The product manufacturer shall certify the applicator.

B. Products: All products used on this project shall be VOC compliant in the State of California.

C. Concrete Substrate Requirements:

1. Finish: All concrete floor surfaces scheduled to receive a sealed finish shall have a smooth, hard, glazed steel trowel finish. This finish shall be achieved under the work of Section 03 33 00.
2. Cure Time: Prior to application of floor sealer/hardener treatment, concrete shall be cured a minimum of 45 days, or as directed by finish system manufacturer.
3. Protection: Petroleum stains are not allowed at areas where floor finish system is to be applied. Provide the following protective measures:
 - a. Diaper all hydraulic equipment.
 - b. Keep all vehicles off concrete slab or provide non-porous drop cloths where vehicles are parked on concrete slab.
 - c. Do not cut pipe on concrete slab.
 - d. Do not place steel directly on concrete slab.
 - e. All equipment shall be equipped with non-marking tires.
 - f. Cover floor with floor protection product specified in this Section.

D. Pre-Installation Meetings:

1. Conduct pre-installation meeting in accordance with Division 01.

2. Convene pre-installation meeting prior to commencing work of this Section.
3. Coordinate work in this Section with work in related Sections.
4. Take minutes of meeting. Distribute to attendees and concerned parties within five days.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Comply with requirements of Division 01.
- B. Deliver products in manufacturer's original containers, dry and undamaged, with seals and labels intact.
- C. Storage and Protection: Store materials in a dry secure place.

1.8 PROJECT/SITE CONDITIONS

- A. Environmental Requirements:
 1. Comply with manufacturer's written instructions for substrate temperature and moisture content, ambient temperature and humidity, ventilation, and other conditions affecting concrete finishing performance.
 2. Close areas to traffic during and after floor application as specified in this Section.

1.9 MAINTENANCE

- A. Operations and Maintenance Data: Submit in accordance with Division 01. Provide cleaning and maintenance information.

PART 2 PRODUCTS

2.1 MANUFACTURERS AND PRODUCTS

- A. Manufacturers and products are the Basis of Design for the sealed concrete finishing system and are listed to establish minimum requirements as to quality and performance. Comply with provisions of Division 01 for substitutions.
- B. Concrete Sealer/Hardener Treatment:
 1. Ashford Formula by Curecrete Distribution, Inc., Springville, UT; 800-998-5664, www.ashfordformula.com.
 2. or accepted equal.
- C. Concrete Sealer:
 1. Retro Guard by Advanced Floor Products, Provo, UT; 801-812-3420, www.retroplatesystem.com.
 2. Or accepted equal.
- D. Floor Protection:
 1. The System with EZ Cover as manufactured by McTech group, Inc., Loganville, GA; 866-913-8363, www.mctechgroup.com. System shall be breathable and biodegradable.
 2. Or accepted equal.

2.2 RELATED MATERIALS

- A. Water: Potable.
- B. Masking Tape: Blue Masking Tape by 3M or accepted equal.

2.3 FINISH

- A. Hard steel troweled concrete slab.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine substrate in the presence of installer for conditions affecting performance of finish.
- B. Verify that the concrete slab meets the tolerances for concrete floor slabs as specified in Section 03 30 00.
- C. Report unacceptable conditions to Architect. Begin installation only when unacceptable conditions have been corrected.

3.2 PREPARATION

- A. Protect adjacent surfaces such as walls, cabinets, doors, frames, and equipment using 3M Blue Masking Tape and polyethylene sheet.
- B. Clean concrete surface, free from oil, grease, and other surface contaminants that may affect surface treatment. Employ methods and procedures that will prevent dust, airborne contaminants, and damage to adjacent surfaces.

3.3 APPLICATION

- A. General:
 - 1. Apply products of sealed concrete system strictly in accordance with manufacturer's instructions.
 - 2. Clean concrete surface, free from oil, grease, and other surface contaminants that may affect surface treatment. Employ methods and procedures that will prevent dust, airborne contaminants, and damage to adjacent surfaces.
- B. Concrete Sealer/Hardener Treatment:
 - 1. Apply penetrating sealer/hardener (Ashford Formula) at coverage rates as recommended by manufacturer. Use a power scrubber with a stiff nylon-bristled brush to work the sealer into the pores of the concrete surface.
- C. Concrete Sealer Treatment:
 - 1. Apply sealer (Retro Guard) at coverage rates as recommended by manufacturer. Use a power scrubber with a stiff nylon-bristled brush to work the sealer into the pores of the concrete surface.
 - 2. After scrubbing, use a mop and ringer bucket with clean water to rinse the surface of remaining residue.
 - 3. Apply a second coat two hours to four hours after the first coat.
 - 4. Let dry (minimum 24 hours) before opening to light traffic.

3.4 FIELD QUALITY CONTROL

- A. Field Testing: Engage a qualified walkway auditor to perform field testing to determine if polished concrete floor finish complies with specified coefficient of friction.
 - 1. Test per ANSI B101.1 for static coefficient of friction.
 - 2. Test per ANSI B101.3 for dynamic coefficient of friction.

3.5 PROTECTION

- A. At all areas of exposed concrete floor finish, protect finished work until Project Completion in accordance with manufacturer's recommendations using floor protection system specified in this Section.

3.6 CLEANING

- A. Remove protective covering. Repair damage to adjacent surfaces at no cost to Owner.
- B. Clean as recommended by manufacturer. Do not use materials or methods which may damage finish surface or surrounding construction.

END OF SECTION

SECTION 04 05 13
MASONRY MORTARING

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 SECTION INCLUDES

- A. Mortar for masonry.

1.3 RELATED REQUIREMENTS

- A. Section 04 05 16 – Masonry Grouting.
- B. Section 04 22 00 – Concrete Unit Masonry

1.4 REFERENCE STANDARDS

- A. Utilize the edition of the listed document as identified in the “Design Criteria Notes” in the structural drawings. If not listed in the “Design Criteria Notes”, use the edition adopted or referenced by the listed governing building code or material standard. If no specific edition is adopted, use the latest edition.
 - 1. ASTM C5 - Standard Specification for Quicklime for Structural Purposes.
 - 2. ASTM C91 - Standard Specification for Masonry Cement.
 - 3. ASTM C94 - Standard Specification for Ready-Mixed Concrete.
 - 4. ASTM C144 - Standard Specification for Aggregate for Masonry Mortar.
 - 5. ASTM C150 - Standard Specification for Portland Cement.
 - 6. ASTM C207 - Standard Specification for Hydrated Lime for Masonry Purposes.
 - 7. ASTM C270 - Standard Specification for Mortar for Unit Masonry.
 - 8. ASTM C780 - Standard Test Method for Preconstruction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry.
 - 9. ASTM C979 - Standard Specification for Pigments for Integrally Colored Concrete.
 - 10. ASTM C1072 - Standard Test Methods for Measurement of Masonry Flexural Bond Strength.
 - 11. ASTM C1314 - Standard Test Method for Compressive Strength of Masonry Prisms.
 - 12. ASTM C1714 - Standard Specification for Preblended Dry Mortar Mix for Unit Masonry.
 - 13. ASTM E518 - Standard Test Methods for Flexural Bond Strength of Masonry.
 - 14. TMS 402/602 - Building Code Requirements and Specification for Masonry Structures.

1.5 SUBMITTALS

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

- B. Product Data: Include design mix and indicate whether the Proportion or Property specification of ASTM C270 is to be used. Also include required environmental conditions and admixture limitations.
- C. Samples: Submit two samples of mortar, illustrating mortar color and color range.
- D. Reports: Submit reports on mortar indicating compliance of mortar to property requirements of ASTM C270 and test and evaluation reports per ASTM C780.
- E. Manufacturer's Certificate: Certify that products meet or exceed specified requirements. Submit documentation on all materials including but not limited to:
 - 1. Aggregates.
 - 2. Cement.
 - 3. Admixtures.

1.6 QUALITY ASSURANCE

- A. Comply with provisions of TMS 402/602, except where exceeded by requirements of Contract Documents.
 - 1. Maintain one copy of each on the Project site.

1.7 PRECONSTRUCTION TESTING

- A. A testing program is required prior to start of construction. Testing program to be done in Compliance with the current building design code requirements and in collaboration with Testing Laboratory, Design team, contractor, owner and submitted for review by the agency in charge of building enforcement. Requirements below are minimum requirements; additional requirements may be required in final testing program.
- B. Testing will be conducted by an independent test agency, in accordance with provisions of Section 01 40 00 - Quality Requirements.
- C. Sample panel construction: For masonry governed by Level 2 or 3 Quality Assurance, construct sample panels of masonry walls per TMS 602 Article 1.6 D. The specifier has the option of permitting a segment of the masonry construction to serve as a sample panel or requiring a separate stand-alone panel.
- D. Mortar Mixes: Test mortars prebatched by weight in accordance with ASTM C780 recommendations for preconstruction testing.
 - 1. Test results will be used to establish optimum mortar proportions and establish quality control values for construction testing.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Maintain packaged materials clean, dry, and protected against dampness, freezing, and foreign matter.

1.9 FIELD CONDITIONS

- A. Cold Weather Construction to be in accordance with TMS 602.
- B. Hot Weather Construction to be in accordance with TMS 602.

PART 2 PRODUCTS

2.1 MORTAR APPLICATIONS

- A. At Contractor's option, mortar may be field-mixed from packaged dry materials, made from factory premixed dry materials with addition of water only, or ready-mixed.
- B. Mortar Color: Natural gray unless otherwise indicated.
- C. Mortar Mix Designs: ASTM C270, Property Specification.
 - 1. Structural Load Bearing and Shear Walls: Type S.
 - 2. Mortar shall be made with admixtures that are proportioned, added and mixed in strict accordance with manufacturer's directions. Calcium Chloride cannot be used in mortar mixes.

2.2 MATERIALS

- A. Packaged Dry Material for Mortar for Unit Masonry: Premixed Portland cement, hydrated lime, and sand; complying with ASTM C1714 and capable of producing mortar of the specified strength in accordance with ASTM C270 with the addition of water only.
- B. Portland Cement: ASTM C150, Type I or II, low alkali; natural gray.
- C. Hydrated Lime: ASTM C207, Type S.
- D. Quicklime: ASTM C5, non-hydraulic type.
- E. Mortar Aggregate: ASTM C144.
- F. Pigments for Colored Mortar: Pure, concentrated mineral pigments specifically intended for mixing into mortar and complying with ASTM C979.
 - 1. Color(s): As selected by Architect from manufacturer's full range.
- G. Water: Clean and potable.
- H. Bonding Agent: Latex type.
- I. Integral Water-Repellent and Efflorescence-Control Admixture: Polymeric liquid admixture added to mortar at the time of manufacture.
 - 1. Performance of Mortar with Integral Water Repellent:
 - a. Water Permeance: When tested per ASTM E514 and for a minimum of 72 hours:
 - 1) No water visible on back of wall above flashing at the end of 24 hours.
 - 2) No flow of water from flashing equal to or greater than 0.032 gallons per hour at the end of 24 hours.
 - 3) No more than 25 percent of wall area above flashing visibly damp at end of test.
 - b. Flexural Bond Strength: ASTM C1072; minimum 10 percent increase.
 - c. Compressive Strength: ASTM C1314; maximum 5 percent decrease.
 - 2. Use only in combination with masonry units produced with integral water-repellent admixture.

3. Product: Master Builders MasterPel 240MA.

2.3 MORTAR MIXING

- A. Thoroughly mix mortar ingredients using mechanical batch mixer, in accordance with ASTM C270 and in quantities needed for immediate use.
- B. Mix mortar in accordance with TMS 602 Articles 2.6A and 2.6B.
- C. Accurately measure materials in suitably calibrated devices; shovel measurements are not acceptable.
- D. Maintain sand uniformly damp immediately before the mixing process.
- E. Place sand, cement and water in mixer in that order and mix for at least 2 minutes; then add lime putty and continue mixing as long as necessary to secure a uniform mass, but in no case less than 10 minutes.
- F. Colored Mortar: Proportion selected pigments and other ingredients to match Architect's sample, without exceeding manufacturer's recommended pigment-to-cement ratio; mix in accordance with manufacturer's instructions, uniform in coloration.
- G. Add admixtures in accordance with manufacturer's instructions; mix uniformly.
- H. Do not use anti-freeze compounds to lower the freezing point of mortar.
- I. If water is lost by evaporation, re-temper only within two hours of mixing. Retempering by dashing water over mortar will not be permitted.

PART 3 EXECUTION

3.1 PREPARATION

- A. Apply bonding agent to existing concrete surfaces.

3.2 INSTALLATION

- A. Install mortar to requirements of section(s) in which masonry is specified.
- B. Remove excess mortar from grout spaces.

3.3 FIELD QUALITY CONTROL

- A. An independent testing agency will perform field tests, in accordance with provisions of Section 01 40 00 - Quality Requirements.

3.4 DEFECTIVE MORTAR

- A. Should the strength of mortar fall below that specified, remainder of Work shall be adjusted to reach required strength. Work in place representing inferior mortar and indicating a strength less than the minimum specified shall be tested by taking and testing core samples. Number and location of cores shall be determined by Structural Engineer.
- B. Should compression tests of cores fail to meet required strength, masonry shall be deemed to be defective and shall be removed and replaced at no cost to Owner.

- C. Costs relative to taking and testing of core samples shall be paid by Owner and will be deducted from Contract Amount. Cost of patching core holes shall be borne by Contractor.

END OF SECTION

SECTION 04 05 16
MASONRY GROUTING

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 SECTION INCLUDES

- A. Grout for masonry.

1.3 RELATED REQUIREMENTS

- A. Section 04 05 13 – Masonry Mortaring.
- B. Section 04 22 00 – Concrete Unit Masonry

1.4 REFERENCE STANDARDS

- A. Utilize the edition of the listed document as identified in the “Design Criteria Notes” in the structural drawings. If not listed in the “Design Criteria Notes”, use the edition adopted or referenced by the listed governing building code or material standard. If no specific edition is adopted, use the latest edition.
 - 1. ASTM C5 - Standard Specification for Quicklime for Structural Purposes.
 - 2. ASTM C94 - Standard Specification for Ready-Mixed Concrete.
 - 3. ASTM C150 - Standard Specification for Portland Cement.
 - 4. ASTM C404 - Standard Specification for Aggregates for Masonry Grout.
 - 5. ASTM C476 - Standard Specification for Grout for Masonry.
 - 6. ASTM C780 - Standard Test Method for Preconstruction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry.
 - 7. ASTM C979 - Standard Specification for Pigments for Integrally Colored Concrete.
 - 8. ASTM C1019 - Standard Test Method for Sampling and Testing Grout for Masonry.
 - 9. ASTM C1072 - Standard Test Methods for Measurement of Masonry Flexural Bond Strength.
 - 10. ASTM C1314 - Standard Test Method for Compressive Strength of Masonry Prisms.
 - 11. ASTM E518 - Standard Test Methods for Flexural Bond Strength of Masonry.
 - 12. TMS 402/602 - Building Code Requirements and Specification for Masonry Structures.

1.5 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data:

1. Include mix design.
2. Include required environmental conditions and admixture limitations.
- C. Reports: Submit reports on grout indicating compliance of component grout materials to requirements of ASTM C476 and test and evaluation reports to requirements of ASTM C1019.
- D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements. Submit documentation on all materials including but not limited to:
 1. Aggregates.
 2. Cement.
 3. Admixtures.
- E. Manufacturer's Installation Instructions: Submit packaged dry mortar manufacturer's installation instructions.

1.6 QUALITY ASSURANCE

- A. Comply with provisions of TMS 402/602, except where exceeded by requirements of Contract Documents.
 1. Maintain one copy of each on the Project site.

1.7 PRECONSTRUCTION TESTING

- A. A testing program is required prior to start of construction. Testing program to be done in Compliance with the current building design code requirements and in collaboration with Testing Laboratory, Design team, contractor, owner and submitted for review by the agency in charge of building enforcement. Requirements below are minimum requirements; additional requirements may be required in final testing program.
- B. Testing will be conducted by an independent test agency, in accordance with provisions of Section 01 40 00 - Quality Requirements.
- C. Sample panel construction: For masonry governed by Level 2 or 3 Quality Assurance, construct sample panels of masonry walls per TMS 602. The specifier has the option of permitting a segment of the masonry construction to serve as a sample panel or requiring a separate stand-alone panel.
- D. Grout Mixes: Test grout batches in accordance with ASTM C1019 procedures.
 1. Test results will be used to establish optimum grout proportions and establish quality control values for construction testing.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Maintain packaged materials clean, dry, and protected against dampness, freezing, and foreign matter.

1.9 FIELD CONDITIONS

- A. Cold Weather Construction to be in accordance with TMS 602.
- B. Hot Weather Construction to be in accordance with TMS 602.

PART 2 PRODUCTS

2.1 GROUT APPLICATIONS

- A. At Contractor's option, grout may be field-mixed from packaged dry materials, made from factory premixed dry materials with addition of water only, or ready-mixed.
- B. Grout Mix Designs:
 - 1. Provide premixed type in accordance with ASTM C476.
 - 2. Grout shall have a 28-day compressive strength of 2000 psi or f'm as indicated in the Drawings, whichever is greater. Grout shall conform to TMS 602.
 - 3. Fine Grout or Coarse Grout: The contractor is to determine the proper application of Fine Grout or Coarse Grout based on the grout pour height used and the clear grout space width for multi-wythe construction or clear grout space dimensions for hollow units in accordance with TMS 402 Table 3.2.1.
 - 4. Add grout admixture in accordance with the manufacturer's recommendations. Calcium Chloride cannot be used in grout mixes.

2.2 MATERIALS

- A. Packaged Dry Material for Grout for Masonry: Premixed cementitious materials and dried aggregates; capable of producing grout of the specified strength in accordance with ASTM C476 with the addition of water only.
 - 1. Type: Fine or Coarse.
- B. Portland Cement: ASTM C150, Type I or II, low alkali; natural gray.
- C. Quicklime: ASTM C5, non-hydraulic type.
- D. Grout Aggregate: ASTM C404.
- E. Water: Clean and potable.
- F. Water-Reducing Admixture: expanding, retarding, and water-reducing.
 - 1. Product: Sika Grout Aid.
- G. Bonding Agent: Latex type.
- H. Integral Water-Repellent and Efflorescence-Control Admixture: Polymeric liquid admixture added to grout at the time of manufacture.
 - 1. Use only in combination with masonry units produced with integral water-repellent admixture.
 - 2. Product: Master Builders MasterPel 240MA.
- I. Bond Beam Mesh: Barrier to stop grout when filling block wall cells
 - 1. Manufacturers:
 - a. Grout Stop: www.wirebond.com/products/grout-stop
 - b. Mortar/Grout Screen: www.h-b.com

c. Mortar Mesh: www.bontool.com/mortar-mesh-100-x-4-81-118

2.3 GROUT MIXING

- A. Mix grout in accordance with ASTM C476.
- B. Thoroughly mix grout ingredients in quantities needed for immediate use in accordance with ASTM C476 for fine and coarse grout.
- C. Add admixtures in accordance with manufacturer's instructions; mix uniformly.
- D. Do not use anti-freeze compounds to lower the freezing point of grout.

PART 3 EXECUTION

3.1 PREPARATION

- A. Apply bonding agent to existing concrete surfaces.
- B. Plug clean-out holes for grouted masonry with brick masonry units. Brace masonry to resist wet grout pressure.

3.2 INSTALLATION

- A. Install grout to requirements of section(s) in which masonry is specified.
- B. Work grout into masonry cores and cavities to eliminate voids.
- C. Do not install grout in lifts greater than 16 inches without reconsolidating.
- D. Do not displace reinforcement while placing grout.

3.3 GROUTING

- A. General Requirements:
 - 1. All cells shall be grouted solid as indicated on the Drawings.
 - 2. Use of grout lifts above or below 5'-4" at Contractor's option.
 - 3. Use grout pump, hopper or bucket to place grout.
 - 4. Place grout in final position within 1 1/2 hours after introduction of mixing water.
 - 5. Stop grout approximately 1 1/2 inches below top of last course; except at top course bring grout to top of wall. Do not form grout keys within beams.
- B. Grout pours less than 5'-4":
 - 1. Do not lay units higher than 5'-4" before grouting.
 - 2. If mortar has been allowed to set prior to grouting, remove all fins protruding more than 1/2 inch into grout space.
 - 3. Conform to requirements of TMS 602.
 - 4. Consolidate each lift with mechanical vibration twice per Article 3.5 E of TMS 602. Once while placing grout and once more after initial absorption of water but before set.
- C. Grout pours greater than 5'-4":

1. Conform to requirements of TMS 602.
2. Layup walls, subject to maximum height limitations of Table 6 under Article 3.5 of TMS 602.
3. Provide clean out holes at the bottom of every pour in cells containing vertical reinforcement. Construct clean out courses with open bottom bond beam units inverted to permit cleaning of all cells by flushing. Cleanouts shall be not less than 3x4 inch openings cut from one face shell. Do not plug clean out holes until masonry work, reinforcement, and final cleaning of the grout spaces have been completed and inspected.
4. Clean mortar droppings from the bottom of the grout space and from reinforcing steel. Remove mortar fins protruding more than ½ inch into the grout space by dislodging the projections with a rod or stick as the work progresses or by washing the grout space at least twice a day during erection using a high-pressure stream of water.

3.4 FIELD QUALITY CONTROL

- A. An independent testing agency will perform field tests, in accordance with provisions of Section 01 40 00 - Quality Requirements.
- B. Test and evaluate grout in accordance with ASTM C1019 procedures.
 1. Test with same frequency as specified for masonry units.

3.5 DEFECTIVE GROUT

- A. Should the strength of grout fall below that specified, remainder of Work shall be adjusted to reach required strength. Work in place representing inferior grout and indicating a strength less than the minimum specified shall be tested by taking and testing core samples. Number and location of cores shall be determined by Structural Engineer.
- B. Should compression tests of cores fail to meet required strength, masonry shall be deemed to be defective and shall be removed and replaced at no cost to Owner.
- C. Costs relative to taking and testing of core samples shall be paid by Owner and will be deducted from Contract Amount. Cost of patching core holes shall be borne by Contractor.

END OF SECTION

SECTION 04 22 00
CONCRETE UNIT MASONRY

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Concrete block.
- B. Reinforcement.
- C. Bolts and Post-Installed Anchors.
- D. Accessories.

1.2 RELATED REQUIREMENTS

- A. Section 03 10 00 - Concrete Forming and Accessories.
- B. Section 03 20 00 - Concrete Reinforcing.
- C. Section 03 30 00 - Cast-in-Place Concrete.
- D. Section 04 05 13 - Masonry Mortaring.
- E. Section 04 05 16 - Masonry Grouting.
- F. Section 05 50 00 - Metal Fabrications.
- G. Section 06 10 00 - Rough Carpentry.

1.3 REFERENCE STANDARDS

- A. Utilize the edition of the listed document as identified in the "Design Criteria Notes" in the structural drawings. If not listed in the "Design Criteria Notes", use the edition adopted or referenced by the listed governing building code or material standard. If no specific edition is adopted, use the latest edition.
 - 1. ASTM A153 - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
 - 2. ASTM A480 - Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip.
 - 3. ASTM A580 - Standard Specification for Stainless Steel Wire.
 - 4. ASTM A615 - Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
 - 5. ASTM A641 - Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire.
 - 6. ASTM A653 - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

7. ASTM A706 - Standard Specification for Deformed and Plain Low-Alloy Steel Bars for Concrete Reinforcement.
8. ASTM A951 - Standard Specification for Steel Wire for Masonry Joint Reinforcement.
9. ASTM A1064 - Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.
10. ASTM C90 - Standard Specification for Loadbearing Concrete Masonry Units.
11. ASTM C140 - Standard Test Methods for Sampling and Testing Concrete Masonry Units and Related Units.
12. ASTM C150 - Standard Specification for Portland Cement.
13. ASTM C979 - Standard Specification for Pigments for Integrally Colored Concrete.
14. ASTM C1314 - Standard Test Method for Compressive Strength of Masonry Prisms.
15. ASTM E154 - Standard Test Methods for Water Vapor Retarders Used in Contact with Earth Under Concrete Slabs, on Walls, or as Ground Cover.
16. ASTM E514 - Standard Test Method for Water Penetration and Leakage Through Masonry.
17. TMS 402/602 - Building Code Requirements and Specification for Masonry Structures.

1.4 ADMINISTRATIVE REQUIREMENTS

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

1.5 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide data for masonry units, fabricated wire reinforcement, and masonry accessories.
- C. Shop Drawings: Indicate pertinent dimensions, materials, anchorage, size and type of fasteners.
- D. Samples: Submit four samples of decorative block units to illustrate color, texture, and extremes of color range.
- E. Manufacturer's Certificate: Certify that masonry units meet or exceed specified requirements.
- F. Test Reports: Concrete masonry manufacturer's test reports for units with integral water repellent admixture where utilized.
- G. Manufacturer's Qualification Statement.
- H. Installer's Qualification Statement.

- I. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.

- 1. See Section 01 60 00 - Product Requirements, for additional provisions.

1.6 QUALITY ASSURANCE

- A. Comply with provisions of TMS 402/602, except where exceeded by requirements of Contract Documents.

- 1. Maintain one copy of each on the Project site.

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

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

1.7 MOCK-UPS

- A. Sample panel construction: For masonry governed by Level 2 or 3 Quality Assurance, construct sample panels of masonry walls per TMS 602. The specifier has the option of permitting a segment of the masonry construction to serve as a sample panel or requiring a separate stand-alone panel.

- B. Locate where directed.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, handle, and store masonry units by means that will prevent mechanical damage and contamination by other materials.

- B. Store masonry units off the ground in a dry location, covered and protected from absorbing moisture.

- C. Store masonry accessories, including metal items, in such a way as to prevent corrosion or accumulation of dirt and oil.

PART 2 PRODUCTS

2.1 CONCRETE MASONRY UNITS

- A. Concrete Block: Comply with referenced standards and as follows:

- 1. Size: 8" wide by 8" high x 16" long unless as otherwise indicated on the Drawings.
 - 2. Special Shapes: Provide bond beam units, open end units, lintel units and other special units as indicated. Use open end units at cells containing vertical reinforcement wherever possible.
 - 3. Load-Bearing Units: ASTM C90.
 - a. Weight: As indicated in the Drawings.
 - b. Hollow block, as indicated in the Drawings.

- c. Exposed Faces: Manufacturer's standard color and texture where indicated in the Drawings.
 - d. Exposed Faces: Special color and texture where indicated in the Drawings.
- 4. Pre-Faced Units: ASTM C90, hollow block, with smooth resinous facing complying with ASTM C744.
 - a. Colors and styles: As indicated on the Drawings.
 - 1) Substitutions: See Section 01 60 00 - Product Requirements.
- 5. Units with Integral Water Repellent: Concrete block units as specified in this section with polymeric liquid admixture added to concrete masonry units at the time of manufacture.
 - a. Performance of Units with Integral Water Repellent:
 - 1) Water Permeance: When tested per ASTM E514 and for a minimum of 72 hours.
 - a) No water visible on back of wall above flashing at the end of 24 hours.
 - b) No flow of water from flashing equal to or greater than 0.032 gallons per hour at the end of 24 hours.
 - c) No more than 25 percent of wall area above flashing visibly damp at end of test.
 - 2) Flexural Bond Strength: ASTM C1072; minimum 10 percent increase.
 - 3) Compressive Strength: ASTM C1314; maximum 5 percent decrease.
 - b. Use only in combination with mortar that also has integral water repellent admixture.
 - c. Use water repellent admixtures for masonry units and mortar by a single manufacturer.

2.2 REINFORCEMENT

- A. Reinforcing Steel: Type as specified in Section 03 20 00; size as indicated on the Drawings.
- B. Joint Reinforcement: Use ladder type joint reinforcement where vertical reinforcement is involved and truss type elsewhere, unless otherwise indicated.
- C. Single Wythe Joint Reinforcement: ASTM A951.
 - 1. Type: Truss or ladder.
 - 2. Material: ASTM A1064 steel wire, mill galvanized to ASTM A641 Class 3.
 - 3. Size: 9 gauge (0.1483 inch) side rods with 9 gauge (0.1483 inch) cross rods; width as required to provide not less than 5/8 inch of mortar coverage on each exposure and minimum 2 inches less than the nominal width of walls.
 - 4. Cross-rods are to be butt welded to side rods. Cross-rods to be spaced 16 inches on center.

2.3 BOLTS AND POST-INSTALLED ANCHORS

- A. Anchor Bolts:
 - 1. As indicated on the Drawings.
- B. Expansion Anchors:
 - 1. As indicated on the Drawings.
- C. Adhesive Anchors:
 - 1. As indicated on the Drawings.
- D. Screw Anchors:
 - 1. As indicated on the Drawings.
- E. Anchor Finish:
 - 1. Interior Exposure: All anchors, nuts and washers for use in interior environments free of potential moisture shall be manufactured from carbon steel and zinc coated.
 - 2. Exterior or Exposed Use: All anchors, nuts, and washers for use in exposed or potentially wet environments, or for attached of exterior cladding materials shall be galvanized or stainless steel. Galvanized anchors, nuts and washers shall conform to ASTM A153. Stainless steel anchors shall be manufactured from 300 series stainless steel. and nuts and washers from 300 series or Type 18-8 stainless steel.

2.4 ACCESSORIES

- A. Non-Metallic Expansion Joint Strips: Premolded, flexible cellular neoprene rubber filler strips complying with ASTM D1056, Grade RE 41E1, capable of compression up to 35% of width and thickness indicated.
- B. Premolded Control Joint Strips: Material as indicated below, designed to fit standard sash block and maintain lateral stability in masonry wall; size and configuration as indicated.
 - 1. Premolded PVC Control Joint Strips. Strips shall be polyvinyl chloride complying with ASTM D 2287, Type PVC 654-4 with a durometer hardness of 90.
 - 2. Manufacturers:
 - a. Blok-Lok Limited: www.blok-lok.com.
 - b. Hohmann & Barnard, Inc: www.h-b.com.
 - c. WIRE-BOND: www.wirebond.com.
 - d. Substitutions: See Section 01 60 00 - Product Requirements.
- C. Joint Filler: Closed cell polyvinyl chloride; oversized 50 percent to joint width; self expanding; in maximum lengths available.
 - 1. Manufacturers:
 - a. Hohmann & Barnard, Inc: www.h-b.com.
 - b. WIRE-BOND: www.wirebond.com.
 - c. Substitutions: See Section 01 60 00 - Product Requirements.

D. Drainage Fabric: Polyester or polypropylene mesh bonded to a water and vapor-permeable fabric.

1. Manufacturers:

- a. Advanced Building Products, Inc;
Mortairvent: www.advancedbuildingproducts.com.
- b. Mortar Net Solutions; DriPlane: www.mortarnet.com.
- c. York Manufacturing, Inc; Weep Armor Weep Vent
Protection: www.yorkmfg.com.
- d. Substitutions: See Section 01 60 00 - Product Requirements.

E. Cleaning Solution: Non-acidic, not harmful to masonry work or adjacent materials.

2.5 JOINTS

A. All joints to be tooled per Architectural Requirements.

2.6 SEALER

A. Contractor shall provide and install minimum two coats, BASF MasterProtect H107 masonry sealer, or equal, at all CMU walls. BASF MasterProtect H107 product, or equal, shall meet all state vapor requirements. Sealer shall be clear and non-gloss product.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine areas to receive masonry and verify following:

- 1. That foundation surface is level to permit bed joint with range of 1/4 inch minimum to 3/4 inch maximum for partially grouted or 1-1/4 inch maximum for fully grouted.
- 2. That edge is true to line to permit projection of masonry to less than 1/4 inch.
- 3. That projecting dowels are free from loose scale, dirt, concrete, or other bond inhibiting substances and properly spaced and located.
- 4. Do not begin work before unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Clean concrete surfaces to receive masonry. Remove laitance or other foreign material lodged in surfaces by sandblasting or other means as required. Joints between concrete and masonry shall be considered construction joints. See Concrete specifications.
- B. Ensure masonry units are clean and free from dust, dirt, or other foreign materials before laying. Do not use damaged masonry units, damaged components of structure, or damaged packaged materials.
- C. Establish lines, levels, and coursing. Protect from disturbances.

- D. Provide temporary bracing during installation of masonry work. Maintain in place until building structure provides permanent bracing.
- E. Direct and coordinate placement of metal anchors supplied for installation under other sections.

3.3 COLD AND HOT WEATHER REQUIREMENTS

- A. Cold Weather Construction to be in accordance with TMS 602.
- B. Hot Weather Construction to be in accordance with TMS 602.

3.4 COURSING

- A. Place masonry to lines and levels indicated to the specified tolerances.
- B. Maintain masonry courses to uniform dimension. Form vertical and horizontal joints of uniform thickness.
- C. Preserve the vertical continuity of cells in concrete unit masonry per Article 3.3E of TMS 602.
- D. Concrete Masonry Units:
 - 1. Bond: Running, unless otherwise indicated on the Drawings.
 - 2. Coursing: One unit and one mortar joint to equal 8 inches, unless otherwise indicated on the Drawings.
 - 3. Mortar Joints: Concave.

3.5 PLACING AND BONDING

- A. Do not install cracked, broken or chipped masonry units.
- B. Lay only dry concrete masonry units. Do not wet concrete masonry prior to laying up units unless written permission is obtained from the Engineer.
- C. Lay hollow masonry units with face shell bedding on head and bed joints.
 - 1. Block Cap: Lay with full mortar coverage on horizontal and vertical joints.
 - 2. Install grout cap where and as indicated.
- D. Fully bond intersections and external and internal corners.
- E. Buttering corners of joints or excessive furrowing of mortar joints is not permitted.
- F. Remove excess mortar and mortar smears as work progresses.
- G. Remove excess mortar with water repellent admixture promptly. Do not use acids, sandblasting or high pressure cleaning methods.
- H. Interlock intersections and external corners, except for units laid in stack bond.

- I. Do not shift or tap masonry units after mortar has achieved initial set. Where adjustment must be made, remove mortar and replace.
- J. Perform job site cutting of masonry units with proper tools to provide straight, clean, unchipped edges. Prevent broken masonry unit corners or edges. Install cut units with cut surfaces and, where possible, cut edges concealed.
- K. Cut mortar joints flush where wall tile is scheduled or resilient base is scheduled.
- L. Isolate masonry partitions from vertical structural framing members with a control joint as indicated.
- M. Step back unfinished work for joining with new work. Do not use toothing.
- N. Provide cleanouts as indicated in "grouting" below.
- O. Matching Existing Masonry Work: Match coursing, bonding, color and texture of new masonry work with existing work wherever possible.

3.6 JOINTS

- A. Horizontal and vertical joints at masonry units shall be 3/8 inch wide and as follows:
 - 1. Point joint tight in unpurged masonry below ground.
 - 2. All end joints shall be fully filled with mortar and joints squeezed in bed joints shall be held back approximately 1/2 inch from cell to provide positive bond with grout.
 - 3. Joints shall be struck flush at all areas to receive plaster, stucco and any other finish material other than paint.

3.7 REINFORCEMENT

- A. Place reinforcement in accordance with TMS 602.
- B. Reinforcing steel shall not be bent or straightened in a manner that will damage the material. Bars with kinks or bends not shown on the plans shall not be used. Heating of bars for bending is not permitted.
 - 1. Bars shall conform accurately to the sizes, shapes, lines and dimensions shown on drawings and with hooks and beds made as detailed. Bars shall be placed as indicated on the Drawings.
 - 2. At the time grout is place around it, reinforcing steel shall be clean of mill scale or other coatings that will destroy or reduce bond.
- C. Foundation dowels that interfere with unit webs are permitted to be bent to a maximum of 1 inch horizontally for every 6 in of vertical height.
- D. Reinforcing steel shall be secured to all foundation dowels and held in place at spacing not to exceed 192 bar diameters.

3.8 GROUTING

- A. General Requirements:

1. Refer to 04 05 16 Masonry Grouting.

3.9 CONTROL AND EXPANSION JOINTS

- A. See the Drawings for type and location of expansion and/or control joints.
- B. Where control joints are not indicated on the drawings the Contractor shall submit a proposed control joint layout for Architect and Engineer approval. General guidelines for control joint locations are as follows:
 1. At major changes in wall height.
 2. At changes in wall thicknesses.
 3. At corresponding control joints in foundations, floors, or roof construction.
 4. Near wall intersections.
 5. At column centerlines.
- C. Maximum Spacing: Maximum control joint spacing in concrete masonry construction shall be such that the ratio of wall length to height shall not exceed 1.5 with a maximum spacing of 25 feet.
- D. Form expansion joint as detailed on drawings.

3.10 BOND BEAMS

- A. Bond beams shall be located where shown and detailed on the drawings, and shall be reinforced as indicated and as herein after specified.

3.11 BUILT-IN WORK

- A. Miscellaneous Embedded Items: All items indicated to be embedded in masonry shall be carefully located and anchored to prevent movement during grouting operations. Solidly grout spaces around built-in items. Consult other trades in advance and make provisions for installation of their work to avoid cutting and patching. Install chases minimum of one full masonry unit length for jambs
- B. As work progresses, install built-in metal door frames and glazed frames and other items to be built into the work and furnished under other sections.
- C. Install built-in items plumb, level, and true to line.
- D. Bed anchors of metal door and glazed frames in adjacent mortar joints. Fill frame voids solid with grout.
- E. Do not build into masonry construction organic materials that are subject to deterioration.

3.12 TOLERANCES

- A. Install masonry within the site tolerances found in TMS 402/602.
- B. Maximum Variation from Alignment of Columns: 1/4 inch.

- C. Maximum Variation from Unit to Adjacent Unit: 1/16 inch.
- D. Maximum Variation from Plane of Wall: 1/4 inch in 10 ft and 1/2 inch in 20 ft or more.
- E. Maximum Variation from Plumb: 1/4 inch per story non-cumulative; 1/2 inch in two stories or more.
- F. Maximum Variation from Level Coursing: 1/8 inch in 3 ft and 1/4 inch in 10 ft; 1/2 inch in 30 ft.
- G. Maximum Variation of Mortar Joint Thickness: Head joint, minus 1/4 inch, plus 3/8 inch.
- H. Maximum Variation from Cross Sectional Thickness of Walls: 1/4 inch.

3.13 CUTTING AND FITTING

- A. Cut and fit for chases. Coordinate with other sections of work to provide correct size, shape, and location.
- B. Obtain approval prior to cutting or fitting masonry work not indicated or where appearance or strength of masonry work may be impaired.

3.14 FIELD QUALITY CONTROL

- A. An independent testing agency will perform field quality control tests, as specified in Section 01 40 00 - Quality Requirements.
- B. Concrete Masonry Unit Tests: Test each variety of concrete unit masonry in accordance with ASTM C140 for compliance with requirements of this specification.
- C. Mortar Tests: Test each type of mortar in accordance with ASTM C780, testing with same frequency as masonry samples.

3.15 REPAIR, POINTING, AND CLEANING

- A. Remove and replace masonry units which are loose, chipped, broken, stained or otherwise damaged, or if units do not match adjoining units.
- B. Pointing: During the tooling of joints, enlarge any voids or holes and completely fill with mortar.
- C. Dry brush masonry surface after mortar has set, at each day's work and after final pointing.
- D. Remove excess mortar and mortar droppings.
- E. Replace defective mortar. Match adjacent work.
- F. Clean soiled surfaces with cleaning solution.
- G. Use non-metallic tools in cleaning operations.

- H. Upon completion of masonry installation, repair all holes. Defective joints shall be cut out and rejointed. Exposed masonry surfaces shall be cleaned free of mortar, green stain and efflorescence.

3.16 PROTECTION

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

3.17 DEFECTIVE MASONRY

- A. Materials or workmanship not conforming to appearance or strength specified, will be deemed defective and shall be removed and replaced at no cost to Owner.
- B. Defective mortar or grout, as defined under Section 04 05 13 and Section 04 05 16 shall constitute defective masonry.

END OF SECTION

SECTION 04 73 00
MANUFACTURED STONE MASONRY

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Manufactured stone veneer.
- B. Mortar.
- C. Anchorage and accessories.

1.2 RELATED SECTIONS

- A. Section 04 22 00 – Concrete Unit Masonry.
- B. Section 06 10 00 – Rough Carpentry.
- C. Section 07 19 19 – Water Repellents.
- D. Section 07 25 00 – Weather Barriers.
- E. Section 07 92 00 – Joint Sealants.
- F. Section 09 24 00 – Portland Cement Plastering.

1.3 REFERENCES

- A. The publications listed below form a part of this Section to the extent referenced. The publications are referred to in the text by the basic designation only. Refer to Division 01 for definitions, acronyms, and abbreviations.
- B. Standards, manuals, and codes refer to the latest edition of such standards, manuals, and codes in effect as of the date of issue of this Project Manual, unless indicated otherwise in CBC Chapter 35 and CFC Chapter 80.
- C. Referenced Standards:
 - 1. ASTM C39 – Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
 - 2. ASTM C67 – Standard Test Methods for Sampling and Testing Brick and Structural Clay Tile.
 - 3. ASTM C91 – Standard Specification for Masonry Cement.
 - 4. ASTM C144 – Standard Specification for Aggregate for Masonry Mortar.
 - 5. ASTM C150 – Standard Specification for Portland Cement.
 - 6. ASTM C177 – Standard Test Method for Steady State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded Hot Plate Apparatus.
 - 7. ASTM C192 – Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory.
 - 8. ASTM C207 – Standard Specification for Hydrated Lime for Masonry Purposes.

9. ASTM C270 – Standard Specification for Mortar for Unit Masonry.
10. ASTM C482 – Standard Test Method for Bond Strength of Ceramic Tile to Portland Cement Paste.
11. ASTM C932 – Standard Specification for Surface Applied Bonding Compounds for Exterior Plastering.
12. ASTM C954 – Standard Specification for Steel Drill Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Steel Studs from 0.033 in. (0.84 mm) to 0.112 in. (2.84 mm) in Thickness.
13. ASTM C979 – Standard Specification for Pigments for Integrally Colored Concrete.
14. ASTM C1002 – Standard Specification for Steel Self Piercing Tapping Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs.
15. ASTM C1059 – Standard Specification for Latex Agents for Bonding Fresh To Hardened Concrete.
16. ICC Evaluation Service - Evaluation Report AC51- Acceptance Criteria for Precast Stone Veneer.

1.4 SUBMITTALS

- A. Submit shop drawings under provisions of Division 01.
- B. Submit samples under provisions of Division 01.
- C. Furnish five individual samples of stone showing variations in color and texture.
- D. Furnish manufacturer's certification under provisions of Division 01 that the stone veneer, mortar, and accessories furnished meet or exceed the requirements of these specifications.
- E. Submit manufacturer's installation instructions under provisions of Division 01.

1.5 QUALITY ASSURANCE

- A. Requirements of Regulatory Agencies: The stone veneer shall comply with the requirements of this Section and shall conform to the applicable requirements of the California Building Code, Title 24, Part 2, Chapter 14, Section 1404.10.
 1. Exterior Adhered Masonry Veneer: Exterior adhered units shall not exceed 5/8 inch thickness and 24 inches in any face dimension nor more than 3 square feet in total face area and shall weigh not more than 9 pounds per square foot.
- B. Installer Qualifications: Installation shall be done only by an installation firm normally engaged in this business. All work shall be performed by qualified mechanics working under an experienced supervisor.
- C. Specifications for stone veneer work specified herein are minimum requirements. It shall be Stone Veneer System Contractor's responsibility to comply with the complete requirements of the material manufacturers.

1.6 MOCKUP

- A. Provide mockup of masonry under provisions of Division 01.

- B. Erect four-foot long x four-foot high panel to include selected color and texture range, bonding, mortar color, corner and edge conditions, quality of workmanship, and grouting of masonry.
 - 1. Accepted panel will be used as the standard of quality for all subsequent stone veneer work.
 - 2. Accepted mockup may be incorporated into the completed work.

1.7 TESTS AND INSPECTIONS

- A. Tests and Inspections requested by Architect shall be made by a testing laboratory employed and paid for by Owner. Any masonry work failing to meet required design stresses as specified in this Section shall be dismantled and replaced at no cost to Owner.
 - 1. Veneer: Inspection per CBC Sections 1410 and 1705.4.1.

1.8 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Store stone veneer units above ground on level platforms which allow air circulation under stacked units and will prevent contamination of mud, dust or materials likely to cause staining or other defects.
- B. Cover and protect materials as necessary to protect from the elements.
- C. Handle units on pallets or flat bed barrows.
- D. Handle and store setting materials in strict compliance with the manufacturer's instructions; avoid exposure to moisture.
- E. Contractor shall take precautions to protect products from freezing or from excessive heat.

1.9 PROJECT CONDITIONS

- A. Maintain materials and surrounding air temperature to minimum 40 degrees F prior to, during, and for 48 hours after completion of work.
- B. Protect materials from rain, moisture, and freezing temperatures prior to, during, and for 48 hours after completion of work.
- C. Allow no construction activity on opposite side of wall during installation, and for 48 hours after completion of work.

1.10 WARRANTY

- A. Provide manufacturer's fifty year material warranty under provisions of Division 01.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Eldorado Stone, San Marcos, CA; 800-925-1491, www.eldoradostone.com. Product: Mountain Ledge Series.
 - 1. Size Ranges:
 - a. Height: 1 inch to 4 inches.
 - b. Length: 3.5 inches to 19 inches.

- c. Thickness: 0.625 inch to 2.625 inches
- 2. Shapes: Flat and Corners.
- 3. Color: Yukon or Durango as selected by Architect.
- B. Creative Mines, San Diego, CA; 800-453-7040, www.creativemines.us.
- C. Coronado Stone Products, Fontana, CA; 800-847-8663, www.coronado.com.
- D. Boral Material Technologies Cultured Stone, Roswell, GA; 770-645-4500, www.boralna.com.
- E. Daltile Manufactured Stone, Dallas, TX; 214-398-1411, www.daltilemanufacturedstone.com.
- F. Substitutions: Under provisions of Division 01.

2.2 STONE VENEER

- A. Stone veneer units shall consist of Portland cement, lightweight aggregates, and mineral oxide pigments. Properties:
 - 1. Compressive strength per ASTM C39 and ASTM C192, five sample average: Greater than 1,800 psi.
 - 2. Weight per ASTM C1670: 15 pounds per square foot, saturated.
 - 3. Shear bond per ASTM C482: 50 psi minimum.
 - 4. Thermal Resistance per ASTM C177: 0.473 at 1.387 inch thickness.
 - 5. Water absorption per ICC Evaluation service AC 51: Less than 22 percent when density is less than 85 pounds per cubic foot; less than 18 percent when density is less than 105 pounds per cubic foot.
 - 6. Freeze-thaw test per ASTM C67: Less than three percent weight loss and no disintegration.

2.3 MORTAR AND MORTAR MATERIALS

- A. Portland Cement: ASTM C150, Type II, low alkali, gray color.
 - 1. Option: ASTM C91 Type N or Type S masonry cement.
- B. Sand: Comply with ASTM C144, with not less than five percent passing the No. 100 sieve.
- C. Lime: ASTM C207.
 - 1. Lime is not required when using Type N or Type S masonry cement.
- D. Color Pigment: ASTM C979, mineral oxide pigments.
- E. Water: Potable.

2.4 ACCESSORIES

- A. Weather-Resistant Barrier and Accessories: Refer to Section 07 25 00.
- B. Metal Lath: Self furred, grooved, galvanized expanded metal flat diamond mesh; weighing 3.4 pounds per square yard; continuous horizontal grooves 1/4 inch deep at 6-3/16 inches on center as manufactured by ClarkDietrich Building Systems, Cemco, Amico or accepted equal.

1. Acceptable Alternative Metal Lath: Structa Mega Lath as manufactured by Structa Wire Corporation with the following characteristics:
 - a. Weight: 1.95 pounds per square yard.
 - b. No. 17 gauge x No. 16 gauge galvanized cold-rolled steel wire welded to form 0.7 inch x 1.5 inch openings.
 - c. Six secondary cold-rolled flat longitudinal wires spaced nominally every 5-3/8 inches to form a twin track.
 - d. Furring:
 - 1) Width of Furring Leg: 1/4 inch.
 - 2) Furring Height: 1/4 inch to underside of cross wire.
 - 3) Furring Spacing: 2-1/8 inch on center.
 - 4) Every cross wire is furred.
- C. Bonding Agent: Exterior integral bonding agent complying with ASTM C932 or ASTM C1059, Type II.
- D. Masonry Sealer: Refer to Section 07 19 19.

PART 3 EXECUTION

3.1 INSPECTION

- A. Surface Acceptance: Inspect concrete foundations and surfaces to which masonry work is to be installed and report to Contractor, with a letter to Architect, any corrective action, or unsatisfactory conditions such as excessive unevenness of tops of foundation walls. The start of the stone veneer work on any surface shall be evidence of acceptance of such surface.
- B. Verify initial absorption rate of the stone veneer is within acceptable limits.

3.2 PREPARATION

- A. General: Before starting installation, surface to be covered shall be cleaned to remove soil, mortar, and all deleterious materials.
- B. Surface Preparation: Prepare substrate in accordance with manufacturer's installation instructions for the type of substrate being covered.
- C. Plan work to minimize job site cutting. Perform necessary cutting with proper tools to provide uniform edges, take care to prevent breaking units corners or edges.
- D. Verify that the cement plaster scratch and brown coats have been fully cured.

3.3 MORTAR MIXING

- A. Thoroughly mix mortar ingredients in quantities needed for immediate use in accordance with stone manufacturer's recommendations and ASTM C270, Type N or Type S.
 1. Add color pigment to grout joint mortar in accordance with pigment manufacturer's instructions. Color as selected by Architect.

- B. Machine Mixing: Mixer shall be a rotating blade type mortar mixer. Start machine, and add sand then cement. Mix only long enough to wet out the batch. Do not overmix. Stop mixer and dump mortar from mixer promptly.
- C. Hand Mixing: Premix the dry ingredients (sand and cement). Adjust amount of liquid or dry material to obtain proper consistency.
- D. Do not use anti-freeze compounds to lower the freezing point of mortar.

3.4 INSTALLATION

- A. Apply stone veneer accordance with manufacturer's installation instructions.
- B. Sheathed Surfaces: Install one layer of weather-resistant barrier under provisions of Section 07 25 00.
- C. Lath:
 - 1. Lath shall be installed as specified in CBC Section 2510 and CBC Table 2507.2 for wire fabric lath. The lath shall be installed with the cross wires parallel to the framing and shall be attached with fasteners at the furring crimps.
 - 2. Attach metal lath to framing members at maximum 6 inches on center.
 - 3. Lath shall stand off substrate immediately behind the lath a minimum of 1/4 inch.
- D. Apply nominal 1/2 inch thickness of mortar, ensuring the lath is completely encapsulated with mortar. When the mortar is thumbprint hard, score the surface horizontally to create a scratch coat. Moist cure the scratch coat. Just prior to applying the stone veneer, dampen the scratch coat so the surface is wet, but free of standing water.
- E. Fully butter the back of each stone unit with mortar to a nominal thickness of 1/2 inch. Firmly work stone unit onto scratch coat, slightly sliding back and forth or with slight rotating motion to set stone unit. Achieve mortar squeeze-out in a volume which results in a full setting bed which covers the scratch coat completely. Do not move stone units after initial set.
- F. Tight fitted stone veneer shall be applied from the corners toward the middle of the wall and from the bottom to the top of the wall.
- G. Install outside corner return units with short and long lengths alternated.
- H. Remove excess mortar; do not allow mortar to set up on face of units.
- I. Grouting of joints shall be performed only when mild contact with stone units will not break the bonding. Install grout using a grout bag, filling joints to desired depth; ensure that mortar is forced into all voids. Grout shall be thumbprint hard before raking joints. Clean grout from face of stone units with a dry, soft-bristled brush.

3.5 PROTECTION OF WORK

- A. Protect sills, ledges and offsets from mortar drippings or other damage during construction.
- B. Remove misplaced mortar immediately.
- C. Protect partially completed stone veneer against weather when work is not in progress by covering top of walls with a strong, waterproof, non-staining membrane. Extend membrane at least two feet down the sides of wall and anchor securely in place.

- D. Protect face materials against staining.
- E. Protect jambs and corners from damage during construction.

3.6 REPAIR AND CLEAN

- A. Upon completion of stone veneer installation, repair all holes. Defective joints shall be cut out and rejointed.
- B. Exposed stone veneer surfaces shall be cleaned per stone manufacturer's recommendations. All stains and efflorescence shall be removed.
 - 1. Near the completion of the project and prior to the application of liquid water repellent, areas where efflorescence has reappeared shall be recleaned.
 - 2. Final cleaning and liquid water repellent application shall not be scheduled until stone veneer has thoroughly dried out.
- C. Protection: Contractor shall take precautions to protect the finished work from damage by other trades.
- D. Defective Work: All work installed or damaged beyond satisfactory repair shall be replaced by Contractor with no additional cost to Owner.

3.7 CLEAN-UP

- A. At the conclusion of the work of this Section, clean stone veneer and remove all equipment used in work. Remove all surplus material, rubbish and debris from the premises.

END OF SECTION

SECTION 05 12 00
STRUCTURAL STEEL FRAMING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SECTION INCLUDES

- A. Structural steel framing members.
- B. Structural steel support members, plates, and bracing angles.
- C. Bolts, washers, and other steel accessories.
- D. Base plates, shear stud connectors and expansion joint plates.
- E. Grouting under base plates.
- F. Prime coat painting and touch up.
- G. Templates for cast-in-place anchor bolts.

1.3 RELATED REQUIREMENTS

- A. Section 05 50 00 - Metal Fabrications.
- B. Division 09 - "Paintings and Coatings" for surface-preparation and priming requirements.

1.4 DEFINITIONS

- A. Structural Steel: Elements of structural-steel frame, as classified by American Institute of Steel Construction (AISC) 303, "Code of Standard Practice for Steel Buildings and Bridges."
- B. Heavy Sections: Rolled and built-up sections as follows and subjected to special notch toughness, fabrication, welding and inspection requirements as defined in this specification:
 - 1. Shapes included in ASTM A6 with flanges thicker than 2 inches.
 - 2. Welded built-up members with plates thicker than 2 inches.
 - 3. Column base plates thicker than 2 inches.
 - 4. All ASTM A6 shapes with flange thickness greater than 1-1/2 inches that are part of the Seismic Force Resisting System.
 - 5. Welded built-up members with plates thicker than 1-1/2 inches if part of the Seismic Force Resisting System.
- C. Seismic Force Resisting System (SFRS): These elements are those which resist seismic loads and include braced frames, moment frames and collector elements and are indicated on the drawings.

- D. Protected Zone: Areas of critical members in the Seismic Force Resisting System that are expected to behave inelastically during a seismic event. Refer to the Structural Drawings for designation of the Protected Zones. Within the Protected Zones, the following shall apply:
 - 1. Discontinuities created by fabrication or erection operations such as tack welds, erection aids, air-arc gouging and thermal cutting shall be repaired as required by the Structural Engineer.
 - 2. No welded shear studs and decking attachments (excluding decking arc spot welds) shall be placed on beam flanges.
 - 3. No welded, bolted, screwed, or shot-in attachments for edge angles, exterior facades, partitions, duct work, piping and other construction.
- E. Demand Critical Welds (DCW): Welds in the Seismic Force Resisting System which invoke special welding and inspection requirements in this specification. Welds shall be considered DCW on this project as defined for each SFRS indicated in AISC 341 and as otherwise indicated on the Drawings as DCW.

1.5 REFERENCE STANDARDS

- A. Utilize the edition of the listed document as identified in the "Design Criteria Notes" in the structural drawings. If not listed in the "Design Criteria Notes", use the edition adopted or referenced by the listed Governing Building Code or material standard. If no specific edition is adopted, use the latest edition.
 - 1. AISC 360 - Specification for Structural Steel Buildings
 - 2. AISC 303 - Code of Standard Practice for Steel Buildings and Bridges.
 - 3. AISC 341 - Seismic Provisions for Structural Steel Buildings.
 - 4. AISC 358 - Prequalified Connections for Special and Intermediate Steel Moment Frames for Seismic Applications.
 - 5. ASTM A36 - Standard Specification for Carbon Structural Steel.
 - 6. ASTM A53 - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
 - 7. ASTM A123 - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
 - 8. ASTM A153 - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
 - 9. ASTM A307 - Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60,000 PSI Tensile Strength.
 - 10. ASTM A449 - Standard Specification for Hex Cap Screws, Bolts and Studs, Steel, Heat Treated, 120/105/90 ksi Minimum Tensile Strength, General Use.
 - 11. ASTM A500 - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
 - 12. ASTM A501 - Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing.
 - 13. ASTM A563 - Standard Specification for Carbon and Alloy Steel Nut.
 - 14. ASTM A572 - Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel.
 - 15. ASTM A913 - Standard Specification for High-Strength Low-Alloy Steel Shapes of

Structural Quality, Produced by Quenching and Self-Tempering Process

16. ASTM A992 - Standard Specification for Structural Steel Shapes.
17. ASTM A1085 - Standard Specification for Cold-Formed Welded Carbon Steel Hollow Structural Sections (HSS)
18. ASTM C1107 - Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Non shrink).
19. ASTM E94 - Standard Guide for Radiographic Examination Using Industrial Radiographic Film.
20. ASTM E164 - Standard Practice for Contact Ultrasonic Testing of Weldments.
21. ASTM E165 - Standard Practice for Liquid Penetrant Testing for General Industry.
22. ASTM E709 - Standard Guide for Magnetic Particle Testing.
23. ASTM F436 - Standard Specification for Hardened Steel Washers Inch and Metric Dimensions.
24. ASTM F959 - Standard Specification for Compressible-Washer-Type Direct Tension Indicators for Use with Structural Fasteners.
25. ASTM F1554 - Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength.
26. AWS D1.1 - Structural Welding Code.
27. AWS D1.8 - Structural Welding Code – Seismic Supplement.
28. RCSC (HSBOLT) - Specification for Structural Joints Using High-Strength Bolts; Research Council on Structural Connections.
29. SSPC-Paint 15 - Steel Joist Shop Primer/Metal Building Primer.
30. SSPC-Paint 20 - Zinc-Rich Coating (Type I - Inorganic, and Type II - Organic).
31. SSPC-SP 1 - Solvent Cleaning.
32. SSPC-SP 2 - Hand Tool Cleaning.
33. SSPC-SP 3 - Power Tool Cleaning.
34. SSPC-SP 6 - Commercial Blast Cleaning.
35. UL (FRD) - Fire Resistance Directory Current Edition.

1.6 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Shop Drawings:
 1. Direct copies (including electronic versions) of SEOR plans and details are not allowed. Using SEOR plans as a background for the development of the submittal plans is acceptable.
 2. Submit shop drawings to Architect for review and obtain Architect's acceptance prior to start of fabrication. Where shop drawings are resubmitted, the Contractor shall cloud and identify all changes made due to additions, deletions, and corrections to the shop drawing. Shop drawings resubmitted without each change being clouded and identified will be

returned for resubmission.

3. Shop drawings shall include complete details and schedules for fabrication and assembly of structural steel members, procedures, and diagrams.
4. Provide setting drawings, templates, and directions for installation of anchor bolts and other anchorages to be installed by others.
5. Include layout, member size, and weights, materials used, and beam marks as well as orientation and relation of members to appropriate grid lines and setting elevations for column bases. Reference shop drawings to specific location and detail number on the Structural Drawings.
6. Include details of cuts, connections, splices, camber, holes, openings, doubler plates, stiffeners and other pertinent data, including bolt hole sizes, connection materials, and welded joint designations.
7. Include embedment drawings.
8. Indicate welds by standard AWS symbols, distinguishing between shop and field welds, and show size, length, and type of each weld. Show backing bars that are to be removed and supplemental fillet welds where backing bars are to remain.
9. Indicate type, size, and length of bolts, distinguishing between shop and field bolts. Identify pre-tensioned and slip-critical high-strength bolted connections.
10. Indicate surface preparation and finishes.
11. Submit plans of all levels locating the edge of slab at perimeter and at interior openings at locations where bent plate closure occurs.
12. Identify members and connections of the Seismic-Force-Resisting System (SFRS).
13. Indicate locations and dimensions of protected zones.
14. Identify welds that are part of the SFRS.
15. Identify Demand Critical Welds.
16. Shop drawings shall include connection details drawn to scale for members of the Seismic Force-Resisting System.
17. Dimensions required to locate structural steel for manufactured items such as mechanical equipment, electrical equipment, dock levelers, etc., shall be coordinated and provided by the General Contractor. General Contractor shall also coordinate and provide dimensions to locate structural steel for window washing supports such as davits, tie-backs, etc.
18. Connections required but not specifically referenced.

C. Erection Procedures:

1. Submit procedures, methods, sequences of erection, temporary shoring and guying, and equipment proposed for erecting structural steel. Erection procedures are submitted for record only and therefore will not be returned to the Contractor.

D. Bearing Assemblies:

1. Submit shop drawings and technical specifications for the slide bearing assemblies used in the project.

E. Jacking and Tensioning Procedures:

1. Submit procedures, methods, sequences of jacking and tensioning, instrumentation and monitoring devices if implemented within the project.

- F. Welding Procedure Specifications (WPSs) and Procedure Qualification Records (PQRs): Provide according to AWS D1.1, "Structural Welding Code - Steel," AWS D1.8, "Structural Welding Code – Seismic Supplement," and AISC 341 for each welded joint whether prequalified or qualified by testing, including items listed below. All submitted Procedures shall be reviewed by the Testing Agency prior to use on the project. The Procedures will be submitted to the Engineer for review after review by the testing agency is complete.
1. The WPSs and PQRs shall include all essential variables and parameters required by AWS D1.1 and AWS D1.8.
 2. Where backgouging is required provide back gouging criteria (e.g. smoothness, grinding, gouge shape, inspection by the welder, etc.) per AISC 341, AWS D1.1, and AWS D1.8.
 3. Explicitly note which WPSs will be used for welding of members and connections of the SFRS and Demand Critical Welds.
 4. For multi-pass welds define sequence and layering of passes.
 5. Welding Procedure Qualification Record (WPQR) Tests: For WPSs that are not pre-qualified per AWS D1.1, submit the supporting WPQR tests results conducted in accordance with AWS D1.1 along with the corresponding WPS.
 6. When the required effective throat thickness of flare groove welds is larger than allowed by Table J2.2 of AISC "Steel Construction Manual", submit data establishing by qualification the consistent production of such larger effective throat thickness. Qualification of effective throat thickness shall be as required by the AISC specification.
 7. For non-prequalified, complete butt or groove welds of the SFRS, include CVN weld test records.
 8. In addition to the WPS submit fabrication and erection procedures where needed to control shrinkage, fabrication tolerances, or to insure proper inspections.
 9. Include CVN tests, requirements and procedures in compliance with AWS D1.1, AWS D1.8 and the requirements of the contract documents. Test temperature shall be specified herein. Where specified CVN properties in the contract documents exceed the minimum requirements in AWS D1.1 / AWS D1.8, CVN tests shall be performed to the properties in the contract documents.
 10. All welds for the SFRS are according to AWS D1.8 as a minimum.
 11. WPS and WPQR's shall include specific reference to the manufacturer's make and model of weld material. Provide manufacturer's data sheet for all weld material indicating recommended welding parameters and variables.
- G. Weld Shrinkage and Distortion Procedures: Submit weld shrinkage and distortion procedures for all welded connections where distortion due to weld shrinkage may cause damage to the steel material. The welding sequence and procedures are to minimize the effect of weld shrinkage, residual stresses, and to maintain erection tolerances. These procedures shall be reviewed by Testing Agency, and then used by Testing Agency to verify conformance. As a minimum, procedures shall be submitted for the following connections:
1. Welding of continuity plates and doubler plates into the WF columns.
 2. Field welding beam-to-column connection (include beam flange welds, rib welds, connection plate bolting and weld).
 3. Welding columns to base plates.

- H. Fastener Installation Procedures: Submit written procedures for the pre-installation testing, installation snugging, pre-tensioning, and post-installation inspection of fasteners. The procedures shall meet all requirements of the Research Council on Structural Connections (RCSC) "Specification for Structural Joints Using ASTM A325 or A490 Bolts" and the Contract Documents. Provide installation procedure and inspection for direct tension indicator washers detailed in supplemental specifications provided by the manufacturer for approval.
- I. Manufacturer's Mill Certificate: Certify that products meet or exceed specified requirements.
- J. Mill test reports for structural steel, including chemical and physical properties, regardless of thickness or use. Reports shall comply with ASTM A6 and be submitted to the Owner's Quality Assurance Agency.
 - 1. Submit a mill report for each heat of steel used, and certified fastener reports for all fasteners, including nuts, washers and direct tension indicators prior to the start of fabrication. For unsatisfactory mill test report, retest steel.
 - 2. Include Charpy test results for heavy sections and for materials where Charpy values are specified. Testing required per AISC 360 section A3.1c and AISC 341 section A3.3 and as specified herein.
 - 3. Mill test reports shall include ladle analysis and tensile elongation.
 - 4. Mill reports shall be traceable to individual pieces of steel used.
 - 5. In addition to other requirements mill reports shall address the following elements: copper, columbium, chromium, nickel, molybdenum, silicone, and vanadium.
 - 6. Provide mill reports for all welding consumables used on this project.
- K. Fabricator Test Reports: Comply with ASTM A1011.
- L. Welders' Qualification Statement: Welders' certificates in accordance with AWS B2.1 and dated no more than 12 months before start of scheduled welding work. Submit to welding special inspector for approval. Submit final copies to Architect for review.
- M. General Contractor Verification of Compliance for Materials: General Contractor's review and acceptance shall be included with each submittal stating that the Contractor has reviewed the submitted manufacturer's test reports and certifications, and that the materials being furnished for the project are in conformance with the applicable standards and project documents. The review shall be submitted along with the manufacturer's test reports and certifications for structural steel, fasteners, welding filler metals, and shear studs.
- N. Product Test Reports and Certifications: Submit manufacturer's test reports and certifications as listed below. Test Reports and Certifications are submitted for record only and therefore will not be returned to the Contractor. A copy of the test reports and certifications shall be sent to the owners Quality Assurance Agency. The Contractor Certificate of Compliance letter shall accompany the Manufacturer's Certifications.
 - 1. Bolts, nuts, and washers including mechanical properties and chemical analysis. Certifications for high strength bolts shall conform to certification requirements contained in ASTM A325, A490, F1852, F2280.
 - 2. Direct-tension indicators.
 - 3. Tension-control, high-strength bolt-nut-washer assemblies.
 - 4. Shear stud connectors. Shear studs, as supplied, shall meet the requirements of AWS D1.1, Sections 7.2 and 7.3.

5. Shop primers.
 6. Non shrink grout.
 7. Welding electrodes, fluxes and shielded gas products. Certifications shall satisfy the applicable AWS A5 and project requirements.
 8. Spray-on fireproofing. Submit certificate issued by paint manufacturer ensuring compatibility between the primer and the spray-on fireproofing.
- O. Submit fabricators identification mark system to Testing Agency prior to fabrication.
- P. Fabricator's Qualification Statement.
- Q. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.
- R. As-Built Drawings: At the end of the work included in this Section submit a complete set of reproducible drawings incorporating all changes, additions and deletions to the Construction Drawings due to revisions, change orders, field conditions, or any other reason.

1.7 QUALITY ASSURANCE

- A. Comply with the referenced ASTM standards for materials.
- B. Verification of accuracy:
1. Engage and pay for a registered Professional Engineer or licensed Land Surveyor to check the alignment, plumbness, elevation, and overall accuracy of the erected framing at appropriate stages during construction and at completion of erection. Prior to erection, a survey shall be made of the as-built locations of all anchor rods and other embedded items associated with the attachment of structural steel. The party providing the survey shall submit written verification that the entire installation is in accordance with the contract documents and meets the allowable erection tolerances as set forth in the AISC "Code of Standard Practice for Steel Buildings and Bridges".
 2. Columns shall be verified at each lift. Column shim details and procedures shall be submitted for review.
- C. Tests and Inspections: Provide special inspections and testing as described in the "Statement of Structural Special Inspections and Testing" within the structural drawings and as required by this section.
1. Unless waived in writing by the Architect and the Authority Having Jurisdiction, all materials, work, methods and equipment shall be subject to inspection at the mill, fabricating plant and at the building site. Material or workmanship not complying fully with the Contract Documents will not be accepted. The Contractor shall give the Testing Laboratory reasonable notice when ready for inspection and shall supply samples and test pieces and all facilities for inspection without extra charge.
- D. Testing Agency: Shop and field testing and inspection of steelwork specified in this document or requested by the Owner will be performed by an independent agency engaged by the Owner.
1. The Testing Agency shall be furnished with the following:

- a. One complete set of fabrication and erection drawings.
 - b. Material bills, cutting lists, order sheets and mill test reports.
 - c. Information regarding time, place of rolling and shipment of materials to shop.
 - d. If requested, representative sample pieces for testing.
 - e. Full and ample means and assistance for testing materials.
 - f. Access and facilities, including scaffolding, temporary work platforms, etc., for testing and inspection at all places where materials or components are stored, fabricated or erected in the mill, shop or field.
 - g. Complete set of welding procedures.
 - h. Welder qualifications.
 - i. AISC fabricator certification documents, QA/QC manual and most recent AISC audit, unless waived by the SEOR.
 - j. Reports for all Contractor tests and inspections.
2. In addition to the work specified elsewhere in the Contract Documents, the Testing Agency shall review the following for compliance with project specifications:
- a. Fastener Installation Procedures.
 - b. WPSs and WPQRs.
 - c. Manufacturer's Test Reports and Certifications.
 - d. Welder qualification.
- E. Comply with applicable provisions of the governing building code, reference standards, specifications, and documents, except where more stringent requirements are shown or specified.
- F. Structural steel members designated as architecturally-exposed structural steel (AESS) to also comply with Section 05 12 13.
- G. All work shall be performed by qualified operators experienced in their field of work and as otherwise required by these specifications.
- H. Fabricator Qualifications: Unless waived by the SEOR, a qualified fabricator that participates in the AISC Quality Certification Program and is designated an AISC-Certified Plant, Category STD, unless waived by SEOR.
- I. Installer Qualifications: A qualified installer who participates in the AISC Quality Certification Program and is designated an AISC-Certified Erector, Category ACSE.
- J. Shop-Painting Applicators: A qualified applicator with a minimum of 12 months prior experience working with the fabricator.
- K. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1 for each process, position and joint configuration. Each operator shall have been qualified as prescribed by AWS and shall be approved by the Testing Agency. Qualification performed more than six months prior to the start of the welding by the welder is acceptable, provided written documentation is submitted showing that the welder has continued to use the applicable welding process on an ongoing basis since the test was conducted, with no lapse in service exceeding six months.
1. Welder Certificates shall be submitted to Testing Agency prior to welding.

2. Welders shall be checked by welding inspector. Those not doing satisfactory work may be removed, and may be required to pass qualification tests again. All qualification testing shall be at the Contractor's expense.
 3. Require welders to retake the qualification test if, as determined by the Architect or Testing Agency, there is a reasonable doubt as to the proficiency of the welder. If the welder does not requalify, he shall not perform any welding on the project.
 4. In addition to AWS D1.1 requirements on welder Qualification, qualify welders making welds with restricted access (such as welding the bottom flanges of girders to column flanges through cope or access holes in the girder webs) by using a mock-up assembly identical to the actual conditions of producing weldments in the field, using the approved WPS.
 5. Welder qualification shall include passing the bend test.
 6. Welders and welding operators performing work on Demand Critical Welds, beam bottom flange to column welds, or welds that must be made by welding through a beam access hole shall pass the supplemental welder qualification testing, as required by AWS D1.8.
 - a. Supplemental Qualification test shall be in accordance with AWS D1.8. The qualification test specimens shall be made with the same electrodes, processes and welding procedures that will be used on this project and also using the highest weld deposition rate allowed by the WPS.
 - b. Documentation showing that a welder has passed a similar qualification test within the last 36 months will be acceptable if in the opinion of the Testing Agency the test meets the criteria.
 - c. Testing Agency will perform and/or witness the tests on the qualification test specimen.
 - d. FCAW-S and FCAW-G shall be considered separate processes for welding personnel qualification.
- L. Contractor's Quality Control Plan: Quality Control includes the functions performed by the Contractor to ensure that the material and workmanship of structural steel construction meets the project specifications and applicable standards. The Contractor shall submit a Quality Control Plan that addresses all inspection issues, including fabrication/erection testing and inspection per AWS D1.1, AWS D1.8 and AISC 341 Chapter J. The verification testing and inspection carried out by the Testing Agency does not relieve the contractor of the responsibility for conducting their own quality control/inspection program to ensure the requirements of the Contract Documents have been met. The Contractor's Quality Control Plan will be reviewed by the Testing Agency.
- M. Protected Zone: The Contractor's Quality Control Plan shall include procedures that will be followed to ensure the Protected Zone is clearly identified on the required elements of the Seismic Load Resisting System and all necessary subcontractors are made aware of the requirements of this section.
- N. Quality Control Inspector Qualifications: Along with Quality Control Plan, Contractor shall submit written qualifications for all inspectors to be assigned Quality Control functions for structural steel work, including general inspection, bolting inspection, welding inspection, and non-destructive testing. Qualifications for welding inspectors shall show evidence of ability to monitor all WPS variables, check weld sizes, and visually detect weld defects.

O. Prefabrication and Preinstallation Conference: Prior to performing fabrication or erection work, there shall be a pre-fabrication and pre-erection meeting to review welding procedures, bolting procedures, and inspection requirements for all welding and bolting operations. The meeting shall include the following individuals: Owner's Representative, Testing Agency, Special Inspector, Steel Fabricator and Erector personnel supervising the shop, field and Quality Control work.

P. Paint:

1. Single Source Responsibility: Provide primers and other undercoat paint produced by same manufacturer as finish coats. Use thinners approved by paint manufacturer, and use within recommend limits.
2. Coordination of Work: Review other Sections in which prime paints are to be provided to ensure compatibility of coatings system for various substrates. Upon request, furnish information or characteristics of finish materials to be used.
3. Requirements of Regulatory Agencies: Comply with applicable rules and regulations of governing agencies for air quality control.

Q. Maintain one copy of each document on site.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Store materials to permit easy access for inspection and identification.
- B. Store fasteners in a protected place in sealed containers with manufacturer's labels intact.
- C. Requirements for storage and handling of electrodes shall be per AWS D1.1 and AWS D1.8. Additional requirements include:
1. Long term storage of weld consumables shall be indoors, where moisture or dew does not collect, and in undamaged manufacturer's shipping bags, boxes, and containers.
 2. Open Flux Cored Arc Welding (FCAW) electrodes shall be completely covered during hours of non-use (i.e., weekends, nights of nonuse, days of nonuse, etc.). Where rain or dew could be expected to collect (i.e., open floors of erection site, open shop bays, etc.), electrodes shall also be covered.
 3. Electrode Storage and Exposure Limits for Demand Critical Welds: The exposure time limit for electrodes shall be in conformance with AWS D1.8 Section 6.4.

1.9 COORDINATION

- A. Surveys: Contractor shall conduct field surveys and field verification as required to incorporate existing conditions from previous works, such as foundations and existing buildings, to the work before shop drawings are produced.
- B. Coordinate installation of anchorage items to be embedded in or attached to other construction without delaying the Work. Provide setting diagrams, templates, instructions, and directions for installation.
- C. Notify the Owner's Representative in sufficient time prior to shop or field fabrication or erection to permit testing and inspection without delaying work.
- D. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' recommendations to ensure that shop primers and topcoats are compatible with one another.

PART 2 PRODUCTS

2.1 MATERIALS

- A. All hot rolled steel shapes, plates, and bars shall be new steel conforming to ASTM A6, unless otherwise noted in the Drawings. Structural steel shall be as follows:
 - 1. Wide Flange and WT Shapes: ASTM A992.
 - 2. M- and S- Shapes: ASTM A36.
 - 3. C- and MC- Shapes: ASTM A992.
 - 4. L- Shapes: ASTM A572 Grade 50.
 - 5. Round HSS: ASTM A500 Grade C ($F_y = 46$ ksi).
 - 6. Rectangular HSS: ASTM A500 Grade C ($F_y = 50$ ksi).
 - 7. Pipe: ASTM A53, Grade B ($F_y = 35$ ksi).
 - 8. Base Plates up to 4" thick: ASTM A572 Grade 50.
 - 9. All other Plate Material: ASTM A572 Grade 50.
 - 10. Built-Up Columns: ASTM A572 Grade 50.
 - 11. Plate Girders: ASTM A572, Grade 50.
 - 12. Connection Material:
 - a. Column Continuity Plates and Doubler Plates: ASTM A572 Grade 50.
 - b. Brace Frame Gusset Plates: ASTM A572 Grade 50.
- B. Heavy sections as defined in this specification: ASTM A36 and/or ASTM A572 Grade 50 with supplementary requirements S5 Charpy V-Notch Impact Test and ASTM A6 with supplementary requirements S91 Fine Austenitic Grain Size. For location of Charpy V-Notch test, see ASTM A6 Supplementary Requirement S30. Charpy V-Notch test shall be per ASTM A673, frequency P and shall meet a minimum average value of 20 ft-lbs absorbed energy at 70 degrees Fahrenheit.
- C. Steel using complete joint penetration groove welds that fuse through the thickness of the flange or web that is part of the SFRS shall have a minimum Charpy V-notch impact testing value of 20 ft-lbs at 70 degrees Fahrenheit.
- D. Heavy Sections in the Seismic Force-Resisting System shall be supplied with Charpy V-notch (CVN) testing in accordance with AISC 341 requirements.
- E. Welding Materials
 - 1. Welding Material: Filler metal requirements shall conform to AWS D1.1, and AISC "Specification for Structural Steel Buildings". Filler metal used in welds designated as part of the SFRS or as Demand-Critical shall comply with AWS D1.8. Minimum classified tensile strength of 70 ksi (E70). Use low hydrogen electrodes as defined by AWS D1.1, unless noted otherwise. For all CJP welds used on Heavy Structural Sections that are not part of the Seismic Load Resisting System the filler metal shall have a Charpy V-Notch (CVN) toughness of at least 20 ft-lb at 70 degrees Fahrenheit.
 - 2. Welding Materials for Seismic Force Resisting System:

- a. All filler metal used in the Seismic Load Resisting System shall have a Charpy V-Notch (CVN) toughness not less than of 20 ft-lb at 0 degrees Fahrenheit, using AWS A5 classification test methods.
- b. Filler metal for welds defined as Demand Critical Welds (DCW) shall have a Charpy V-Notch (CVN) toughness of 20 ft-lb at minus 20 degrees Fahrenheit as determined by the appropriate AWS classification test method and 40 ft-lb at 20 degrees above the lowest anticipated service temperature of the structure as determined by AISC 341 and AWS D1.8.
- c. Refer to AISC 341 and AWS D1.8 for additional filler metal requirements.

F. Bolts, Connectors, and Anchors

1. High-Strength Bolts, Nuts, and Washers: ASTM A325, Type 1, heavy-hex steel structural bolts unless noted otherwise; ASTM A563, Grade C heavy-hex carbon-steel nuts or equal per ASTM A325-10 Section 3.2; and ASTM F436, Type 1, hardened carbon-steel washers; all with plain finish. ASTM F1852 Twist-Off Type Torque Control Bolts are a suitable alternative to ASTM A325 bolts.
2. High-Strength Bolts, Nuts, and Washers: ASTM A490, Type 1, heavy-hex steel structural bolts, where noted on drawings; ASTM A563, Grade DH, heavy-hex carbon-steel nuts or equal per ASTM A490-10 Section 3.2; and ASTM F436, Type 1, hardened carbon-steel washers with plain finish. ASTM F2280 Twist-Off Type Torque Control Bolts are a suitable alternative to ASTM A490 bolts.
3. Zinc-Coated High-Strength Bolts, Nuts, and Washers: ASTM A325, Type 1, heavy-hex steel structural bolts; ASTM A563, Grade DH heavy-hex carbon-steel nuts; and ASTM F436, Type 1, hardened carbon-steel washers.
 - a. Finish: Hot-dip zinc coating.
 - b. Zinc-Coated ASTM F1852 Twist-Off Type Torque Control Bolts are a suitable alternative to ASTM A325 bolts.
4. Unfinished Bolts and Nuts (Machine Bolts) and Threaded Rods: ASTM A307, Grade A, low carbon steel bolts and nuts; ASTM F436, Type 1, hardened carbon-steel washers.
5. Shear Studs: ASTM A108, Grades 1015 or 1020, headed-stud type, cold-finished carbon steel; AWS D1.1, Type B and conform to requirements of AWS D1.1 Section 7.
 - a. Tensile strength, 60,000 psi.
 - b. Elongation in 2 inches, 20 percent
 - c. Reduction of area, 50 percent.
6. Unheaded Anchor Rods: ASTM F1554 Grade 36, Grade 55 (weldable per S1 Supplementary Requirements), or Grade 105, where noted on drawings.
 - a. Configuration: Straight
 - b. Nuts: ASTM A563 heavy-hex carbon steel.
 - c. Plate Washers: ASTM A572 Grade 50 carbon steel.
 - d. Washers: ASTM F436, Type 1, hardened carbon steel.
 - e. Finish: Plain or Hot-dip zinc coating, ASTM A153, Class C.
7. Headed Anchor Rods: ASTM F1554 Grade 36, ASTM F1554 Grade 55, weldable where notes on drawings, or ASTM F1554 Grade 105.
 - a. Nuts: ASTM A563 heavy-hex carbon steel.

- b. Plate Washers: ASTM A572 Grade 50 carbon steel.
 - c. Washers: ASTM F436, Type 1, hardened carbon steel.
 - d. Finish: Plain or Hot-dip zinc coating, ASTM A153, Class C.
8. Threaded Rods: ASTM A36 or A572, Grade 50.
- a. Nuts: ASTM A563 heavy-hex carbon steel.
 - b. Plate Washers: ASTM A572 Grade 50 carbon steel.
 - c. Washers: ASTM F436, Type 1, hardened carbon steel.
 - d. Finish: Plain or Hot-dip zinc coating, ASTM A153, Class C.
9. Williams 150 KSI All-Thread-Bars.
- a. Nuts: ASTM A29 or A576 hex.
 - b. Plate Washers: ASTM A572 Grade 50 carbon steel.
 - c. Washers: ASTM F436, Type 1, hardened carbon steel.
 - d. Finish: Plain or Hot-dip zinc coating, ASTM A153, Class C.
 - e. Williams 150 ksi All-Thread-Bar is not to be subjected to the heat of a torch, welding or used as a ground.
10. Tie Rods: ASTM A36 or A572, Grade 50.
- a. Nuts: ASTM A563 heavy-hex carbon steel.
 - b. Washers: ASTM F436, Type 1, hardened carbon steel.
 - c. Finish: Plain or Hot-dip zinc coating, ASTM A153, Class C
11. Clevises and Turnbuckles: Made from cold-finished carbon steel bars, ASTM A108, Grade 1035. Dimensions and minimum capacities to conform to the values listed in AISC "Steel Construction Manual".
12. Eye Bolts and Nuts: Made from cold-finished carbon steel bars, ASTM A108, Grade 1030.
13. Sleeve Nuts: Made from cold-finished carbon steel bars, ASTM A108, Grade 1018. Minimum proof load of sleeve nuts shall be such that when loaded axially the sleeve nut shall be stronger than the ultimate capacity of the connected parts.
14. Structural Slide Bearings: Low-friction assemblies, of configuration indicated, that provide vertical transfer of loads and allow horizontal movement perpendicular to plane of expansion joint while resisting movement within plane of expansion joint.
- a. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following manufacturers:
 - 1) Amscot Structural Products Corp.
 - 2) Fluorocarbon Company Limited.
 - 3) R.J. Watson Bridge & Structural Engineered Systems.
 - 4) Seismic Energy Products, L.P.
 - b. Mating Surfaces: to be specified.
 - c. Coefficient of Friction: to be specified.
 - d. Design Load: to be specified.

- e. Total Movement Capability: to be specified.

G. Primer

1. Comply with Division 09.
2. Primers and paints shall meet all federal and state environmental and air quality requirements.
3. Primer Paint shall comply with all applicable SSPC requirements and shall be compatible with finish paints and spray-on fireproofing specified elsewhere.
4. Galvanizing Repair Paint: MPI#18, MPI#19, or SSPC-Paint 20 per ASTM A780.
5. Primer:
 - a. Typical Interior Primer: SSPC-Paint 25, Type II or SSPC-Paint 23. Primer shall comply with the requirements called out in the "Green Seal Standard for Anti-Corrosive Paints" (GC-03).
 - b. Typical Exterior Primer: SSPC-Paint 20, Type II, Organic.

H. Grout

1. Grout shall have a minimum 6,000 psi compressive strength in 3 days and 10,000 psi compressive strength at 28 days.
2. Metallic, Shrinkage-Resistant Grout: ASTM C1107, factory-packaged, metallic aggregate grout, mixed with water to consistency suitable for application and a 30-minute working time.
3. Nonmetallic, Shrinkage-Resistant Grout: ASTM C1107, factory-packaged, nonmetallic aggregate grout, noncorrosive and nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

2.2 FABRICATION

- A. Structural Steel: Fabricate and assemble in shop to greatest extent possible. Fabricate according to AISC 303 and AISC 360.
1. Camber structural-steel members where indicated. Fabricate beams and girders with natural camber upward, unless noted otherwise on the drawings.
 2. Fabricate beams with rolling camber up.
 3. Identify high-strength structural steel according to ASTM A6 and maintain markings until structural steel has been shop erected.
 4. Mark and match-mark materials for field assembly. Members shall be fabricated for delivery in a sequence that will expedite erection and minimize field handling of structural steel.
 5. Splice members only where indicated on Structural Drawings or where accepted by the Structural Engineer.
 6. All hollow members exposed to weather shall be sealed with continuous welds, incorporating structural welds where shown or required, or provide weep holes where water may accumulate.
 7. Grind burrs, sharp arises and ragged edges that would prevent solid seating of the connected parts.
 8. AISC Group 4 and 5 shapes and built up members shall meet the requirements for joints in AISC Sections J1.5, J1.6, J2.7 and M2.2.

9. Complete structural-steel assemblies, including welding of units, before starting shop-priming operations.
- B. Holes and attachments to structural steel in areas designated as the Protected Zone are not allowed except as explicitly shown or noted on structural drawings.
- C. Tolerances: Except as noted as follows, maintain fabrication tolerances of structural steel within the tolerances specified on the drawings and AISC's "Code of Standard Practice for Steel Buildings and Bridges."
- D. Thermal Cutting: Perform thermal cutting by machine to greatest extent possible. An unguided torch may be used provided the cut is within 1/8 inch of the required line.
 1. Plane thermally cut edges to comply with requirements in AWS D1.1.
- E. Bolt Holes: Cut, drill, or punch standard bolt holes perpendicular to metal surfaces.
 1. Use standard holes unless otherwise indicated on the Drawings. Holes shall be drilled or punched at right angles to the surface of the metal. Making or enlarging holes by burning is prohibited.
 2. Flame cut holes for fasteners are not acceptable.
 3. Holes in column baseplates shall be within the limits of Table 14.2 of AISC "Steel Construction Manual".
- F. Bending Steel Plate:
 1. Bend plates perpendicular to the rolling direction.
 2. Grind flame cut plate edges transverse to the bend line.
 3. Grind out nicks in plate edges transverse to the bend line.
 4. Round sharp corners on plate edges transverse to the bend line.
 5. Bent plate deck edge closure may be excluded from Items 1-4 above.
- G. Heat Straightening: Will be permissible by the use of properly controlled heat, skilled personnel, proper equipment and in accordance with documents prepared by the fabricator and accepted. Reject materials that contain kinks or sharp angles. Material straightened prior to fabrication shall be rejected where it shows signs of distress or defects.
- H. Planing and Milling:
 1. Bearing surfaces of columns and base plates shall be finished and constructed in accordance with AISC 360 Section M2.6, M2.8 and M4.4.
 2. Bearing surfaces of column end cuts shall meet a surface roughness of 500 micro inches or better.
- I. Cleaning: Clean and prepare steel surfaces that are to remain unpainted according to SSPC-SP 1, "Solvent Cleaning" or SSPC-SP 2, "Hand Tool Cleaning" or SSPC-SP 3, "Power Tool Cleaning."
- J. End-Welded Studs:
 1. Automatic end-welded studs: Automatically end-weld in accordance with the manufacturer's recommendations in such a manner as to provide complete fusion

- between the end of the stud and the plates. There shall be no porosity or evidence of lack of fusion between the welded end of the stud and the plate. The stud shall decrease in length during welding approximately 1/8 inch for 5/8 inch, and 3/16 inch for 3/4 inch diameter. Stud sizes indicated on drawings represent the finish stud height.
2. Fillet-end welded studs: Studs may be welded using prequalified FCAW, GMAW, or SMAW processes provided the requirements of the AWS D1.1 Chapter 7 Section 7.5.5 are met as well as any other pertinent requirements of D1.1.
- K. Bolt Holes and Holes for Other Work: Provide holes required for securing other work to structural steel and for other work to pass through steel framing members.
1. Provide holes, slots and openings together with necessary reinforcing as shown on the Drawings required for securing work of other trades to the work specified here. Where openings are shown on the Drawings no change shall be permitted without prior approval. Openings shall be done in the shop.
 2. Cut, drill, or punch holes perpendicular to steel surfaces. Do not thermally cut bolt holes or enlarge holes by burning.
 3. Weld threaded nuts to framing and other specialty items indicated to receive other work.
 4. Unless noted otherwise, make holes 1/16 inches larger than the nominal bolt diameter.
- L. The Contractor shall cooperate fully with requests from inspection and testing personnel for access to the connections and joints to be inspected and tested. This includes beam and column turning in shop, weld backing removal when nondestructive examination indicates rejectable conditions, and access to platforms or scaffolding as required to perform the work safely.
- M. Any technique not covered by this section shall be submitted to the SEOR for approval.

2.3 FINISH

- A. Prepare structural component surfaces in accordance with SSPC-SP 3.
- B. Shop prime structural steel members. Do not prime surfaces that will be fireproofed, field welded, in contact with concrete, or high strength bolted, and where enclosed within the building finish and thereby protected from exterior exposure.
- C. Galvanize structural steel members to comply with ASTM A123. Provide minimum 1.7 oz/sq ft galvanized coating.

2.4 SOURCE QUALITY CONTROL

- A. Testing Agency: Testing Agency to perform shop tests and inspections as defined by AWS, AISC and these specifications. Testing Agency shall summarize their finding in inspection and testing reports. Reports shall identify any findings that are not in compliance with requirements of the project specifications.
 1. Provide testing agency with access to places where structural-steel work is being fabricated or produced to perform tests and inspections.
- B. See Part 1 of this specification for additional testing and inspection requirements. As a minimum the inspector will make all tests and inspections as required by the Special Inspection provisions of the governing building code. Testing Agency will make all the tests and inspections indicated in the Contract Documents.

- C. Contractor shall correct deficiencies in Work that test reports and inspections indicate does not comply with the Contract Documents.
 - 1. Owner's Representative reserves right, at any time before final acceptance, to reject material not complying with requirements.
 - 2. Any tests that may be necessary to reconfirm any noncompliance of original work, and as may be necessary to show compliance of corrected work, shall be at Contractor's expense.
- D. Each person installing connections shall be assigned an identifying symbol or mark and all shop and field connections shall be so identified so that the Inspector can refer back to the person making the connection.
- E. Bolted Connections: Shop-bolted connections will be tested and inspected according to RCSC's "Specification for Structural Joints Using ASTM A325 or A490 Bolts."
 - 1. High Strength Bolted Connections: Furnish certified test reports for each lot of bolts in accordance with Section 9 of ASTM A325 and A490. Install bolts under the supervision of a qualified inspector in accordance with Section 9, Research Council "Specifications for Structural Joints using ASTM A325 or A490 Bolts". High strength bolts specified as Snug-Tight (ST) need not be inspected for bolt tension. For high strength bolts specified as Slip-Critical (SC), verify that 10% or a minimum of 2 bolts per connection are tensioned in accordance with the RCSC Specification.
 - 2. If high strength bolting inspection is indicated on the structural drawings or required by the applicable referenced standards, the testing laboratory shall provide inspection in accordance with AISC 360 Section N.
 - 3. High Strength Bolted Connections in the Seismic Force Resisting System will, in addition, comply with the required inspection in AISC 341 Section J.
 - 4. Tension Calibrator: A tension measuring device shall be required at all job sites where bolts in slip-critical joints are being installed and tightened. The tension measuring device shall be used to confirm: (1) the suitability to satisfy the requirements of AISC for the complete fastener assembly, including lubrication if required to be used in the work, (2) calibration of wrenches, if applicable, and (3) the understanding and proper use by the bolting crew of the method to be used. The frequency of confirmation testing, the number of tests to be performed and the test procedure shall be as specified in 1.d. below, as applicable. The accuracy of the tension measuring device shall be confirmed through calibration by an approved testing agency at least annually.
 - 5. Direct Tension Indicators: Observe all Direct Tension Indicators to see if proper tightness was achieved.
 - 6. Joint Assembly and Tightening of Shear/Bearing Connections: Bolts in connections not within the slip-critical category shall be installed in properly aligned holes, but need only be tightened to the snug tight condition. The snug tight condition is defined as the tightness that exists when all plies in a joint are in firm contact. This may be attained by a few impacts of an impact wrench or the full effort of a man using an ordinary spud wrench. If a slotted hole occurs in an outer ply, a flat hardened washer or common plate washer shall be installed over the slot.
 - 7. Joint Assembly and Tightening of Connections Requiring Full Pre-tensioning. Slip-critical connections shall be installed in properly aligned holes and tightened by one of the

following methods.

- a. Turn-of-nut Tightening: When turn-of-nut tightening is used, hardened washers are not required except as specified in the AISC. A representative sample of not less than three bolts and nuts of each diameter, length and grade to be used in the work shall be checked at the start of work in a device capable of indicating bolt tension. The test shall demonstrate that the method of estimating the snug-tight condition and controlling turns from snug tight to be used by the bolting crews develops a tension not less than five percent greater than the tension required for slip-critical connections.
 - b. Installation of Alternate Design Bolts: A representative sample of not less than three bolts of each diameter, length and grade shall be checked at the job site in a device capable of indicating bolt tension. The test assembly shall include flat hardened washers, if required in the actual connection, arranged as in the actual connections to be tensioned. The calibration test shall demonstrate that each bolt develops a tension not less than five percent greater than the tension required by AISC. Manufacturer's installation procedure shall be followed for installation of bolts in the calibration device and in all connections. When alternate design features of the fasteners involve an irreversible mechanism such as yield or twist-off of an element, bolts shall be installed in all holes of the connection and initially brought to a snug tight condition. All fasteners shall then be tightened, progressing systematically from the most rigid part of the connection to the free edges in a manner that will minimize relaxation of previously tightened fasteners prior to final twist-off or yielding of the control or indicator element of the individual fasteners. In some cases, proper tensioning of the bolts may require more than a single cycle of systematic tightening.
8. Mark bolts that have been completely tightened with an identifying symbol.
 9. Standard Bolted Connections: Testing Agency shall inspect the installation of A307 bolts to verify that 10% of all bolts or a minimum of 2 bolts per connection are installed properly and tightened to a Snug-Tight (ST) condition.

F. Welded Connections:

1. Testing Agency shall be present during welding operations as necessary to perform required testing and inspections.
2. Welding equipment: Welding equipment to be used in each case shall be acceptable to welding inspector. Use equipment with suitable devices to regulate speed, and manually adjust operating amperage and voltage. The amperage capacity shall be sufficient to overcome line drop, and to give adequate welding heat.
3. Welded Joint Details as Part of the SFRS:
 - a. Weld in accordance with AWS D1.8.
 - b. Weld Backing: The use of weld backing shall be in accordance with AWS D1.1. Weld backing shall be removed where required by the Contract Documents or for the WPS by AWS D1.1.
 - 1) Connections of the SFRS in which backing is not removed: backing shall be attached to the member or plate that does not have its surface prepared for the groove weld. Attachment shall be by either a 5/16" fillet or 3/16" groove weld along the complete bar length on the side of the bar opposite the groove weld.
 - 2) Beam-Column Connection Joints Requiring Removal of Weld Backing: Conform with AWS D1.8. Perform MT on the fillet weld and the immediately adjacent area.
4. Visual Inspection of Welding: Testing Agency shall visually inspect shop and field welding of structural steel in accordance with the governing building code and AWS D1.1. Visual

- inspection of welds shall include but not be limited to the following:
- a. Verify: Welding Procedure Specification (WPS) sheet has been provided and has been reviewed with each welder making the weld, welder qualification and identification, fit-up meets tolerances of WPS and mark joint prior to welding, welding consumables are per the Contract Documents and the WPS, amperage and voltage at the arc with hand-held meters, meters on welding equipment are functioning and accurate.
 - b. Observe preheat and interpass temperatures, weld pass sequence and size of weld bead.
 - c. Multi-pass shop and field welds shall be inspected as required per the governing building code, AWS D1.1, AWS D1.8, AISC 360 Table N5.4 and AISC 341 Table J6.
 - d. Visually inspect welds of heavy structural sections, or plates of 1-1/2 inch minimum thickness, as follows:
 - 1) Columns – visually inspect first two (2) production columns 48 or more hours after completion of welding. If columns successfully pass inspection, no additional 48 hour delayed visual inspections are required.
 - 2) Plate Girders – visually inspect all plate girders 48 or more hours after completion of welding for presence of cracks.
 - e. Visually inspect areas where backing bars and welds tabs are removed for conformance with the surface roughness criteria of the specifications.
 - f. Verify that the effective throat thickness of flare groove welds is consistently obtained when flush to bar or section. This verification shall be based on test sections where necessary.
5. Nondestructive Testing Requirements: Testing Agency shall perform non-destructive testing of shop and field welding in accordance with the project specifications, governing building code, and AWS D1.1. Extent of non-destructive testing shall be as follows:
- a. Complete Joint Penetration (CJP) welds: UT 100% CJP welds greater than 5/16-inch. MT 25% all DCW CJP welds. MT 100% of all DCW CJP weld ends.
 - b. Partial Joint Penetration (PJP) welds: UT 100% of PJP welds greater than 5/16-inch. UT 100% PJP in column splices.
 - c. Column Web Material at Continuity Plate: MT the WF column webs 3-inches above and below the weld terminations at the first 50 continuity plates and doubler plates installed. Test shall be conducted when weld has cooled to ambient temperature. If no web cracks are found, then no more testing required. This test shall also be conducted for all locations where the Contractor has welded into the “no weld” zone shown on the Drawings for continuity plates.
 - d. Access holes at splices in Heavy Structural Sections – MT or PT 100%.
6. Special non-destructive testing for welds in the Seismic Force Resisting System shall have additional testing per AISC Seismic Provisions, AWS D1.8 and the governing building code, and as follows:
- a. Backing Bars Removed - MT 20% of the locations where the backing bars and weld tabs are removed after the roughness criterion is attained.
 - b. Reinforcing Fillet Weld placed where backup bars are removed - MT 100% of the welds.

- c. Access holes and copes in SMRF beams – MT or PT 100%.
 - d. Heavy Structural Section flanges and/or plate thicker than 1-1/2 inches where subject to through-thickness weld shrinkage strains (including column flanges and base plates) – UT flange or plate material for lamellar discontinuities 3" to each side of CJP weld prior to CJP weld (this includes base plates). If rejectable defects are found then beam shall not be welded to the flange or plate at this location. This test should be conducted in the shop. In addition, UT material after weld for discontinuities behind and adjacent to such welds. The test procedure and acceptance criteria shall be per ASTM A898 Level I or ASTM A435.
 - e. Fillet Welds: Fillet welds of gusset plates to beams, columns and base plates - MT 10% of the following fillet welds and reduce to 5% if no significant cracks are found in the first 50 tested: a) gusset plate fillet welds to beam and columns; b) base plate fillet welds.
- 7. All full penetration groove welds will be subject to ultrasonic testing, as per AWS D1.1, Clause 6 "Inspection, Part "F", Ultrasonic Testing (UT) of Groove Welds. All defective welds shall be repaired and retested with ultrasonic equipment at the Contractor's expense.
 - 8. Box columns and built-up members shall have ultrasonic testing before and after welding.
 - 9. Column Flanges: An area extending 6 inches above and below point where girder flanges are attached will be inspected. Column flange edges will be inspected visually and entire area ultrasonically for lamination, plate discontinuities, and non-metallic inclusions.
 - 10. When ultrasonic indications arising from the weld root can be interpreted as either a weld defect or the backing strip itself, the Engineer will be notified. The Engineer may require the removal of backing strip. The backing strip will be removed at the expense of the Contractor, and if no root defect is visible the weld will be retested. If no defect is indicated on this retest, and no significant amount of base and weld metal have been removed, no further repair of welding is necessary. If a defect is indicated, it will be repaired and retested at Contractor's expense.
 - 11. The ultrasonic instrumentation will be calibrated by the technician to evaluate the quality of the welds in accordance with AWS D1.1.
 - 12. Other methods of inspection, for example, X-Ray, gamma ray, magnetic particle, or dye penetrant, may be used on welds if felt necessary by the inspection laboratory, and with the approval of the Engineer.
 - 13. Base metal thicker than 1-1/2 inches, when subjected to through thickness weld shrinkage strains, shall be ultrasonically inspected for discontinuities directly behind such weld before and after joint completion.
 - 14. At the discretion of the owner's testing agency, except for Demand Critical Welds as per AISC 341 Section J6.2g, the ultrasonic testing frequency may be reduced but may not be less than the following:
 - a. Initially, all welds requiring ultrasonic testing will be tested at the rate of 100 percent in order to establish the qualifications of each individual welder. If the reject rate is demonstrated to be less than 5 percent of the welds tested for each welder, then the frequency of testing for that welder may be reduced to 25 percent. If the reject rate increases to 5 percent or more, 100 percent testing will be re-established until the rate is reduced to less than 5 percent. The percentage of rejects will be calculated for each welder independently.

- b. A sampling of a least 40 completed welds will be made for such reduction evaluation. Reject rate is defined as the number of welds containing rejectable defects divided by the number of welds completed. For evaluating the reject rate of continuous welds over 3 ft in length where the effective throat is 1" or less, each 12 inch increment or fraction thereof shall be considered as one weld. For evaluating the reject rate of continuous welds over 3 ft in length where the effective throat is greater than 1", each 6 inch of length or fraction thereof shall be considered one weld.
- G. In addition to visual inspection, shop-welded shear studs will be tested and inspected according to requirements in AWS D1.1 and the governing building code for stud welding and as follows:
 1. The type and capacity of the welding equipment shall be in accordance with the manufacturer's recommendations and shall be checked and approved.
 2. At the beginning of each day's work, a minimum of 2 test stud welds shall be made, with the equipment to be used, to metal which is the same as the actual work piece. The test studs shall be subjected to a 90-degree bend test by striking them with a heavy hammer. After the above test, the weld section shall not exhibit any tearing or cracking.
 3. Bend tests will be performed if visual inspections reveal either a less-than-continuous 360-degree flash or welding repairs to any shear connector.
 4. Tests will be conducted on additional shear studs if weld fracture occurs on shear studs already tested, according to requirements in AWS D1.1.
- H. Inspection Records
 1. The inspector will maintain a daily record of the work that has been inspected and its disposition. One copy of each report will be submitted to the Owner on a weekly basis. Test reports will be made on the form suggested in the AWS D1.1 "Structural Welding Code".
 2. Make systematic record of all shop welds, including:
 - a. Date of inspection.
 - b. Location and type of weld.
 - c. Identification marks of welders.
 - d. List of defective welds.
 - e. Manner of correction of defects.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify, with steel Erector present, locations of anchor rods, bearing plates, and other embedments for compliance with requirements.
 1. Prepare a certified survey of bearing surfaces, anchor rods, bearing plates, and other embedments showing dimensions, locations, angles, and elevations.

- B. Discrepancies: In the event of discrepancy, immediately notify the Owner's Representative in writing. Do not proceed with construction in the region of the discrepancy until all such discrepancies have been resolved.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Provide temporary shores, guys, braces, and other supports during erection to keep structural steel secure, plumb, and in alignment against temporary construction loads and loads equal in intensity to design loads. Remove temporary supports when permanent structural steel, connections, and bracing are in place unless otherwise indicated.
 - 1. The Contract Drawings indicate the completed structure. The Contractor is fully responsible for all temporary measures necessary for erection, except where specific sequences and requirements are specified on the Drawings.
 - 2. Do not remove temporary shoring supporting composite deck construction until cast-in-place concrete has attained its design compressive strength.
- B. Furnish templates for exact locations of items to be embedded in concrete and any setting instructions required for installation.

3.3 CONNECTIONS

- A. General Bolting:
 - 1. Product containers must be marked with lot numbers and traceability information so that correspondence with mill reports can be established. Manufacturer's symbol and grade markings shall appear on all bolts, nuts, through-hardened washers and direct tension indicators.
 - 2. Bolts shall be of a length that will extend to a point at least flush with the surface of the nuts, though not more than a length equal to the height of the nut, beyond the nuts unless otherwise noted.
 - 3. Bolts shall be installed with threads excluded from the shear plane.
 - 4. Washers shall be used on all bolts. Use beveled washers where bolts bear on sloping surface.
- B. High-Strength Bolts: Shop install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A325 or A490 Bolts" for type of bolt and type of joint specified. Contact surfaces of bolted parts shall as a minimum comply with the Class A requirements.
 - 1. Joint Type shall be as noted on drawings.
 - 2. Direct tension indicator (load indicating washers or "Tension-Set" bolts) method shall be used at slip-critical connections. "Turn-of-Nut" methods are not an acceptable alternative.
 - 3. When connection has bolts and welds, fully tighten bolts prior to welding with the exception that in moment connections the flange welds shall be completed prior to final tightening of high strength bolts.
 - 4. When already tensioned bolts have had their tension relaxed, replace the bolt and tension indicator and re-tighten.
- C. Weld Connections: Comply with AWS D1.1 and AWS D1.8 for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work. Quality of materials and design and fabrication of all welded connections shall conform to

AISC "Specifications for the Design, Fabrication and Erection of Structural Steel for Building," "AWS Code for Welding in Building Construction," and requirements of this section.

1. Location and type of all welds shall be as shown. Make no other welded splices, except those shown on drawings, without prior approval of the Structural Engineer.
2. Automatic Welding: Use electrode wire and flux for automatic and semi-automatic welding acceptable to Structural Engineer. All methods, sequences, qualification and procedures, including preheating, and post heating if necessary, shall be detailed in writing and submitted to the Structural Engineer for review.
3. Preparation of surface: Surfaces to be welded shall be free of loose scale, slag, rust, grease, paint, and any other foreign material.
4. Shop welds shall be inspected in the shop before the work is painted or shipped.
5. Control cooling process after weld is completed by either step down post heat or thermal blankets as determined by procedures and prequalification.
6. Weld sizes where shown shall be assumed to be effective weld sizes.
7. All groove or butt welds shall be full penetration unless noted otherwise on the Drawings.
8. Where structural steel members are to remain exposed in the finished work, welds exposed to view shall be uniformly made and ground smooth.
9. Remove runoff tabs and grind surfaces smooth where the tabs would interfere with architectural finishes.
10. Weld tabs shall be in accordance with AWS D1.1. In addition, weld tabs shall extend beyond the edge of the joint a distance not less than 1-inch except at access holes in beam/girder webs and at continuity plate clips. Weld tabs shall be oriented parallel to the joint preparation and to the weld direction. Weld dams are not allowed.
11. Remove weld tabs and backup plates and grind surfaces smooth as required for inspection or testing. Where tabs or backup bars interfere with architectural treatment or are exposed to view in the final structure, remove and grind smooth.
12. Splices of members in tension, all members of moment frames and all members of braced frames that are made from heavy steel sections shall be made in conformance with Section J1.5 of AISC 360.
13. Weld variables shall be consistent with the recommendations of the electrode manufacturer.
14. Do not weld into column flange-to-web intersection as defined the AISC "k" and "k1" distances except for the doubler plate to column welds. Continuity plate welds shall stay clear of this area as noted on the drawings.
15. Sequence the work as necessary to accommodate testing.
16. Assemble and weld built-up sections by methods that will maintain true alignment of axes without exceeding tolerances in AISC 303 for mill material.
17. Welding Procedures:
 - a. Weld only in accordance with the Welding Procedure Specifications. WPS shall be readily available to all welders, inspectors, and supervisors during the production process.

- b. Consider toughness and notch sensitivity of steel in formation of the welding procedures to prevent brittle and premature fracture during fabrication and erection. Toughness requirements are to match those of the parent metal.
 - c. Weld in a manner to minimize accumulation and concentration of through-thickness strains due to weld shrinkage. Sequence welds in a manner to reduce residual stresses (caused by welding) to a minimum value. Welding procedures shall incorporate measures necessary to eliminate cracking.
 - d. Do not mix different electrodes in the same weld joint unless the interactions have been shown not to cause problems.
 - e. Stringer passes only, no weaving or wash passes. Manipulation of the electrode for vertical welds (oscillation) shall be kept to a maximum movement of 4 to 5 electrode diameters.
 - f. Welding shall not begin until joint elements are bolted or tacked in intimate contact and adjusted to dimensions shown in the Drawings, with proper allowance for any weld shrinkage.
 - g. All tack welds shall be of the same quality as final welds. Tack welds within Demand Critical welds at Seismic Force Resisting System members shall be per AWS D1.8; all other tack welds shall be per AWS D1.1.
18. Additional Welding Requirements:
- a. Weld Access Holes shall be in accordance with AISC Specification J1.6 and AWS D1.1 except as otherwise noted in the Construction Documents. The access hole shall be ground smooth to a surface roughness not to exceed 500 micro-inches, and shall be free of notches and gouges. For this purpose, a notch of gouge is any depression deeper than the overall surface roughness.
 - b. Pay increased attention to uniform and adequate preheat.
 - c. Maximum interpass temperature not to exceed 550 degrees F when notch toughness properties are specified.
 - d. Complete individual weld layers prior to applying portions of subsequent layers. Ends of interrupted passes to be staggered. Minimize starts and stops within body of the weld.
 - e. Where required by specifications and/or contract drawings, remove backing bars and apply reinforcing fillet weld per note J of figure 3.4 of AWS D1.1 and AWS D1.8 section 6.7 and 6.8. Remove backing bar with air carbon arc cutting, grinding, chipping or thermal cutting. The process shall be controlled to minimize gouging and removal of base metal except for material immediately adjacent to the weld. After removal of backing the root shall be backwelded with a reinforcing fillet weld with a minimum leg of 5/16-inch.
 - f. At continuity plate to column welds, the backing bars do not need to be removed.
 - g. At Demand Critical Welds: Cut off weld tabs 1/8-inch (1/4-inch at continuity plates) from the edge and grind to a surface roughness of 500 micro-inches or better.
 - h. Where bottom cover plates are acting as back-up plates, welds in the vicinity of the web cope area shall be carefully checked by ultrasonic inspection. Any indication of weld discontinuities shall be cause to remove suspect portions of welds by cut-outs. The cut-out areas shall be ground smooth to sound bright metal for visual inspection. If visual inspection is inconclusive or questionable, verify by magnetic particle testing. If weld defects, slag inclusions, etc. are present, remove them by air arcing and clean up by grinding. Repair welds and add a reinforcing fillet weld at least 1/4 of the bottom

flange thickness but need not be greater than 5/16 inch. If there are no defects, clean up by grinding and reinforce with fillet weld. Ultrasonic testing (UT) inspection shall be conducted from both sides of the flange to ensure sound welds.

- i. Flame cut surfaces at weld access holes within heavy sections shall be ground per AISC 360 Section M2.2.

D. Refer to the Structural Drawings for additional requirements.

3.4 SHOP PRIMING

- A. Shop prime all steel surfaces exposed to weather or not completely concealed by interior finishes unless noted otherwise and excepting the following:
 1. Surfaces embedded in concrete or mortar. Extend priming of partially embedded members to a depth of 2 inches.
 2. Surfaces to be field welded and areas within 4 inches on each side of field welds.
 3. Top surfaces of beams to receive metal deck.
 4. Surfaces to be high-strength bolted except surfaces painted with Type B Primer. Areas with high-strength bolts exposed to the weather shall receive a primer coat compatible with slip-critical type connections.
 5. Surfaces to receive sprayed fire-resistive materials (applied fireproofing).
 6. Galvanized surfaces.
 7. Machined surfaces.
 8. Welded shear studs.
 9. Where enclosed within the building finish and thereby protected from exterior exposure.
- B. Steel members not otherwise painted shall be painted when subjected to condensation from piping, are in shower or steam rooms, are exposed to chemical fumes or are exposed to other conditions of potentially aggressive corrosion
- C. Surface Preparation: Clean surfaces to be painted. Remove loose rust and mill scale and spatter, slag, or flux deposits. Prepare surfaces according to the applicable SSPC specification requirements for each primer. As a minimum, all surfaces shall be prepared according to the following specifications and standards:
 1. SSPC-SP1 "Solvent Cleaning"
 2. SSPC-SP 2, "Hand Tool Cleaning"
 3. SSPC-SP3, "Power Tool Cleaning"
 4. Where jobsite exposure is expected to exceed 6 months, SSPC-SP6 Commercial Blast Cleaning is required.
- D. Priming: Immediately after surface preparation, apply primer according to manufacturer's written instructions and at rate recommended by SSPC to provide a minimum dry film thickness as recommended by manufacturer. Use priming methods that result in full coverage of joints, corners, edges, and exposed surfaces.
 1. Material: Type A Tnemec Company, Inc., Series V10; Sherwin Williams Steel Spec Universal; Metal Case 94-231 Series or approved equal.

2. Number of Coats: One.
 3. Volume Solids: 56.0 +/- 2.0% minimum.
 4. Generic Description: Modified Alkyd.
 5. Stripe paint corners, crevices, bolts, welds, and sharp edges.
 6. Apply two coats of shop paint to surfaces that are inaccessible after assembly or erection. Change color of second coat to distinguish it from first.
- E. Unless noted otherwise in subsection G, use the following Type B shop painting systems on all exterior steelwork and interior steelwork subjected to wet conditions or fumes (see subsection G for additional requirements)
1. Surface Preparation: SSPC-SP6 Commercial Blast Cleaning
 2. Application: Follow coating manufacturer's printed directions.
 3. Material: Type B Tnemec 90-97 Tneme-Zinc primer or approved equal
 4. Number of Coats: One
 5. Dry Film Thickness: 2.5 to 3.5 mils
 6. Volume Solids: 63% +/- 2%
 7. Generic Description: Zinc-Rich Urethane
- F. Unless noted otherwise in subsection G, use the following finish painting systems on all exterior steelwork and interior steel work subjected to wet conditions or fumes (see subsection G for additional requirements):
1. Application: Follow coating manufacturer's printed directions. Apply over Type B primer system above.
 2. Material: Tnemec Series 750 UVX paint or approved equal
 3. Number of Coats: One
 4. Dry Film Thickness: 2.5 to 5 mils
 5. Volume Solids: 72% +/- 2%
 6. Generic Description: Polyfunctional Hybrid Polyurethane
- G. All exterior steelwork and all interior steelwork subjected to wet conditions or fumes, including all welds, bolts, washers and other connection components, shall be primed and painted or hot-dip galvanized, as specified by the Architectural finish specifications. In the absence of Architectural finish specifications, all exterior steelwork and all interior steelwork subjected to wet conditions and fumes, including all welds, bolts, washers and other connection components, shall be hot-dip galvanized, conforming to the requirements set forth in ASTM A123 and ASTM A153.
- H. All steel exposed to weather in the final structure shall be galvanized or painted.
- I. Use special care if steel is fabricated, cleaned, and painted in damp weather to remove moisture from mill scale cracks.
- J. Clean contact surfaces of high strength bolts of all burrs and material which might prevent solid seating of the parts. Steel to receive bolts shall be primer painted except beneath the contact area of slip-critical bolts.

3.5 GALVANIZING

- A. Hot-Dip Galvanized Finish: Apply zinc coating by the hot-dip process to structural steel according to ASTM A123 and to bolts, nuts, and washers according to ASTM A153. Galvanize all items noted on Drawings to be galvanized and fasteners that connect galvanized components, except that ASTM A490 bolts shall not be hot-dip galvanized. Where ASTM A490 bolts connect galvanized components, use A490 Type 3 bolts.
 - 1. Fill vent and drain holes that will be exposed in the finished Work unless they will function as weep holes, by plugging with engine freeze/core plugs installed per manufacturer's recommendations.
 - 2. Galvanize lintels and shelf angles attached to structural-steel frame and located in exterior walls.
 - 3. Roughen faying surfaces of slip-critical high-strength bolted connections to achieve Class C surface accordance with the RCSC Specifications.

3.6 ERECTION

- A. Structural steel erection: Comply with AISC "Specification for the Design, Fabrication and Erection of Structural Steel for Building", latest edition.
- B. Erection Sequence: Erect steel in accordance with special erection sequences where special erection sequences are indicated on the contract documents.
- C. Mark each member with erection identification corresponding to mark shown on erection drawings. Carefully plan erection of structural steel so that no cutting and removal of material will be necessary. Do not torch burn in the field, unless specifically permitted by Engineer.
- D. Set structural steel accurately in locations and to elevations indicated and according to AISC 303 and AISC 360. Check plumbness after erection of each tier.
- E. Dimensions shown on drawings are based on an assumed design temperature of 70 degree Fahrenheit. Fabrication and erection procedures shall take into account the ambient temperature range at the time of the respective operations.
- F. Care shall be taken to protect work already installed from damages resulting from structural steel erection.
- G. Base Bearing and Leveling Plates: Clean concrete- and masonry-bearing surfaces of bond-reducing materials, and roughen surfaces prior to setting plates. Clean bottom surface of plates. Remove any templates used for the setting of anchor bolts.
 - 1. Set plates for structural members on wedges, shims, or setting nuts as required.
 - 2. Weld plate washers to top of baseplate at locations that are specified per the structural design details.
 - 3. Snug-tighten or Pretension anchor rods after supported members have been positioned and plumbed. If used, do not remove wedges or shims but, if protruding, cut off flush with edge of plate before packing with grout.
 - 4. Grout solid under plates with a flowable non-shrink grout per Section 03 30 00 prior to placement of concrete fill over metal deck at any floor level. Neatly finish exposed surfaces; protect grout and allow to cure. Comply with manufacturer's written installation instructions for shrinkage-resistant grouts.

- H. Maintain erection tolerances of structural steel within AISC 303.
- I. Align and adjust various members that form part of complete frame or structure before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that will be in permanent contact with members. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.
 - 1. Level and plumb individual members of structure.
 - 2. Make allowances for difference between temperature at time of erection and mean temperature when structure is completed and in service.
 - 3. Shimming or other adjustments not indicated on drawings shall be approved by the Engineer prior to installation. Column shimming shall be $\frac{1}{4}$ inch.
- J. All welds shall be full and clean, and conform to AISC and AWS specifications.
- K. Splice members only where indicated.
- L. Do not use thermal cutting during erection unless approved by SEOR. Finish thermally cut sections within smoothness limits in AWS D1.1.
- M. Do not enlarge unfair holes in members by burning or using drift pins. Ream holes that must be enlarged to admit bolts. Where a hole is required to be enlarged by more than 3/32-inch ream to and use next larger bolt size.
- N. Shear Studs: Prepare steel surfaces as recommended by manufacturer of shear studs. Use automatic end welding of headed-stud shear studs according to AWS D1.1 and manufacturer's written instructions.
- O. Temporary Shoring and Bracing:
 - 1. The Contract Drawings indicate the completed structure. The Contractor is fully responsible for all temporary measures necessary for erection, except where specific sequences and requirements are specified on the Drawings. See the Drawings for erection sequence notes and minimum requirements.
 - 2. Contractor is responsible for identifying need for temporary construction and for the design, installation and use of all temporary bracing and supports necessary to stabilize the framing until complete.
 - 3. Provide temporary works as necessary to erect the structure and achieve proper alignment as erection proceeds. In addition, provide temporary bracing and shoring to brace the incomplete structure against loads such as wind and seismic forces comparable in intensity to the design loads for the completed structure.
 - 4. Make all necessary provisions for temporary bracing and for completion of erection where structural members are temporarily left out for erection at a later time.
- P. Temporary Flooring:
 - 1. Provide planking and scaffolding necessary in connection with erection of structural steel, support of erection machinery, and construction materials. Temporary floors and use of steel shall be as required by applicable regulatory requirements.
 - 2. If steel decking is used as a working platform, it shall be temporarily tack-welded to supports to extent necessary for such use in accordance with applicable regulatory requirements. The concentrated loading from welding machines and other heavy machinery required for steel erection shall be distributed by planking or other approved

means. Metal decking that becomes damaged as the result of being used as a working platform shall be replaced at no additional cost to the Owner.

Q. Hoisting and Bracing:

1. Provide all hoisting and erecting equipment and power.
2. Provide and maintain any and all safety railings, etc., required for the erection of steel framing and metal decking or as directed by the General Contractor.
3. Brace the erected frame in a manner which will assure safety and proper alignment to receive the metal decking in accordance with Contractor's approved erection procedure.
4. Erect building frame true and level. Erect columns in a manner to allow for movement due to welding shrinkage and thermal expansion and contraction of framing. Check plumbness after erection of each level. Maintain structural stability of frame during erection. Provide temporary bracing where necessary to maintain frame stability and to support required loads, including equipment and its operation.

R. After erection, prime welds, abrasions, and surfaces not shop primed, except surfaces to be in contact with concrete.

S. Shop Drawings for temporary works located within the building envelope shall be submitted to the Engineer of Record for review and approval. Temporary works Shop Drawings shall show fabrication of structural-steel components, including details of layout and connections, fabrication of all members, and element and erection plans, and erection sequence. Shop Drawings shall identify temporary works members to remain in the permanent structure. Review of Shop Drawings by the Engineer of Record is of a general nature only.

3.7 FIELD CONNECTIONS

- A. Field connection requirements shall be as a minimum equal to those specified in Part 2 of this document.
- B. Erection bolts for welded connection shall be tightened securely and left in place, unless noted otherwise.
- C. High-Strength Bolts: Install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A325 or A490 Bolts" for type of bolt and type of joint specified.
- D. Weld Connections: Comply with AWS D1.1 and AWS D1.8 for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.
1. Comply with AISC 303 and AISC 360 for bearing, alignment, adequacy of temporary connections, and removal of paint on surfaces adjacent to field welds.
 2. Remove backing bars or weld tabs where required by specifications or contract drawings, back gouge, and grind steel smooth.
 3. Assemble and weld built-up sections by methods that will maintain true alignment of axes without exceeding tolerances in AISC 303 for mill material.
 4. Weld in manner to prevent warping or distortion of finished product. Use jigs which will not restrain piece from moving during welding or cooling after welding. Sequence weld passes at a joint to prevent excessive heat build-up or cause shrinkage cracks to form.
 5. Auxiliary Member Connections and Temporary Welds shall be per AWS provided that

- preheating may be omitted on ASTM A36 steel for single pass fillet welds with low hydrogen electrodes under the following conditions: Air temperature is 60 degrees Fahrenheit or over, steel is dry, and welds to structural base material are more than 1" away from corners or ends of plates.
6. Preheat and post-heat procedures for welded joints shall be utilized to prevent rapid cooling of welds, particularly in cold weather. Procedures are Contractor's responsibility.
- E. Shear Studs: The shear studs shall be automatically end welded in accordance with AWS D1.1 and the manufacturer's recommendations in such a manner as to provide complete fusion between the end of the stud and the plate.
1. There should be no porosity or evidence of lack of fusion between the welded end of the stud and the plate.
 2. Shear studs through metal deck shall be welded through the deck within 1 day of laying the deck.
- F. Bearing Pads: Install bearing pads in accordance with manufacturer's recommendations.

3.8 FIELD QUALITY CONTROL

- A. Field quality control shall, as a minimum, conform to the requirements specified under Source Quality Control in Part 2.
- B. Erection Tolerances: Unless otherwise noted, level and plumb individual members of the structure as per AISC 303 Section 7.13 'Erection Tolerances'. Make level and plumb based on the mean operating temperature of the structure, allowing for the difference in temperature at time of erection and the mean temperature of the structure when completed and in service. Base measurements relating to tolerances on the theoretical centerline of the columns.
1. Columns: Gaps exceeding 1/8 inch between milled ends not permitted. Shim acceptable gaps with non-tapered mild steel shim stock.
 2. In order to provide a true, flat plane for the exterior elevations, install perimeter steel deck edge closure such that the vertical face does not vary from its intended alignment more than +/- 3/4" at any location.
 3. All columns and beams shall adhere to Section M2.7 of the referenced "Specification for Structural Steel for Buildings" which states that completed members shall be free of twists, bends, and open joints. Take special care that column base plates are parallel and perpendicular to faces of columns and that bolt holes are accurately placed.
- C. Special Inspections: Owner will engage a qualified special inspector to perform the following special inspections:
1. Verify structural-steel materials and inspect steel frame joint details.
 2. Verify weld materials and inspect welds.
 3. Verify connection materials and inspect high-strength bolted connections.
- D. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- E. Bolted Connections: Bolted connections will be tested and inspected according to RCSC's "Specification for Structural Joints Using ASTM A325 or A490 Bolts."
1. The Inspector shall observe all Direct Tension Indicators to see if proper tightness is achieved.

F. Welded Connections: Field welds will be visually inspected according to AWS D1.1, the governing building code, and Part 2 of this document, by the Testing Agency.

G. Defective Work:

1. Correct deficiencies in Work that test reports and inspections indicate does not comply with the Contract Documents. Work deemed defective will be removed from the site at the Contractor's expense.
2. Any special tests not specifically covered by this specification that are proposed by the Contractor as a result of failure to comply with this Section shall be at the Contractor's expense. The Contractor shall be responsible for any consequential costs or delays.
3. The results of those tests will be accepted, at the discretion of the Architect, as proof of adequate materials or workmanship.

3.9 REPAIRS AND PROTECTION

- A. Galvanized Surfaces: Clean areas where galvanizing is damaged or missing and repair galvanizing to comply with ASTM A780.
- B. Touchup Painting: Immediately after erection, clean exposed areas where primer is damaged or missing and paint with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
1. Clean and prepare surfaces by SSPC-SP 2 hand-tool cleaning or SSPC-SP 3 power-tool cleaning.
- C. Touchup Painting: Cleaning and touchup painting are specified in Division 09 painting Sections.
- D. Repair of Openings: For all members exposed to view in the final structure, close all lifting holes, access openings, etc. in such a manner that no visual evidence of the opening remains.

END OF SECTION

SECTION 05 50 00
METAL FABRICATIONS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Metal fabrications as follows:

1. Site enclosure gates.
2. Air compressor canopy.
3. Bollards, metal.
4. Downspouts.
5. Access ladders.
6. Bicycle racks.
7. Miscellaneous metal fabrications.

1.2 RELATED SECTIONS

- A. Section 03 30 00 – Cast-In-Place Concrete.
- B. Section 07 41 13 – Metal Roof Panels.
- C. Section 09 91 00 – Painting.

1.3 REFERENCES

- A. The publications listed below form a part of this Section to the extent referenced. The publications are referred to in the text by the basic designation only. Refer to Division 01 for definitions, acronyms, and abbreviations.
- B. Standards, manuals, and codes refer to the latest edition of such standards, manuals, and codes in effect as of the date of issue of this Project Manual, unless indicated otherwise in CBC Chapter 35 and CFC Chapter 80.
- C. Referenced Standards:
- | | |
|--------------------|---|
| 1. ANSI A14.3 | – American National Standards for Fixed Ladders & Safety Requirements. |
| 2. ASTM A36/A36M | – Standard Specification for Carbon Structural Steel. |
| 3. ASTM A53/A53M | – Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless. |
| 4. ASTM A123/A123M | – Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products. |
| 5. ASTM A283/A283M | – Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates. |
| 6. ASTM A307 | – Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength. |

7. ASTM A500	– Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
8. ASTM A554	– Standard Specification for Welded Stainless Steel Mechanical Tubing.
9. ASTM A653/A653M	– Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
10. ASTM E488	– Standard Test Methods for Strength of Anchors in Concrete and Masonry Elements.
11. AWS A2.4	– Standard Symbols for Welding, Brazing, Nondestructive Examination.
12. AWS D1.1	– Structural Welding Code – Steel.
13. AWS D1.3	– Structural Welding Code – Sheet Steel.
14. SSPC-Paint 20	– Zinc-Rich Coating, Type I-Inorganic and Type II-Organic.
15. SSPC-Paint 29	– Zinc Dust Sacrificial Primer, Performance-Based.
16. SSPC SP-2	– Hand Tool Cleaning.
17. SSPC SP-6	– Commercial Blast Cleaning.

1.4 SUBMITTALS

- A. Submit under provisions of Division 01.
- B. Shop Drawings: For each item specified, indicate profiles, sizes, connection attachments, reinforcing, anchorage, size and type of fasteners and accessories. Include erection drawings, elevations and details where applicable.
- C. Product Data: Submit product data for each manufactured product specified by name and model number in this Section with the product and selected attributes clearly identified.
- D. Samples: Submit two 12 inch by 12 inch samples of perforated metal steel panel.
- E. Indicate welded connections using standard AWS A2.4 welding symbols. Indicate net weld lengths.

1.5 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to the following:
 - 1. AWS D1.1, "Structural Welding Code – Steel."
 - 2. AWS D1.3, "Structural Welding Code – Sheet Steel."
- B. Conform to 2022 California Building Code (CBC), Chapter 17 "Special Inspections and Tests" and Chapter 22 "Steel".
 - 1. Materials:
 - a. Material Identification per CBC Chapter 22, Section 2202 "Identification of Steel for Structural Purposes".

2. Inspection and Tests:

- a. Welding Inspection per CBC Chapter 17, Section 1705, Paragraph 1705.2 "Steel Construction".
- b. Non-Destructive Weld Testing per CBC Chapter 17, Section 1705, Paragraph 1705.13.1 "Structural Steel".

C. Painting: Refer to Section 09 91 00 for field painting.

1. Do not paint galvanized surfaces that are indicated to remain galvanized.

1.6 QUALIFICATIONS

- A. Welders' Certificates: Submit certificates under provisions of Division 01, certifying welders employed on the Work, verifying AWS qualification within the previous twelve months.

1.7 FIELD MEASUREMENTS

- A. Verify that field measurements are as indicated on shop drawings.

PART 2 PRODUCTS

2.1 MATERIALS

A. Steel: Unless otherwise noted, provide steel materials as follows:

1. Steel Plates, Shapes, and Bars: ASTM A36/A36M.
2. Plates: ASTM A283/A283M.
3. Zinc-Coated (Galvanized) Steel Sheet: ASTM A653/A653M, G90 (Z275) coating designation, structural quality.
4. Pipe: ASTM A53/A53M, Type E or S, Grade B.
5. HSS:
 - a. Tubing: ASTM A500, Grade C.
 - b. Round: ASTM A500, Grade C.
6. Bolts, Nuts and Washers: ASTM A307.

B. Anchorage:

1. Cast-in-Place Anchors in Concrete: Anchors capable of sustaining, without failure, a load equal to four times the load imposed, as determined by testing according to ASTM E488, conducted by a qualified independent testing agency.
2. Expansion Anchors: Anchor bolt and sleeve assembly with capability to sustain, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E488, conducted by a qualified independent testing agency.

C. Welding Materials:

1. Steel: AWS D1.1; type as required for materials being welded.
2. Sheet Steel: AWS D1.3; type as required for materials being welded.
3. Stainless Steel: AWS D1.6; type as required for materials being welded.

- D. Weld filler material: All weld filler material shall have a minimum tensile strength of 70 ksi per AWS D1.1, latest edition approved by code enforcement agency.
- E. Steel Shop and Touch-Up Primer: TNEMEC Series 115 Uni-Bond DF or accepted equal.
- F. Shop and Touch-Up Zinc Rich Primer for Galvanized Surfaces: ZRC Galviline Galvanizing Repair Compound as manufactured by ZRC Worldwide Company, Phone: (800) 831-3275, or accepted equal.

2.2 SITE ENCLOSURE GATES

A. Components:

- 1. Posts and Framing Members: HSS Tubing, ASTM A500, Grade C. Sizes, thicknesses, and configuration as shown on Drawings.
- 2. Metal Panels:
 - a. Perforated Panels: 18 gauge galvanized steel with 1/2 inch diameter holes at 11/16 inch staggered centers as manufactured by McNichols or accepted equal.
 - b. Solid Panels: 18 gauge galvanized steel.
- 3. Provide metal fabrications to accept gate hardware as indicated on Drawings.

B. Hardware: Refer to Drawings.

- 1. All accessible gates shall meet all applicable requirements for doors per CBC Chapter 11B, Sections 11B-206.5 and 11B-404.1.
- 2. Hand-activated opening hardware, handles, pulls, latches, locks and other operating devices for accessible gates shall have a shape that is easy to grasp with one hand and does not require tight grasping, tight pinching or twisting of the wrist to operate per CBC Sections 11B-309.4 and 11B-404.2.7.
- 3. The lever of lever actuated latches or locks for an accessible gate shall be curved with a return to within 1/2 inch of the face of gate per California Referenced Standards code, Title 24, Part 12, Section 12-10-202, Item (F).
- 4. The bottom 10 inches of an accessible gate shall have a smooth, uninterrupted surface on each side. Bottom of the gates shall be within 3 inches of finish surface of the path of travel. Maximum effort to operate a gate shall not exceed 5 pounds per CBC Sections 11B-404.2.9.

C. Finishes:

- 1. Shop Finish: Hot-dip galvanized after fabrication in accordance with ASTM A123/A123M, minimum 1.25 ounces per square foot.
- 2. Site Finish: Paint finish under provisions of Section 09 91 00. Color as selected by Architect.

2.3 AIR COMPRESSOR CANOPY

A. Components:

- 1. HSS Tubing: ASTM A500, Grade C; sizes, thicknesses, and configuration as shown on Drawings.
- 2. Steel Plates and Sections: ASTM A36/A36M; sizes, thicknesses, and configuration as shown on Drawings.

3. Metal Deck: 22 gauge corrugated metal roof panels. Refer to Section 07 41 13.

B. Finishes:

1. Structural Elements:

- a. Shop Finish: Hot-dip galvanize all components in accordance with ASTM A123/A123M, minimum 1.25 ounces per square foot.
- b. Site Finish: Industrial paint finish under provisions of Section 09 91 00. Colors as selected by Architect.

2. Metal Deck: Factory finish in color indicated on Drawings.

2.4 BOLLARDS, METAL

A. Pipe Bollard: ASTM A53/A53M; Schedule 40, Weight Class STD, steel pipe, galvanized.

1. Designator and Dimensions:

- a. NPS Designator: 6 inches NPS.
- b. Outside Diameter: 6.625 inches.
- c. Wall Thickness: 0.280 inch.
- d. Height and Embedment: As indicated on Drawings.

2. Fill fixed bollards with concrete. See Section 03 30 00 for concrete requirements.

- a. Cap bollard with concrete dome.

B. Removable Bollards:

1. Bollards shall have 1/4-inch thick galvanized threaded steel cap.
2. Sleeves: Fabricate sleeves for removable bollards from Schedule 40 galvanized steel pipe or 1/4-inch wall-thickness galvanized steel pipe with 1/4-inch-thick galvanized steel plate welded to bottom of sleeve. Sleeves shall be depth indicated on Drawings and inside diameter shall be 1/4 inch maximum larger than outside diameter of bollard.
3. Provision for Padlock: Provide 1/2 inch diameter eye bolts welded to bollard and sleeve as indicated on Drawings.

C. Finish: Field paint in accordance with Section 09 91 00; color as indicated on Drawings.

2.5 DOWNSPOUTS

A. Downspouts and Support Brackets:

1. Pipe: ASTM A53/A53M, Schedule 40, round, galvanized, size as indicated on Drawings.
2. Support Brackets: Steel plates, sections, and sheets: galvanized; size and thickness as shown on Drawings.
3. Finish: Site paint finish under provisions of Section 09 91 00. Color as selected by Architect.

2.6 ACCESS LADDERS

A. Access Ladders, General:

1. Regulatory Requirements: Conform to ANSI A14.3, OSHA, and UL requirements, as applicable.

2. Support each ladder at top and bottom, and not more than 48 inches on center, with brackets made from same metal as ladder.
3. Provide brackets and anchorage as indicated on Drawings.

B. Aluminum Ladders:

1. Acceptable Manufacturers:
 - a. Basis-of-Design: Alaco Ladder Company, Chino, CA; 888-310-7040, www.alacoladder.com. Product: Model No. MP75-75° Pivotal Ships Ladder.
 - b. O'Keeffe's, Inc., Brisbane, CA; 888-653-3333, www.okeeffes.com.
 - c. Precision Ladders, LLC, Morristown, TN; 423-588-2265, www.precisionladders.com.
 - d. Substitutions: Under provisions of Division 01.
2. Folding Wall Ladders:
 - a. Product: Model No. HP70 (460) folding wall ladder.
 - b. Fabrication:
 - 1) Aluminum ladders and their components shall be fabricated from 6061-T6 aluminum alloy with mill finish.
 - 2) Folding wall ladders shall be 24 inches wide and shall have 4-1/4 inch wide flat steps with nonslip ridges, mounted at 12 inch centers.
 - 3) Side rail depth shall be 4-1/8 inches.
 - 4) Ladders shall have 1-1/4 inch diameter handrails fabricated from serrated, round aluminum tubing with cast aluminum fittings. Handrails shall extend 42 inches above the top step.
 - 5) Ladders shall be equipped with mounting bracket-slide assemblies for flat storage against the wall.
 - 6) Non-marking solid rubber feet shall extend 3/4 inch from the rail ends for secure installation at a 75 degree angle.

2.7 BICYCLE RACKS

- A. Basis-of-Design Product: Varsity Bike Dock – DV215 by Ground Control Systems, Sacramento, CA; 800-630-7225, www.groundcontrolsystems.com.
- B. Acceptable Manufacturers: Provide the product named above or accepted equal by one of the following:
 1. American Bicycle Security Company, Ventura, CA; 800-245-3723, www.ameribike.com.
 2. BRP Enterprises, Inc., Lincoln, NE; 888-438-5311, www.brponline.com.
 3. Substitutions: Under provisions of Division 01.
- C. Materials:
 1. Steel: ASTM A36 steel for structural steel plate; ASTM A53 steel for pipes.
 2. Smart Guards: Two cushioned black injection molded urethane Smart Guards that attach to the Locking Loops (wings) for protection for bikes against paint damage from the metal dock.
- D. Capacity: Two bicycles per unit.

- E. Mounting: Provide model WAK-215 wedge anchoring kit for surface mounting to concrete substrate.
- F. Finish: Manufacturer's standard DuraPlas black polyester powder coat paint factory finish, with standard Ground Control Systems Smart Guard label.

2.8 MISCELLANEOUS METAL FABRICATIONS

- A. Provide miscellaneous metal fabrications as required to complete work under other Sections, but not specified in those Sections.
- B. Miscellaneous metal work, including, but not limited to, the following items:
 - 1. Steel Framing and Supports For:
 - a. Countertops.
 - b. Sectional doors.
 - c. Bi-fold doors.
 - d. Mechanical and electrical equipment.
 - 2. Loose bearing and leveling plates.
 - 3. Steel weld plates and angles for casting into concrete not specified in other Sections.

2.9 SHOP FABRICATION

- A. Fit and shop assemble in largest practical sections, for delivery to site.
 - 1. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.
- B. Fabricate panels and gates as shown on Drawings and accepted shop drawings.
- C. Fabricate items with joints tightly fitted and secured.
- D. Grind exposed joints flush and smooth with adjacent finish surface. Make exposed joints butt tight, flush, and hairline. Ease exposed edges to small uniform radius.
- E. Cut, drill, and punch metals cleanly and accurately. De-burr rough edges and holes.
- F. Form exposed work true to line and level with accurate angles and surfaces and straight edges.
- G. Exposed Mechanical Fastenings: Flush countersunk screws or bolts; unobtrusively located; consistent with design of component, except where specifically noted otherwise.
- H. Supply components required for anchorage of fabrications. Fabricate anchors and related components of same material and finish as fabrication except where specifically noted otherwise.
- I. Miter and weld members, welds ground smooth.
- J. Provide for anchorage of type indicated; coordinate with supporting structure. Space anchoring devices to secure metal fabrications rigidly in place and to support indicated loads.

2.10 FINISHES

- A. Prepare structural component surfaces in accordance with SSPC SP-2 at concealed locations and SSPC SP-6 at exposed locations.
- B. Do not prime surfaces in direct contact with concrete, where field welding is required, or contact surfaces of steel-to-steel connections.
- C. Shop prime all exposed interior steel with shop primer unless otherwise noted. Apply primer in one coat, to meet or exceed the minimum mil thickness required by the primer manufacturer.
- D. All unexposed, concealed, or enclosed interior or exterior steel requires no finish.
- E. All exposed exterior steel shall be galvanized after fabrication unless otherwise noted.
 - 1. Galvanizing shall be in accordance with ASTM A123/A123M, on designated steel items. Provide minimum 1.25 ounces per square foot galvanized coating.
 - 2. At galvanized members, touch-up all welds with zinc-rich primer.
- F. Stainless Steel Finishes: As specified in this Section. Do not paint stainless steel surfaces.
- G. Painting shall conform to applicable requirements of Section 09 91 00.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine job site conditions and verify field dimensions.
- B. Verify structure or substrate is plumb, level, and ready to receive work.
- C. Verify that appropriate backing, blocking, or structural reinforcing is provided at walls.
- D. Report unacceptable conditions to Architect. Begin installation only when unacceptable conditions have been corrected.

3.2 PREPARATION

- A. Clean and strip primed steel items to bare metal where site welding is required.
- B. Supply items required to be cast into concrete or embedded in masonry with setting templates, to appropriate Sections.

3.3 INSTALLATION

- A. Install items plumb and level, accurately fitted, free from distortion or defects.
- B. Install manufactured items in accordance with manufacturer's printed instructions.
- C. Allow for erection loads and for sufficient temporary bracing to maintain true alignment until completion of erection and installation of permanent attachments.
- D. Field weld components indicated on shop drawings.
- E. Perform field welding in accordance with AWS D1.1 for steel and AWS D1.3 for sheet steel.

- F. Obtain Architect's acceptance prior to site cutting or making adjustments not scheduled.
- G. After erection, prime welds, abrasions and surfaces not shop primed, except surfaces to be in contact with concrete.
- H. Post Setting in Concrete: Install support posts as indicated on Drawings.
 - 1. Cast-In Posts: Set cast-in support posts in concrete footing with smooth top, shaped to shed water. Protect portion of posts above footing from concrete splatter. Verify that posts are set plumb or at correct angle and are aligned and at correct height and spacing. Hold posts in position during placement and finishing operations until concrete is sufficiently cured.
 - 2. Posts Set into Voids in Concrete: Form or core-drill holes for installing posts in concrete to depth recommended in writing by manufacturer of site furnishings and 3/4 inch larger than outside diameter of post. Clean holes of loose material, insert posts, and fill annular space between post and concrete with non-shrink, nonmetallic grout or anchoring cement, mixed and placed to comply with anchoring material manufacturer's written instructions. In exterior locations top shall be smoothed and shaped to shed water.
 - 3. Pipe Sleeves: Use steel pipe sleeves preset and anchored into concrete for installing posts. After posts have been inserted into sleeves, fill annular space between post and sleeve with non-shrink, nonmetallic grout or anchoring cement, mixed and placed to comply with anchoring material manufacturer's written instructions. In exterior locations, top shall be smoothed and shaped to shed water.

3.4 CLEANING

- A. Inspect components after completing installation. Remove dirt and debris. Repair damaged finishes to match original finish or replace component.

END OF SECTION

SECTION 06 10 00
ROUGH CARPENTRY

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 SECTION INCLUDES

- A. Structural dimension lumber framing.
- B. Exposed timber structural framing.
- C. Nonstructural dimension lumber framing.
- D. Rough opening framing for doors, windows, and roof openings.
- E. Sheathing.
- F. Preservative treated wood materials.
- G. Fire retardant treated wood materials.
- H. Miscellaneous framing and sheathing.
- I. Communications and electrical room mounting boards.
- J. Concealed wood blocking, nailers, and supports.
- K. Drilling, saw cuts, knock-outs and framing for ventilation.
- L. Wood sheathing backing at tile walls.
- M. Miscellaneous wood nailers, furring, and grounds.
- N. Steel hardware and attachment brackets

1.3 RELATED REQUIREMENTS

- A. Section 03 30 00 - Cast-in-Place Concrete: Setting anchors in concrete.
- B. Section 05 12 00 - Structural Steel Framing: Prefabricated beams and columns for support of wood framing.
- C. Section 05 50 00 - Metal Fabrications: Miscellaneous steel connectors and support angles for wood framing.
- D. Section 06 17 00 – Shop-Fabricated Structural Wood
- E. Section 06 17 33 - Wood I-Joists.
- F. Section 06 17 53 - Shop-Fabricated Wood Trusses.

G. Section 06 18 00 - Glued-Laminated Construction.

1.4 REFERENCE STANDARDS

- A. Utilize the edition of the listed document as identified in the "Design Criteria Notes" in the structural drawings. If not listed in the "Design Criteria Notes", use the edition adopted or referenced by the listed governing building code or material standard. If no specific edition is adopted, use the latest edition.
1. ASTM A36 - Standard Specification for Carbon Structural Steel.
 2. ASTM A123 - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
 3. ASTM A153 - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
 4. ASTM A563 - Standard Specification for Carbon and Alloy Steel Nuts.
 5. ASTM A653 - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 6. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar. AWWA - Wood Preservative: American Wood-Preservers' Association:
 - a. U1, Use Category System: User Specification for Treated Wood.
 - b. M4, Standard for the Care of Preservative-Treated Wood Products.
 7. AWS B2.1 - Specification for Welding Procedure and Performance Qualification.
 8. AWS D1.1 - Structural Welding Code - Steel.
 9. CBC – California Building Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
 10. ICC (IECC) - International Energy Conservation Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
 11. NDS – National Design Specification for Wood Construction
 12. SDPWS - Special Design Provisions for Wind & Seismic
 13. PS 1 - Structural Plywood.
 14. PS 2 - Performance Standard for Wood Structural Panels.
 15. PS 20 - American Softwood Lumber Standard.
 16. RIS (GR) - Standard Specifications for Grades of California Redwood Lumber.
 17. WCLIB - Standard Grading Rules for West Coast Lumber No. 17.
 18. WWSA - Western Lumber Grading Rules.

1.5 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Certification:
1. Preservative Treated Wood: Certification for waterborne preservative and that moisture content was reduced to 19 percent maximum, after treatment.

- C. Shop-fabricated structural wood: Submit manufacturer's published structural data including span tables, marked to indicate which sizes and grades are being used; if shop-fabricated structural wood is being substituted for dimension lumber or timbers, submit grading agency structural tables marked for comparison.
- D. Manufacturer's Certificate: Certify that wood products supplied for rough carpentry meet or exceed specified requirements.
- E. Warranty Documentation: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.
- F. Welders' Qualification Statement: Welders' certificates in accordance with AWS B2.1 and dated no more than 12 months before start of scheduled welding work.

1.6 QUALITY ASSURANCE

A. General:

- 1. Coordinate the work of all trades to ensure proper placement of all materials, anchors, etc., as well as providing for openings and anchors for the installation of surface mounted materials and equipment.
- 2. Qualifications for Workers: Provide sufficient skilled workers and supervisors who shall be present at all times during execution of this portion of the work and who shall be thoroughly familiar with the type of construction involved and the materials and techniques specified.
- 3. Rejection: In the acceptance or rejection of rough carpentry, no allowance will be made for lack of skill on the part of the workers.

B. Tests and Inspections:

- 1. A testing program is required prior to start of construction. Testing program to be done in Compliance with the CBC requirements and in collaboration with Testing Laboratory, Design team, contractor, owner and submitted for review by the agency in charge of building enforcement. Requirements below are minimum requirements; additional requirements may be required in final testing program.

- C. Welder Qualifications: Welding processes and welding operators qualified in accordance with AWS D1.1 and no more than 12 months before start of scheduled welding work.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. General: Cover wood products to protect against moisture. Support stacked products to prevent deformation and to allow air circulation.

B. Protection:

- 1. After delivery, store all materials off the ground, covered, and in such a manner as to ensure proper ventilation and drainage and to protect against damage and the weather. Maintain wood at the maximum moisture levels indicated in Materials Section.
- 2. Keep all material clearly identified with all grade marks legible; keep all damaged material clearly identified as damaged, and separately store to prevent its inadvertent use. Do not allow installation of damaged or otherwise non-complying material.
- 3. Fire Retardant Treated Wood: Prevent exposure to precipitation during shipping, storage, and installation.
- 4. Use all means necessary to protect the installed work and materials of all other trades.

5. Replacements: In the event of damage, immediately make all repairs and replacements necessary to the approval of the Architect and at no additional cost to the Owner.

1.8 WARRANTY

- A. See Section 01 78 00 - Closeout Submittals for additional warranty requirements.
- B. Correct defective work within a two-year period commencing on Date of Substantial Completion.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS

- A. Dimension Lumber:
 1. Meet requirements of following minimum grades. All grades shall be per WCLIB Grading Rules No. 17 or WWPA Western Lumber Grading Rules. Species Combination shall be Douglas Fir – Larch. Douglas Fir – Larch (North) and Douglas Fir (South) are not permitted without approval from the structural engineer.
 2. Furnish S4S unless otherwise noted.

2.2 SOURCE QUALITY CONTROL

- A. Grade Mark each piece of lumber. Marking must be done by recognized agency.
 1. Douglas Fir shall bear WCLIB or WWPA grade stamp.
 2. Pressure treated Douglas Fir shall bear AWPA Quality mark.
- B. Wood Sheathing: Each panel shall be legibly identified as to type, grade and species by APA grade. If plies are spliced, the slope of the scarf shall not be steeper than 1:8. White pockets will not be permitted in face plies.

2.3 DIMENSION LUMBER FOR CONCEALED APPLICATIONS

- A. Grading Agency: Western Wood Products Association; WWPA or West Coast Lumber Inspection Bureau; WCLIB.
- B. Sizes: Size to conform to rules of governing standard. Sizes shown are nominal unless otherwise noted.
- C. Materials:
 1. Dimensional Lumber and Timbers:
 - a. Maximum Moisture Content at Initial Use: As indicated on the Drawings
 - b. Species: As indicated on the Drawings.
 - c. Grade: As indicated on the Drawings.
- D. Maximum Moisture Content "at Initial Use" shall be that point at which nails, screws, bolts, split rings, shear plates or other fasteners or the holes for said fasteners are placed in the wood.
- E. All dimension lumber is assumed to be enclosed in the dry building envelope in the final service condition, unless noted otherwise, and free to dry to moisture content less than 19%.

- F. All studs, plates, joists, rafters and beams 3x and thicker shall be free of heart center in accordance with the specified grading standards.

2.4 DIMENSION LUMBER FOR EXPOSED EXTERIOR APPLICATIONS

- A. Submit manufacturer's certificate that products meet or exceed specified requirements, in lieu of grade stamping.
- B. Sizes: Size to conform to rules of governing standard. Sizes shown are nominal unless otherwise noted.
- C. Materials:
 - 1. Dimensional Lumber and Timbers:
 - a. Maximum Moisture Content at Initial Use: As indicated on the Drawings.
 - b. Species: As indicated on the Drawings.
 - c. Grade: As indicated on the Drawings.
- D. All studs, plates, joists, rafters and beams 3x and thicker shall be free of heart center in accordance with the specified grading standards.

2.5 SHOP-FABRICATED STRUCTURAL WOOD

- A. At Contractor's option, shop-fabricated structural wood may be substituted for concealed dimension lumber and timbers.
- B. Shop-fabricated structural wood: Factory fabricated beams, headers, and columns, of sizes and types indicated on drawings; structural capacity as published by manufacturer.
 - 1. Columns: Use laminated veneer lumber, laminated strand lumber, or parallel strand lumber with manufacturer's published modulus of elasticity, E: 1,800,000 psi, minimum.
 - 2. Beams: Use laminated veneer lumber, laminated strand lumber, or parallel strand lumber with manufacturer's published modulus of elasticity, E: 1,800,000 psi, minimum.
 - 3. Headers Not Longer Than 48 inches: Use laminated veneer lumber, laminated strand lumber, or parallel strand lumber.
 - 4. Products:
 - a. Boise Cascade Company: www.bc.com.
 - b. RedBuilt LLC: www.redbuilt.com.
 - c. Weyerhaeuser Company: www.weyerhaeuser.com.
 - d. Substitutions: See Section 01 60 00 - Product Requirements.

2.6 WOOD SHEATHING

- A. Floor Sheathing : PS 1 or PS 2 APA rated sheathing.
 - 1. Thickness and Type: As indicated on Drawings.
 - 2. Glue: Exterior
 - 3. Edges: Tongue and groove.
- B. Roof Sheathing : PS 1 or PS 2, APA rated sheathing.

1. Thickness and Type: As indicated on Drawings.
 2. Glue: Exterior
 3. Edges: Square.
- C. Wall Sheathing : PS 1 or PS 2, APA rated sheathing.
1. Thickness and Type: As indicated on Drawings.
 2. Glue: Exterior
 3. Edges: Square.
- D. Communications and Electrical Room Mounting Boards: PS 1 A-D plywood, or medium density fiberboard; 3/4 inch thick; flame spread index of 25 or less, smoke developed index of 450 or less, when tested in accordance with ASTM E84.
- E. Other Applications:
1. Where indicated on the Architectural Drawings as interior wall backing behind tile and in all toilet rooms behind sheet rock, to be C-C APA rated sheathing with exterior glue. Thickness shall be 5/8-inch at all locations.
 2. Flooring: C-C APA Performance rated tongue and groove with exterior glue. Thickness type and grade shall be as indicated on the Drawings.
 3. Plywood Concealed From View But Located Within Exterior Enclosure: PS 1, C-C Plugged or better, Exterior grade.
 4. Plywood Exposed to View But Not Exposed to Weather: PS 1, A-D, or better.
 5. Other Locations: PS 1, C-D Plugged or better.

2.7 ACCESSORIES

- A. Rough Hardware Fastenings and Connections: All types including bolts, lag screws, nails, spikes, screws, washers and other rough hardware, of kinds that may be purchased and that require no further fabrication, shall be furnished and installed for all finish and rough carpentry and shall conform to NDS Standards and dimensions. All hardware exposed to weather shall be hot-dipped galvanized per ASTM A153 Standards. All nails used into pressure treated lumber shall be hot-dipped galvanized per ASTM A153 or stainless steel.
1. Common wire nails or spikes shall be used unless noted otherwise on the Drawings. Box nails and sinker nails are not permitted. Vinyl coating is permitted on nails when not exposed to weather. Nails and staples shall conform to requirements of CBC.
 2. Bolts: Bolt material shall conform to ASTM A307, Grade A. Bolt dimensions shall conform to ANSI/ASME B18.2.1 with hex head of sizes indicated.
 3. Lag Screws: Lag screws shall conform to ASTM 307, Grade A. All lag screws shall have hex heads where exposed.
 4. Washers: Standard flat washers shall conform to ANSI B18.22.1, Type A, Wide Pattern. Steel plate washers shall be Simpson BP or BPS or equivalent. Malleable iron washers shall be standard malleable iron washers.
 5. Power-Actuated Fasteners: Tempered steel pins with special corrosive resistant plating or coating. Pins shall have guide washers to accurately control penetration. Fastening shall be accomplished by low-velocity piston-driven power activated tool. Pins and tool shall be as manufactured by Hilti Fastening Systems or equivalent. See Drawings for size, type

and embedment.

6. Expansion Anchors: See Section 03 30 00 for anchors to concrete and Section 04 20 00 for anchors to masonry.
 7. Adhesive Anchors: See Section 03 30 00 for anchors to concrete and Section 04 20 00 for anchors to masonry.
 8. Fabricated Metal Timber Framing Connectors: Connectors shall be punched for nailing and bolting. Nails and nailing shall conform to the manufacturer's instructions with a nail provided for each punched hole. All connectors must have specific ICC approval. Types as noted on Drawings are Simpson Strong-Tie. Hardware suppliers other than Simpson shall submit a comparative material list itemizing product designation, load rating and supported member size for review by the enforcement agency and the Structural Engineer.
 - a. For contact with preservative treated wood in exposed locations, provide minimum G185 galvanizing complying with ASTM A653.
 9. Steel Connections and Brackets: ASTM A36 weldable quality, galvanize per ASTM A123 or ASTM A666, Type 304 stainless steel where indicated on the Drawings.
 - a. Fabricate steel hardware and connections with joints neatly fitted, welded, and ground smooth
 - b. Welding: Perform welding in accordance with AWS D1.1.
 10. Anchor Bolts: ASTM F3125, Type 1 heavy hex high strength bolts and ASTM A563 nuts; hot-dip galvanized to meet requirements of ASTM A153, matching washers.
- B. Building Paper: Fed. Spec. UU-B-790a, Type I, Grade B (15 lb. min. unless noted elsewhere).
- C. Subfloor Adhesives: Gap-filling construction adhesive for bonding wood structural panels to wood-based floor system framing; complying with ASTM D3498.
- D. General Purpose Construction Adhesives: Comply with ASTM C557.
- E. Radiant Barrier: Aluminum radiant barrier; designed for factory laminating to roof sheathing.
1. Products:
 - a. Louisiana-Pacific Corporation; TechShield: www.lpcorp.com/#sle.
 - b. Substitutions: See Section 01 60 00 - Product Requirements.

2.8 FACTORY WOOD TREATMENT

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

- of 25 when tested in accordance with ASTM E84, with no evidence of significant combustion when test is extended for an additional 20 minutes both before and after accelerated weathering test performed in accordance with ASTM D2898.
- a. Kiln dry wood after treatment to a maximum moisture content of 19 percent for lumber and 15 percent for plywood.
 - b. Treat exterior rough carpentry items.
 - c. Treat exposed exterior rough carpentry items, including stairways, balconies, and covered walkways
 - d. Do not use treated wood in direct contact with the ground.
2. Interior Type A: AWP A U1, Use Category UCFA, Commodity Specification H, low temperature (low hygroscopic) type, chemically treated and pressure impregnated; capable of providing a maximum flame spread index of 25 when tested in accordance with ASTM E84, with no evidence of significant combustion when test is extended for an additional 20 minutes.
- a. Kiln dry wood after treatment to a maximum moisture content of 19 percent for lumber and 15 percent for plywood.
 - b. Interior rough carpentry items are to be fire retardant treated.
 - c. Treat rough carpentry items as indicated.
 - d. Do not use treated wood in applications exposed to weather or where the wood may become wet.
- C. Preservative Treatment:
1. All wood in contact with concrete or masonry shall be preservative treated.
 2. Preservative Pressure Treatment of Lumber Above Grade: AWP A U1, Use Category UC3B, Commodity Specification A using waterborne preservative.
 - a. Kiln dry lumber after treatment to maximum moisture content of 19 percent.
 3. Preservative Pressure Treatment of Plywood Above Grade: AWP A U1, Use Category UC2 and UC3B, Commodity Specification F using waterborne preservative.
 - a. Kiln dry plywood after treatment to maximum moisture content of 19 percent.
 4. Preservative Pressure Treatment of Lumber in Contact with Soil: AWP A U1, Use Category UC4A, Commodity Specification A using waterborne preservative.
 - a. Preservative for Field Application to Cut Surfaces: As recommended by manufacturer of factory treatment chemicals for brush-application in the field.
 - b. Restrictions: Do not use lumber or plywood treated with chromated copper arsenate (CCA) in exposed exterior applications subject to leaching.

PART 3 EXECUTION

3.1 PREPARATION

A. Inspection:

1. Prior to all work of this Section, carefully inspect the installed work of all other trades and verify that all such work is complete to the point where this installation may properly proceed.
2. Verify that rough carpentry may be performed in strict accordance with the original design

and all pertinent codes and regulations.

- B. Discrepancies: In the event of discrepancy, immediately notify Architect. Do not proceed with installation in areas of discrepancy until all such discrepancies have been fully resolved.
- C. Coordinate installation of rough carpentry members specified in other sections.

3.2 INSTALLATION - GENERAL

- A. Protect all work in progress and all work installed, as well as the work of all other trades. Any work damaged as a result of the work under this section shall be corrected to its original condition or replaced if directed by the Architect at no increase in cost to the Owner.
- B. Ventilation: Contractor shall include all labor and materials necessary to provide ventilation requirements of roof overhangs, eaves, attics, and all other components of the building required by codes to be ventilated. Work shall include removing knock-outs in wood I-joists for cross ventilation, drilling of blocking, wood sheathing, and other wooden components of the structure necessary to comply with requirements of the CBC for ventilation of buildings.
- C. Select material sizes to minimize waste.
- D. Reuse scrap to the greatest extent possible; clearly separate scrap for use on site as accessory components, including: shims, bracing, and blocking.
- E. General: All rough carpentry shall produce joints true, tight, and well nailed with all members assembled in accordance with the Drawings and with all pertinent codes and regulations.
- F. Selection of Lumber Pieces: Carefully select all members. Select individual pieces so that knots and obvious defects will not interfere with placing bolts or proper nailing or making proper connections. Cut out and discard all defects which will render a piece unable to serve its intended function.
- G. Lumber may be rejected by the Architect, whether or not it has been installed, for excessive warp, twist, bow, crook, mildew, fungus, or mold, as well as for improper cutting and fitting.
- H. Shimming: do not shim any framing component.
- I. Care shall be taken that notching and boring of members is in strict conformance with the Drawings and that there are no over-cuts.
- J. Where treated wood is used on interior, provide temporary ventilation during and immediately after installation sufficient to remove indoor air contaminants.

3.3 INSTALLATION - FRAMING AND ROUGH CARPENTRY

- A. Set structural members level, plumb, and true to line. Discard pieces with defects that would lower required strength or result in unacceptable appearance of exposed members.
- B. Make provisions for temporary construction loads, and provide temporary bracing sufficient to maintain structure in true alignment and safe condition until completion of erection and installation of permanent bracing.
- C. Sills: Shall be in long lengths of sizes shown, fastened with anchor bolts as indicated, a minimum of two anchor bolts per piece. Place steel plate washers (but not standard flat or malleable iron washers) under nuts bearing on wood. Set sills level and true.

- D. Studs, Posts and Columns: Shall be full length. Corners shall be as detailed. Partitions or walls containing plumbing, heating or other piping shall be so formed as to give proper clearance for materials. Cut members as required to provide full bearing at ends. Connect to structure as indicated.
- E. Plates: Shall be full length of wall segment or 12-foot minimum and spliced as shown.
- F. Joists and Beams: Shall be full span length and spliced over bearings unless shown otherwise. Install with crown side up. Beams or headers indicated to be built up of two or more joists shall be fabricated on the job using full length members. For two piece 2x members, stitch nail pieces together with 16d common nails spaced not over 12 inches c.c. and staggered. Clinch nails protruding through members. For three or more piece members, stitch bolt pieces together with ½" bolts spaced not over 12 inches c.c. and staggered.
 - 1. Provide double joists and headers at all openings through roof unless otherwise shown on Drawings.
 - 2. Provide typical headers at all openings through walls where one or more studs are required to be cut. For penetration through walls narrower than stud spacing, provide solid blocking on all sides for fastening finish materials.

3.4 INSTALLATION - BLOCKING, NAILERS, AND SUPPORTS

- A. Blocking: Blocking shall be same thickness and width of studs or joists unless shown otherwise. Blocking shall not be spaced over 8'-0" c.c. Install fire blocking in accordance with CBC. Horizontal fire blocking in walls shall be placed at floor lines and ceiling lines unless noted otherwise. Install blocking at all sheathing joints where noted on the Drawings. Install wall width full height solid blocking at floor joists beneath all posts in walls. Blocking shall be installed around all wall, floor and roof penetrations.
- B. Provide the following specific nonstructural framing and blocking:
 - 1. Cabinets and shelf supports.
 - 2. Wall brackets.
 - 3. Handrails.
 - 4. Grab bars.
 - 5. Towel and bath accessories.
 - 6. Wall-mounted door stops.
 - 7. Chalkboards and marker boards.
 - 8. Wall paneling and trim.
 - 9. Joints of rigid wall coverings that occur between studs.

3.5 INSTALLATION - SHEATHING

- A. Wood Sheathing: Install to pattern indicated and provide blocking at joints where noted on the Drawings. Center all joints over bearing supports. Nail to framing as indicated. Install wood sheathing with face plies perpendicular to joists unless indicated otherwise. Wall wood sheathing shall continue uninterrupted by ceilings or soffit from floor to floor or floor to roof unless specifically detailed on the Structural Drawings.

3.6 INSTALLATION - FASTENERS

- A. Nailing: Except as otherwise indicated on Drawings or specified, all nailing shall be as required by CBC Table 2304.10.2 - Fastening Schedule.
 - 1. Nails or Spikes shall be common wire unless noted otherwise. Penetration of nails or spikes shall be one-half the length of the nail or spike into the piece receiving the point. However, to connect pieces 2" in thickness, 16d nails shall be used unless noted otherwise.
 - a. Bore holes for nails wherever necessary to prevent splitting.
 - b. Use finish or casing for finish work.
 - c. Use of machine nailing is subject to a satisfactory installation of nails. Minimum edge distances shall be maintained. Nails installed through sheathing with nail guns shall not penetrate into the outer plies deeper than hand nailing. Submittal of guns and nails is required.
 - d. All nailing into Pressure-Treated lumber shall utilize hot-dipped zinc coated galvanized nails or stainless steel nails per CBC.
- B. Bolts and Lag Screws: Bolts shall be sizes indicated on Drawings. Holes for bolts shall be 1/16-inch larger than the bolt diameter. Malleable, Steel plate or standard flat washers shall be used where heads or nuts would otherwise bear directly on wood surfaces. Malleable or plate washers shall be used on all anchor bolts. Cut washers are not permitted. Lag screws shall be screwed (not driven) into place. For the shank, holes shall be bored the same depth and diameter as shank. For threaded portion, holes shall be pre-drilled to 50% of the shank diameter, except as follows:
 - 1. 7/8" Diameter Lag Screw: Pre-Drill 1/2" diameter hole.
 - 2. 1" Diameter Lag Screw: Pre-Drill 5/8" diameter hole.
 - 3. Soap Lag screws prior to installation.
 - 4. Tighten all bolts and screws before closing in.
- C. Framing Devices: Install according to the manufacturer's instructions unless otherwise noted.

3.7 INSTALLATION, MISCELLANEOUS

- A. Install all items under other sections specified to be furnished and installed in other sections which relate to the rough carpentry work.
- B. Miscellaneous Carpentry Work not included under other sections but, indicated or required yet not specified elsewhere shall be furnished and installed hereunder, including appropriate fastening devices. Contractor shall provide miscellaneous carpentry work for all sections and divisions of work identified.
- C. Wood Furring, Stripping: Install as shown or required to provide nailing materials or passage of pipes, conduits, etc., not otherwise accommodated including ceiling stripping for gypsum drywall construction.
- D. Bridging: Space not over 8'-0" c.c. for spans over 16'-0". Joists 8 inches or less in depth shall not require bridging unless specifically indicated.
- E. Solid Wood Backing: Solid wood backing shall be provided for all wall and ceiling finishes and for supporting of mounted items for all trades, including but not limited to metal toilet partitions, toilet room accessories, frames, cabinets, casework, mirrors, trim, applied wall finishes,

athletic equipment, food service equipment, piping, conduit, ducts, etc. Contractor shall coordinate placement of backing and supports with Subcontractor supplying mounted items.

- F. Building Paper: Install in all locations indicated except where included in other sections of the specifications.
- G. Cant Strips and Crickets: Shape to sizes shown. Rigidly fasten to construction. Form neat mitered corners.
- H. Wood Sheathing Backing: All toilet rooms, restrooms, single or joint occupancy shall have all walls backed with 5/8-inch thick wood sheathing with no surface voids. Install sheathing between the framing members and wallboard. The same wood sheathing shall also be provided and installed at all tile locations. At tile locations wood sheathing shall be installed between the framing members and the resin-cement backing board.
- I. Wood Curbs for Equipment: Construct all wood curbs for roof mounted equipment as detailed. Provide all miscellaneous blocking, bracing, supports, and other wood items as shown or required to complete the work.
- J. Plywood Backing for Electrical, telephone, and similar types of wall mounted equipment shall be provided hereunder where required. Plywood shall be 3/4-inch thick exterior A-C plywood with 'A' face exposed.
- K. Fire/Draft Stops: Construct fire and drafts stops in furred attic spaces where indicated or required by CBC code. Unless otherwise indicated on Drawings construct of not less than 5/8-inch Type 'X' gypsum wallboard or 1/2" wood sheathing, adequately supported by 2x4's at 24 inches c.c., braced diagonally to the roof structure. Draft stop and installation work shall conform to code requirements.
- L. Shoring and Bracing: Shore or brace for temporary support of all work as required during the construction period except any shoring and bracing specified and included under other sections of these specifications.

Temporary Enclosures: Provide and maintain all barricades and enclosures required to protect the work in progress.
- M. Protect all work in progress and all work installed, as well as the work of all other trades. Any work damaged as a result of the work under this section shall be corrected to its original condition or replaced if directed by the Architect at no increase in cost to the Owner.
- N. Ventilation: Contractor shall include all labor and materials necessary to provide ventilation requirements of roof overhangs, eaves, attics, and all other components of the building required by codes to be ventilated. Work shall include removing knock-outs in wood I-joists for cross ventilation, drilling of blocking, wood sheathing, and other wooden components of the structure necessary to comply with requirements of the CBC for ventilation of buildings.

3.8 SITE APPLIED WOOD TREATMENT

- A. Apply preservative treatment compatible with factory applied treatment at site-sawn cuts, complying with manufacturer's instructions.
- B. Allow preservative to dry prior to erecting members.

3.9 TOLERANCES

- A. Framing Members: 1/4 inch from true position, maximum.

- B. Surface Flatness of Floor: 1/8 inch in 10 feet maximum, and 1/4 inch in 30 feet maximum.
- C. Variation from Plane, Other than Floors: 1/4 inch in 10 feet maximum, and 1/4 inch in 30 feet maximum.

3.10 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements for additional requirements.

3.11 CLEANING

- A. Waste Disposal: See Section 01 74 19 - Construction Waste Management and Disposal.
 - 1. Comply with applicable regulations.
 - 2. Do not burn scrap on project site.
 - 3. Do not burn scraps that have been pressure treated.
 - 4. Do not send materials treated with pentachlorophenol, CCA, or ACA to co-generation facilities or "waste-to-energy" facilities.
- B. Do not leave wood, shavings, sawdust, etc. on the ground or buried in fill.
- C. Prevent sawdust and wood shavings from entering the storm drainage system.

3.12 SCHEDULES

- A. Lower Level Floor Joists: MSR Lumber.
- B. Upper Level Floor and Ceiling Joists, Rafters: Spruce-Pine-Fir, No. 2 Grade.
- C. Exposed Beams: Western Cedar, Select Structural Grade.

END OF SECTION

SECTION 06 17 00
SHOP-FABRICATED STRUCTURAL WOOD

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 SECTION INCLUDES

- A. Shop-fabricated structural wood (SFSW).
- B. All blocking, bridging, etc., for the installation of members.
- C. Clips, angles, straps, hangers, etc., incidental to installation of members.
- D. Nails, bolts, washers and other fasteners used for erecting and securing members.

1.3 RELATED REQUIREMENTS

- A. Section 06 10 00 – Rough Carpentry.
- B. Section 06 17 13 – Wood I-Joists.
- C. Section 06 17 53 – Shop-Fabricated Wood Trusses.
- D. Section 06 18 00 – Glued-Laminated Construction

1.4 REFERENCE STANDARDS

- A. AITC 117 - Standard Specifications for Structural Glued Laminated Timber of Softwood Species.
- B. AITC A190.1 - American National Standard for Wood Products - Structural Glued Laminated Timber.
- C. ASTM D2559 - Standard Specification for Adhesives for Bonded Structural Wood Products for Use Under Exterior Exposure Conditions.
- D. ASTM D2898 - Standard Practice for Accelerated Weathering of Fire-Retardant-Treated Wood for Fire Testing.
- E. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
- F. AWP A U1 - Use Category System: User Specification for Treated Wood.
- G. AWS B2.1 - Specification for Welding Procedure and Performance Qualification.
- H. AWS D1.1 - Structural Welding Code - Steel.
- I. FM (AG) - FM Approval Guide Current Edition.

- J. NDS – National Design Specification for Wood Construction
- K. SDPWS - Special Design Provisions for Wind & Seismic
- L. RIS (GR) - Standard Specifications for Grades of California Redwood Lumber.
- M. UL (DIR) - Online Certifications Directory Current Edition.
- N. UL (FRD) - Fire Resistance Directory Current Edition.
- O. WCLIB - Standard Grading Rules for West Coast Lumber No. 17.
- P. WWPA - Western Lumber Grading Rules.

1.5 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide technical data on wood preservative materials, application technique and resultant performance information.
- C. Shop Drawings: Indicate framing system, sizes and spacing of members, loads and cambers, bearing and anchor details, bridging and bracing, and framed openings.
 - 1. Show large scale details of connections, connectors and other accessories.
 - 2. Indicate species and laminating combination, adhesive type, and other variables in required work.
- D. Manufacturer's Qualification Statement.

1.6 QUALITY ASSURANCE

- A. Manufacturing facility shall be approved by an independent inspection agency approved by the International Accreditation Service, Inc. (IAS).
- B. Each Shop-fabricated structural wood member shall be stamped with an identifying mark. Mark shall include all pertinent data, such as grade and species of lumber, plant number, independent inspection agency, logo, ICC ES report number and other such information as may be required.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver undamaged products to site in manufacturer's protective wrappings with legends intact. Store on site secure from weather, soil and physical damage.
- B. Transport, handle and store in strict accordance with the manufacturer's recommendations. Use padded, non-marring slings.
- C. Architectural Appearance Grade members shall be shipped, handled and stored with complete weather and damage protection wrapping. Maintain wrappings in place until immediately prior to deck installation.
- D. Industrial Appearance Shop-fabricated structural wood members shall be wrapped in a water resistant covering during transit. Contractor shall be responsible for protection during hauling and unloading at job site.

- E. If members must be stored prior to erection, they shall be stored in a vertical position off the ground, covered and protected from weather.
- F. Protect members to AITC requirements for not wrapped.
- G. Leave individual wrapping in place until finishing occurs.
- H. Fire Retardant Treated Wood: Prevent exposure to precipitation during shipping, storage, or installation.

PART 2 PRODUCTS

2.1 SHOP-FABRICATED STRUCTURAL WOOD (SFSW)

- A. SFSW members shall be of the types and sizes indicated on Drawings and as specified here. Shop-fabricated structural wood shall have specific ICC approval, and shall meet all specified structural design properties. Proposed SFSW members may be used only if equivalent, in the Architect's opinion, to the SFSW specified.

2.2 MATERIALS

A. Lumber:

1. Laminated Veneer Lumber (LVL): LVL shall be manufactured in accordance with the manufacturer's ICC-ES Report and have properties equal to or greater than as specified on the Drawings. Lumber species, thickness, etc. shall be such that the nailing capacity is equal to or better than that specified.
2. Parallel Strand Lumber (PSL): PSL shall be manufactured in accordance with the manufacturer's ICC-ES Report and have properties equal to or greater than as specified on the Drawings. Lumber species, thickness, etc. shall be such that the nailing capacity is equal to or better than that specified.
3. Laminated Strand Lumber (LSL): LSL shall be manufactured in accordance with the manufacturer's ICC-ES Report and have properties equal to or greater than as specified on the Drawings. Lumber species, thickness, etc. shall be such that the nailing capacity is equal to or better than that specified.
4. Various SFSW products shall only be used where specifically indicated on the Drawings. No substitutions shall be made without written approval.

B. Adhesive:

1. According to manufacturers ICC ES Report.

C. Types:

1. Sizes, properties and additional information as shown on the Drawings.

D. Laminating Adhesive: Tested for wet/exterior service in accordance with ASTM D2559.

2.3 FABRICATION

A. Fabrication shall be in compliance with manufacturer's ICC ES Report.

1. Fabrication shall be in accordance with best practices with adequate plant equipment and under supervision of properly qualified personnel.

- 2. Moisture content of components at time of gluing shall comply with the manufacturer's ICC ES Report.
- B. Boring of holes in members shall be in strict conformance with the Drawings. Notching is prohibited except where specifically detailed.
- C. Verify dimensions and site conditions prior to fabrication.
- D. Cut and fit members accurately to length to achieve tight joint fit.
- E. Field cuts and holes in preservative treated members shall be preservative treated and sealed.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Prior to installation of the work of this Section, carefully inspect and verify that the installed work of all other trades is complete to the point where this installation may properly commence.
- B. Verify that specified items may be installed in accordance with the approved design.
- C. In the event of a discrepancy, immediately notify Architect. Do not proceed in discrepant areas until discrepancies have been fully resolved.

3.2 PREPARATION

- A. Coordinate placement of bearing items.

3.3 PROTECTION

- A. Protect work and materials of this Section prior to and during installation, and protect the installed work and materials of other trades.
- B. In the event of damage, make all repairs and replacements necessary to the approval of the Architect at no additional cost to the Owner.

3.4 HANDLING

- A. Use equipment and methods that avoid damages that may impair strength of SFSW members. Sharp instruments and unprotected wire rope, chain slings and the like shall not be permitted.

3.5 ERECTION

- A. Shop-fabricated structural wood members are to be erected and installed in accordance with the Drawings and manufacturer's recommendations.
- B. Set structural members level and plumb, in correct positions or sloped where indicated.
- C. Provide temporary bracing and anchorage to hold members in place until permanently secured.
- D. Fit members together accurately without trimming, cutting, splicing, or other unauthorized modification.
- E. Swab and seal the interior wood surfaces of field drilled holes in members with primer.

3.6 TOLERANCES

- A. Framing Members: 1/2 inch maximum from true position.

3.7 CLEANUP

- A. Keep premises free from accumulated waste materials, rubbish and debris resulting from this work. Upon completion, remove tools, appliances, surplus materials, waste materials, rubbish, debris and accessory items used in or resulting from said Work, and legally dispose of off the site.

END OF SECTION

SECTION 06 17 33

WOOD I-JOISTS

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 SECTION INCLUDES

- A. Wood I-joists for roof and floor framing.
- B. Bridging, bracing, and anchorage.
- C. Framing for openings.
- D. Preservative treatment of wood.

1.3 RELATED REQUIREMENTS

- A. Section 05 12 00 – Structural Steel Framing
- B. Section 06 10 00 - Rough Carpentry
- C. Section 06 17 00 – Shop-Fabricated Structural Wood
- D. Section 06 17 53 – Shop-Fabricated Wood Trusses
- E. Section 06 18 00 – Glued-Laminated Construction

1.4 REFERENCE STANDARDS

- A. Utilize the edition of the listed document as identified in the “Design Criteria Notes” in the structural drawings. If not listed in the “Design Criteria Notes”, use the edition adopted or referenced by the listed governing building code or material standard. If no specific edition is adopted, use the latest edition.
 - 1. ASTM D2559 - Standard Specification for Adhesives for Bonded Structural Wood Products for Use Under Exterior Exposure Conditions.
 - 2. ASTM D5055 - Standard Specification for Establishing and Monitoring Structural Capacities of Prefabricated Wood I-Joists.
 - 3. AWPA U1 - Use Category System: User Specification for Treated Wood.
 - 4. PS 1 - Structural Plywood.
 - 5. PS 2 - Performance Standard for Wood Structural Panels.

1.5 DESIGN REQUIREMENTS

- A. As indicated on the Drawings.

1.6 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Manufacturer's literature describing materials, dimensions, allowable spans and spacings, bearing and anchor details, bridging and bracing requirements, and installation instructions; identify independent inspection agency.
- C. Shop Drawings: Where indicated on Drawings, show erection plans, sizes, types, and location of wood I-joists. Drawings shall also indicate sizes and location of blocking, hangers, etc., with sufficient detailing to ensure correct installation.

1.7 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum five years of documented experience.
- B. Manufacturing facility shall be approved by an independent inspection agency approved by the International Accreditation Service, Inc. (IAS).
- C. All joists shall bear a stamp indicating the plant number, independent inspection agency, logo and ICC ES Report number.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to site in manufacturer's original packaging with manufacturer's name and product identification intact and legible.
- B. Protect products from damage due to weather and breakage.
- C. Protect joists from warping or other distortion by stacking in upright position, braced to resist movement, with air circulation under coverings and around stacks.
- D. Handle individual joists in the upright position.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Wood I-Joists:
 - 1. Boise Cascade Company: www.bc.com/#sle.
 - 2. RedBuilt LLC; Redbuilt I-Joist: www.redbuilt.com/#sle.
 - 3. Weyerhaeuser Company: www.weyerhaeuser.com/#sle.
 - 4. Substitutions: See Section 01 60 00 - Product Requirements.

2.2 MATERIALS

- A. Wood I-Joists: Solid lumber top and bottom flanges and oriented strand board (OSB) webs bonded together with structural adhesive, with published span rating to meet project requirements.
 - 1. Span Rating: Established and monitored in accordance with ASTM D5055 by independent inspection agency.
 - 2. Oriented Strand Board: Comply with PS 2.

3. Plywood: Comply with PS 1.
4. Adhesive: Tested for wet/exterior service in accordance with ASTM D2559 and as indicated in the manufacturer's ICC ES Report.
5. Depth: As indicated on Drawings.
6. Fabrication Tolerances: Shall be in compliance with manufacturer's ICC ES Report.
7. Marking: Mark each piece with depth, joist spacing, and allowable span for joist spacing.
8. Provide bearing stiffeners if required by span rating or joist hanger manufacturer.

B. Joist Hangers: As indicated on the Drawings.

C. Joist Bridging: Type, size and spacing recommended by joist manufacturer or as indicated on the Drawings.

D. Wood Blocking, Plates, and Miscellaneous Framing: As specified in Section 06 10 00 or 06 17 00.

E. Fasteners: Electrogalvanized steel, type to suit application.

F. Bearing Plates: Electrogalvanized steel, unfinished.

2.3 WOOD TREATMENT

A. Factory-Treated Lumber and Plywood: Comply with requirements of AWPA U1 - Use Category System for wood treatments determined by use categories, expected service conditions, and specific applications.

B. Surface-Applied Wood Preservative: As specified in Section 06 10 00.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that supports and openings are ready to receive joists.

B. Verify that field measurements are as indicated on the Drawings.

C. Verify that items are installed in accordance with the approved Drawings.

D. In the event of discrepancy, immediately notify Architect. Do not proceed in discrepant areas until discrepancies have been fully resolved.

3.2 PREPARATION

A. Coordinate placement of bearing items.

3.3 PROTECTION AND HANDLING

A. Protect work and materials of this Section during installation, and protect the installed work and materials of other trades.

- B. Use equipment and methods that avoid damages that may impair strength of wood I-joists. Sharp instruments and unprotected wire rope, chain slings and the like shall not be permitted.

3.4 ERECTION

- A. Install joists in accordance with the Drawings and manufacturer's instructions.
- B. Set structural members level and plumb, in correct position.
- C. Make provisions for erection loads and for sufficient temporary bracing to maintain structure plumb and in true alignment until completion of erection and installation of permanent bracing.
- D. Do not field cut or alter structural members without approval of Architect.
- E. Install permanent bridging and bracing.
- F. Install headers and supports to frame openings required.
- G. Frame openings between joists with lumber in accordance with Section 06 10 00.
- H. Coordinate installation of sheathing/decking with work of this section.

3.5 SITE APPLIED WOOD TREATMENT

- A. Apply preservative treatment in accordance with manufacturer's instructions.
- B. Brush apply one coat of preservative treatment on wood in contact with cementitious materials and roofing and related metal flashings. Treat site-sawn cuts.
- C. Allow preservative to dry prior to erecting members.

3.6 TOLERANCES

- A. Framing Members: 1/2 inch maximum, from true position.

3.7 CLEANUP

- A. Keep premises free from accumulated waste materials, rubbish and debris resulting from this Work. Upon completion, remove tools, appliances, surplus materials, waste materials, rubbish, debris and accessory items used in or resulting from said Work, and legally dispose of off the site.

END OF SECTION

SECTION 06 17 53
SHOP-FABRICATED WOOD TRUSSES

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 SECTION INCLUDES

- A. Shop-fabricated wood trusses.
- B. Truss bridging.
- C. Fire-retardant treatment of wood.
- D. Preservative treatment of wood.

1.3 SCOPE

- A. Furnish all material, equipment and labor necessary for the prefabrication, delivery and temporary setting of the wood trusses on plate line as shown on the drawings. It shall also include all the miscellaneous parts, including bridging, temporary and permanent bracing, and all related items of hardware.

1.4 RELATED REQUIREMENTS

- A. Section 06 10 00 - Rough Carpentry.
- B. Section 06 17 00 – Shop-Fabricated Structural Wood
- C. Section 06 18 00 – Glued-Laminated Construction.

1.5 REFERENCE STANDARDS

- A. Utilize the edition of the listed document as identified in the “Design Criteria Notes” in the structural drawings. If not listed in the “Design Criteria Notes”, use the edition adopted or referenced by the listed governing building code or material standard. If no specific edition is adopted, use the latest edition.
 - 1. ANSI/TPI 1 - National Design Standard for Metal-Plate-Connected Wood Truss Construction.
 - 2. ASTM A653 - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 - 3. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
 - 4. ASTM D2898 - Standard Practice for Accelerated Weathering of Fire-Retardant-Treated Wood for Fire Testing.
 - 5. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building

Materials.

6. AWPA U1 - Use Category System: User Specification for Treated Wood.
7. NDS – National Design Specification for Wood Construction
8. SDPWS - Special Design Provisions for Wind & Seismic
9. RIS (GR) - Standard Specifications for Grades of California Redwood Lumber.
10. SBCA (BCSI) - Building Component Safety Information: Guide to Good Practice for Handling, Installing, Restraining & Bracing of Metal Plate Connected Wood Trusses.
11. TPI DSB-89 - Recommended Design Specification for Temporary Bracing of Metal Plate Connected Wood Trusses.
12. WCLIB - Standard Grading Rules for West Coast Lumber No. 17.
13. WWSA - Western Lumber Grading Rules.

1.6 DESIGN REQUIREMENTS

- A. As indicated on the Drawings.

1.7 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Manufacturer's data sheets on plate connectors, bearing plates, bridging and bracing requirements, and metal bracing components.
- C. Shop Drawings: Submit shop drawings prior to fabrication or erection. Show truss configurations, sizes, spacing, size and type of plate connectors, cambers, framed openings, bearing and anchor details, and bridging and bracing.
1. Include identification of engineering software used for design.
 2. Provide shop drawings stamped or sealed by design engineer.
 3. Structural calculations proving capacity to carry the loads shown on the drawings. Calculations shall be signed by a Professional Engineer registered in the State in which the Project is located
- D. Designer's Qualification Statement.
- E. Fabricator's Qualification Statement.

1.8 QUALITY ASSURANCE

- A. Designer Qualifications: Perform design by or under direct supervision of a Professional Engineer experienced in design of this Work and licensed in the State in which the Project is located.
- B. Fabricator Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years of documented experience.
- C. All trusses shall be marked with the manufacturers name and truss type keyed to the erection plans.
- D. All connector plates shall be marked with the manufacturer's name.
- E. All trusses shall bear TPI Quality Control marks.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Handle trusses in accordance with SBCA (BCSI).
- B. Store trusses in vertical position resting on bearing ends.
- C. Time delivery and erection of trusses to avoid extended on-site storage and to avoid delaying work of other trades whose work must follow erection of trusses.
- D. Fire-Retardant Treated Wood: Prevent exposure to precipitation during shipping, storage, or installation.

PART 2 PRODUCTS

2.1 TRUSSES

- A. Wood Trusses: Design and fabricate trusses in accordance with ANSI/TPI 1 and to achieve specified design requirements indicated.
 - 1. Design and fabricate temporary bracing in accordance with TPI DSB-89.
 - 2. Structural Design:
 - a. Comply with applicable code for structural loading criteria.
 - b. Design shall account for all loads indicated and all mechanical units in conformance with the referenced codes.
 - c. Design and construction of connections shall be in accordance with published approvals by ICC. Heel joint design shall consider the effects of eccentric loading.
 - d. Truss layout shall be as shown on the Structural Drawings. Do not deviate without obtaining written approval from the Structural Engineer prior to preparing shop drawings.
 - e. Design Trusses in accordance with the design loads and criteria as indicated on the Drawings.
 - 3. Fire Retardance: Comply with applicable codes.
 - 4. Decay Resistance: Factory preservative-treated wood.

2.2 MATERIALS

- A. Lumber:
 - 1. Species and Grade: Douglas Fir, WWPA Grade No. 2 and better.
 - 2. Moisture Content: The moisture content of all lumber shall not exceed 19% nor be less than 7% at the time of fabrication.
- B. Steel Connectors: Hot-dipped galvanized steel sheet, ASTM A653 Structural Steel (SS) Grade 33, with G90 coating; die stamped with integral teeth; thickness shall be 20 gauge minimum.
 - 1. ASTM A666, Type 304 stainless steel sheet may be used in lieu of Hot-dipped galvanized steel sheet.
- C. Truss Bridging: Type, size and spacing recommended by truss manufacturer.

2.3 ACCESSORIES

- A. Wood Blocking, Bridging, Plates, and Miscellaneous Framing: As specified in Section 06 10 00.
- B. Fasteners: Electrogalvanized steel, type to suit application.
- C. Bearing Plates: Electrogalvanized steel.

2.4 WOOD TREATMENT

- A. Treated Lumber and Plywood: Comply with requirements of AWWA U1 - Use Category System for wood treatments determined by use categories, expected service conditions, and specific applications.
- B. Fire-Retardant Treatment, Exterior Type: AWWA U1, Use Category UCFB, Commodity Specification H, chemically treated and pressure impregnated, maximum flame spread index of 25 when tested in accordance with ASTM E84 and with no evidence of significant combustion when test is extended for an additional 20 minutes both before and after accelerated weathering test performed in accordance with ASTM D2898; kiln dried after treatment to maximum moisture content of 19 percent for lumber and 15 percent for plywood.
 - 1. Marking: Mark each piece of wood with producer's stamp indicating compliance with specified requirements.
- C. Fire-Retardant Treatment, Interior Type A: AWWA U1, Use Category UCFA, Commodity Specification H, low temperature (low hygroscopic) type, chemically treated and pressure impregnated, maximum flame spread index of 25 when tested in accordance with ASTM E84 and with no evidence of significant combustion when test is extended for an additional 20 minutes; kiln dried after treatment to maximum moisture content of 19 percent for lumber and 15 percent for plywood.
 - 1. Marking: Mark each piece of wood with producer's stamp indicating compliance with specified requirements.
- D. Preservative Pressure Treatment of Lumber: AWWA U1, Use Category UC3B, Commodity Specification A using waterborne preservative to 0.25 lb/cu ft retention.
 - 1. Kiln dry after treatment to maximum moisture content of 19 percent.
 - 2. Marking: Mark each piece with stamp of an ALSC-accredited testing agency, certifying level and type of treatment in accordance with AWWA standards.
- E. Preservative Pressure Treatment of Plywood: AWWA U1, Use Category UC3B using waterborne preservative to 0.25 lb/cu ft retention.
 - 1. Kiln dry plywood after treatment to maximum moisture content of 19 percent.
 - 2. Marking: Mark each piece with stamp of an ALSC-accredited testing agency, certifying level and type of treatment in accordance with AWWA standards.
- F. Surface-Applied Wood Preservative: As specified in Section 06 10 00.

2.5 FABRICATION

- A. All items specified to be fabricated hereunder shall be accurately cut or fitted, and rigidly fastened to produce quality trusses in accordance with designs and criteria contained in these specifications and the Structural Drawings.

- B. Cut truss members to accurate lengths, angles and sizes to produce close fitting joints with proper wood-to-wood bearing in assembled units.
- C. Fabricate metal connector plates to proper size, configuration, thickness and anchorage details required for types of joint designs indicated.
- D. Assemble truss members in design configuration indicated using jigs or other means to ensure uniformity and accuracy of assembly with close fitting joints. Position members to produce design camber as required.
- E. Truss designer shall oversize connector plates for chord members to account for wood defects like knots, knotholes and greatly distorted grains. Maximum allowable defect size per member shall be 2 square inches. No defects allowed under plates for web members.
- F. Built up girder trusses shall be laminated. Laminating requirements shall be according to the Structural Drawings.
- G. Gable end trusses shall be 2x verticals at 16" cc typical unless noted otherwise.
- H. All hardware required for connecting trusses (Truss to bearing wall or beam, Jack to Hip, Hip to Girder, or Girder to Girder, etc.) shall be designed, detailed and provided by truss fabricator.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that field measurements are as indicated on the Drawings.
- B. Verify that supports and openings are ready to receive trusses.
- C. In the event of discrepancy, immediately notify Architect. Do not proceed in discrepant areas until discrepancies have been fully resolved.

3.2 PREPARATION

- A. Coordinate placement of bearing items.

3.3 PROTECTION

- A. Protect work and materials of this Section during installation, and protect the installed work and materials of other trades.
- B. In the event of damage, make all repairs and replacement necessary to the approval of the Architect at no additional cost to the Owner.

3.4 ERECTION

- A. Hoist units in place by means of proper lifting equipment suited to sizes and types of trusses required, applied at proper lift points as recommended by Fabricator, exercising care not to damage truss members or joints by out-of-place bending or other causes.
- B. Install trusses in accordance with manufacturer's instructions, SBCA (BCSI); maintain a copy of applicable documents on site until installation is complete.

- C. Erect trusses with planes of truss webs vertical (plumb) and parallel to each other, locate accurately at design spacings indicated.
- D. Make provisions for erection loads, and for sufficient temporary bracing to maintain structure plumb, and in true alignment until completion of erection and installation of permanent bracing.
- E. Do not field-cut, alter structural members, or remove trusses without approval of the Architect and the Structural Engineer of Record.
- F. Install permanent bracing, end pieces, blocking and related components to enable trusses to maintain design spacing, withstand live and dead loads including lateral loads, and to comply with other indicated requirements.
- G. Anchor trusses securely at all bearing points to comply with methods and details indicated.
- H. Install headers and supports to frame openings required.
- I. Frame openings between trusses with lumber in accordance with Section 06 10 00.
- J. Coordinate placement of decking with work of this section.
- K. After erection, touch-up primed surfaces with primer consistent with shop coat.

3.5 SITE-APPLIED WOOD TREATMENT

- A. Treat all site-sawn cuts of pressure-treated wood using same type of treatment (i.e. preservative or fire-retardant).
- B. Apply preservative treatment to non-pressure-treated wood wherever it will come into contact with cementitious materials, roofing, asphaltic materials, or metals.
- C. Apply fire-retardant treatment to all exposed surfaces after erection where required.
- D. Apply treatment in accordance with manufacturer's instructions.
- E. Allow field-applied treatment to dry prior to erecting members.

3.6 TOLERANCES

- A. Framing Members: 1/2 inch maximum, from true position.

3.7 CLEANUP

- A. A. Keep premises free from accumulated waste materials, rubbish and debris resulting from this work. Upon completion, remove tools, appliances, surplus materials, waste materials, rubbish, debris and accessory items used in or resulting from said Work, and legally dispose of off the site.

END OF SECTION

SECTION 06 18 00
GLUED-LAMINATED CONSTRUCTION

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 SECTION INCLUDES

- A. Glue laminated wood beams and purlins.
- B. Preservative treatment of wood.
- C. Fire retardant treatment of wood.

1.3 RELATED REQUIREMENTS

- A. Section 06 10 00 – Rough Carpentry.
- B. Section 06 17 00 – Shop-Fabricated Structural Wood
- C. Section 06 17 13 – Wood I-Joists.
- D. Section 06 17 53 – Shop-Fabricated Wood Trusses.

1.4 REFERENCE STANDARDS

- A. Utilize the edition of the listed document as identified in the “Design Criteria Notes” in the structural drawings. If not listed in the “Design Criteria Notes”, use the edition adopted or referenced by the listed governing building code or material standard. If no specific edition is adopted, use the latest edition.
 - 1. AITC 117 - Standard Specifications for Structural Glued Laminated Timber of Softwood Species.
 - 2. AITC A190.1 - American National Standard for Wood Products - Structural Glued Laminated Timber.
 - 3. ASTM D2559 - Standard Specification for Adhesives for Bonded Structural Wood Products for Use Under Exterior Exposure Conditions.
 - 4. ASTM D2898 - Standard Practice for Accelerated Weathering of Fire-Retardant-Treated Wood for Fire Testing.
 - 5. ASTM D3737 - Standard Practice for Establishing Allowable Properties for Structural Glued Laminated Timber (Glulam).
 - 6. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
 - 7. AWPA U1 - Use Category System: User Specification for Treated Wood.
 - 8. FM (AG) - FM Approval Guide Current Edition.

9. NDS – National Design Specification for Wood Construction
10. SDPWS - Special Design Provisions for Wind & Seismic
11. RIS (GR) - Standard Specifications for Grades of California Redwood Lumber.
12. UL (DIR) - Online Certifications Directory Current Edition.
13. UL (FRD) - Fire Resistance Directory Current Edition.
14. WCLIB - Standard Grading Rules for West Coast Lumber No. 17.
15. WWPA - Western Lumber Grading Rules.

1.5 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide technical data on wood preservative materials, application technique and resultant performance information.
- C. Shop Drawings: Indicate framing system, sizes and spacing of members, loads and cambers, bearing and anchor details, bridging and bracing, and framed openings.
 1. Show large scale details of connections, connectors and other accessories.
 2. Indicate species and laminating combination, adhesive type, and other variables in required work.
- D. Manufacturer's Qualification Statement.

1.6 QUALITY ASSURANCE

- A. Manufacturer/Fabricator Qualifications: Company specializing in manufacture of glue laminated structural units with three years of documented experience, and certified by AITC in accordance with AITC A190.1.
- B. Each structural glued-laminated member shall be stamped with an identifying mark. Mark shall include all pertinent data, such as grade and species of lumber, type of glue, extremes of moisture content and other such information as may be required.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver undamaged products to site in manufacturer's protective wrappings with legends intact. Store on site secure from weather, soil and physical damage.
- B. Transport, handle and store in strict accordance with the manufacturer's recommendations. Use padded, non-marring slings.
- C. Architectural Appearance Grade members shall be shipped, handled and stored with complete weather and damage protection wrapping. Maintain wrappings in place until immediately prior to deck installation.
- D. Industrial Appearance Grade glued laminated timber members shall be wrapped in a water resistant covering during transit. Contractor shall be responsible for protection during hauling and unloading at job site.
- E. Protect members to AITC requirements for not wrapped.
- F. Leave individual wrapping in place until finishing occurs.

- G. Fire Retardant Treated Wood: Prevent exposure to precipitation during shipping, storage, or installation.

PART 2 PRODUCTS

2.1 GLUED-LAMINATED UNITS

- A. Glued-Laminated Units: Fabricate in accordance with AITC 117 Industrial grade.
1. Verify dimensions and site conditions prior to fabrication.
 2. Cut and fit members accurately to length to achieve tight joint fit.
 3. Fabricate member with camber built in.
 4. Do not splice or join members in locations other than those indicated without permission from the Architect and Structural Engineer of Record.
 5. After end trimming, seal with penetrating sealer in accordance with AITC requirements.

2.2 MATERIALS

A. Lumber:

1. Lumber used for laminating structural members shall be well manufactured and shall conform to requirements of WCLIB Standard Grading and Dressing Rules No. 17, or WWPA - Western Lumber Grading Rules. Such lumber shall be inspected, identified by individual piece, and certified as meeting requirements of said standard specifications by an approved lumber grading agency. It is assumed that each lamination is graded on basis of requirement for nominal size of individual lamination. When lumber is resawn, it shall be regraded on basis of new size.

B. Type: Glued Laminated Timber Protected from Weather

1. Species: Douglas Fir or Western Larch
2. Stress Grade: AITC Combination 24F-V4 for simple beams, 24F-V8 for cantilever or continuous beams.
3. Extreme fiber bending - $F_b = 2400$ psi
4. Adhesives: Wet use
5. Appearance Grade: AITC Industrial for concealed uses, Architectural appearance at exposed uses.
6. Preservative Treatment: Portions of beams exposed to weather shall be preservative treated.
7. Laminations: Provide outer tension laminations or proof load testing as required by ANSI/AITC A190.1.
8. Sealing: Shop seal all surfaces with 2 coats of clear penetrating sealer.

C. Type: Glued Laminated Timber Exposed to Weather

1. Species: Alaskan Yellow Cedar
2. Stress Grade: AITC Combination 20F-V12 for simple beams, 20F-V13 for cantilever or continuous beams.

3. Extreme fiber bending - $F_b = 2000$ psi
4. Adhesives: Wet use
5. Appearance Grade: Architectural
6. Laminations: Provide outer tension laminations or proof load testing as required by ANSI/AITC A190.1.
7. Sealing: Shop seal all surfaces with 2 coats of clear penetrating sealer.

D. Laminating Adhesive: Tested for wet/exterior service in accordance with ASTM D2559.

2.3 WOOD TREATMENT

A. Factory-Treated Lumber: Comply with requirements of AWP A U1 - Use Category System for pressure impregnated wood treatments determined by use categories, expected service conditions, and specific applications.

B. Fire Retardant Treatment:

1. Exterior Type: AWP A U1 Use Category UCFB, Commodity Specification H, chemically treated and pressure impregnated; maximum flame spread index of 25 when tested in accordance with ASTM E84 and with no evidence of significant combustion when test is extended for an additional 30 minutes both before and after accelerated weathering test performed in accordance with ASTM D2898.
 - a. Kiln dry wood after treatment to a maximum moisture content of 19 percent prior to lamination.
2. Interior Type A: AWP A U1, Use Category UCFA, Commodity Specification H, low temperature (low hygroscopic) type, chemically treated and pressure impregnated; maximum flame spread index of 25 when tested in accordance with ASTM E84 and with no evidence of significant combustion when test is extended for an additional 20 minutes.
 - a. Kiln dry wood after treatment to a maximum moisture content of 19 percent prior to lamination.
 - b. Do not use treated wood in applications exposed to weather or where the wood may become wet.
3. Marking: Mark each piece of wood with producer's stamp indicating compliance with specified requirements.
4. Products:
 - a. Blaze FRT Chemicals by Viance, Inc. (ESR-2645)
 - b. Pyro-Guard FRT by Hoover Treated Wood Products, inc. (ESR-1791)
 - c. Substitutions: See Section 01 60 00 - Product Requirements.

C. Preservative Pressure Treatment:

1. Preservative Pressure Treatment of Glued-Laminated Structural Units: AWP A U1, Use Category UC3B, Commodity Specification F using waterborne preservative to 0.25 lb/cu ft retention.
 - a. Kiln dry lumber after treatment and before lamination to maximum moisture content of 19 percent.
2. Marking: Marked each piece with stamp of an ALSC-accredited testing agency, certifying level and type of treatment in accordance with AWP A standards.

- D. Surface-Applied Wood Preservative: As specified in Section 06 10 00.
- E. Shop treat wood materials in accordance with manufacturer's instructions.

2.4 FABRICATION

- A. Fabricate glue laminated structural members in accordance with AITC Industrial grade.
- B. Laminations shall be machine finished to a smooth surface, but not sanded, and to a uniform thickness with a maximum allowable variation of 1/64 inch. Warp, twist, or other characteristics which will prevent intimate contact of adjacent glued faces or interfere with uniform bending to a required curvature when under clamping pressure shall not be permitted. Surfaces to be glued shall be clean and free from oil, dust and other foreign material which would be detrimental to satisfactory gluing.
- C. Moisture content of lumber at time of gluing shall be not less than 7 percent nor more than 12 percent.
- D. Slips, misses, and wane are not permitted.
- E. Boring of holes in members shall be in strict conformance with the Drawings. Notching is prohibited except where specifically detailed.
- F. Verify dimensions and site conditions prior to fabrication.
- G. Cut and fit members accurately to length to achieve tight joint fit.
- H. Fabricate member with camber built in.
- I. Do not splice or join members in locations other than those indicated without permission.
- J. After end trimming, seal with penetrating sealer in accordance with AITC requirements.
- K. Field cuts and holes in preservative treated members shall be preservative treated and sealed.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Prior to installation of the work of this Section, carefully inspect and verify that the installed work of all other trades is complete to the point where this installation may properly commence.
- B. Verify that specified items may be installed in accordance with the approved design.
- C. In the event of a discrepancy, immediately notify Architect. Do not proceed in discrepant areas until discrepancies have been fully resolved.

3.2 PREPARATION

- A. Coordinate placement of bearing items.

3.3 PROTECTION

- A. Protect work and materials of this Section prior to and during installation, and protect the installed work and materials of other trades.
- B. In the event of damage, make all repairs and replacements necessary to the approval of the Architect at no additional cost to the Owner.

3.4 ERECTION

- A. Glued Laminated members are to be erected and installed in accordance with the Drawings and manufacturer's recommendations.
- B. Lift members using protective straps to prevent visible damage.
- C. Set structural members level and plumb, in correct positions or sloped where indicated.
- D. Provide temporary bracing and anchorage to hold members in place until permanently secured.
- E. Fit members together accurately without trimming, cutting, splicing, or other unauthorized modification.
- F. Swab and seal the interior wood surfaces of field drilled holes in members with primer.

3.5 TOLERANCES

- A. Framing Members: 1/2 inch maximum from true position.

3.6 CLEANUP

- A. Keep premises free from accumulated waste materials, rubbish and debris resulting from this work. Upon completion, remove tools, appliances, surplus materials, waste materials, rubbish, debris and accessory items used in or resulting from said Work, and legally dispose of off the site.

END OF SECTION

SECTION 06 41 00
ARCHITECTURAL WOOD CASEWORK

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Custom fabricated casework.
- B. Countertops.
- C. Cabinet hardware.

1.2 RELATED SECTIONS

- A. Section 03 30 00 – Cast-In-Place Concrete.
- B. Section 06 10 00 – Rough Carpentry.
- C. Section 07 92 00 – Joint Sealants.
- D. Section 09 29 00 – Gypsum Board.
- E. Divisions 21-23 – Mechanical.
- F. Divisions 26-28 – Electrical.

1.3 REFERENCES

- A. The publications listed below form a part of this Section to the extent referenced. The publications are referred to in the text by the basic designation only. Refer to Division 01 for definitions, acronyms, and abbreviations.
- B. Standards, manuals, and codes refer to the latest edition of such standards, manuals, and codes in effect as of the date of issue of this Project Manual, unless indicated otherwise in CBC Chapter 35 and CFC Chapter 80.
- C. Referenced Standards:
 - 1. ANSI 135.4 – Basic Hardboard.
 - 2. ANSI A118.4 – Modified Dry Set Cement Mortar.
 - 3. ANSI A208.1 – Particleboard.
 - 4. ANSI A208.2 – Medium Density Fiberboard (MDF) for Interior Applications.
 - 5. ANSI Z124.6 – American National Standard for Plastic Sinks.
 - 6. ANSI/BHMA 156.9 – Cabinet Hardware.
 - 7. ANSI/HPVA HP-1 – Hardwood and Decorative Plywood.
 - 8. ASTM A123/A123M – Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
 - 9. ASTM A653/A653M – Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

10. ASTM A666	– Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
11. ASTM C39	– Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
12. ASTM C97	– Standard Test Methods for Absorption and Bulk Specific Gravity of Dimension Stone.
13. ASTM C99	– Standard Test Method for Modulus of Rupture of Dimension Stone.
14. ASTM C170	– Standard Test Method for Compressive Strength of Dimension Stone.
15. ASTM C501	– Standard Test Method for Relative Resistance to Wear of Unglazed Ceramic Tile by the Taber Abraser.
16. ASTM C1026	– Standard Test Method for Measuring the Resistance of Ceramic and Glass Tile to Freeze-Thaw Cycling.
17. ASTM D790	– Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
18. ASTM D1037	– Standard Test Methods for Evaluating Properties of Wood-Base Fiber and Particle Panel Materials.
19. ASTM E84	– Standard Test Method for Surface Burning Characteristics of Building Materials.
20. ASTM G21	– Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.
21. NEMA LD3	– High-Pressure Decorative Laminates.
22. NFPA 255	– Standard Method of Test of Surface Burning Characteristics of Building Materials.
23. NSF/ANSI 51	– Food Equipment Materials.
24. PS 1	– Construction and Industrial Plywood.
25. PS 20	– American Softwood Lumber Standard.
26. UL 723	– Test for Surface Burning Characteristics of Building Materials.
27. WI/AWMAC	– North American Architectural Woodwork Standards, including WI Supplemental Text.

1.4 SUBMITTALS

- A. General: Submit in accordance with Division 01. Begin fabrication only after required approvals have been obtained.
- B. Shop Drawings: Comply with Section 1 of WI/AWMAC North American Architectural Woodwork Standards – Basic Requirements for Architectural Millwork Shop Drawings. Submit as follows:
 - 1. Submit two copies of shop drawings, 11 inch by 17 inch minimum size.
 - 2. Architect furnished Drawings indicate form and profile concept only. Submit shop drawings to illustrate Fabricator's understanding of Architect's Drawings and to show intended fabrication details. Photocopies, traced copies, or other reproduction of Architectural Drawings will not be acceptable.

3. Prepare shop drawings using field verified dimensions. Report any major discrepancies between Architect's Drawings and field dimensions before work fabrication.
 4. Indicate casework conditions, identified with location, grade, type of finish, and wood species.
 5. Show casework in relation to adjacent construction with sectional drawings at full size or at 3 inch to 1 foot scale.
 6. Coordinate dimensions of built-in equipment and fixtures. Show casework hardware indicating brand name and model used.
 7. Show special accessory components not included in manufacturer's product data.
 8. Show anchoring and attachment method. Show seismic restraint in accordance with CBC. Show method of scribing.
 9. Furnish a WI Certified Compliance Label on shop drawings as specified in this Section.
- C. Product Data: Submit product data for each product specified in this Section with the product and selected attributes clearly identified.
- D. Samples: The following physical sample requirements shall be waived if the products specified by model number in this Section or indicated on the Finish Legend in the Drawings are submitted.
1. Two 6 inch by 12 inch samples of quartz solid surfacing of countertop finish.
 2. Two individual samples of each high pressure plastic laminate type and color specified.
 - a. Chain sets of plastic laminate samples shall not be submitted.
 3. One sample of each type of cabinet hardware.
- E. Quality Assurance/Control Submittals: Submit the following in accordance with appropriate provisions of this Section:
1. Manufacturer qualifications.
 2. Installer qualifications.
 3. WI Compliance Certification.

1.5 SYSTEM DESCRIPTION

- A. Casework design and construction shall be in accordance with WI/AWMAC North American Architectural Woodwork Standards as follows:
1. Grade: Custom.
 2. Construction Style: A – Frameless.
 3. Construction Type: Type I – Multiple Self-Supporting Units.
 4. Door and Drawer Front Style: Flush overlay.
 5. Shelves: Conform to WI requirements subject to a fifty pounds per square foot uniformly spaced load not to exceed 200 pounds per shelf.
 6. Provide seismic anchorage in accordance with CBC.
 7. Non-housing casework will not be permitted.

1.6 QUALITY ASSURANCE

A. Qualifications:

1. Fabricator/Installer Qualifications: Firm specializing in fabricating and installing products specified in this Section with a minimum five years' experience. Fabricator/Installer shall be a WI Accredited Millwork Company.

B. Certification Requirements:

1. WI Compliance Certification: Submit a certification stating that millwork products furnished and installed meet all the requirements of the WI Grade or Grades specified.
2. WI Certified Compliance Label: Show WI Certified Compliance Label on the first page of each set of shop drawings.

C. Pre-Installation Meetings:

1. Conduct pre-installation meeting in accordance with Division 01.
2. Convene pre-installation meeting prior to commencing work of this Section.
3. Coordinate work in this Section with work in related Sections. Coordinate work with plumbing and electrical rough-in. Ensure orderly and efficient sequencing of installation of interdependent trades, construction elements, and include provisions for future work.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Comply with requirements of Division 01.

- ### B. Deliver materials and manufactured products only when the area is ready for installation, broom clean, totally enclosed, and the relative humidity is fifty percent or less at 70 degrees F. Allow casework to acclimate to above conditions for 72 hours minimum prior to installation.

- ### C. Storage and Protection: Store materials in a dry secure place. Protect from weather, surface contaminants, construction traffic, and other potential damage.

1.8 MAINTENANCE DATA

A. Submit in accordance with Division 01.

- ### B. Provide cleaning and maintenance information. Include hardware adjustment information.

PART 2 PRODUCTS

2.1 SPECIAL ENVIRONMENTAL REQUIREMENTS

- #### A. Provide composite wood products whose bonding agents contain no urea-formaldehyde.

2.2 LUMBER

- #### A. Lumber: Conform to PS 20; Premium Grade in accordance with WI/AWMAC North American Architectural Woodwork Standards, Section 3. Dimensions as shown on Drawings. Properties as follows:

1. Moisture Content: Kiln dried; moisture content six percent to twelve percent.

2. Wood Species:

Use	Species
Framing, internal construction.	Douglas Fir

2.3 WOOD BASED PANELS

- A. Formaldehyde emissions of wood-based panels shall not exceed limits established by the Department of Housing and Urban Development (HUD) and 24 CFR, Section 3208.308. Products containing urea-formaldehyde resins shall not be allowed.
- B. Softwood Plywood: Veneer-core plywood; conforming to PS 1, Exposure 1, Grade A-A, Group 1. Nominal thickness shall be as indicated in this Section and as shown on Drawings.
- C. Particleboard: Meets or exceeds ANSI A208.1, Class M2, NAF resin, minimum 45 pounds per cubic foot density. At wet areas, meet moisture resistant specifications for ANSI MR30 per ASTM D1037 for 24 hour water absorption.
1. Products:
- a. Encore as manufactured by SierraPine or accepted equal.
 - b. FreeForm as manufactured by Collins Pine or accepted equal.
- D. Medium Density Fiberboard (MDF): Meets or exceeds ANSI A208.2, Class SDF, NAF resin, minimum 45 pounds per cubic foot density. At wet areas, meet moisture resistant specifications for ANSI Grade 155 MR50 per ASTM D1037 for 24 hour water absorption.
1. Products:
- a. Standard MDF: Medite II as manufactured by SierraPine or accepted equal.
 - b. Moisture-Resistant MDF: Medex as manufactured by SierraPine or accepted equal.
- E. Hardboard: ANSI 135.4, Class 1 – Tempered; smooth-one-side (S1S), minimum sixty pounds per cubic foot density.
- F. Thermally Fused Melamine: Low-pressure decorative laminate (LPDL) thermoset overlays pre-laminated to substrate (hardboard, particleboard, or MDF as specified in this Section) by thermal fusion; performance characteristics equal to a general purpose grade or liner grade high pressure laminate as per NEMA LD3 Grade CLS. Color as selected by Architect.

2.4 PLASTIC LAMINATE

- A. Manufacturers:
1. Acceptable Manufacturers:
- a. Arborite, Quebec, Canada; 800-996-0366, www.arborite.com.
 - b. Wilsonart International, Temple, TX; 800-433-3222; www.wilsonart.com.
 - c. Nevamar Decorative Surfaces, a division of Panolam Industries International, Inc., Shelton, CT; 877-726-6526; www.nevamar.com.
 - d. Formica Corporation, Cincinnati, OH; 800-367-6422; www.formica.com.
2. Substitutions: Under provisions of Division 01.

B. High-Pressure Decorative Laminates (HPDL): NEMA LD3; grades and thickness as follows:

Use/Application	NEMA LD3 Grade	Min. Thickness
Horizontal surface where postforming is not required.	HGS or HGL	0.048 inch ± 0.005 inch
Exposed vertical surfaces of casework components where postforming is not required.	VGS	0.028 inch ± 0.004 inch
Cabinet liner.	CLS	0.020 inch
Backing sheet. Provide at backside of plastic laminated panel substrates to enhance dimensional stability where laminate finish is applied to only one surface.	BK	0.020 inch

C. Colors: As indicated on Drawings.

2.5 QUARTZ SOLID SURFACING MATERIAL

A. Products and Manufacturers:

1. Acceptable Products and Manufacturers:

- a. Wilsonart Quartz by Wilsonart International, Temple, TX; 800-433-3222, www.wilsonart.com.
- b. Corian Quartz by DuPont, Wilmington, DE; 800-426-7426, www2.dupont.com.
- c. Hyundai L&C LLC USA, Atlanta, GA; 470-632-1402, www.hanexsolidsurfaces.com. Product: HanStone Quartz.
- d. Silestone Stellar Series by Cosentino USA, Inc., Sugar Land, TX; 877-532-6394, www.silestoneusa.com.
- e. CaesarStone Quartz Surfacing by CaesarStone USA, Inc., Van Nuys, CA; 877-978-2789, www.caesarstoneus.com.
- f. Cambria Quartz by Cambria, Eden Prairie, MN; 866-226-2742, www.cambriausa.com.

2. Substitutions: Under provisions of Division 01.

B. Solid Surfacing Material (SSM): Homogeneous quartz surface composed of approximately 93 percent crystalline silica bound in polymer creating a solid surfacing material. Color and pattern shall extend throughout the material.

1. Thickness: 3/4 inch, unless otherwise indicated on Drawings.
2. Color: As indicated on Drawings.

C. Properties:

1. Flexural Strength: >5,300 psi, per ASTM D790.
2. Flexural Modulus: 5.3–5.7E6 psi, per ASTM D790.
3. Compressive Strength (Dry, Wet): ~27,000 psi, ~24,000 psi, per ASTM C170.
4. Hardness: 7, Mohs' Hardness Scale.
5. Fungal Resistance: No growth, per ASTM G21.

6. Freeze-Thaw Cycling: Unaffected, per ASTM C1026.
7. Point Impact: Passes ANSI Z 124.6.4.2
8. Ball Impact: 164 inches, per NEMA LD 3.3.8, based on NEMA LD 3-2000.
9. Abrasion Resistance: 139, per ASTM C501.
10. Density: ~2400 kg/m³.
11. Flammability: ASTM E84, UL 723 (Class I and Class A) and NFPA 255
12. Flame Spread Index: FSI <15 for 3/4-inch.
13. Smoke Developed Index: <100 for 3/4-inch.
14. Nominal Weight: Ten pounds per square foot.

D. Solid Surfacing Accessories:

1. Joint Adhesive: Manufacturer's standard two-part adhesive kit to create inconspicuous non-porous joints, with a chemical bond.
2. Panel Adhesive: Manufacturer's standard neoprene-based panel adhesive.
3. Sealant: Manufacturer's standard mildew resistant, FDA and UL recognized silicone sealant in color matching or clear formulations.

2.6 STAINLESS STEEL COUNTERTOPS

A. Counter Top and Backsplash Materials:

1. Sheet Material: ASTM A666 Type 304 stainless steel; 16 gauge; AISI No. 4 satin finish; grain direction shall be horizontal.
2. Configuration: As indicated on Drawings.
3. Tops: Form tops with 1 inch lip and 1/2 inch return flange, with 16 gauge reinforcing applied to underside as required for rigidity and sound dampening. Coat underside with sound dampening material.
 - a. Sound Dampening Material: Waterborne, non-flammable, with flame retardant clay, with no VOCs; minimum film thickness of 20 mils.
 - b. Provide integral 4 inch high stainless steel backsplash. Form edges, flanges, and backsplashes integrally with top, from one sheet of metal.

2.7 GALVANIZED STEEL COUNTERTOPS

A. Counter Top and Backsplash Materials:

1. Sheet Material: ASTM A653 galvanized steel; 14 gauge; Hot dip galvanized to G90 minimum in accordance with ASTM A123.
2. Configuration: As indicated on Drawings.
3. Tops: Form tops with 1 inch lip and 1/2 inch return flange, with 16 gauge reinforcing applied to underside as required for rigidity and sound dampening. Coat underside with sound dampening material.
 - a. Sound Dampening Material: Waterborne, non-flammable, with flame retardant clay, with no VOCs; minimum film thickness of 20 mils.
 - b. Provide integral 4 inch high backsplash. Form edges, flanges, and backsplashes integrally with top, from one sheet of metal.

2.8 ACCESSORIES

- A. Edge Banding: PVC vinyl; 0.125 inch (3 mm) thick by 15/16 inch wide. Color and pattern shall closely match exposed door and drawer front laminate color and pattern as accepted by Architect.
- B. Vinyl Countertop Edge: PVC vinyl; 0.125 inch (3 mm) thick. Color and pattern shall closely match countertop laminate color and pattern as accepted by Architect.
- C. Fasteners: Nails, screws, and other fasteners of size and type best suitable for the purpose. Staples, screws, or T-nails not permitted at exposed surfaces. Staples and nails not permitted in casework joinery.
- D. Adhesives, Caulks, and Sealants:
 - 1. Comply with provisions of Division 01. Adhesives, caulks, sealants, and fillers shall meet VOC requirements of South Coast Air Quality Management District (SCAQMD) Rule No. 1168.
 - 2. Adhesives shall be selected for their ability to provide a durable, permanent bond and shall take into consideration such factors as materials to be bonded, expansion and contraction, bond strength, fire rating, and moisture resistance.
 - 3. Wood Joinery: CS 35-61 Type II (water-resistant). Shall withstand cold-soak tests specified in ANSI/HPVA HP-1.
 - 4. Laminate Adhesive: Water-based contact adhesive, type recommended by plastic laminate manufacturer.
 - 5. Caulk: Clear, 100 percent silicone. Use to fill voids and joints between laminated components and adjacent surfaces.
 - 6. Sealant: Mold and mildew resistant; type and composition recommended by substrate manufacturer to provide a moisture barrier at sink cutouts and other locations where unfinished substrate edges may be subjected to moisture.

2.9 CABINET HARDWARE

- A. Hardware shall be furnished and installed as required to provide for a complete and operable casework installation. All hardware shall conform to ANSI/BHMA 156.9 Grade 2, except where a higher grade is specified.
- B. Manufacturers:
 - 1. Acceptable Manufacturers:
 - a. Accuride International, Inc., Santa Fe Springs, CA; 562-903-0200, www accuride.com.
 - b. Amerock Corp., Mooresville, NC; 800-435-6959; www.amerock.com.
 - c. Doug Mockett & Company, Inc., Torrance, CA; 800-523-1269, www.mockett.com.
 - d. EPCO – The Engineered Products Co., Flint, MI; 888-414-3726 www.epcohardware.com.
 - e. Häfele America Co., Archdale, NC; 800-423-3531, www.hafele.com.
 - f. Hettich America L.P., Buford, GA; 800-777-1772, www.hettichamerica.com.
 - g. Knappe & Vogt Mfg. Co., Grand Rapids, MI; 800-253-1561, www.knappeandvogt.com.
 - h. National Cabinet Lock / CompX International Inc., Mauldin, SC; 864-297-6655, www.compnet.com/national.html.

- i. Richelieu, Montreal, Canada; 800-619-5446, www.richelieu.com.
 - j. RPC – Rockford Process Control, Rockford, IL; 815-966-2000, www.rpchingesandhardware.com.
- 2. Substitutions: Under provisions of Division 01.
- C. Overlay Institutional Hinges: ANSI/BHMA 156.9 Grade 1.
 - 1. Five-knuckle type; US26D satin chrome finish. Products: RPC Part No. 456, Häfele Cat. No. 354.65.400, or accepted equal.
- D. Pulls: 5-7/16 inches long x 13/32 inch wide x 1-3/8 inch projection Zamak handle with brushed nickel finish. Product: Richelieu Modern Metal Pull #BP873128195 or accepted equal.
- E. Drawer Slides:
 - 1. Pencil drawers: Full extension; steel ball bearings; hold-in detent; silenced in and out; low profile; 1/2 inch side space; minimum 50 pounds rated load. Product: Accuride Model No. 2632, Knappe & Vogt Model No. 8400, or accepted equal.
 - 2. Box drawers: Full extension; steel ball bearings; hold-in detent; progressive movement; 1/2 inch side space; 100 pounds rated load. Product: Accuride Model No. 3832, Knappe & Vogt Model No. 8405, or accepted equal.
- F. Adjustable Shelf Supports: ANSI/BHMA 156.9 Grade 1; nickel plated zinc die-cast shelf supports, 5 mm pin diameter with additional pin for shelf. Product: Hettich Sekura 6 Cat. No. 079707, Häfele Cat. No. 282.24.720, or accepted equal.
- G. Countertop Supports: Steel angles; sizes and configurations as indicated on Drawings. Paint finish under provisions of Section 09 91 00.
- H. Countertop Brackets: Steel workstation bracket with 15 inch x 21 inch x 1/8 inch thick legs and minimum 1000 pound capacity. Bracket shall have a 3 inch x 3 inch 45 degree notch to allow for wall cleat and wiring. Product: Workstation Bracket by Futaba or accepted equal by Häfele or Knappe & Vogt.
 - 1. Finish: Manufacturer's standard powder coat finish, color as selected by Architect from full range of manufacturer's standard colors.
- I. Elbow Catch: Heavy duty solid brass. Product: Epco Part No. 1018-N, or accepted equal.
- J. Cabinet Locks:
 - 1. General: All locks shall be BHMA certified.
 - 2. Single: Deadbolt locks with 90 degree turn; key removable in both locked and unlocked positions. Provide two keys per lock. Provide strike bars at doors and angle strikes at drawers. Cylinder lengths: 7/8 inch at doors and 1-3/8 inch at drawers. Finish: US26D, satin chrome. Products:
 - a. Doors: CompX National C8173 or accepted equal.
 - b. Drawers: CompX National C8179 or accepted equal.
 - 3. All casework locks and keying shall match facility's casework needs and keying system. Locks shall be keyed in groups per functional operations.
- K. Cable Grommets: 2-1/2 inch diameter plastic grommet; color as selected by Architect. Product: Doug Mockett & Company, Inc. Model EDP (flip-top tab), Häfele Cat. No. 429.99.324 (spring-loaded rotating segment in cover), or accepted equal.

2.10 FABRICATION

- A. Fabricate and assemble casework components at the shop site to the maximum extent possible. Construction and fabrication of cabinets and their components shall meet or exceed WI grade requirements as indicated in this Section.
- B. Closely fit casework at site. Provide filler inserts and trim where necessary, scribe for a tight fit.
- C. Provide cutouts for inserts, grommets, and fittings. Install grommets where indicated on the drawings after site verification of locations and dimensions. Seal surfaces of cut edges.
- D. Operable parts for all accessible casework shall comply with CBC Section 11B-309.
- E. Plastic Laminates:
 - 1. Apply plastic laminate in full uninterrupted sheets, consistent with manufactured sizes.
 - 2. Fit corners and joints hairline. Slightly bevel arises.
 - 3. Secure plastic laminated panels with concealed fasteners.
 - 4. Apply laminate backing sheets to reverse side of panels with high-pressure decorative laminates on one face.
- F. Sheet Materials Application:

Use/Application		Thickness	Wood-Based Panel
Casework carcass.		Min. 3/4 inch	Plywood, Particleboard, or MDF
Doors and drawer false fronts.		3/4 inch	Particleboard or MDF
Drawer box.	Sides, backs, and subfronts.	Min. 1/2 inch, Max. 5/8 inch	Plywood, Particleboard, or MDF
	Bottom.	Min. 1/4 inch	Hardboard or MDF
Cabinet backs.		Min. 1/4 inch	Hardboard or MDF
Laminate clad countertops.		Min. 3/4 inch	Plywood, Particleboard, or MDF
Shelves: Up to 32 inch span with LPDL finish.		Min. 3/4 inch	Plywood, Particleboard, or MDF
Shelves: Up to 35 inch span with HPDL finish.		Min. 3/4 inch	Plywood, Particleboard, or MDF
Shelves: Up to 36 inch span with LPDL finish.		Min. 1 inch	Plywood, Particleboard, or MDF
Shelves: Up to 42 inch span with HPDL finish.		Min. 1 inch	Plywood, Particleboard, or MDF

- G. Casework Carcass:
 - 1. Glue frame components together. Brace top corners, bottom corners and cabinet bottoms with hardwood blocks, or metal or plastic braces.
 - 2. Joinery Method: Acceptable joinery methods shall be as follows:
 - a. Tops, exposed ends, and bottoms:

- 1) Steel European assembly fasteners 1-1/2 inch from end, 5 inches on center. Fasteners shall not be visible on exposed parts.
- 2) Doweled and glued under pressure – approximately four dowels per 12 inches of joint.
- 3) Stop dado, glued under pressure, and either nailed or screwed. Fasteners shall not be visible on exposed parts.
- 4) Spline or biscuit and glued under pressure.
- b. Cabinet backs (wall hung cabinets):
 - 1) Wall hung cabinet backs must not be relied upon to support the full weight of the cabinet and its anticipated load for hanging/mounting purposes. Method of back joinery and hanging/mounting mechanism should transfer the load to case body members.
 - 2) Fabrication method: Full bound, capture in grooves on cabinet sides, top, and bottom. Cabinet backs for floor standing cabinets shall be side bound, captured in grooves, glued and fastened to top and bottom.

H. Drawer Assembly:

1. Drawer box with drawer false front.
2. Acceptable joinery methods:
 - a. Multiple dovetail (all corners) or French dovetail front/dadoed back, glued under pressure.
 - b. Doweled, glued under pressure.
 - c. Lock shoulder, glued and pin nailed.
 - d. Bottoms shall be set into sides, front, and back, 1/4 inch deep groove, with a minimum 3/8 inch standing shoulder.
3. File Drawers: Unless otherwise indicated, direction of file folders shall be parallel to drawer door. Provide adequate, clear inside dimensions for hanging file folders. Minimum clear inside drawer dimensions shall be as follows:
 - a. Letter size file folders: Minimum 13-1/4 inch wide by 10-1/2 inch high.
 - b. Legal size file folders: Minimum 16-1/4 inch wide by 10-1/2 inch high.

I. Shelving:

1. Fixed shelves: Dadoed or doweled into cabinet sides.
2. Adjustable shelves: 0.197 inch bore holes at 1-1/4 inch on center.

J. Laminate Countertops and Backsplash:

1. Edge Style: As indicated on Drawings.
2. Mechanically fasten back splash to countertops at minimum 16 inches on center.
3. Substrate shall be moisture-resistant where countertops receive sinks, lavatories, or are subject to liquids.

2.11 FINISH

A. Finish – Laminated Casework:

1. Drawer box: Thermally fused melamine.

2. Semi-exposed surfaces, as defined in WI/AWMAC North American Architectural Woodwork Standards Section 10:
 - a. Cabinet with doors: Thermally fused melamine.
 - b. Cabinets with open shelves: High-pressure decorative laminate.
3. Exposed surfaces, as defined in WI/AWMAC North American Architectural Woodwork Standards Section 10: High-pressure decorative laminate with PVC edge banding.
4. Doors and drawer false fronts: High-pressure decorative laminate with PVC edge banding.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify field measurements, dimensions, location, and layout.
- B. Verify location and sizes of utility rough-in associated with work of this Section.
- C. Verify adequacy of backing and support framing.
- D. Report unacceptable conditions to Architect. Begin installation only when unacceptable conditions have been corrected.

3.2 INSTALLATION

- A. Install in accordance with accepted shop drawings and with applicable WI grade requirements as indicated in this Section.
- B. Install fabricated assemblies, level, plumb, square, and true to line, in locations as shown on Drawings.
- C. Anchorage:
 1. Attach and anchor casework securely to floors and walls with mechanical fasteners appropriate for the substrate.
 2. Use concealed fasteners to attach and secure casework components, countertops, and plumbing fixtures.
- D. Carefully scribe casework abutting other components with a maximum gap of 1/32 inch. Do not use additional overlay trim for this purpose.
- E. Install solid surfacing per manufacturer's written instructions.
- F. Install stainless steel countertops and galvanized steel countertops as indicated on Drawings.
- G. Install cable grommets in countertops at all casework knee-spaces and where shown on Drawings.

3.3 ADJUSTING

- A. Adjust moving or operating parts for smooth, uniform operation.
- B. Drawer slides shall be adjusted such that the drawer does not act as the stop.

3.4 CLEANING

- A. Clean as recommended by manufacturer. Do not use materials or methods which may damage finish surface or surrounding construction.

END OF SECTION

SECTION 06 73 00
COMPOSITE WOOD DECKING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Composite wood decking.

1.2 REFERENCES

- A. The publications listed below form a part of this Section to the extent referenced. The publications are referred to in the text by the basic designation only. Refer to Division 01 for definitions, acronyms, and abbreviations.
- B. Standards, manuals, and codes refer to the latest edition of such standards, manuals, and codes in effect as of the date of issue of this Project Manual, unless indicated otherwise in CBC Chapter 35 and CFC Chapter 80.
- C. Referenced Standards:
 - 1. ASTM D1037 – Standard Test Methods for Evaluating Properties of Wood-Base Fiber and Particle Panel Materials.
 - 2. ASTM D1761 – Standard Test Methods for Mechanical Fasteners in Wood and Wood-Based Materials.
 - 3. ASTM D4761 – Standard Test Methods for Mechanical Properties of Lumber and Wood-Base Structural Material.
 - 4. ASTM E84 – Standard Test Method for Surface Burning Characteristics of Building Materials.

1.3 SUBMITTALS

- A. Submit under provisions of Division 01.
- B. Product Data: Indicate sizes, profiles, surface finishes, and performance characteristics.
- C. Samples: Submit two 12 inch long decking samples illustrating size, profile, color, and surface finish.
- D. Closeout Submittals:
 - 1. Maintenance Data: Manufacturer's written installation instructions on care and cleaning of composite wood products.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, and handle composite wood in accordance with manufacturer's written installation instructions.
- B. Store composite wood level and flat, off ground or floor, with supports at each end and maximum 24 inches on center.
- C. Do not stack composite wood over 12 feet high.
- D. Cover composite wood with waterproof covering, vented to prevent moisture buildup.

1.5 WARRANTIES

- A. Furnish manufacturer's 25 year warranty providing coverage against checking, splitting, splintering, rotting, structural damage from termites, and fungal decay of composite wood.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Trex Company, Inc., 800-289-8739, www.trex.com. Product: Select.
- B. TimberTech, 877-275-2935, www.timbertech.com.
- C. Substitutions: Under provisions of Division 01.

2.2 MATERIALS

- A. Composite Wood:
 - 1. Composition: Reclaimed wood and plastic with integral coloring; free from toxic chemicals and preservatives.
 - 2. Profile: Nominally 2 inches x 2 inches x maximum practical length.
 - 3. Surface Texture: Deeply grained.
 - 4. Colors: Colors as selected by Architect from full range of manufacturer's standard colors.
 - 5. Characteristics:
 - a. Flame Spread Rating: 70, tested to ASTM E84.
 - b. Thermal expansion coefficient, 36 inch long samples:
 - 1) Width: 42.7×10^{-6} .
 - 2) Length: 19.2×10^{-6} .
 - c. Water absorption, 1.20 percent, 24 hour immersion, tested to ASTM D1037.
 - d. Fastener withdrawal, tested to ASTM D1761:
 - 1) Screw: 388 pounds per inch.
 - e. Termite Resistance: 9.7 rating, tested to AWPA E-1.
 - f. Modulus of Rupture: 3750 PSI ultimate, 500 PSI design, tested to ASTM D4761.
 - g. Modulus of Elasticity: 400,000 PSI ultimate, 200,000 PSI design, tested to ASTM D4761.

2.3 ACCESSORIES

- A. Fasteners: Stainless steel wood screws of length and shank diameter recommended by composite wood manufacturer for profile being fastened.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine job site conditions and verify field dimensions.
- B. Verify structure or substrate is plumb, level, and ready to receive work.

- C. Report unacceptable conditions to Architect. Begin installation only when unacceptable conditions have been corrected.

3.2 INSTALLATION

- A. Install composite wood in accordance with manufacturer's written installation instructions.
- B. Cut, drill, and rout composite wood using carbide tipped blades.
- C. Pre-drill fastener holes located closer than 1 inch from edges.
- D. Cut ends square and true.
- E. Do not exceed maximum spans recommended by manufacturer.
- F. Place boards perpendicular to supports.
- G. Leave expansion spaces between abutting boards and between boards and adjacent construction:
 - 1. Side gaps between boards: 1/4 inch minimum at ambient temperatures of 60 degrees F and above and 3/8 inch at ambient temperatures below 60 degrees F.
 - 2. Gaps between boards and adjacent construction: 1/4 inch minimum at ambient temperatures of 60 degrees F and above and 1/2 inch at ambient temperatures below 60 degrees F.
- H. Fasten each board to each support with 2 fasteners.

3.3 CLEANING

- A. Clean composite wood to remove stains:
 - 1. Mold and mildew: Clean surfaces with conventional deck wash containing detergent or sodium hypochlorite.
 - 2. Rust and ground-in dirt: Clean surfaces with cleaner containing oxalic or phosphoric acid.
 - 3. Oil and grease: Clean surfaces with detergent containing degreasing agent.

END OF SECTION

SECTION 07 19 19
WATER REPELLENTS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Clear water repellent coating on all manufactured stone masonry surfaces.

1.2 RELATED WORK

- A. Section 04 73 00 – Manufactured Stone Masonry.
- B. Section 07 92 00 – Joint Sealants.
- C. Section 09 96 23 – Anti Graffiti Coating.

1.3 SUBMITTALS

- A. Submit to Architect copies of manufacturer's current technical data sheet for material.

1.4 DESCRIPTION OF SYSTEMS

- A. Water repellent compounds specified herein are clear, deep-penetrating, non-film forming, non-silicone or urethane, non-yellowing, heavy duty, chemical water repellent solutions.

1.5 QUALITY ASSURANCE

A. Manufacturer's service

1. Prior to commencement of application, manufacturer and applicator shall inspect all surfaces to be treated. All deficiencies or flaws in the construction of the substrate which would ultimately effect the performance of the water repellent shall be noted in writing by manufacturer and a copy delivered to the Contractor and Architect.
2. Manufacturer's representative shall be present at commencement of material application to assure utilization of proper equipment, verify material quantities, and supervise material application technique upon a substantial wall section which shall act as a comparative standard for the project.
3. Manufacturer's representative shall inspect all treated surfaces after work is complete to verify proper application.

B. Contractor's Requirements:

1. Applying contractor shall comply with recommendations and instructions set forth by manufacturer as part of manufacturer's service in addition to complying with the terms of the manufacturer's Warranty and the following:
2. Contractor shall not proceed with application of material until all deficiencies noted in the manufacturer's pre-application inspection have been corrected.
3. Contractor shall notify manufacturer no less than 72 hours prior to commencement of work.

1.6 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Use all means necessary to protect material before, during, and after installation and to protect the work of other trades. If damage occurs, immediately make all repairs and replacements necessary at no additional cost to Owner.
- B. Deliver materials in original sealed containers, clearly marked with manufacturer name type of material and batch number. Store material where temperatures are not less than 45 degrees F.

1.7 ENVIRONMENTAL REQUIREMENTS

- A. All liquid water repellent materials shall comply with current Federal and State environmental requirements.

1.8 WARRANTY

- A. The material and workmanship in this application shall be warranted jointly and separately, under a single document to the Owner, signed by the manufacturer and applicator of materials. The applicator shall warrant workmanship for a period of two years, and the manufacturer shall warrant against water intrusion for a period of ten years from date of Substantial Completion.

PART 2 PRODUCTS

2.1 MANUFACTURER AND PRODUCT

- A. Basis of Design: RainguardPro, Phoenix, AZ; 888-765-7070, <https://rainguardpro.com>. Product: "Micro-Seal" w/Micro-Lok.
- B. Substitutions: Under provisions of Division 01.

PART 3 EXECUTION

3.1 ACCEPTANCE OF SURFACES

- A. Before commencing application, make certain that the surfaces to be coated are in proper condition. New substrates shall be allowed to cure for a minimum of 30 days prior to application. Cured substrates shall be allowed three to seven days drying time following rainfall prior to application. Moisture content shall be no higher than 15 percent as registered on an electronic moisture meter. In climates where freezing conditions exist prior to the application, allow adequate time for building to thaw. Materials shall not be applied if substrate temperature is below 45 degrees F. Allow at least 24 hours between application of clear repellent and water-based paint or stain. Verify that all cracks have been filled with pointing mortar or approved caulking sealant. Verify that voids in masonry joints or joints found to be unsound or otherwise defective have been raked out and pointed with mortar to create a joint of full-face shell thickness.

3.2 PREPARATION OF SURFACES

- A. Substrate surfaces shall be thoroughly cleaned of foreign substances, such as dirt, efflorescence, mortar spills, etc., prior to work. A "dry" cleaning method is preferred. Allow three days minimum drying time before applying material if wet cleaning method is utilized.

3.3 APPLICATION

- A. Follow instructions in the manufacturer's current technical data sheet for general information, application instructions and coverage rates.
- B. Material shall be applied by high-volume, low-pressure spray equipment.

3.4 CLEANING

- A. Cleaning all drips, runs, and overspray residue while still wet. Protect all windows and other surfaces not to be sealed, including plant life.

END OF SECTION

SECTION 07 21 00
THERMAL INSULATION

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Thermal insulation in exterior wall and underside of roof deck construction.
- B. Exterior wall rigid sheathing/insulation.

1.2 RELATED SECTIONS

- A. Section 06 10 00 – Rough Carpentry.
- B. Section 09 29 00 – Gypsum Board.
- C. Section 09 81 00 – Acoustic Insulation.

1.3 REFERENCES

- A. The publications listed below form a part of this Section to the extent referenced. The publications are referred to in the text by the basic designation only. Refer to Division 01 for definitions, acronyms, and abbreviations.
- B. Standards, manuals, and codes refer to the latest edition of such standards, manuals, and codes in effect as of the date of issue of this Project Manual, unless indicated otherwise in CBC Chapter 35 and CFC Chapter 80.
- C. Referenced Standards:
 - 1. ASTM C578 – Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation.
 - 2. ASTM C665 – Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing.
 - 3. ASTM C1303 – Standard Test Method for Predicting Long-Term Thermal Resistance of Closed-Cell Foam Insulation.
 - 4. ASTM D1621 – Standard Test Method for Compressive Properties of Rigid Cellular Plastics.
 - 5. ASTM E84 – Standard Test Method for Surface Burning Characteristics of Building Materials.
 - 6. UL 723 – Test for Surface Burning Characteristics of Building Materials.

1.4 SUBMITTALS

- A. Submit under provisions of Division 01.
- B. Product Data: Provide data on product characteristics, performance criteria, and limitations.
- C. Manufacturer's Certificate: Certify that products meet or exceed California Quality Standards.

1.5 SYSTEM DESCRIPTION

- A. Materials of this Section: Provide continuity of thermal barrier at building enclosure elements.

1.6 COORDINATION

- A. Coordinate work with other trades under provisions of Division 01.

PART 2 PRODUCTS

2.1 GLASS FIBER BATT INSULATION

A. Acceptable Manufacturers:

1. Knauf Insulation, Shelbyville, IN; 317-398-4434, www.knaufusa.com. Product: EcoBatt.
2. Owens-Corning, Toledo, OH; 800-438-7465, www.owenscorning.com.
3. Certainteed Corp., Insulation Group, Valley Forge, PA; 800-233-8990, www.certainteed.com.
4. Johns Manville, Denver, CO; 800-654-3103, www.specJM.com.
5. Substitutions: Under provisions of Division 01.

B. Batt Insulation: Preformed glass fiber batt in accordance with 2022 CBC Section 720, California Referenced Standards Code Chapter 12-13, ASTM E84, and UL 723, conforming to the following:

1. Facings:
 - a. Faced on one side with foil reinforced kraft (FSK) face at exposed locations (facing not covered by finish materials); Type III, Class A per ASTM C665; flame spread 25 and smoke developed 50 per ASTM E84.
 - b. Kraft facing at locations where insulation will be covered by finish materials; Type II, Class C per ASTM C665. In concealed locations, facings shall be installed behind and in substantial contact with the unexposed surface of the ceiling or wall finish.
2. Provide formaldehyde-free thermal insulation products.
3. Recycled Content: Minimum twenty percent post-consumer.

C. Accessories:

1. Staples: Steel wire; galvanized; type and size to suit application.
2. Tape: Polyester self-adhering type, mesh reinforced, 2 inches wide.

2.2 RIGID SHEATHING/INSULATION

A. Acceptable Manufacturers:

1. Dow Building Solutions, Midland, MI; 866-583-2583, www.dowbuildingmaterials.com. Product: Styrofoam Brand Square Edge Insulation.
2. Owens Corning.
3. Substitutions: Under provisions of Division 01.

B. Rigid Sheathing Insulation: ASTM C578, Type IV, rigid, closed cell extruded polystyrene thermal insulation with square edges, ICC ES Listed; UL Listed.

1. Thickness: As indicated on Drawings.
2. Compressive Strength: 25 psi minimum per ASTM D1621.
3. Surface Burning Characteristics: Flame Spread: 15; Smoke Developed: 165 per ASTM E84 when no thermal barrier is installed.
4. Long-Term Thermal Resistance (LTTR) value: Minimum R-5.0 per inch of thickness per ASTM C1303; CAN/ULC-S770.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify existing site conditions.
- B. Verify that substrate, adjacent materials, and insulation are dry and ready to receive insulation.

3.2 INSTALLATION – BATT INSULATION

- A. Install insulation in accordance with insulation manufacturer's instructions and with the flame spread rating and smoke density requirements of CBC Section 720, ASTM E84, and UL 723.
- B. Install in exterior walls and between roof joists, full width, depth, and height of cavity, without gaps or voids. Do not compress insulation.
- C. Trim insulation neatly to fit spaces. Insulate miscellaneous gaps and voids.
- D. Fit insulation tight in spaces and tight to exterior side of mechanical and electrical services within the plane of insulation.
- E. Install with factory applied vapor retarder membrane facing interior side of building spaces. Lap ends and side flanges of membrane over framing members.
- F. Securely fasten and anchor insulation in place to prevent displacement or sagging of material in all areas.
 1. At wood stud walls and joists, staple facing flanges in place at maximum 6 inches on center.
- G. Tape seal butt ends, lapped flanges, and tears or cuts in membrane.

3.3 INSTALLATION – RIGID SHEATHING/INSULATION

- A. Install insulation in accordance with insulation manufacturer's instructions and with the flame spread rating and smoke density requirements of CBC Section 2603.
- B. Place insulation over exterior sheathing and fasten to exterior wood stud wall framing using insulation manufacturer's recommended type and length screw fasteners with washers. Abut panels tightly together and around openings and penetrations.
 1. Install insulation panels horizontally with correct surface, per the manufacturer, to the exterior. Use maximum lengths to minimize number of joints. Locate edge joints parallel to and on framing. Center end joints over supports and stagger in each course. Provide additional framing wherever panel joints do not bear against framing plate or sill members.

2. Fasten panels to each support with fasteners spaced 12 inches on center at perimeter of the panel and 16 inches on center in panel field. Set back perimeter fasteners 3/8 inch from edges and ends of panel units. Drive fasteners to bear tight and flush with surface of insulation. Do not overdrive fastener causing damage to the insulation board facer. Perimeter fasteners can be detailed to bridge the gap of abutting board joints due to the 2 inch diameter of the washer used to fasten the board to the studs. Maximum of two board joints may be bridged per fastener.
3. Install flashing at end and edge joints in accordance with insulation manufacturer's joint sealing recommendations.
4. Install flashing behind wall tie and mechanical fastening assemblies for rain screen claddings according to manufacturer's recommendations.
5. Seal sheathing joints and penetrations of sheathing in accordance with insulation manufacturer's joint and penetration sealing recommendations.

3.4 SCHEDULE

- A. Insulation shall conform to the following minimum requirements:
 1. Wall and Ceiling Insulation: R19 and R30 batt.

END OF SECTION

SECTION 07 25 00
WEATHER BARRIERS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Weather barrier membrane.
- B. Seam tape.
- C. Flexible flashings.
- D. Fasteners.
- E. Accessories.

1.2 RELATED SECTIONS

- A. Section 06 10 00 – Rough Carpentry.
- B. Section 07 46 46 – Mineral-Fiber Cement Siding.
- C. Section 07 62 00 – Sheet Metal Flashing and Trim.
- D. Section 08 11 13 – Hollow Metal Doors and Frames.
- E. Section 08 41 13 – Aluminum-Framed Entrances and Storefronts.
- F. Section 08 91 19 – Fixed Louvers.
- G. Section 09 24 00 – Portland Cement Plastering.

1.3 REFERENCES

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only. Refer to Division 01 for definitions, acronyms, and abbreviations.
- B. Standards, manuals, and codes refer to the latest edition of such standards, manuals, and codes in effect as of the date of issue of this Project Manual, unless indicated otherwise in CBC Chapter 35 and CFC Chapter 80.
- C. Referenced Standards:
 - 1. ASTM C920 – Standard Specification for Elastomeric Joint Sealants.
 - 2. ASTM C1193 – Standard Guide for Use of Joint Sealants.
 - 3. ASTM D882 – Test Method for Tensile Properties of Thin Plastic Sheeting.
 - 4. ASTM D1117 – Standard Guide for Evaluating Non-Woven Fabrics.
 - 5. ASTM E84 – Test Method for Surface Burning Characteristics of Building Materials.
 - 6. ASTM E96 – Test Method for Water Vapor Transmission of Materials.

- 7. ASTM E1677 – Specification for Air Retarder Material or System for Framed Building Walls.
- 8. ASTM E2178 – Test Method for Air Permeance of Building Materials.
- 9. ASTM E2357 – Test Method for Determining Air Leakage of Air Barrier Assemblies.
- 10. AATCC Test Method 127 – Water Resistance: Hydrostatic Pressure Test.
- 11. TAPPI Test Method T-410 – Grams of Paper and Paperboard (Weight per Unit Area).
- 12. TAPPI Test Method T-460 – Air Resistance of Paper (Gurley Hill Method).

1.4 SUBMITTALS

- A. Submit under provisions of Division 01.
- B. Product Data: Submit product data for each product specified in this Section with the product and selected attributes clearly identified.
- C. Quality Assurance Submittals:
 - 1. Design Data, Test Reports: Provide manufacturer test reports indicating product compliance with indicated requirements.
 - 2. Manufacturer Instructions: Provide manufacturer's written installation instructions and details.
 - 3. Manufacturer's Field Service Reports: Provide site reports from authorized field service representative, indicating observation of weather barrier assembly installation.
- D. Closeout Submittals:
 - 1. Weather Barrier Warranty: Manufacturer's executed warranty form with authorized signatures and endorsements indicating date of Substantial Completion.

1.5 QUALITY ASSURANCE

- A. Qualifications:
 - 1. Installer shall have experience with installation of specified weather barrier and flexible flashing assemblies under similar conditions.
 - 2. Installation shall be in accordance with weather barrier manufacturer's installation guidelines and recommendations.
- B. Single Source Responsibility: Provide building wrap, flashings, and accessory materials from a single manufacturer to ensure system compatibility and quality, and to comply with manufacturer's warranty requirements.
- C. Pre-installation Meeting:
 - 1. Conduct pre-installation meeting in accordance with provisions of Division 01.
 - 2. Hold a pre-installation conference, two weeks prior to start of weather barrier installation. Attendees shall include Contractor, Architect, installer, Owner's Representative, and weather barrier manufacturer's designated representative.
 - 3. Review all related project requirements and submittals, status of substrate work and preparation, areas of potential conflict and interface, availability of weather barrier assembly materials and components, installer's training requirements, equipment, facilities and scaffolding, and coordinate methods, procedures and sequencing

requirements for full and proper installation, integration, and protection.

1.6 DELIVERY, STORAGE AND HANDLING

- A. Deliver, store, and handle products and materials under provisions of Division 01.
- B. Deliver weather barrier materials and components in manufacturer's original, unopened, undamaged containers with identification labels intact.
- C. Store weather barrier materials as recommended by weather barrier manufacturer.

1.7 SCHEDULING

- A. Review requirements for sequencing of installation of weather barrier assembly with installation of windows, doors, louvers, and flashings to provide a weather-tight barrier assembly.
- B. Schedule installation of weather barrier materials and exterior cladding within nine months of weather barrier assembly installation.

1.8 WARRANTY

- A. Product and Labor Warranty: Weather barrier manufacturer shall warranty weather barrier assemblies for a period of ten years from date of Project Completion.
 - 1. Weather barrier manufacturer's approval for warranty is required prior to assembly installation.

PART 2 PRODUCTS

2.1 MANUFACTURER

- A. Basis of Design: DuPont Building Innovations, Wilmington, DE; 800-448-9835, <http://construction.tyvek.com>. Products:
 - 1. DuPont Tyvek CommercialWrap D.
 - 2. DuPont FlexWrap NF.
 - 3. DuPont StraightFlash.
- B. Substitutions: Under provisions of Division 01.

2.2 MATERIALS

- A. Building Wrap: High-performance, flash spun-bonded olefin, non-woven, non-perforated weather barrier and related assembly components.
- B. Performance Characteristics:
 - 1. Air Penetration Resistance: <0.04 cfm/ft² at 1.57 psf, when tested in accordance with ASTM E2357. Type 1 per ASTM E1677.
 - 2. Water Vapor Permeance: 30 perms, when tested in accordance with ASTM E96, Procedure A.
 - 3. Water Penetration Resistance: Hydrostatic head resistance greater than 7.7 feet when tested in accordance with AATCC Test Method 127.

4. Basis Weight: Minimum 2.4 ounces per square yard, when tested in accordance with TAPPI Test Method T-410.
5. Air Penetration Resistance: >750 seconds/100cc, when tested in accordance with TAPPI Test Method T-460.
6. Breaking Strength: Minimum 33/41 lbs/in., when tested in accordance with ASTM D882.
7. Tear Resistance: 6/9 pounds, when tested in accordance with ASTM D1117.
8. Surface Burning Characteristics: Class A, when tested in accordance with ASTM E84. Flame Spread: 15, Smoke Developed: 25.

2.3 FLEXIBLE FLASHINGS

- A. Flexible membrane flashing materials for openings and penetrations.
- B. Straight flashing membrane materials for flashing window, door, and louver openings and sealing penetrations.

2.4 ACCESSORIES

- A. Seam Tape: DuPont Tyvek Tape, three inches wide, as manufactured by DuPont Building Innovations.
- B. Fasteners: Tyvek Wrap Cap Screws, as manufactured by DuPont Building Innovations.
 1. 1-5/8 inch corrosion resistant screws with 2-inch diameter high density polyethylene cap washers with UV inhibitors.
- C. Sealants:
 1. Provide sealants that comply with ASTM C920, elastomeric polymer sealant to maintain watertight conditions. All sealants shall be California VOC compliant.
 2. Acceptable Products:
 - a. DuPont Commercial Sealant.
 - b. Dow Corning 756.
 - c. Tremco 830.
 - d. Tremco Butyl.
 - e. Other sealants recommended by the weather barrier manufacturer.
- D. Adhesives:
 1. Provide adhesive recommended by weather barrier manufacturer. All adhesives shall be California VOC compliant.
- E. Primers for Flashings:
 1. Provide flashing manufacturer synthetic rubber-based, spray applied primer to assist in adhesion between substrate and flashing. All primers shall be California VOC compliant.
 2. Acceptable Products:
 - a. DuPont Adhesive Primer.
 - b. Other primers recommended by the flashing manufacturer.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify substrate and surface conditions are in accordance with weather barrier manufacturer recommended tolerances prior to installation of weather barrier and accessories.

3.2 INSTALLATION - WEATHER BARRIER

- A. Install weather barrier over exterior face of exterior wall substrate in accordance with manufacturer recommendations and as indicated on Drawings.
- B. Install weather barrier prior to installation of windows, doors, louvers, and exterior cladding materials.
- C. Start weather barrier installation at a building corner, leaving 6 inches to 12 inches of weather barrier extended beyond corner to over lap.
- D. Install weather barrier in a horizontal manner starting at the lower portion of the wall surface with subsequent layers installed in a shingling manner to overlap lower layers. Maintain weather barrier plumb and level.
- E. Sill Plate Interface: Extend lower edge of weather barrier over sill plate interface a minimum of 1 inch. Secure to foundation with elastomeric sealant as recommended by weather barrier manufacturer.
- F. Window, Door, and Louver Openings: Extend weather barrier completely over openings.
- G. Overlap weather barrier:
 - 1. Exterior Corners: Minimum 12 inches.
 - 2. Seams: Minimum 6 inches.
- H. Weather Barrier Attachment:
 - 1. Attach weather barrier to wood studs through exterior sheathing. Secure using weather barrier manufacturer recommend fasteners, space 6 inches to 18 inches vertically on center along stud line, and 24 inches on center, maximum horizontally.

3.3 SEAMING

- A. Seal seams of weather barrier with seam tape at all vertical and horizontal overlapping seams.
- B. Seal any tears or cuts as recommended by weather barrier manufacturer.

3.4 OPENING PREPARATION

- A. Flush cut weather barrier at edge of sheathing around full perimeter of opening.
- B. Cut a head flap at 45-degree angle in the weather barrier at opening head to expose 8 inches of sheathing. Temporarily secure weather barrier flap away from sheathing with tape.

3.5 FLEXIBLE FLASHINGS

- A. Cut wide DuPont FlexWrap a minimum of 4 inches wider than stud depth and 12 inches longer than length of sill rough opening.
- B. Cover horizontal sill by aligning DuPont FlexWrap edge with inside edge of sill. Adhere to rough opening across sill and up jambs a minimum of 6 inches. Secure flashing tightly into corners by working in along the sill before adhering up the jambs.
- C. Fan DuPont FlexWrap at bottom corners onto face of wall. Firmly press in place. Mechanically fasten fanned edges.
- D. Apply 9 inch wide strips of DuPont StraightFlash at jambs. Align flashing with interior edge of jamb framing. Start StraightFlash at head of opening and lap sill flexible flashing by at least 2 inches. StraightFlash shall extend 2 inches to 3 inches onto face of wall. Where stud depth is greater than 6 inches, apply a second strip of StraightFlash so that the jamb flashing extends 2 inches to 3 inches onto face of wall.
- E. Spray-apply primer to top 6 inches of jambs and exposed sheathing.
- F. Install DuPont FlexWrap at opening head using same installation procedures used at sill. Overlap jamb flashing a minimum of 2 inches.
- G. Coordinate flashing with window, door, and louver installation.
- H. On exterior, install backer-rod in joint between window, door, and louver frames and flashed rough framing. Apply sealant at jambs and head, leaving sill unsealed. Apply sealants in accordance with sealant manufacturer's instructions and ASTM C1193.
- I. Position weather barrier head flap across head flashing. Adhere using 4 inch wide DuPont StraightFlash over the 45-degree seams.
- J. Tape top of opening in accordance with manufacturer recommendations.
- K. On interior, install backer rod in joint between frame of windows, doors, and louvers, and flashed rough framing. Apply sealant around entire opening to create air seal. Apply sealant in accordance with sealant manufacturer's instructions and ASTM C1193.

3.6 FIELD QUALITY CONTROL

- A. Notify manufacturer's designated representative to obtain required periodic observations of weather barrier assembly installation.

3.7 PROTECTION

- A. Protect installed weather barrier from damage.
- B. Weather barrier shall be covered with exterior cladding materials prior to manufacturer's recommended maximum exposure time.

END OF SECTION

SECTION 07 26 50
VAPOR EMISSION CONTROL SYSTEM

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Vapor emission control system for application over concrete slabs indicated to receive finished floor coverings.

1.2 RELATED SECTIONS

- A. Section 03 30 00 – Cast-In-Place Concrete.
- B. Section 09 65 00 – Resilient Flooring.

1.3 REFERENCES

- A. The publications listed below form a part of this Section to the extent referenced. The publications are referred to in the text by the basic designation only. Refer to Division 01 for definitions, acronyms, and abbreviations.
- B. Standards, manuals, and codes refer to the latest edition of such standards, manuals, and codes in effect as of the date of issue of this Project Manual, unless indicated otherwise in CBC Chapter 35 and CFC Chapter 80.
- C. Referenced Standards:
 - 1. ASTM D1308 – Standard Test Method for Effect of Household Chemicals on Clear and Pigmented Organic Finishes.
 - 2. ASTM E96 – Standard Test Methods for Water Vapor Transmission of Materials, Wet Method net perm rate (grains h-1 ft-2 in Hg-1).
 - 3. ASTM F710 – Standard Practice for Preparing Concrete Floors to Receive Resilient Flooring.
 - 4. ASTM F2170 – Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs Using in situ Probes.
 - 5. ASTM F3010 – Standard Practice for Two-Component Resin Based Membrane-Forming Moisture Mitigation Systems for Use Under Resilient Floor Coverings.

1.4 SUBMITTALS

- A. General: Submit under provisions of Division 01.
- B. Submittal Requirements: Submit product data, independent third party testing laboratory test reports, certificates, and manufacturer's standard warranty.
- C. Submit concrete slab relative humidity and pH test results, performed and certified by a qualified independent testing agency.

- D. Submit manufacturer's Certificate of Conformance stating that, per independent third party testing laboratory verification, the System installed on this project meets or exceeds all aspects of the standards set forth in ASTM F3010. Certificate shall be on manufacturer's letterhead and shall be signed by manufacturer.

1.5 DEFINITIONS

- A. The System: Vapor emission control system specified in this Section referred to as "System" or "the System" in this Section for brevity.

1.6 QUALITY ASSURANCE

A. Qualifications:

1. Installer Qualifications:

- a. Installer shall be either manufacturer's trained personnel; or manufacturer's factory-trained and certified installer.
- b. Installer shall have a minimum of five years' experience in the installation of specified vapor emission control system and shall have worked on a minimum of five installations using the same system.

2. Manufacturer Qualifications:

- a. Minimum ten years' experience in manufacturing water vapor emission control systems, specifically formulated and used for reducing water vapor emissions, and alkalinity control in concrete slabs, without change of system formulation for a minimum period of five years at the time of application.
- b. Experience in product application in similar projects requiring vapor emission control at new and existing concrete slabs.
 - 1) Similar projects shall have documented success of system being installed at in-situ relative humidity of 98 percent or greater, when tested according to ASTM F2170.
- c. Manufacturer shall provide independent laboratory test reports documenting performance of the System as follows:
 - 1) Water Vapor Transmission (Water Method), ASTM E96: Performance of the System shall be documented by an independent testing laboratory. Test net perm rate results shall not exceed 0.11 grains h-1 ft-2 in Hg-1.
 - 2) Alkalinity Test, ASTM D1308: Insensitivity to alkaline environment up to pH 14 in a 14-day test with no effect or degradation of sample.
- 3. Testing Agency Qualifications: Qualified and experienced independent testing agency or International Concrete Repair Institute (ICRI) accredited individual to perform relative humidity (RH) and pH tests, as specified in this Section.
- 4. System Qualifications: The System shall meet or exceed all aspects of the standards set forth in ASTM F3010.

- B. Environmental Requirements: The System shall meet applicable VOC requirements of authorities having jurisdiction at Project site.

1.7 DELIVERY, STORAGE AND HANDLING

- A. Deliver products to the job site in manufacturer's original unopened containers, clearly labeled with the manufacturer's name and brand designation.

- B. Store products in a ventilated dry area, protected from dampness, freezing, and direct sunlight. Products shall not be stored in areas with temperatures in excess of 90 degrees F or below 50 degrees F, or with humidity in excess of 80 percent.

1.8 SITE CONDITIONS

- A. Concrete Curing: The System shall be capable of being successfully installed on new concrete with a minimum curing period of seven days.
- B. Enclosures and Environmental Limitations:
 - 1. Prior to testing concrete slabs for vapor emission rates, building shall be fully enclosed, and weather-tight. Interior wet work shall be completed and nominally dry, and work above ceilings completed. Test sites shall be maintained at the same temperature and humidity expected during normal building use.
 - 2. Concrete slabs shall be fully protected, with no water accumulation on the surface.
 - 3. Do not apply the System when ambient temperature is lower than 50 degrees F or higher than 90 degrees F, or expected to fall below 50 degrees F or rise above 90 degrees F within 24 hours of the System application, or when ambient humidity level is above 80 percent. In addition, the surface temperature of the concrete shall be a minimum of 5 degrees F removed from dewpoint and rising.

1.9 WARRANTY

- A. Provide manufacturer's written warranty for the System, covering system materials, testing, surface preparation, and installation. Additionally, warranty shall cover the cost of cementitious underlayment and floor covering repair or replacement, as acceptable to Owner and Architect, including, but not limited to, removal work, surface preparation, underlayment, floor covering materials, primers, adhesives, and associated installation work.
 - 1. Warranty Period: Fifteen years, minimum, or the life of finished floor covering, whichever comes first.
 - 2. Replacement Cost: In the event of failure of the System during warranty period, manufacturer's warranty shall cover all costs for removal and replacement work including the System and floor covering, up to \$5,000,000 per occurrence.
- B. Manufacturer's warranty exclusion shall be limited to the following:
 - 1. System failure due to topical intrusion of water due to plumbing failure, or other substances entering from the surface.
 - 2. Seismic damage occurring after installation.
 - 3. Water intrusion including, but not limited to, plumbing or flooding leaks below the slab.
 - 4. Damage due to removal and demolition work necessitated by replacement of installed floor covering during warranty period.
- C. Warranty shall not exclude cracks visible at the time of installation or improper System installation.

PART 2 PRODUCTS

2.1 MANUFACTURERS AND PRODUCTS

- A. Vapor Emission Control System:

1. Acceptable Manufacturers and Products:

- a. Koster American Corporation, Virginia Beach, VA; 757-425-1206; www.koesterusa.com. Products:
 - 1) Vap I 2000 Zero VOC.
 - 2) LevelStrong SLU Self Leveling Underlayment.
 - 3) SC skim coat finish.
 - 4) Vap I 06 Primer.
- b. Ardex Engineered Cements, Aliquippa, PA; 724-203-5000; www.ardex.com. Products:
 - 1) MC Rapid.
 - 2) Ardex cementitious underlayment products.
- c. Substitutions: Under provisions of Division 01.

B. Relative Humidity and pH Testing Supplies:

- 1. Provide digital RH meter by one of the following or accepted equal:
 - a. Rapid RH 4.0 Easy Reader with Smart Sensors by Wagner Electronics, Rogue River, OR; 800-634-9961, www.wagnermeters.com.
 - b. Hygromaster with HygroStik by GE Sensing, Goleta, CA; 800-472-6075, www.gesensing.com.
 - c. TotalCheck RH Tester by Delmhorst Instrument Co., Towaco, NJ; 877-335-6467, www.delmhorst.com.
 - d. Digital RH Meter: Relative Humidity Meter with probes and sleeves by American Moisture Test, Tustin, CA; 866-670-9700, americanmoisturetest.com.
- 2. Provide digital pH meter by one of the following or accepted equal:
 - a. Model PH100 ExStik® pH Meter by Extech Instruments Corporation, Nashua, NH; 877-239-8324, www.extech.com.
 - b. Model #PH100 by Taylor Tools, Denver, CO; 303-371-7667, www.taylorertools.com.
 - c. AMT Concrete Digital Alkalinity-pH Meter by American Moisture Test, Tustin, CA; 866-670-9700, americanmoisturetest.com.
- 3. Substitutions: Under provisions of Division 01.

2.2 SYSTEM DESCRIPTION

- A. General: Vapor emission control system shall be warranted to control concrete slab relative humidity up to 100 percent as determined by:
 - 1. Site conditions.
 - 2. Concrete mix design.
 - 3. Age of concrete substrate.
 - 4. Relative humidity in the concrete slab.
 - 5. pH test results.
 - 6. Compatibility with finished floor covering products.

- B. System Performance: Installed system shall bring pH levels within the range of 8-9, as determined by pH testing, in one or two coats at all areas indicated to receive a finished floor covering.
 - 1. Water Vapor Transmission: ASTM E96 (Water Method); performance of the System shall be documented by an independent testing laboratory. Net perm rate results shall not exceed 0.11 grains h-1 ft-2 in Hg-1.
 - 2. Relative Humidity Testing: ASTM F2170; the System shall perform as specified with relative humidity test results of 100 percent or less.
 - 3. Alkaline Exposure Testing: ASTM D1308; insensitivity to alkaline environment up to pH 14 in a 14-day test.
 - 4. Certified acceptance of exposure to continuous topical water exposure after final curing of the System.
 - 5. Vapor emission control system shall be applied in one or two coats as required for full performance of System, and shall include a cementitious underlayment over the System for subsequent adhesion of floor covering.
- C. System Materials: Two-component epoxy resin system, 100 percent solids, zero VOCs, containing specifically formulated chemicals and resins to provide the characteristics and properties specified in this Section. Epoxy systems containing water are not allowed.
- D. Accessories: Concrete repair materials, underlayment, and primers used in conjunction with vapor emission control system shall be as recommended by or acceptable to the System manufacturer. Underlayment used over the System shall be acceptable to vapor emission control system, flooring adhesive, and floor covering manufacturers. Underlayment shall attain minimum 5,000 psi compressive strength at 28 days.

2.3 MIXING

- A. Use clean containers and mix System components thoroughly, in accordance with manufacturer's printed instructions, to obtain a homogeneous mixture.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine substrates, with Installer present, for compliance with requirements and for other conditions affecting performance of the System.
- B. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance.
- C. Do not begin installation of the System until minimum seven day concrete curing and drying period has passed, after unsatisfactory conditions have been corrected, and after surfaces are dry.

3.2 CONCRETE SLAB TESTING

- A. Testing Schedule: Testing shall be performed prior to application of the System.
 - 1. Conduct tests at the same temperature and humidity expected during normal facility use. If this is not possible, the test conditions shall be 75 degrees F $\pm$ 10 degrees F and 50 percent $\pm$ 10 percent relative humidity. Maintain these conditions 48 hours prior to and during tests.

2. All relative humidity and pH test results shall be distributed to Contractor, Architect, and Owner.
- B. Pre-Installation Testing: Perform pre-installation testing of concrete slab using relative humidity and pH tests prior to surface preparation for application of the System. Testing shall be performed by ICRI certified independent testing personnel and testing agency.
- C. Installation contractor shall submit pre-installation checklist to the System manufacturer and written confirmation that the warranty will be enforced prior to beginning installation.
 1. Concrete Testing: At new concrete slabs, confirm that proposed concrete curing methods are acceptable to System manufacturer prior to beginning curing procedures. Silicate based curing compounds are not allowed.
 2. Relative Humidity Testing: Perform tests for relative humidity in the concrete slab per ASTM F2170. Perform three tests for the first 1,000 square feet and one test for each 1,000 square feet thereafter.
 3. pH Testing: Perform three pH tests for the first 1,000 square feet and one test for each 1,000 square feet thereafter.
- D. Post-Installation Testing:
 1. After the System is installed, Owner may engage a testing agency to perform additional testing at Owner's cost before installation of floor covering. Coordinate and schedule testing work with Owner's testing agency. Number of tests shall be determined by the testing agency. Provide testing surfaces as required by Owner's testing agency using ASTM E96 wet method test for net perms (grains h-1 ft-2 in Hg-1).
 - a. Test floors for moisture by using the test method described in ASTM E96. Results shall be submitted to Architect for evaluation. When test results are above the allowable moisture emission specified for the intended floor covering materials, resolve the condition prior to installation of floor covering. Environment of all tests shall be the same during testing.
 2. Adhesion Test: Perform adhesion compatibility test for flooring adhesives, coatings, and leveling compounds over completed vapor emission control system, as acceptable to Architect and Owner. Document and submit all adhesion test results to Architect and Owner.

3.3 PREPARATION

- A. Prior to installation of System, all walls shall be masked or otherwise protected from the effects of scarification and System application.
- B. Clean and prepare substrates according to the System manufacturer's written recommendations to produce clean, dust-free, dry substrate for the System application.
- C. Remove silicate based floor hardeners or curing compounds from concrete slabs as recommended by the System manufacturer.
- D. Remove defective materials, and foreign matter, such as, dust, adhesives, paint, dirt, floor hardeners, bond breakers, oil, grease, curing agents, form release agents, efflorescence, and laitance.
- E. Cracks, control joints, and cold joints shall be prepared and treated in accordance with the System manufacturer's recommendations.

- F. Clean and fill chips, voids and other surface irregularities with water resistant repair materials as recommended by System manufacturer.
- G. Acid etching is not permitted.
- H. Shot blast concrete surface to profile recommended by System manufacturer to ensure bonding of the System to concrete.
- I. Concrete slabs to receive finished floor coverings shall conform to applicable requirements of ASTM F710.
- J. Before application of the System, prepared surfaces shall be inspected by and acceptable to the System manufacturer's technical representative.

3.4 INSTALLATION

- A. Install vapor emission control system in strict accordance with manufacturer's written instructions.
- B. A leveling or trowel grade cementitious underlayment is required over completed vapor emission control system. Apply appropriate primer to the cured vapor emission control system, as recommended by the System manufacturer. Underlayment shall have adequate thickness to absorb any residual water from the flooring adhesive; thickness as recommended by the flooring/adhesive manufacturer.

3.5 FIELD QUALITY CONTROL

- A. Any product testing to verify conformance to manufacturer's specifications shall be performed by taking unopened containers of product to an independent laboratory, with testing performed in accordance with the methods provided in manufacturer's technical literature.

3.6 CLEANING

- A. Remove all debris resulting from the System installation from Project site.

3.7 PROTECTION

- A. Protect installed vapor emission control system during curing period and prior to finished flooring installation from traffic, topical water, and surface contaminants.

END OF SECTION

SECTION 07 41 00
METAL SOFFIT PANELS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Preformed, vented, prefinished metal soffit panel system.
- B. All trim, flashings, closures, fasteners, sealants, and other accessory items.

1.2 RELATED SECTIONS

- A. Section 06 10 00 – Rough Carpentry.
- B. Section 07 60 00 – Flashing and Sheet Metal.
- C. Section 07 92 00 – Joint Sealants.

1.3 REFERENCES

- A. The publications listed below form a part of this Section to the extent referenced. The publications are referred to in the text by the basic designation only. Refer to Division 01 for definitions, acronyms, and abbreviations.
- B. Standards, manuals, and codes refer to the latest edition of such standards, manuals, and codes in effect as of the date of issue of this Project Manual, unless indicated otherwise in CBC Chapter 35 and CFC Chapter 80.
- C. Referenced Standards:
 - 1. ASTM A653/A653M – Standard Specification for Steel Sheet, Zinc-coated (Galvanized) or Zinc-Iron Alloy (Galvannealed) by the Hot Dip Process.
 - 2. ASTM A792/A792M – Standard Specification for Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process.
 - 3. ASTM D1005 – Standard Test Method for Measurement of Dry-Film Thickness of Organic Coatings Using Micrometers.

1.4 SUBMITTALS

- A. Submit under provisions of Division 01.
- B. Metal Soffit Panels:
 - 1. Shop Drawings: Clearly show all pieces with all pertinent dimensions, layout, joints, expansion joints, construction details, methods of anchorage to support structure, flashings and trim, and interface with adjacent materials.
- C. Manufacturer's Data: Manufacturer's descriptive data and specifications; include recommended installation and maintenance procedures.
- D. Samples: Three 12 inch x 12 inch samples of each material, finish, and color specified.
- E. Certificates: Manufacturer's certificates that materials meet specification requirements.

1.5 PERFORMANCE REQUIREMENTS

- A. Movement: Accommodate movement within systems without damage to components or deterioration of seals, movement within system, movement between system and perimeter components when subject to seasonal temperature cycling, dynamic loading and release of loads, and deflection of structural support framing.
- B. Drainage: Provide positive drainage to exterior for moisture entering or condensation occurring within panel systems.
- C. Thermal: Provide continuity of thermal barrier at building closure elements in conjunction with thermal insulating materials.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: Installation shall be by experienced mechanics directly employed by metal soffit panel manufacturer or by erector currently licensed or franchised by panel manufacturer to erect projects of similar or greater complexity.

1.7 DELIVERY, STORAGE AND HANDLING

- A. Deliver, store, protect and handle products under provisions of Division 01.
- B. Provide adequate protection so material is not exposed to weather or moisture prior to erection.
- C. Units of panels that become deformed or damaged from any cause whatsoever, to the extent that they are weakened or unsuitable for use as part of the finish surface, shall be replaced unless they can be repaired to the satisfaction of Architect.
- D. Protect panels from accelerated weathering by removing or venting sheet plastic shipping wrap.
- E. Store pre-finished material off the ground, protected from weather to prevent twisting, bending or abrasion, and to provide ventilation. Slope metal sheets to ensure drainage.
- F. Prevent contact with dissimilar materials capable of causing corrosion, discoloration, or staining.

1.8 WARRANTIES

- A. Immediately upon acceptance of metal panel work at the time of Final Project Completion, the Contractor, metal panel installer and metal panel manufacturer shall execute and deliver to Owner, the following Guarantees/Warranties:
 - 1. Twenty year unlimited Penal Sum Warrantee for material failure and finish failure (cracking, checking, blistering, peeling, flaking, chipping, chalking, and fading) by metal panel manufacturer for all panel systems specified in this Section.
 - 2. Two year watertightness Guarantee/Warrantee by Contractor and Metal Panel Installer warranting panels, flashings, sealants, fasteners and accessories against defective materials and workmanship, to remain watertight and weatherproof:
 - a. Emergency repairs shall be made within 24 hours' notice by Owner of leakage or defect. As soon as weather permits, affected areas shall be permanently restored to standards of quality, i.e. workmanship, durability and appearance called for in the Contract Documents. Emergency repairs shall be made without any charge to the

Owner. The value of this Agreement shall not be limited to a specific maximum sum. Owner maintenance shall not be required as a condition to continuation of this Agreement in force for two years.

- b. Excluded from this Agreement are leaks or defects caused by abuse, vandalism, extraordinary building movement, fire or other casualty. This agreement binds the undersigned and any of their agents, successors, legal representatives or assigns during the life of the Agreement.
- B. Warranty includes removal, replacement, repair, and making good without cost to the Owner, of defects due to defective materials or workmanship.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers:

1. AEP Span, West Sacramento, CA; 800-733-4955, www.aepspan.com. Product: Prestige Series No Reveal, Flat Pan.
2. MBCI, Atwater, CA; 800-829-9324, www.mbc.com.
3. Carlisle Metal Products, Carlisle, PA; 800-479-6832, www.carlislemetalproducts.com.
4. Metal Sales Manufacturing Corporation, Louisville, KY; 800-406-7387, www.metalsales.us.com.
5. Morin, a Kingspan Group Company, Bristol, CT; 800-640-9501, www.morincorp.com.
6. Firestone Metal Products LLC, Anoka, MN; 800-426-7737, www.firestonemetal.com.

B. Substitutions: Under provisions of Division 01.

2.2 SOFFIT PANEL SYSTEM

- A. Pre-finished panels shall be fabricated of 22 gauge galvanized steel in full lengths as shown on the Drawings. Panels shall have a depth of 1-1/2 inches and have 12 inches net coverage. Individual panels shall be removable for replacement of damaged material.

1. Vented Panels: Perforation pattern with 13.8 percent open area.

2.3 SOFFIT PANEL MATERIALS

- A. Base metal shall be 22 gauge steel with 1.9 mil thick Zinalume protective coating conforming to ASTM A792.
- B. Flashings, trims, reveals, and all other items, unless otherwise indicated on the Drawings, shall be pre-finished to match soffit panels and shall be furnished and installed hereunder. All items shall conform to ASTM A792, 24 gauge, unless indicated otherwise.
- C. Fasteners, clips, etc., shall be corrosion-resistant type as recommended by the manufacturer to provide a complete concealed anchorage system and to ensure a water and weatherproof installation.
1. All exposed fasteners shall have neoprene washers.

2.4 FABRICATION

- A. Form sections to configuration indicated on the Drawings, accurate in size, square, and free from distortion or defects.
- B. Form pieces in longest practical lengths.

2.5 FINISH

- A. Factory Finish:
 - 1. Exposed Face: Dura Tech 5000 Polyvinylidene Fluoride (PVDF) paint system consisting of a baked-on 0.2 mil thick corrosion-resistant primer and a baked-on 0.8 mil thick finish coat containing 70 percent Kynar 500/Hylar 5000 resins for total coating of 1.0 mil dry film thickness.
 - 2. Concealed Face: Corrosion-resistant primer coat with 0.15 mils dry film thickness and finish coat of polyester paint with 0.35 mils dry film thickness for total coating of 0.50 mil dry film thickness.
 - 3. All dry film thickness measurements shall be in accordance with ASTM D1005.
- B. Color as indicated on Drawings.

2.6 SEALANTS

- A. As recommended by the manufacturer and complying with the requirements of Section 07 92 00.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify supporting substrate surfaces are ready to receive panel system. Surfaces in contact with panels shall be free from debris or objects that may damage panels.
- B. Do not proceed with installation until all conditions are satisfactory.

3.2 INSTALLATION

- A. Workmanship: All work shall be neat, trim, true to line and, upon completion, shall present a true finished surface of the specified profile, free of dents, deformations, creases or other noticeable defects.
 - 1. The completed installation shall provide an installation with all seams aligned and straight.
- B. Installation of soffit panel anchorage and all accessories shall be in strict accordance with manufacturer's standard instructions and approved shop drawings.
 - 1. Remove any strippable protective coating on the panels and flashings prior to installation and in any case do not allow the strippable coating to remain on the panels in extreme heat, cold or in direct sunlight or other UV source.
 - 2. Panels shall be attached to substrate with clips and fasteners as indicated on approved shop drawings.
 - 3. Sheets shall be installed with approved side lap.

4. Flashings and trim pieces shall be attached with mechanical fasteners and sealant as per manufacturer's recommendations or as indicated on the Drawings.
5. There shall be no perforation of the panels except as required for anchoring and installation of trim members. Exposed fasteners shall be stainless steel. Screws shall have hot bonded neoprene washers.

3.3 ERECTION TOLERANCES

- A. Maximum offset from indicated alignment between adjacent members butting or in line: 1/16 inch, non-cumulative.
- B. Maximum variation from plane or location indicated on the Drawings: 1/4 inch.

3.4 ADJUST AND CLEAN

- A. Cleaning and Finishing: Upon completion of the work clean all exposed surfaces with mild soap and water, removing any discoloration or foreign matter. Touch up all abraded or cut areas and exposed edges with finishing material recommended by the manufacturer. Touch-up shall not be obvious.
- B. Defective Work: Remove and replace any defective work which cannot be properly repaired, cleaned or touched up, as directed by the Architect, with no additional cost to the Owner.
- C. Protect all installed work against damage from other construction work.

3.5 CLEAN-UP

- A. Upon completion of the work of this Section, remove all surplus materials, rubbish and debris from the premises.

END OF SECTION

SECTION 07 41 13
METAL ROOF PANELS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Preformed metal roofing panels, standing seam.
- B. Preformed metal roofing panels, corrugated.
- C. Gutters, rain water leaders, and downspouts.
- D. Flashings, trim, closures, fasteners, sealants, and other accessory items.
- E. Insulation.

1.2 RELATED SECTIONS

- A. Section 06 10 00 – Rough Carpentry.
- B. Section 07 62 00 – Sheet Metal Flashing and Trim.
- C. Section 07 92 00 – Joint Sealants.
- D. Section 08 62 23 – Tubular Skylights.

1.3 REFERENCES

- A. The publications listed below form a part of this Section to the extent referenced. The publications are referred to in the text by the basic designation only. Refer to Division 01 for definitions, acronyms, and abbreviations.
- B. Standards, manuals, and codes refer to the latest edition of such standards, manuals, and codes in effect as of the date of issue of this Project Manual, unless indicated otherwise in CBC Chapter 35 and CFC Chapter 80.
- C. Referenced Standards:
 - 1. ASTM A792/A792M – Standard Specification for Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process.
 - 2. ASTM A924/A924M – Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot Dip Process.
 - 3. ASTM C1289 – Standard Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board.
 - 4. ASTM C1371 – Standard Test Method for Determination of Emittance of Materials Near Room Temperature Using Portable Emissometers.
 - 5. ASTM C1549 – Standard Test Method for Determination of Solar Reflectance Near Ambient Temperature Using a Portable Solar Reflectometer.
 - 6. ASTM D226 – Standard Specification for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing.

7. ASTM D1056	– Standard Specification for Flexible Cellular Materials – Sponge or Expanded Rubber.
8. ASTM D1970	– Standard Specification for Self-Adhering Polymer Modified Bituminous Sheet Materials Used as Steep Roofing Underlayment for Ice Dam Protection.
9. ASTM E84	– Standard Test Method for Surface Burning Characteristics of Building Materials.
10. ASTM E96	– Standard Test Methods for Water Vapor Transmission of Materials.
11. ASTM E108	– Standard Test Methods for Fire Tests of Roof Coverings.
12. ASTM E408	– Standard Test Method for Total Normal Emittance of Surfaces Using Inspection-Meter Techniques.
13. ASTM E1918	– Standard Test Method for Measuring Solar Reflectance of Horizontal and Low-sloped Surfaces in the Field.
14. CAN/ULC S770	– Test Method for Determination of Long-Term Thermal Resistance of Closed-Cell Thermal Insulating Foams.

1.4 SUBMITTALS

- A. Submit under provisions of Division 01.
- B. Shop Drawings: Indicate layout including dimensions, sizes, and components. Show details of anchoring, closure, clips, trims, and accessories. Include layouts of roof panels, details of edge and penetration conditions, spacing and type of connections, flashings, underlayments, and special conditions. Show interface with adjacent surfaces.
- C. Product Data: Submit product data for each product specified in this Section with the product and selected attributes clearly identified.
- D. Samples: Submit two 12 inch by 12 inch panel samples for each material, finish, and color specified.
 - 1. Physical sample requirements shall be waived if the Basis-of-Design product is submitted.

1.5 PERFORMANCE REQUIREMENTS

- A. Movement: Accommodate movement within roof panel system including perimeter components without damage to components or deterioration of seals when subjected to seasonal temperature cycles, dynamic loading and release of loads, and deflection of structural support framing.
- B. Drainage: Provide positive drainage to exterior for moisture entering or condensation occurring within panel systems.
- C. Thermal: Provide continuity of thermal barrier at building closure elements in conjunction with thermal insulating materials.

1.6 SUSTAINABLE BUILDING DESIGN REQUIREMENTS

- A. Provide highly reflective Energy Star® compliant roofing system with emissivity of at least 0.9 when tested in accordance with ASTM E408 for a minimum of 75 percent of the roof surface.

1. Thermal emissivity shall be measured in accordance with ASTM C1371.
 2. Solar Reflectivity shall be measured in accordance with ASTM C1549.
 3. Solar Reflectance Index shall be measured in accordance with ASTM E1918.
- B. Provide insulation products manufactured free from environment-harmful blowing agents chlorofluorocarbon (CFC) and hydrochlorofluorocarbon (HCFC).

1.7 QUALITY ASSURANCE

A. Qualifications:

1. Manufacturer Qualifications: Firm specializing in manufacturing products specified in this Section with a minimum ten years' experience.
2. Installer Qualifications: Firm specializing in installing work specified in this Section directly employed by manufacturer or acceptable to manufacturer with experience on at least five projects of similar nature in past three years.

B. Requirements of Regulatory Agencies:

1. Metal roofing systems shall be Class A per CBC Section 1505.
2. Metal roofing systems shall meet or exceed the wind uplift requirements for the location of the installation as per CBC.
3. Metal roofing systems installed on this project shall have a current and valid ICC ES Evaluation Report.

C. Pre-Installation Meetings:

1. Conduct pre-installation meeting in accordance with provisions of Division 01.
2. Convene pre-installation meeting one week prior to commencing work of this Section.
3. Coordinate work in this Section with work in related Sections.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect and handle products under provisions of Division 01.

- B. Provide adequate protection so material is not exposed to weather or moisture prior to erection.
- C. Units of panels that become deformed or damaged from any cause whatsoever, to the extent that they are weakened or unsuitable for use as part of the finish surface, shall be replaced unless they can be repaired to the satisfaction of Architect.
- D. Protect panels from accelerated weathering by removing or venting sheet plastic shipping wrap.
- E. Store pre-finished material off the ground, protected from weather to prevent twisting, bending or abrasion, and to provide ventilation. Slope metal sheets to ensure drainage.
- F. Prevent contact with materials capable of causing discoloration or staining.

1.9 WARRANTIES

- A. Immediately upon acceptance of roofing work at the time of Final Project Completion, the Contractor, metal panel installer and metal panel manufacturer shall execute and deliver to Owner, the following Guarantees/Warrantees:
1. Twenty year unlimited Penal Sum Warrantee for material failure and finish failure (cracking, checking, blistering, peeling, flaking, chipping, chalking, and fading) by metal panel manufacturer for all panel systems specified in this Section.
 2. Two year watertightness Guarantee/Warrantee by Contractor and Metal Panel Installer warranting panels, flashings, sealants, fasteners and accessories against defective materials and workmanship, to remain watertight and weatherproof:
 - a. Emergency repairs shall be made within 24 hours notice by Owner of leakage or defect. As soon as weather permits, affected areas shall be permanently restored to standards of quality, i.e. workmanship, durability and appearance called for in the Contract Documents. Emergency repairs shall be made without any charge to the Owner. The value of this Agreement shall not be limited to a specific maximum sum. Owner maintenance shall not be required as a condition to continuation of this Agreement in force for two years.
 - b. Excluded from this Agreement are leaks or defects caused by abuse, vandalism, extraordinary roof deck movement, fire or other casualty.
 3. Twenty year watertightness Guarantee/Warranty by metal panel manufacturer for all panel systems specified in this Section.
 - a. Emergency repairs shall be made within 24 hours notice by Owner of leakage or defect. As soon as weather permits, affected areas shall be permanently restored to standards of quality, i.e. workmanship, durability and appearance called for in the Contract Documents. Emergency repairs shall be made without any charge to the Owner. The value of this Agreement shall not be limited to a specific maximum sum.
 - b. This watertightness warranty does not apply where panels fastened with exposed fasteners are installed.
- B. Warranty includes removal, replacement, repair, and making good without cost to the Owner, of defects due to defective materials or workmanship.

PART 2 PRODUCTS

2.1 MANUFACTURERS AND PRODUCTS

- A. Acceptable Manufacturers:
1. Basis of Design: AEP Span, West Sacramento, CA; 800-733-4955, www.aepspan.com. Products:
 - a. SpanSeam roof panels at main building.
 - b. Nu-Wave Corrugated at exterior awnings and canopies.
 - c. Underlayment HT.
 2. MBCI, Atwater, CA; 800-829-9324, www.mbc.com.
 3. Carlisle Metal Products, Carlisle, PA; 800-479-6832, www.carlislemetalproducts.com.
 4. Metal Sales Manufacturing Corporation, Louisville, KY; 800-406-7387, www.metalsales.us.com.

5. Morin, a Kingspan Group Company, Bristol, CT; 800-640-9501, www.morincorp.com.
6. Firestone Metal Products LLC, Anoka, MN; 800-426-7737, www.firestonemetal.com.
7. Taylor Metal Products, Salem, OR; 800-574-1388, www.taylormetal.com.

B. Substitutions: Under provisions of Division 01.

2.2 STANDING SEAM METAL ROOF PANELS

- A. Metal Standing Seam Roofing System: Pre-finished, 16 inch coverage; 2 inch tall standing seam; concealed anchors that resist wind uplift yet permits expansion and contraction with temperature changes.
- B. Base Metal: 22 gauge steel sheet, aluminum-zinc alloy coated by hot-dipped process conforming to ASTM A792/A792M and ASTM A924/A924M, minimum AZ50 coating, minimum yield strength of 40 ksi.

2.3 CORRUGATED METAL ROOF PANELS

- A. Metal Standing Seam Roofing System: Pre-finished, 32 inch net coverage, 7/8 inch deep with corrugations at 2-2/3 inches on center; exposed anchors that resist wind uplift yet permits expansion and contraction with temperature changes.
- B. Base Metal: 22 gauge steel sheet, aluminum-zinc alloy coated by hot-dipped process conforming to ASTM A792/A792M and ASTM A924/A924M, minimum AZ50 coating, minimum yield strength of 40 ksi.

2.4 ACCESSORIES AND RELATED MATERIALS

- A. Fasteners, Clips, Cleats, Thermal Spacer, Flat Bearing Plate: Corrosion-resistant type as provided by manufacturer to complete a concealed anchorage system and to ensure a water and weatherproof installation. Fasten clips over flat bearing plates over rigid insulation. Exposed gutter rivets shall be finished to match roofing material.
- B. Closures: Metal or black closed cell pre-molded neoprene or polyethylene foam meeting ASTM D1056 grade SCE-41 Black EPT.
- C. Flashings, Trims, Gutters, Rain Water Leaders, and Downspouts: Same gauge, material and finish as metal roof. Profile as shown on Drawings.
- D. Downspout Strainer: Wire strainer, same basic material as gutter.
- E. Rigid Insulation: Closed-cell polyisocyanurate foam core integrally laminated to heavy black (non-asphaltic), fiber-reinforced felt facers with square edges; conforming to ASTM C1289, Type II, Class 1; Grade 2 (20 psi minimum compressive strength); surface burning characteristics: flame spread 25 to 50 and smoke developed 50 to 170 per ASTM E84; long-term thermal resistance (LTTR) value minimum 5.5 F·hr·SqFt / Btu / inch at 75 degrees F per CAN/ULC-S770; thickness as indicated on Drawings.
 1. Acceptable Products:
 - a. ACFoam-II by Atlas Roofing Corp., Atlanta, GA; 770-952-1442, www.atlasroofing.com.
 - b. Multi-Max FA-3 by Rmax, Inc., Dallas, TX; 800-527-0890, www.rmaxinc.com.
 - c. ISO 95+ by Firestone Building Products, Indianapolis, IN; 800-428-4442, www.firestonebpco.com.

- d. or accepted equal.
- F. Underlayment: High-tensile strength, SBS modified rubberized asphalt underlayment designed to withstand temperatures up to 250 degrees F without degradation of the adhesive.
 - 1. Surface: White engineered polyolefin composite film with factory-applied anti-skid coating.
 - 2. Thickness: 40 mils.
 - 3. Roll Width: 36 inches.
 - 4. Moisture Vapor Permeance: 0.02 perms per ASTM D1970.
 - 5. Meets or exceeds ASTM D1970.
 - 6. ASTM E108/UL 709 Class A fire resistance.
 - 7. 180-day UV exposure resistance from time of installation.
- G. Sealant: Type specified in Section 07 92 00.

2.5 FABRICATION

- A. Form sections to configuration indicated on Drawings, accurate in size, square and free from distortion or defects.
- B. Fabricate panel pieces in longest practicable lengths; one piece lengths wherever possible.
- C. Fabricate flashings, trim, gutters, rain water leaders, downspouts, and accessories in longest practical lengths.
- D. Sheet Metal Flashing and Trim: Form from materials matching metal panel substrate and finish, unless noted otherwise on Drawings. Fabricate flashing and trim to comply with manufacturer's written instructions, accepted shop drawings, project drawings, and as specified in Section 07 62 00.

2.6 FINISH

- A. Factory Finish:
 - 1. Exposed Face: DuraTech 5000 Polyvinylidene Fluoride (PVDF) paint system consisting of a baked-on 0.2 mil thick corrosion-resistant primer and a baked-on 0.8 mil thick finish coat containing 70 percent Kynar 500/Hylar 5000 resins for total coating of 1.0 mil dry film thickness.
 - 2. Concealed Face: Corrosion-resistant primer coat with 0.15 mils dry film thickness and finish coat of polyester paint with 0.35 mils dry film thickness for total coating of 0.50 mil dry film thickness.
 - 3. All dry film thickness measurements shall be in accordance with ASTM D1005.
- B. Color as indicated on Drawings, meeting "Cool Roof" requirements, with the following values:
 - 1. Solar Reflectance Index (SRI): 34.
 - 2. Light Reflectance Value: 11.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify supporting substrate surfaces are ready to receive panel system. Surfaces in contact with panels shall be free from debris or objects that may damage panels.
- B. Report unacceptable conditions to Architect. Begin installation only when unacceptable conditions have been corrected.

3.2 INSTALLATION

- A. Workmanship: All work shall be neat, trim, true to line and, upon completion, shall present a true finished surface of the specified profile, free of dents, deformations, creases or other noticeable defects.
- B. Protection:
 - 1. Treat, or isolate with protective material, any contacting surfaces of dissimilar materials to prevent electrolytic corrosion.
 - 2. Require workmen working on roofing panels to wear clean, soft-soled shoes that will not pick up stones or other abrasive material which could damage or discolor panel surface.
 - 3. Protect work of other trades from damage.
- C. Insulation Installation:
 - 1. Lay multiple layers of roof insulation to achieve thickness as indicated on Drawings in accordance with manufacturer's instructions. Stagger joints of layers.
 - 2. Lay boards with edges in moderate contact without forcing. Cut insulation to fit neatly to perimeter blocking and around penetrations through roof.
 - 3. Apply no more insulation than can be covered with roof panels in same day.
 - 4. Tape joints of insulation in accordance with insulation manufacturer's instructions.
- D. Underlayment Installation:
 - 1. Install underlayment in accordance with manufacturer's instructions. Beginning at the eaves, install underlayment from the low point to the high point of the roof, running the roll horizontally. The lap seam edges shall be hand-rolled to ensure maximum adhesion. Lap underlayment with all flashings in a shingle-like manner. Weatherlap horizontal and vertical edges a minimum of 6 inches. Continue underlayment 6 inches around inside and outside corners.
- E. Metal Roof Panel Installation:
 - 1. Install roofing anchorage and all accessories strictly in accordance with Current ICC ES Report, manufacturer's instructions, and approved shop drawings.
 - 2. Remove any strippable protective coating on the panels and flashings prior to installation and in any case do not allow the strippable coating to remain on the panels in extreme heat, cold or in direct sunlight or other UV source.
 - 3. Lap panels away from prevailing wind direction.

4. Attach panels to substrate with clips and fasteners. Set clips in bed of compatible weather barrier sealant over underlayment facer. Seal fastener heads with sealant. Secure panels without warp or deflection. Install to allow for thermal movement.
 - a. The length of all fasteners that extend through the wood decking shall be such that the end of the fastener is six threads or 1/2 inch past the bottom of the decking, whichever is longer.
 5. Install flashings to allow for thermal movement.
 6. Attach flashings and trim pieces with mechanical fasteners and sealant.
 7. Install all closures as indicated or required for a watertight installation.
 8. Perforations/punctures of roof panels are not permitted, except as required for anchoring and installation of trims and flashings.
- F. Gutters: Join sections with riveted and soldered joints. Attach gutters to eave with gutter hangers spaced not more than 36 inches on center using manufacturer's standard fasteners. Provide end closures and seal watertight with sealant. Provide for thermal expansion at least every 50 feet, and not more than 25 feet from rigid corners or intersections. Install expansion joint caps. Provide slope to drain at 1/16 inch per foot to gutter outlets connected to downspouts.
- G. Rain Water Leaders and Downspouts: Join sections with telescoping joints. Lap joints in direction of flow. Fasten using straps, anchors, and spacers as required. Provide fasteners designed to hold downspouts securely 1 inch away from walls; locate fasteners at top and bottom and at approximately 60 inches on center in between. Mechanically fasten gutter outlet connections in place and fully solder weathertight.

3.3 ERECTION TOLERANCES

- A. Maximum alignment variation: 1/4 inch in 40 feet.
- B. Maximum variation from plane or location indicated on the Drawings: 1/4 inch.

3.4 ADJUST AND CLEAN

- A. Cleaning and Finishing: Upon completion of the work clean all exposed surfaces with mild soap and water, removing any discoloration or foreign matter. Touch up all abraded or cut areas and exposed edges with finishing material recommended by the manufacturer. Touch-up shall not be noticeable when viewed from ten feet.
- B. Defective Work: Remove and replace any defective work which cannot be properly repaired, cleaned or touched up, as directed by Architect, with no cost to Owner.
- C. Protect all installed work against damage from other construction work.

3.5 CLEAN-UP

- A. Upon completion of the work of this Section, remove all surplus materials, rubbish and debris from the premises. Contractor shall thoroughly clean entire roof area at completion of project.

END OF SECTION

SECTION 07 46 46
MINERAL-FIBER CEMENT SIDING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Furnishing and installation of the following fiber-reinforced cement exterior products and accessories as shown on the Drawings and as specified herein:
 - 1. Board and Batten Siding.
 - 2. Soffit Panels.
 - 3. Trim.
 - 4. Related accessories and fasteners.

1.2 RELATED SECTIONS

- A. Section 06 10 00 – Rough Carpentry: Substrate surfaces.
- B. Section 07 25 00 – Weather Barriers: Building wrap and flexible flashings.
- C. Section 07 92 00 – Joint Sealants.
- D. Section 09 91 00 – Painting: Paint finish.

1.3 REFERENCES

- A. The publications listed below form a part of this Section to the extent referenced. The publications are referred to in the text by the basic designation only. Refer to Division 01 for definitions, acronyms, and abbreviations.
- B. Standards, manuals, and codes refer to the latest edition of such standards, manuals, and codes in effect as of the date of issue of this Project Manual, unless indicated otherwise in CBC Chapter 35 and CFC Chapter 80.
- C. Referenced Standards:
 - 1. ASTM C834 – Standard Specification for Latex Sealants.
 - 2. ASTM C920 – Standard Specification for Elastomeric Joint Sealants.
 - 3. ASTM C1186 – Standard Specification for Flat Fiber-Cement Sheets.
 - 4. ASTM E136 – Standard Test Method for Behavior of Materials in a Vertical Tube Furnace at 750 degrees C.

1.4 SUBMITTALS

- A. Submit under provisions of Division 01.
- B. Product Data: Submit product data for each product specified in this Section with the product and selected attributes clearly identified.

C. Samples: Submit two 12 inch by 12 inch panel samples for each material, finish, and color specified.

1. Physical sample requirements shall be waived if the Basis-of-Design product is submitted.

D. Submit manufacturer's installation instructions.

1.5 DELIVERY, STORAGE AND HANDLING

A. Fiber-cement siding and trim shall be laid flat on smooth, level surface. Edges and corners shall be protected from chipping. Store siding under cover and keep dry prior to installing.

B. Replacements: In the event of damage, immediately make all repairs and replacements necessary to the approval of the Architect and at no additional cost to the Owner.

1.6 WARRANTY

A. Warranty against material manufacturing defects as follows:

1. Board and Batten Siding: 30 years.

2. Soffit Panels: 25 years.

3. Trim: 15 years.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Basis of Design: James Hardie Building Products, Inc., HZ10 Products:

1. Siding: HardiePanel.

2. Battens: 4/4 HardieTrim.

3. Soffit Panels: HardieSoffit.

4. Trim: HardieTrim Boards.

B. Nichiha.

C. Substitutions: Under provisions of Division 01.

2.2 MATERIALS

A. All siding and trim materials shall be provided from a single manufacturer unless noted otherwise in this Section.

B. Non-asbestos fiber-cement siding shall comply with ASTM C1186 Grade II, Type A.

C. Fiber-cement siding shall be non-combustible when tested in accordance with ASTM E136.

2.3 SIDING PANELS

A. Vertical Siding: Fiber reinforced cement panel.

1. Surface Texture: Select Cedarmill.

2. Width: 4 feet.

3. Length: 8 feet, 9 feet or 10 feet.

4. Thickness: 5/16 inch.

2.4 SOFFIT SYSTEM

A. Soffit: Fiber reinforced cement soffit boards.

1. Non-Vented:

- a. Surface Texture: Cedarmill.
- b. Width: As indicated on Drawings.
- c. Length: 12 feet.
- d. Thickness: 1/4 inch.

2. Vented:

- a. Surface Texture: Cedarmill.
- b. Width: As indicated on Drawings.
- c. Length: 12 feet.
- d. Thickness: 1/4 inch.

B. Accessories: PVC splice H-moldings.

2.5 TRIM

A. Trim: Fiber reinforced cement.

- 1. Surface Texture: Rustic.
- 2. Width: 5-1/2 inches.
- 3. Length: 12 feet.
- 4. Thickness: 3/4 inch.

2.6 FINISH

A. Finish: PrimePlus factory applied sealer and primer.

B. Touch-Up Primer: Shall be same as factory applied primer.

C. Finish Painting System: Under provisions of Section 09 91 00.

2.7 ACCESSORIES

A. Building Wrap and Accessories: Refer to Section 07 25 00.

B. Fasteners: Stainless steel corrosion resistant fasteners. Types and sizes as recommended by manufacturer and as required by Code for each application. Box nails will not be allowed.

1. Siding Panels:

- a. Wood Framing: Face nail using 11 gauge roofing nails (0.121 inch shank x 0.371 inch HD x length as required for minimum 1-1/2 inch penetration into framing member) at 6 inches on center vertically at each stud.

2. Soffit Panels:

- a. Wood Framing: Face nail using 11 gauge roofing nails (0.121 inch shank x 0.371 inch HD x length as required for minimum 1-1/2 inch penetration into framing member) at 6 inches on center at edges and at 6 inches on center at each intermediate framing member.

3. Trim:

- a. Wood Framing: Face nail using two-11 gauge roofing nails (0.121 inch shank x 0.371 inch HD x length as required for minimum 1-1/2 inch penetration into framing member) at 12 inches on center vertically.

PART 3 EXECUTION

3.1 GENERAL

- A. Install all materials in accordance with manufacturer's instructions.
- B. Install all materials using manufacturer recommended and approved tools and accessories.

3.2 EXAMINATION

- A. Verify that substrate surfaces and wall openings are ready to receive work.

3.3 PREPARATION

- A. Prime all cut surfaces before installation.
- B. Touch-up interior and exterior factory pre-primed surfaces that are disfigured or damaged by installation and handling.

3.4 INSTALLATION – BUILDING WRAP

- A. Refer to Section 07 25 00.

3.5 INSTALLATION – SIDING PANELS

- A. Install vertical siding in accordance with manufacturer's instructions.
 1. Block framing between studs where the panel siding horizontal joints occur.
 2. Place fasteners no closer than 3/8 inch from panel edges and 2 inches from panel corners.
 3. Allow minimum 1 inch vertical clearance between roof and bottom edge of siding.
 4. Maintain clearance between siding and adjacent finished grade.
 5. Rotate planks to avoid textured pattern repeat.
- B. Touch-up pre-primed paint surfaces that are disfigured or damaged by installation.

3.6 INSTALLATION – SOFFIT PANELS

- A. Install soffit panels as detailed on Drawings and per manufacturer's recommendations.
 1. Do not overdrive fasteners. Fasteners shall be flush to the panel surface.
 2. Fasteners shall be installed a maximum of 8 inches on center at panel edges and at intermediated framing members.
 3. Fasteners shall be installed no closer than 3/8 inch from panel edges and 2 inches from panel corners.
 4. Fasteners shall penetrate wood framing members a minimum of 1 inch.
 5. Panel joints shall be in moderate contact.

6. All panel edges must be supported by framing.

B. Touch-up pre-primed paint surfaces that are disfigured or damaged by installation.

3.7 INSTALLATION – TRIM

A. Install flashing around all wall openings.

B. Fasten through trim into structural framing.

C. Place fasteners no closer than 3/4 inch and no further than 2 inches from side edge of trim board and no closer than 1 inch from end. Space fasteners a maximum 16 inches on center.

D. Maintain clearance between trim and adjacent finished grade.

E. Allow 1/8 inch gap between trim and siding.

F. Seal gap with high quality, paintable caulk meeting ASTM C834 or ASTM C920.

G. Overlay siding with trim moulding at outside corners where indicated on Drawings. Do not place nails between lap joints.

3.8 INSTALLATION TOLERANCES

A. All products shall be installed straight, level, true and plumb.

B. Maximum variation from level: 1/8 inch per 10 feet, non-cumulative.

C. Maximum offset from joint alignment: 1/16 inch, non-cumulative.

3.9 TOUCH-UP

A. Touch-up chipped damaged exposed nail heads with same colors and type of paint applied at the factory.

END OF SECTION

SECTION 07 62 00
SHEET METAL FLASHING AND TRIM

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Exterior wall flashings.
- B. Roof flashings.
- C. Pre-manufactured roof penetration flashings.

1.2 RELATED SECTIONS

- A. Section 07 41 13 – Metal Roof Panels.
- B. Section 07 92 00 – Joint Sealants.
- C. Section 08 91 19 – Fixed Louvers.
- D. Section 09 91 00 – Painting.

1.3 REFERENCES

- A. The publications listed below form a part of this Section to the extent referenced. The publications are referred to in the text by the basic designation only. Refer to Division 01 for definitions, acronyms, and abbreviations.
- B. Standards, manuals, and codes refer to the latest edition of such standards, manuals, and codes in effect as of the date of issue of this Project Manual, unless indicated otherwise in CBC Chapter 35 and CFC Chapter 80.
- C. Referenced Standards:
 - 1. ASTM A653/A653M – Standard Specification for Steel Sheet, Zinc Coated, (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 - 2. ASTM B32 – Standard Specification for Solder Metal.
 - 3. ASTM D1187 – Standard Specification for Asphalt-Base Emulsions for Use as Protective Coatings for Metal.
 - 4. ASTM D4586 – Standard Specification for Asphalt Roof Cement, Asbestos Free.
 - 5. NRCA Roofing Manual.
 - 6. SMACNA Architectural Sheet Metal Manual.

1.4 SUBMITTALS

- A. Submit shop drawings and product data under provisions of Division 01.
- B. Describe material profile, jointing pattern, jointing details, fastening methods and installation details.

1.5 QUALITY ASSURANCE

- A. Applicator: Company specializing in sheet metal flashing work with sufficient documented experience.

1.6 SYSTEM DESCRIPTION

- A. Work of this Section is to physically protect roofing and exterior from damage that would permit water leakage to building interior.

1.7 PERFORMANCE

- A. General: Sheet metal flashing and trim assemblies shall withstand wind loads, structural movement, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Completed sheet metal flashing and trim shall not rattle, leak, or loosen, and shall remain watertight.
- B. Sheet Metal Standard for Flashing and Trim: Comply with NRCA's "The NRCA Roofing Manual" and SMACNA's "Architectural Sheet Metal Manual" requirements for dimensions and profiles shown unless more stringent requirements are indicated.
- C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes to prevent buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
 - 1. Temperature Change: 120 degrees F, ambient; 180 degrees F, material surfaces.

1.8 DELIVERY, STORAGE AND HANDLING

- A. Store products under provisions of Division 01.
- B. Stack preformed material to prevent twisting, bending or abrasion, and to provide ventilation.
- C. Prevent contact with materials during storage that may cause discoloration, staining or damage.

PART 2 PRODUCTS

2.1 SHEET MATERIALS

- A. Galvanized Steel: ASTM A653/A653M, G90 zinc coating; 24 gauge core steel unless noted otherwise on Drawings.

2.2 ACCESSORIES

- A. Fasteners: Galvanized steel or stainless steel with soft neoprene washers. Finish exposed fasteners same as flashing metal.
- B. Bituminous Coating: Cold-applied asphalt emulsion complying with ASTM D1187.
- C. Touch-up Paint: "Galvalloy" or "Galvweldalloy."
- D. Sealant: Type specified in Section 07 92 00.
- E. Bedding Compound: Rubber-asphalt type.

F. Asphalt Roofing Cement: ASTM D4586, asbestos free, of consistency required for application.

G. Solder:

1. Galvanized Steel: ASTM B32, Grade Sn50, 50 percent tin and 50 percent lead with maximum lead content of 0.2 percent.

H. Flux: Type as recommended by sheet metal manufacturer.

2.3 PREMANUFACTURED ROOF PENETRATION FLASHINGS

A. Products as manufactured by Portals Plus or accepted equal.

1. Pipe Portal Systems Pipe Boots: Compression molded EPDM rubber caps mechanically sealed to substrate using two beads formed into the collar of the cover mated with double grooves molded into the inside of the cap. Provide manufacturer's standard adapter rings as required for a watertight installation. Size and type: As required for size and number of pipes to be flashed.
 - a. Provide stainless steel clamps for final securement of pipe boots around penetrations.

2.4 FABRICATION

- A. Form sections true to shape, accurate in size, square, and free from distortion or defects.
- B. Fabricate cleats and starter strips of same material as sheet, interlockable with sheet.
- C. Form pieces in longest practical lengths.
- D. Hem exposed edges on underside 1/2 inch; miter and seam corners.
- E. Form material with flat lock seam.
- F. Solder and seal non-moving metal joints watertight. After soldering, remove flux. Wipe and wash solder joints clean.
- G. Fabricate one piece corners with minimum 18 inch long legs; seam for rigidity, solder joint watertight.
- H. Fabricate vertical faces with bottom edge formed outward 1/4 inch and hemmed to form drip.
- I. Expansion-contraction of sheet metal runs: Provide flat, 4 inch lap joints, sealed watertight with sealant, at maximum of 40 foot intervals.

2.5 FINISHES

- A. Back-paint concealed metal surfaces with bituminous paint to a minimum dry film thickness of 15 mils.
- B. Site paint finish under provisions of Section 09 91 00.

PART 3 EXECUTION

3.1 INSPECTION

- A. Verify shapes and dimensions of surfaces to be covered.
- B. Verify substrates are clean, dry, smooth and free of defects to the extent needed for sheet metal work.
- C. Beginning of installation means acceptance of existing conditions.

3.2 PREPARATION

- A. Field measure site conditions prior to fabricating work.
- B. Install starter and edge strips, and cleats before starting installation.
- C. Secure flashings in place using concealed fasteners. Use exposed fasteners only in locations acceptable to Architect.
- D. Lock and seal all joints.
- E. Apply plastic cement compound between metal flashings and felt flashings.
- F. Apply bituminous coating between dissimilar metals.
- G. Fit flashings tight in place. Make corners square, surfaces true and straight in planes, and lines accurate to profiles.
- H. Solder non-moving metal joints watertight for full metal surface contact. After soldering, wash metal clean with neutralizing solution and rinse with water.
- I. Seal metal joints watertight.

3.3 INSTALLATION

- A. Fabricate and install items in conformance with drawing details and SMACNA and NRCA manuals.
 - 1. Install premanufactured items in accordance with manufacturer's recommendations.
- B. Ensure that items are installed in true and accurate alignment with other items and related work; that joints are accurately fitted; that exposed surfaces are free from dents; that corners are reinforced; that seams are watertight.
- C. All work shall be left free of passivators, oil, grease, or acid residue, ready to receive paint finish.
- D. Wherever possible, all fasteners shall be concealed. All exposed fasteners shall have neoprene gaskets and be capped with a bead of sealant.

3.4 TOUCH-UP

- A. Where galvanized finish is damaged by fabrication or installation, repair with specified touch-up material, applying in accordance with manufacturer's printed instructions.

END OF SECTION

SECTION 07 84 00
FIRESTOPPING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Mineral wool safing insulation in wall and floor/ceiling construction.
- B. Firestop sealants and caulks.
- C. Elastomeric firestop sealants.
- D. Firestop putty.
- E. Intumescent putty pads.
- F. Flexible firestop spray.
- G. Head-of-wall gasket.
- H. Firestop collars.
- I. Firestopping for large openings.
- J. Cast-in-place firestop devices.
- K. Intumescent wrap.
- L. Firestop mortar.
- M. Fire-rated cable pathway.
- N. Fire-rated HVAC retaining angles.
- O. Firestop plugs.
- P. Fire-rated T collar devices.
- Q. Fire-rated grommets.

1.2 RELATED SECTIONS

- A. Section 07 92 00 – Joint Sealants.
- B. Section 09 29 00 – Gypsum Board.
- C. Divisions 21 – 23 Sections, as applicable to mechanical work.
- D. Divisions 26 – 28 Sections, as applicable to electrical work.

1.3 REFERENCES

- A. The publications listed below form a part of this Section to the extent referenced. The publications are referred to in the text by the basic designation only. Refer to Division 01 for definitions, acronyms, and abbreviations.

- B. Standards, manuals, and codes refer to the latest edition of such standards, manuals, and codes in effect as of the date of issue of this Project Manual, unless indicated otherwise in CBC Chapter 35 and CFC Chapter 80.
- C. Referenced Standards:
 - 1. ASTM C679 – Standard test Method for Tack-Free Time of Elastomeric Sealants.
 - 2. ASTM D6904 – Standard Practice for Resistance to Wind-Driven Rain for Exterior Coatings Applied on Masonry.
 - 3. ASTM E119 – Standard Test Methods for Fire Tests of Building Construction and Materials.
 - 4. ASTM E814 – Standard Test Method for Fire Tests of Penetration Firestop Systems.
 - 5. ASTM E1399 – Standard Test Method for Cyclic Movement and Measuring the Minimum and Maximum Joint Widths of Architectural Joint Systems.
 - 6. ASTM E1966 – Standard Test Method for Fire-Resistive Joint Systems.
 - 7. ASTM E2174 – Standard Practice for On Site Inspection of Installed Fire Stops.
 - 8. ASTM E2307 – Standard Test Method for Determining Fire Resistance of Perimeter Fire Barrier Systems Using Intermediate-Scale, Multi-story Test Apparatus
 - 9. ASTM E2393 – Standard Practice for On Site Inspection of Installed Fire Resistive Joint Systems and Perimeter Fire Barriers.
 - 10. ASTM G21 – Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.
 - 11. International Firestop Council Guidelines for Evaluating Firestop Systems Engineering Judgments.
 - 12. UL Fire Resistance Directory.
 - 13. UL 263 – Fire Tests of Building Construction and Materials.
 - 14. UL 723 – Test for Surface Burning Characteristics of Building Materials.
 - 15. UL 1479 – Standard for Fire Tests of Through-Penetration Firestops.
 - 16. UL 2079 – Tests for Fire Resistance of Building Joint Systems.

1.4 SUBMITTALS

- A. Submit under provisions of Division 01.
- B. Provide manufacturer's brochures describing firestop materials and insulation proposed for use, and types of mechanical fasteners to be used in the installation of the firestopping materials.
- C. Certificates of Compliance: Before installation of products specified in this Section, Contractor shall furnish to Architect a certificate certifying that materials to be incorporated in the work conform to specified requirements.
- D. Submit certification that the installers of products specified in this Section meet the qualification requirements described in Article 1.6 of this Section.

- E. Submit manufacturer's product literature and installation procedures for each type of firestop material to be installed. Literature shall indicate product characteristics, typical uses, performance and limitation criteria, and test data.
- F. Submit material safety data sheets for each product at the time firestopping products are delivered to the job site.
- G. Shop Drawings: Show typical installation details for the methods of installation. Indicate which firestop materials will be used where and application requirements to meet specific jobsite conditions.
- H. Provide manufacturer's Engineering Judgment (EJ) identification number and drawing details when no UL system is available for an application. Engineering Judgment shall be developed in accordance with the latest California Fire Code requirements. Engineering Judgment shall include both project name, and name of contractor who will install the firestop system in accordance with EJ drawing. Submit Engineering Judgment to Authority Having Jurisdiction (AHJ) for review and approval prior to installation.

1.5 QUALITY ASSURANCE

- A. Requirements of Regulatory Agencies: Materials and installation shall comply with requirements of governing regulations and authorities.
 - 1. Comply with requirements of 2022 California Building Code, Chapter 7, "Fire and Smoke Protection Features".
- B. Firestopping systems (materials and design) shall be F-rated to meet the hourly rating of the wall or floor as tested by nationally accepted test agencies per ASTM E814, UL 1479, or UL 2079 in a configuration representative of field conditions. T-ratings for floors shall be as required in the 2022 CBC Chapter 7 "Fire and Smoke Protection Features", as applicable to design conditions. L-ratings shall be tested in accordance with ANSI/UL 1479 (smoke barriers) and ANSI/UL 2079 (joints), such that for each 100 square feet of area, the total cumulative leakage of each firestop assembly shall not exceed 50 cubic feet per minute.
- C. To the fullest extent possible, all firestopping products installed on the project shall be from one manufacturer.
- D. Unless specified and approved, no pipe insulation shall be removed; all insulation shall remain intact, continuous and undamaged when firestopped.
- E. A manufacturer's direct representative (not distributor or agent) shall be on-site prior to the initial installation of firestop systems to train appropriate Contractor personnel in proper selection and installation procedures. This shall be done per manufacturer's written recommendations published in their literature and drawing details.
- F. Firestop systems do not reestablish the structural integrity of load-bearing partitions/assemblies, or support live loads and traffic. Installer shall consult the structural engineer prior to penetrating any load-bearing or shear wall assembly.
- G. Firestop applications for which no UL tested system is available through an acceptable manufacturer, submit acceptable manufacturer's Engineering Judgment derived from similar UL design systems or other acceptable tests, to local authorities having jurisdiction, for review and approval prior to installation. Engineering Judgment drawings shall meet the requirements set forth by the International Firestop Council (September 7, 1994).

1.6 INSTALLER QUALIFICATIONS

- A. Engage an experienced installer who is certified, licensed, and FM Approved in accordance with FM 4991, certified by UL as a Qualified Contractor, or otherwise qualified by the firestopping manufacturer as having been provided the necessary training to install firestop products per specified requirements. A manufacturer's willingness to sell its firestopping products to Contractor or to an Installer engaged by Contractor does not confer qualification on the buyer.
- B. Installation Responsibility: Assign installation of through-penetration firestop systems and fire-resistive joint systems to a single sole source firestop specialty contractor.
- C. The work shall be installed by a contractor with at least one of the following qualifications:
 - 1. FM 4991 Approved Contractor.
 - 2. UL Approved Contractor.
 - 3. Qualified by the firestopping manufacturer as having been provided the necessary training to install firestop products per specified requirements.
- D. The installer shall have no less than three years of experience with fire stop installation.

1.7 DEFINITION

- A. Firestopping: Material or combination of materials used to retain integrity of fire-rated construction by maintaining an effective barrier against the spread of flame, smoke, water and hot gases through penetrations in fire-rated wall and floor assemblies.

1.8 SYSTEM DESCRIPTION

- A. Firestopping materials shall comply with ASTM E119, ASTM E814, ASTM E1399, ASTM E1966, ASTM E2307, UL 263, UL 1479 and UL 2079 to achieve a fire rating as noted on Drawings.
- B. Firestop all interruptions to fire rated assemblies, materials, and components.

1.9 PERFORMANCE REQUIREMENTS

- A. Provide and install firestopping materials to meet applicable codes and installation requirements for each firestopping application. Products using caulking, putty, wrap strips, mortar, composite boards and/or mechanical devices shall be used as appropriate for the specific condition.
- B. Provide firestopping composed of components that are compatible with each other, the substrates forming openings, and the items, if any, penetrating the firestopping under conditions of service and application, as demonstrated by the firestopping manufacturer based on testing and field experience.
- C. Provide components for each firestopping system that are needed to install fill material. Use only components specified by the firestopping manufacturer and approved by the qualified testing agency for the designated fire-resistance-rated systems.
- D. When caulking is used, provide and install flexible caulking materials. Cured firestop materials 1/8 inch thick shall be able to bend around a 1 inch mandrel without breaking.

- E. Provide products that upon curing do not re-emulsify, dissolve, leach, breakdown or otherwise deteriorate over time from exposure to atmospheric moisture, sweating pipes, ponding water or other forms of moisture characteristic during and after construction. Latex sealants containing sodium silicate or other water soluble intumescent ingredients are not permitted.
- F. Provide firestop sealants sufficiently flexible to accommodate motion such as pipe vibration, water hammer, thermal expansion and other normal building movement without damage to the seal.
- G. Pipe insulation shall not be removed, cut away or otherwise interrupted through wall or floor openings. Provide products appropriately tested for the thickness and type of insulation utilized.
- H. Fire rated pathway devices shall be the preferred product and shall be installed in all locations where frequent cable moves, add-ons and changes will occur.
- I. When mechanical cable pathways are not practical, openings within walls and floors designed to accommodate voice, data and video cabling shall be provided with re-enterable products specifically designed for retrofit.
- J. Penetrants passing through fire-resistance rated floor-ceiling assemblies contained within chase wall assemblies shall be protected with products tested by being fully exposed to the fire outside of the chase wall. Systems within the UL Fire Resistance Directory that meet this criterion are identified with the words "Chase Wall Optional".
- K. Provide fire-resistive joint sealants sufficiently flexible to accommodate movement such as thermal expansion and other normal building movement without damage to the seal.
- L. Provide fire-resistive joint sealants designed to accommodate a specific range of movement and tested for this purpose in accordance with a cyclic movement test criteria as outlined in UL 2079.
- M. Provide penetration firestop systems subjected to an air leakage test conducted in accordance with Standard, UL 1479 for penetrations with published L-Ratings for ambient and elevated temperatures as evidence of the ability of firestop system to restrict the movement of smoke.
- N. Provide firestopping composed of components that are listed as compatible with each other, the substrates forming openings and the items, if any, penetrating the firestopping under conditions of service and application, as demonstrated by the firestopping manufacturer based on testing and field experience.
- O. Provide components for each firestopping system that is needed to install fill material. Use only components specified by the firestopping manufacturer and approved by the qualified testing agency for the designated fire-resistance rated systems.
- P. Penetrations in Fire Resistance Rated Walls: Provide firestopping with ratings determined in accordance with UL 1479 or ASTM E814.
 - 1. F-Rating: Not less than the fire-resistance rating of the wall construction being penetrated.

- Q. Penetrations in Horizontal Assemblies: Provide firestopping with ratings determined in accordance with UL 1479 or ASTM E814.
 - 1. F-Rating: Minimum of 1-hour rating, but not less than the fire-resistance rating of the floor construction being penetrated.
 - 2. T-Rating: when penetrant is located outside of a wall cavity, minimum of 1-hour rating, but not less than the fire-resistance rating of the floor construction being penetrated.
- R. Penetrations in Smoke Barriers: Provide firestopping with ratings determined in accordance with UL 1479 or ASTM E814.
 - 1. L-Rating: Not exceeding 5.0 cubic feet per minute per square foot of penetration opening at both ambient and elevated temperatures.
- S. At fire rated assemblies, provide a firestop system with an Assembly Rating as determined by UL 2079 that is equal to the time rating of construction assembly.
- T. Mold Resistance: Provide penetration firestopping with mold and mildew resistance rating of one or less as tested per ASTM G21.
- U. Rain and water resistance: Provide perimeter joint sealant tested in accordance with ASTM D6904 with less than one hour tack free time as tested in accordance with ASTM C679.
- V. To the greatest extent possible, provide cast-in-place firestop devices prior to concrete placement.

1.10 DELIVERY, STORAGE AND HANDLING

- A. Deliver materials to the project site in the manufacturer's original packaging. Clearly identify manufacturer, contents, brand name, applicable standard, lot number, UL label and mixing and installation instructions.
- B. Store materials under cover and protect from weather and damage in compliance with manufacturer's requirements, including temperature restrictions. Immediately remove damaged or deteriorated materials from the job site.
- C. Comply with recommended procedures, precautions, or remedies described in material safety data sheets as applicable.
- D. All firestop materials shall be installed prior to expiration of shelf life.
- E. Do not install damaged or expired materials.

1.11 SCHEDULING

- A. Coordinate installation with other trades whose work may be affected or have effect.
- B. Coordinate delivery of materials with scheduled installation date to allow minimum storage time at job-site.

1.12 PROJECT CONDITIONS

- A. Conform to manufacturer's printed instructions for installation and, when applicable, curing in accordance with temperature and humidity. Conform to ventilation and safety requirements.
- B. Do not use materials that contain flammable solvents.

- C. Schedule installation of firestopping after completion of penetrating item installation but prior to covering or concealing of openings.
- D. Verify existing conditions and substrates before starting work. Correct unsatisfactory conditions before proceeding.
- E. Weather conditions:
 - 1. Do not proceed with installation of firestop materials when temperatures exceed the manufacturer's recommended limitations for installation printed on product label and product data sheet.
 - 2. Do not install firestopping products when substrates are wet due to rain, frost, condensation, or other causes.
- F. During installation, provide masking and drop cloths to prevent firestopping materials from contaminating any adjacent surfaces.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Acceptable firestopping manufacturers, unless noted otherwise:
 - 1. Hilti, Tulsa, OK; 866-445-8827, www.us.hilti.com.
 - 2. Specified Technologies Inc. (STI), Somerville, NJ; 800-992-1180, www.stifirestop.com.
 - 3. 3M, St. Paul, MN; 800-328-1687, www.solutions.3m.com.
 - 4. Substitutions: Under provisions of Division 01.

2.2 MINERAL WOOL INSULATION

- A. Acceptable Manufacturers and Products:
 - 1. Owens Corning Thermafiber, Inc., Wabash, IN; 888-834-2371, www.thermafiber.com.
 - 2. Johns Manville, Denver, CO; 800-654-3103, www.jm.com.
 - 3. Rockwool, Milton, Ontario, Canada; 800-265-6878, www.rockwool.com.
 - 4. Substitutions: Under provisions of Division 01.
- B. At through penetrations, head of wall construction gaps, and perimeter safig slots, provide required density mineral wool per tested system, installed with correct orientation for joint movement and properly compressed per tested system.
- C. Accessories: Provide all accessories and anchors for installation as recommended by the manufacturer.

2.3 FIRESTOP SEALANTS

- A. Sealant for penetrations by noncombustible items including steel pipe, copper pipe, rigid steel conduit and electrical metallic tubing (EMT).
- B. Silicone Sealants:
 - 1. Acceptable Manufacturers and Products:
 - a. Hilti. Product: CFS-S SIL Silicone Sealant.

- b. Specified Technologies Inc. Product: SpecSeal SIL Silicone Firestop Sealant.
 - c. 3M. Products:
 - 1) Fire Barrier Water Tight Sealant 1003 SL.
 - 2) Fire Barrier Silicone Sealant 2000+.
 - d. Substitutions: Under provisions of Division 01.
2. Sealant shall be a one-part silicone compound, non-sag for vertical applications and self-leveling for horizontal applications. Sealant shall be UL Classified (UL 1479) and tested in accordance with ASTM E814 requirements. Penetrations in fire rated assemblies shall be protected and sealed in accordance with CBC Chapter 7 requirements.
- C. Intumescent Latex Sealants:
- 1. Acceptable Manufacturers and Products:
 - a. Hilti. Product: FS-One Max.
 - b. Specified Technologies Inc. (STI). Products:
 - 1) SpecSeal Series SSS Sealant.
 - 2) SpecSeal LCI Sealant.
 - 3) LC Sealant.
 - c. Substitutions: Under provisions of Division 01.
 - 2. Sealant shall be a one-part intumescent latex compound. When exposed to high heat or flame, sealant shall be capable of expanding to seal off the annular spaces and voids at the joint. Expansion shall continue at temperatures greater than 230 degrees F. Sealant shall be thixotropic and suitable for caulking or troweling onto vertical and overhead surfaces. Sealant shall be UL Classified (UL 1479) and tested in accordance with ASTM E814 requirements. Penetrations in fire rated assemblies shall be protected and sealed in accordance with CBC Chapter 7 requirements.

2.4 ELASTOMERIC FIRESTOP SEALANT

- A. Sealant for penetrations and joints between structurally separate sections of walls and floors at top-of-walls.
- B. Acceptable Manufacturers and Products:
 - 1. Hilti. Products:
 - a. CFS-S SIL GG.
 - b. CFS-S SIL SL.
 - 2. STI. Product: SpecSeal Series ES100 Elastomeric Sealant.
 - 3. 3M. Products: Fire Barrier Sealants 1000, 1003, 2000, 2000+, 2001, and 2003.
 - 4. Substitutions: Under provisions of Division 01.
- C. Elastomeric sealant shall be a non-halogenated, latex-based or silicone-based, highly flexible caulk. The sealant shall be thixotropic for high-build application using standard caulking equipment or by troweling onto vertical surfaces or overhead. Self-leveling sealants are acceptable for horizontal applications. The sealant shall be UL Classified (UL 2079) and tested to the requirements of ASTM E814. Closures in fire rated assemblies shall be protected and sealed in accordance with CBC Chapter 7.

2.5 ACRYLIC FIRESTOP SEALANT

- A. Universal fire caulk, providing a flexible seal for fire rated joints and through penetrations.
- B. Acceptable Manufacturers and Products:
 - 1. Hilti. Product: CP 606.
 - 2. Substitutions: Under provisions of Division 01.
- C. Acrylic-based firestop sealant that provides movement capability in fire rated joints and seals through-penetrations applications.

2.6 FIRESTOP PUTTY

- A. Putty for penetrations by combustible items (penetrants consumed by high heat and flame) including insulated metal pipe, PVC jacketed flexible cable, or cable bundles and plastic pipe (closed piping systems). Clay-based products will not be allowed.
- B. Acceptable Manufacturers and Products:
 - 1. Hilti. Product: CP 618 Putty Stick.
 - 2. STI. Product: SpecSeal SSP Putty.
 - 3. Substitutions: Under provisions of Division 01.
- C. Putty shall be a one-part intumescent, non-hardening compound. The putty, when exposed to high heat or flame shall be capable of expanding to seal off annular spaces created. Range of continuing expansion shall be from 230 degrees F to greater than 1,000 degrees F. The putty shall be soft and pliable with aggressive adhesion. The putty shall be UL Classified (UL 1479) and tested to the requirements of ASTM E814. Penetrations in fire rated assemblies shall be protected and sealed in accordance with CBC Chapter 7.

2.7 INTUMESCENT PUTTY PAD

- A. Firestop Putty Pads: Intumescent moldable butyl-based firestop putty pad. Clay-based products will not be allowed.
- B. Acceptable Manufacturers and Products:
 - 1. Hilti. Products:
 - a. CFS-P PA Putty Pad.
 - b. CP 617 Putty Pad.
 - 2. STI. Products:
 - a. SpecSeal SSP4S 7.25 inches by 7.25 inches.
 - b. SpecSeal SSP9S 9 inches by 9 inches.
 - 3. Substitutions: Under provisions of Division 01.

2.8 FLEXIBLE FIRESTOP SPRAY

- A. Firestop spray for perimeter fire barrier system, fire-rated construction joints, and other gaps.
- B. Acceptable Manufacturers and Products:
 - 1. Hilti. Product: CFS-SP WB.

2. STI. Products:
 - a. SpecSeal AS200 Elastomeric Firestop Spray
 - b. SpecSeal Fast Tack Elastomeric Silicone/Urethane Hybrid Firestop Spray.
 3. 3M. Products: Firedam Spray and Fire Barrier Spray.
 4. Substitutions: Under provisions of Division 01.
- C. Spray shall be flexible, sprayable water-based coating that dries in ambient conditions to form a flexible seal that will compress/extend with the intended range of the joint. The spray shall be UL classified (UL 2079) and tested to the requirements of ASTM E1966. Closures in fire rated assemblies shall be protected and sealed in accordance with CBC Chapter 7. Provide silicone-based firestopping products where building perimeter fire barrier systems are required.

2.9 HEAD-OF-WALL GASKET

- A. Intumescent cover for head-of-wall track providing fire, smoke, and acoustic ratings.
- B. Acceptable Manufacturers and Products:
1. Hilti. Product: CFS-TTS Top Track System.
 2. STI. Product: SpecSeal Series TTG SpeedFlexTrack Top Gasket.
 3. Substitutions: Under provisions of Division 01.
- C. Preformed gasket shall be UL classified (UL 2079) and tested to the requirements of ASTM E1966. Closures in fire rated assemblies shall be protected and sealed in accordance with CBC Chapter 7.

2.10 FIRESTOP COLLARS

- A. Collars for penetrations by combustible plastic pipe (opening piping systems).
- B. Acceptable Manufacturers and Products:
1. Hilti. Products:
 - a. CP643N Firestop Collar.
 - b. CP644 Firestop Collar.
 2. STI. Products:
 - a. SpecSeal SSC.
 - b. SpecSeal LLC Firestop Collar.
 3. 3M. Products:
 - a. Fire Barrier PPD Plastic Pipe Device.
 - b. Ultra Plastic Pipe Device.
 4. Substitutions: Under provisions of Division 01.
- C. Firestop collar shall be made of a galvanized steel housing and shall contain a section of intumescent material. The material shall be designed to expand when exposed to fire. The collars shall be UL classified (UL 1479) and tested to the requirements of ASTM E814. Closures in fire rated assemblies shall be protected and sealed in accordance with CBC Chapter 7.

2.11 FIRESTOPPING FOR LARGE OPENINGS

- A. Firestopping for large size, complex penetrations made to accommodate cable trays, multiple steel and copper pipes and electrical busways in raceways. Products may be used in conjunction with other firestopping products, systems, and devices.
- B. Acceptable Manufacturers and Products:
 - 1. Hilti. Product: CFS-BL Firestop Block.
 - 2. STI. Products:
 - a. SpecSeal SSB Firestop Pillows.
 - b. SpecSeal CS Composite Sheet.
 - c. SpecSeal SSM Mortar.
 - 3. 3M. Product: Fire Barrier Pillows or Fire Barrier CS-195+ Composite Sheet and Fire Barrier Mortar.
 - 4. Substitutions: Under provisions of Division 01.
- C. For large openings, install intumescent compound or mortar. Intumescent compounds, when exposed to high heat or flame, shall be capable of expanding to seal off annular spaces created. Product shall be UL classified (UL 1479) and tested to the requirements of ASTM E814. Closures in fire rated assemblies shall be protected and sealed in accordance with CBC Chapter 7.

2.12 CAST-IN-PLACE FIRESTOP DEVICES

- A. Devices for use with non-combustible and combustible pipes (closed and open piping systems), conduit, and cable bundles penetrating concrete floors and framed gypsum board wall assemblies.
- B. Acceptable Manufacturers and Products:
 - 1. Hilti. Products:
 - a. CP 680-P Cast-in-Place Firestop Device.
 - 1) Add Aerator Adapter when used in conjunction with aerator (Sovent) system.
 - b. CP 680-M Cast-in-Place Firestop Device for use with non-combustible penetrants.
 - c. CP 653 Firestop Speed Sleeve.
 - 2. STI. Product: SpecSeal CD Cast-In Firestop Device.
 - a. Accessories:
 - 1) Add Aerator Adapter when used in conjunction with aerator (Sovent) system.
 - 2) Metal Deck Adapters on corrugated metal decks.
 - 3) Extension Tubes where required for thick concrete floors.
 - 3. Substitutions: Under provisions of Division 01.
- C. Acceptable Penetrations: Sealing pipes and cables up to 6 inches in diameter in penetration through fire-rated floors, suitable for: vented or closed plastic pipes, PVC, CPVC, ABS, innerduct, FRPP, steel, cast-iron, copper pipes, insulated steel and copper pipes, EMT and ENT electrical conduits, bundled cables, and blank openings.

2.13 INTUMESCENT WRAP

- A. Intumescent Wrap: Precut wrap strips for plastic and insulated pipe penetration through rated assemblies.
- B. Acceptable Manufacturers and Products:
 - 1. Hilti. Product: CP 648, Firestop Wrap Strip.
 - 2. STI. Products:
 - a. SpecSeal RED2.
 - b. SpecSeal BLU2 Wrap Strip.
 - 3. Substitutions: Under provisions of Division 01.

2.14 FIRESTOP MORTAR

- A. Fire-resistant, cement-based mortar for firestop-sealing medium-sized to large openings with non-combustible pipes or cable trays, and permanent fire seal for cables, cable trays and non-combustible pipes. For use with concrete and masonry assemblies, and for walls and floors rated up to three hours.
- B. Acceptable Manufacturers and Products:
 - 1. Hilti. Product: CP 637 Firestop Mortar.
 - 2. STI. Product: SpecSeal SSM Firestop Mortar.
 - 3. Substitutions: Under provisions of Division 01.

2.15 FIRE-RATED CABLE PATHWAY

- A. Gangable fire-rated device modules capable of retrofit, comprised of steel raceway with intumescent foam pads allowing 0 percent to 100 percent cable fill for cable penetrations through gypsum or CMU walls, concrete floors and concrete walls.
- B. Acceptable Manufacturers and Products:
 - 1. STI. Product: SpecSeal EZ Path Pathway Device Series 22, 33 or 44.
 - 2. Substitutions: Under provisions of Division 01.

2.16 FIRE-RATED HVAC RETAINING ANGLES

- A. Steel angle system with integral intumescent firestop gasket for use on steel HVAC ducts.
- B. Acceptable Manufacturers and Products:
 - 1. STI. Product: SpecSeal Fyre-Flange Steel Firestop Retaining Angle.
 - 2. Substitutions: Under provisions of Division 01.

2.17 FIRESTOP PLUGS

- A. Re-enterable, foam rubber plug impregnated with intumescent material for use in blank openings and cable sleeves.
- B. Acceptable Manufacturers and Products:
 - 1. Hilti. Product: CFS-PL Firestop Plug.
 - 2. STI. Product: SpecSeal FP Intumescent Firestop Plug.

- 3. Substitutions: Under provisions of Division 01.

2.18 FIRE-RATED T COLLAR DEVICES

- A. Louvered steel collar system with synthetic aluminized polymer coolant wrap installed on metallic pipes where T Ratings are required by applicable building code requirements.
- B. Acceptable Manufacturers and Products:
 - 1. STI. Product: SpecSeal T-Collar Device.
 - 2. Substitutions: Under provisions of Division 01.

2.19 FIRE-RATED GROMMETS

- A. Molded two-piece grommet made from plenum grade polymer with a foam inner core for sealing individual cable penetrations up to 0.27 inch diameter.
- B. Acceptable Manufacturers and Products:
 - 1. STI. Product: EZ-Firestop Grommet.
 - 2. Substitutions: Under provisions of Division 01.

2.20 ACCESSORIES

- A. Installation Accessories: Clips, collars, fasteners, temporary stops or dams, and other devices required to position and retain materials in place.

PART 3 EXECUTION

3.1 CONDITIONS REQUIRING FIRESTOPPING

- A. General: Provide firestopping for conditions specified whether or not firestopping is indicated and, if indicated, whether such material is designed as insulation, safing or otherwise.
- B. Penetrations:
 - 1. Penetrations include conduit, cable wire, pipe, duct or other elements that pass through one or both outer surfaces of a fire-rated floor, wall or partition.
 - 2. These requirements for penetrations shall apply whether or not sleeves have been provided, and whether or not penetrations are to be equipped with escutcheons or other trim. If penetrations are sleeved, firestop annular space, if any, between sleeve and wall opening.
- C. Provide firestopping to fill miscellaneous voids and openings in fire-rated construction as specified herein.
- D. Provide intumescent moldable pads over backs and sides of all electrical junction and utility boxes at fire rated walls.

3.2 EXAMINATION

- A. Verify site conditions under provisions of Division 01.
- B. Verify openings are ready to receive the work of this Section.

3.3 PREPARATION

- A. Clean substrate surfaces of dirt, dust, grease, oil, loose material or other matter that may affect bond of firestopping material.
- B. Remove incompatible materials that may affect bond.
- C. Install noncombustible backing materials to arrest liquid material leakage.
- D. Examine the areas and conditions where firestops are to be installed and notify Architect of conditions detrimental to the proper and timely completion of the work. Do not proceed with work until unsatisfactory conditions have been corrected by Contractor in a manner acceptable to Architect.
- E. Verify penetrations are properly sized and in suitable condition for application of materials.
- F. Provide masking and temporary covering to prevent soiling of adjacent surfaces by firestopping materials.
- G. Comply with manufacturer's recommendations for temperature and humidity conditions before, during and after installation of firestopping.

3.4 INSTALLATION

- A. General:
 - 1. Installation of firestops shall be performed by an applicator/installer qualified and trained by the manufacturer. Installation shall be performed in strict accordance with manufacturer's detailed installation procedures. Written verification of the manufacturer's training shall be submitted to Architect.
 - 2. Apply firestops in accordance with fire test reports, fire resistance requirements, acceptable sample installations, manufacturer's recommendations, and listing descriptions.
 - 3. Provide sprinkler piping with NFPA 13 required annular space using firestop to allow movement.
 - 4. Coordinate with plumbing, mechanical, electrical and other trades to assure that all pipe, conduit, cable and other items which penetrate fire-rated construction have been permanently installed prior to installation of firestops.
 - 5. All penetrations for pipes, conduits, tubing or other building service elements shall be installed below the head-of-wall joint such that the distance between the top of the wall and the top of the penetrant is a minimum of 3 inches, no exceptions.
- B. Regulatory Requirements: Install firestop materials in accordance with published "Through-Penetration Firestop Systems" in UL's Fire Resistance Directory.
- C. Manufacturer's Instructions: Comply with manufacturer's instructions for installation of through-penetration materials.
 - 1. Seal all holes or voids made by penetrations to ensure an air- and water-resistant seal.
 - 2. Protect materials from damage on surfaces subjected to traffic.
- D. Field Quality Control:
 - 1. Prepare and install firestopping systems in accordance with manufacturer's printed instructions and recommendations.

2. Follow safety procedures recommended in the Material Safety Data sheets.
3. Finish surfaces of firestopping which are to remain exposed in the completed work to a uniform and level condition.
4. All areas of work must be accessible until inspection by the applicable Code authorities.
5. Correct unacceptable firestop installations and provide additional inspection to verify compliance with this Section at no additional cost.
6. All firestop assemblies shall be identified with a permanently affixed ID label as follows:
 - a. Firestop System Warning Label: Minimum 3 inch by 5 inch label, red color or with red colored type and "WARNING: THROUGH PENETRATION FIRESTOP SYSTEM – DO NOT DISTURB. NOTIFY BUILDING MANAGEMENT OF ANY DAMAGE" written in bold type. Label shall be adhesive backed or provide other means of permanent attachment. Identified or included spaces for the following information:
 - 1) Name of manufacturer.
 - 2) Name of Installer.
 - 3) Date firestop system was installed.
 - 4) Firestop System UL number or manufacturer's engineered design number.
 - 5) F Rating and/or T Rating, as applicable.
7. All fire-rated wall assemblies shall be identified with signs or by stenciling in accessible concealed floor, floor-ceiling, or attic spaces at intervals not exceeding 30 feet and within 15 feet of the end of each wall per CBC Section 703.5. Lettering shall be not less than 3 inches in height with a minimum 3/8 inch stroke in contrasting color, incorporating the appropriate wording such as: "FIRE AND/OR SMOKE BARRIER-PROTECT ALL OPENINGS", with the relevant hourly fire resistance rating clearly stated.
8. Examine sealed penetration areas to ensure proper installation before concealing or enclosing areas.
9. Keep areas of work accessible until inspection by applicable code authorities.
10. Perform under this Section patching and repairing of firestopping caused by cutting or penetrating of existing firestop systems already installed by other trades.
- E. Installation shall be completed in a neat, workmanlike manner according to manufacturer's recommendations. Securely fasten and anchor insulation in place to prevent displacement or sagging of material. Safing insulation shall be adequately lapped.
- F. Install material at fire rated horizontal to vertical assembly closures and at fire rated walls or partition openings which contain penetrating sleeves, piping, ductwork, conduit and other items requiring firestopping.
- G. Apply primer and materials in accordance with manufacturer's instructions.
- H. Apply firestopping material in sufficient thickness to achieve rating.
- I. Compress fibered material to achieve a density of forty percent of its uncompressed density.
- J. Dam material to remain.

3.5 INSPECTIONS

- A. Firestopping inspections shall meet the requirements of CBC Section 1705.18.

- B. Inspection of completed work shall be performed by Authority Having Jurisdiction (AHJ) and/or the building underwriter's designee. If required by Authority Having Jurisdiction (AHJ) or underwriter, inspections may be performed by an independent, third-party construction inspection and testing service provided that:
 - 1. Inspections are performed to the requirements of the following standards as applicable:
 - a. Construction Joints: ASTM E2393.
 - b. Service Penetrations: ASTM E2174.
 - 2. Individual(s) performing inspection shall provide evidence of valid Errors and Omissions Insurance coverage for this service.
 - 3. Individual(s) performing inspection shall not have any financial connection to installer, firestop manufacturer, distributor or supplier.

3.6 CLEANING

- A. Clean Work under provisions of Division 01.
- B. Clean adjacent surfaces of firestopping materials.
- C. Remove spilled and excess materials adjacent to firestopping without damaging adjacent surfaces.
- D. Leave finished work in a neat and clean condition with no evidence of spillovers or damage to adjacent surfaces.

3.7 PROTECTION OF FINISHED WORK

- A. Protect finished Work under provisions of Division 01.
- B. Protect adjacent surfaces from damage by material installation.
- C. Where firestopping is installed at locations which will remain exposed in the completed work, provide protection as necessary to prevent damage to adjacent surfaces and finishes, and protect as necessary against damage from other construction activities.

END OF SECTION

SECTION 07 92 00

JOINT SEALANTS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Sealants.
- B. Sealant accessories.

1.2 RELATED SECTIONS

- A. Section 03 30 00 – Cast-In-Place Concrete.
- B. Section 06 41 00 – Architectural Wood Casework.
- C. Section 07 19 00 – Water Repellents.
- D. Section 07 19 19 – Water Repellents.
- E. Section 07 41 13 – Metal Roof Panels.
- F. Section 07 62 00 – Sheet Metal Flashing and Trim.
- G. Section 07 84 00 – Firestopping.
- H. Section 08 11 13 – Hollow Metal Doors and Frames.
- I. Section 08 41 13 – Aluminum-Framed Entrances and Storefronts.
- J. Section 08 81 00 – Glass Glazing.
- K. Section 08 91 19 – Fixed Louvers.
- L. Section 09 29 00 – Gypsum Board.

1.3 REFERENCES

- A. The publications listed below form a part of this Section to the extent referenced. The publications are referred to in the text by the basic designation only. Refer to Division 01 for definitions, acronyms, and abbreviations.
- B. Standards, manuals, and codes refer to the latest edition of such standards, manuals, and codes in effect as of the date of issue of this Project Manual, unless indicated otherwise in CBC Chapter 35 and CFC Chapter 80.
- C. Referenced Standards:
 - 1. ASTM C510 – Standard Test Method for Staining and Color Change of Single or Multicomponent Joint Sealants.
 - 2. ASTM C719 – Standard Test Method for Adhesion and Cohesion of Elastomeric Joint Sealants Under Cyclic Movement (Hockman Cycle).
 - 3. ASTM C794 – Standard Test Method for Adhesion in Peel of Elastomeric Joint Sealants.

4. ASTM C834 – Standard Specification for Latex Sealants.
5. ASTM C881 – Standard Specification for Epoxy Resin Base Bonding Systems for Concrete.
6. ASTM C919 – Standard Practice for Use of Sealants in Acoustical Applications.
7. ASTM C920 – Standard Specification for Elastomeric Joint Sealants.
8. ASTM C1087 – Standard Test Method for Determining Compatibility of Liquid Applied Sealants with Accessories Used in Structural Glazing Systems.
9. ASTM C1193 – Standard Guide for Use of Joint Sealants.
10. ASTM C1248 – Standard Test Method for Staining of Porous Substrate by Joint Sealants.
11. ASTM C1311 – Standard Specification for Solvent Release Sealants.
12. ASTM C1521 – Standard Practice for Evaluating Adhesion of Installed Weatherproofing Sealant Joints.
13. ASTM D2203 – Standard Test Method for Staining from Sealants.

1.4 SUBMITTALS

- A. General: Submit in accordance with Division 01.
- B. Product Data: Submit manufacturer's descriptive literature and product specification for each product, including primers and sealing compounds.
 1. Provide manufacturer's literature with selected colors clearly indicated.
- C. Quality Assurance/Control Submittals:
 1. Product validation/assurance submittals.
 2. Manufacturer's laboratory adhesion and stain testing results.
 3. Joint sealants field adhesion to joint substrates test results.
 4. Installer qualifications.
 5. Written certification from the subcontractor that joints are of the proper size and design, that the materials supplied are compatible with adjacent materials and backing, that the materials will properly perform to provide permanent watertight, airtight or vapor tight seals (as applicable), and that materials supplied meet specified performance requirements.
- D. Sample Manufacturer's Warranty.
- E. Closeout Submittals: Cleaning and maintenance data.

1.5 DEFINITIONS

- A. Sealant Types:
 1. S: Single component sealant, cures by moisture reaction.
 2. M: Multiple component sealant; cures by chemical reaction.
- B. Sealant Grades:
 1. NS: Non-sag or gunnable sealant that permits application in joints on vertical surfaces without sagging or slumping.

2. P: Pourable sealant that has sufficient flow to form a smooth, level surface when applied in a horizontal joint.
3. SL: Self-leveling sealant that has sufficient flow to form a smooth, level surface when applied in a horizontal joint.

C. Sealant Classes:

1. 12.5: A sealant that when tested for adhesion and cohesion under cyclic movement shall withstand an increase and decrease of at least 12.5 percent of the joint width as measured at the time of application.
2. 25: A sealant that when tested for adhesion and cohesion under cyclic movement shall withstand an increase and decrease of at least 25 percent of the joint width as measured at the time of application.
3. 35: A sealant that when tested for adhesion and cohesion under cyclic movement shall withstand an increase and decrease of at least 35 percent of the joint width as measured at the time of application.
4. 50: A sealant that when tested for adhesion and cohesion under cyclic movement shall withstand an increase and decrease of at least 50 percent of the joint width as measured at the time of application.
5. 100/50: A sealant that when tested for adhesion and cohesion under cyclic movement shall withstand an increase of at least 100 percent and a decrease of at least 50 percent of the joint width as measured at the time of application.

D. Sealant Uses:

1. A: Sealant acceptable for use on an aluminum substrate.
2. G: Sealant acceptable for use on a glass substrate.
3. I: Sealant designed for use in joints which are submerged continuously in a liquid.
 - a. Immersion rated sealant applications require primer.
4. M: Sealant acceptable for use on a mortar substrate.
5. NT: Sealant designed for use in joints in non-traffic areas.
6. T: Sealant designed for use in joints in pedestrian and vehicular traffic areas such as walkways, plazas, decks, and parking garages.
7. O: Sealant acceptable for use on substrates other than those listed above including, but not limited to, color anodized aluminum, metals other than aluminum, painted surfaces, brick, stone, tile, and wood.

E. Miscellaneous:

1. FC: Fast cure sealants; provides lesser cure times than corresponding standard cure sealants.

1.6 SUSTAINABLE DESIGN REQUIREMENTS

- A. Meet VOC requirements of South Coast Air Quality Management District (SCAQMD) Rule 1168. Information is available at www.aqmd.gov. VOC limit expressed in grams per liter as follows:

Sealant	VOC Limit
Architectural	250
Roadways	250
Nonmembrane Roof Installation/Repair	300
Other	420

Sealant Primer	VOC Limit
Architectural – Nonporous	250
Architectural - Porous	775
Other	750

- B. Provide sealants with no carcinogen or reproductive toxicant components at more than one percent of total mass of product as defined in the following lists:
1. California OEHHA, Safe Drinking Water and Toxic Enforcement Act of 1986 (Proposition 65). Information is available at www.oehha.ca.gov/prop65.html.
 2. California Air Resources Board (CARB), list of Toxic Air Contaminants (California Air Toxics). Information is available at www.arb.ca.gov/toxics.

1.7 QUALITY ASSURANCE

- A. Qualifications:
1. Manufacturer Qualifications: Firm specializing in manufacturing products specified in this Section.
 2. Applicator Qualifications: Firm specializing in installing work specified in this Section with experience on at least five projects of similar nature in past three years.
- B. Product Validation/Assurance: Provide products with current SWRI Validation or provide independent third-party laboratory test results showing product meets performance requirements in accordance with ASTM C920 and as specified in this Section.
- C. Compatibility: Materials forming joints and adjacent materials shall not adversely affect sealant materials or sealant color per ASTM C1087.
- D. Staining: Sealants shall not stain joint substrates per ASTM C510, ASTM C1248, and ASTM D2203.
- E. Manufacturer Adhesion, Cohesion, and Stain Testing: Provide manufacturer's laboratory adhesion and cohesion testing per ASTM C719 and ASTM C794, and stain testing per ASTM C510, using specimens of actual substrates to ensure sealant compatibility with substrate before product acceptance.

- F. Joint Sealants Field Test for Adhesion and Cohesion to Joint Substrates: Perform field tests for each elastomeric joint sealant in accordance with ASTM C1521, with the manufacturer's representative present prior to installation as follows:
1. Install joint sealants in five foot joint lengths. Allow sealant to fully cure before testing.
 2. Make a knife cut of the sealant across the joint and along each side of the joint approximately 3 inches long.
 3. Place a mark on the sealant tab, 1 inch from the adhered joint to the tab's free end.
 4. Grasp a 2 inch piece of sealant firmly just beyond the 1 inch mark and pull at a 90 degree angle.
 5. Record whether or not sealant in joint maintained adhesion to substrate.
 6. Record percentage length of sealant elongation.
 7. Sealant product acceptance shall be based on pass/fail adhesion performance.
- G. Coordination and Pre-Installation Meetings:
1. Conduct pre-installation meeting in accordance with provisions of Division 01.
 2. Convene pre-installation meeting prior to commencing work of this Section.
 3. Take minutes of meeting. Distribute to all attendees and concerned parties within five days.
 4. Coordinate work in this Section with work in related Sections.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Comply with requirements of Division 01.
- B. Deliver materials in the unopened, original containers or unopened packages with manufacturer's name, labels, product identification, color, expiration period, curing time and mixing instructions for multi-component materials.
- C. Storage and Protection: Store materials in a dry secure location with ambient temperature range of 60 degrees F to 80 degrees F.
- D. Carefully handle and store to prevent inclusion of foreign materials.

1.9 PROJECT/SITE CONDITIONS

- A. Environmental Limitations:
1. Do not proceed with installation of primers and joint sealants under the following conditions:
 - a. When ambient and substrate temperature conditions are less than 40 degrees F, or as otherwise recommended by manufacturer.
 - b. When joint substrates are wet.
- B. Joint-Width Conditions:
1. Do not proceed with installation of joint sealants until contaminants capable of interfering with adhesion are removed from joint substrates.

1.10 SEQUENCING

- A. Apply waterproofing, water repellents, and preservative finishes after sealants have fully cured.

1.11 WARRANTY

- A. Comply with provisions of Division 01.
- B. Provide manufacturer's warranty against material defects, air and water tightness, loss of adhesion, cohesion, and staining as follows:
 - 1. Silicone sealants – Twenty years.
 - 2. Urethane sealants – Five years.
 - 3. Other sealants – Two years.
- C. Provide installer's two year workmanship warranty.

1.12 MAINTENANCE DATA

- A. Submit in accordance with Division 01.
- B. Provide cleaning and maintenance information, recommended inspection intervals, and instructions for repairing and replacing failed sealant joints.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Acceptable Manufacturers:
 - 1. BASF Corporation – Building Systems, Shakopee, MN; 800-433-9517 www.buildingsystems.basf.com.
 - 2. GE Silicones, Huntersville, NC; 951-201-2000, www.gesilicones.com.
 - 3. Pecora Corporation, Harleysville, PA; 800-523-6688, www.pecora.com.
 - 4. Sika Corporation, Lyndhurst, NJ; 800-933-7452, www.usa.sika.com.
 - 5. Specified Technologies Inc. (STI), Somerville, NJ; 800-992-1180, www.stifirestop.com.
 - 6. The Dow Chemical Company, Midland, MI; 800-331-6451, www.consumer.dow.com.
 - 7. The Euclid Chemical Company, Cleveland, OH; 800-321-7628, www.euclidchemical.com.
 - 8. Tremco Sealant Weatherproofing Division of RPM International, Inc., Beachwood, OH; 800-321-7906, www.tremcosealants.com.
 - 9. USG – United States Gypsum Co., Chicago, IL; 800-874-4968, www.usg.com.
- B. Substitutions: Under provisions of Division 01.

2.2 SEALANTS

- A. General:
 - 1. Provide sealants that have been tested and found suitable for the substrates to which they will be applied.

2. Color: As selected by Architect from manufacturer's full range of colors.

B. Exterior Sealants:

1. Exterior Perimeter Sealant: Polyurethane sealant; ASTM C920; Type M; Grade NS; Class 50; uses: A, I, M, NT, O, T.
 - a. Products:
 - 1) Tremco Dymeric 240FC.
 - 2) BASF MasterSeal NP2.
 - 3) Sika Sikaflex-2c NS.
 - 4) or accepted equal.
 - b. Use at:
 - 1) Exterior vertical joints bordered on one or both sides by concrete, metal, and/or window perimeters, threshold bedding, and/or sheet metal flashing lap joints.
 - 2) Porous materials such as concrete, manufactured stone, fiber cement siding, or masonry.
 - 3) Non-porous materials such as painted metal, anodized or mill finish aluminum.
2. Exterior Perimeter Sealant: Medium modulus moisture curing, non-staining, non-bleeding silicone sealant; ASTM C920; Type S; Grade NS; Class 50/50; uses: A, G, M, NT, O.
 - a. Products:
 - 1) The Dow Chemical Company Dowsil 795 Silicone Building Sealant.
 - 2) Tremco Spectrum 2.
 - 3) Sika Sikasil WS-295.
 - 4) or accepted equal.
 - b. Use at:
 - 1) Exterior vertical joints bordered on one or both sides by concrete, metal, and/or window perimeters, threshold bedding, and/or sheet metal flashing lap joints.
 - 2) Porous materials such as concrete, manufactured stone, fiber cement siding, or masonry.
 - 3) Non-porous materials such as painted metal, anodized or mill finish aluminum.
3. Glazing Sealant: Medium modulus, neutral curing, non-staining, non-bleeding silicone sealant; ASTM C920; Type S; Grade NS; Class 50; uses: A, G, M, NT, O.
 - a. Products:
 - 1) Tremco Spectrem 2.
 - 2) The Dow Chemical Company Dowsil 795 Silicone Building Sealant.
 - 3) Pecora 895NST.
 - 4) Sika Sikasil WS-295.
 - 5) or accepted equal.
 - b. Use at exterior joints in window wall systems such as glass to glass, glass to metal, and metal to metal joints.

4. Traffic Sealant: Self leveling, chemical curing, non-staining, non-bleeding polyurethane sealant; ASTM C920; Type M; Grade NS or Grade P; Class 25; uses: M, O, T.
 - a. Products:
 - 1) Pecora Corp. Urexpan NR-200.
 - 2) BASF MasterSeal SL 2.
 - 3) Sika Sikaflex-2c SL.
 - 4) or accepted equal.
 - b. Use at:
 - 1) Exterior horizontal traffic expansion joints in concrete with slopes less than five percent.
 - 2) Interior horizontal traffic joints in low-slope concrete with slopes less than five percent.
5. Traffic Sealant: Slope grade chemical curing, non-staining, non-bleeding polyurethane sealant; ASTM C920; Type M; Grade P; Class 25; use: T.
 - a. Products:
 - 1) Pecora Corp. DynaTrol II-SG.
 - 2) BASF MasterSeal SL 2 Slope Grade.
 - 3) Sika Sikaflex 2c NS TG.
 - 4) or accepted equal.
 - b. Use at:
 - 1) Exterior horizontal traffic expansion joints in concrete with slopes between five percent and ten percent.
6. Metal Lap and Bedding Sealant (non-soldered flashings): Non-drying, non-skinning, non-curing flexible butyl rubber sealant; ASTM C1311; Type S; Grade NS; Class 10; uses: G, M, O.
 - a. Products:
 - 1) Tremco TREMpro JS773 Butyl Sealant.
 - 2) Pecora Corp. BA-98 Butyl Rubber Sealant.
 - 3) or accepted equal.
 - b. Use for bedding thresholds, glazing secondary seals, and sheet metal flashing and trim not exposed to ultraviolet (UV) light.
7. Metal Lap and Bedding Sealant (non-soldered flashings): High performance, moisture curing, gun grade polyurethane sealant; ASTM C920; Type S; Grade NS; Class 25; use: A, I, M, NT, O, T.
 - a. Products:
 - 1) Tremco Vulkem 116.
 - 2) BASF MasterSeal TX1.
 - 3) Sika Sikaflex Textured Sealant.
 - 4) or accepted equal.
 - b. Use for bedding thresholds, glazing secondary seals, and sheet metal flashing and trim exposed to ultraviolet (UV) light.

C. Interior Sealants:

1. Interior Sealant: Nonoxidizing, skinnable, paintable, gunnable, non-staining, non-bleeding acrylic latex sealant; ASTM C834; Type S; Grade NS; Class 12.5; use: O.
 - a. Products:
 - 1) Tremco Tremflex 834.
 - 2) Pecora Corp. AC-20 + Silicone.
 - 3) or accepted equal.
 - b. Use at interior trim and finish joints expecting minimal movement.
2. Interior Sealant: Low modulus, moisture curing, non-staining, non-bleeding polyurethane sealant; ASTM C920; Type S; Grade NS; Class 35; uses: A, M, NT, O.
 - a. Products:
 - 1) Tremco Dymonic FC.
 - 2) Euclid Chemical Company Eucolastic 1NS.
 - 3) Sika Sikaflex 1a.
 - 4) or accepted equal.
 - b. Use at interior vertical expansion, control, and air seal joints.
3. Sanitary Sealant: Mildew resistant with fungicide, acetoxycuring, non-staining, non-bleeding silicone sealant; ASTM C920; Type S; Grade NS; Class 25; uses: A, G, NT, O.
 - a. Products:
 - 1) Tremco Tremsil 200 Sanitary.
 - 2) The Dow Chemical Company Dowsil 785 Mildew Resistant.
 - 3) Pecora 898NST.
 - 4) Sika Sikasil-N Plus US.
 - 5) or accepted equal.
 - b. Use at interior joints with nonporous substrates around ceramic tile, showers, sinks and plumbing fixtures.
4. Acoustical Sealant: Non-skinning, non-hardening synthetic rubber sealant; ASTM C919; Type S; Grade NS; use: O.
 - a. Products:
 - 1) Tremco Acoustical Sealant.
 - 2) Pecora BA-98.
 - 3) or accepted equal.
 - b. Use at concealed joints and penetrations in interior acoustical walls.
5. Acoustical Sealant: Nonoxidizing, skinnable, paintable, gunnable, non-staining, non-bleeding acrylic latex sealant; ASTM C834 and C919; Type S; Grade NS; Class 12.5; use: O.
 - a. Products:
 - 1) Tremco Tremflex 834.
 - 2) Pecora Corp. AC-20 FTR.
 - 3) USG Sheetrock Brand Acoustical Sealant.

- 4) STI LC or SpecSeal Smoke "N" Sound Sealant.
- 5) Hilti CS-S SA Light.
- 6) or accepted equal.

b. Use at exposed joints and penetrations in interior acoustical walls.

2.3 ACCESSORIES

- A. Joint Cleaner: Non-corrosive and non-staining type as recommended by sealant manufacturer; compatible with joint forming materials.
- B. Primers: Non-staining, quick-drying type and consistency recommended by the sealant manufacturer for the particular application.
- C. Joint Backing: Non-adhering backing to sealant; non-staining, compatible with sealant and primer such as round, closed cell or bi-cell polyethylene foam rod; oversized 25 percent to 50 percent larger than joint width. Materials impregnated with oil, bitumen or similar materials are not permitted.
- D. Bond Breakers: Type and consistency recommended by the sealant manufacturer to suit the particular application.
- E. Bond Breaker Tape: Self-adhesive, pressure sensitive polyethylene tape.
- F. Masking Tape: Non-staining, non-absorbent tape compatible with joint sealants and adjacent joint surfaces.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine job site conditions; verify substrate, surfaces, and joint openings are ready to receive work and field measurements are as shown on drawings, as specified in this Section, and as recommended by manufacturer.
- B. Report unacceptable conditions to Architect. Begin installation only when unacceptable conditions have been corrected.

3.2 PREPARATION

- A. Clean, prepare, and prime joints in accordance with ASTM C1193 and manufacturer's written instructions.
- B. Remove loose materials and foreign matter that might impair sealant adhesion. Clean porous materials such as concrete or masonry by grinding, sand or water blast cleaning, mechanical abrading, acid washing or a combination of these methods as required to provide a clean, sound base surface for sealant adhesion.
 1. Remove laitance by acid washing, grinding or mechanical abrading.
 2. Remove form oils, release agents, chemical retardants, by sand or water blast cleaning.
 3. Blow from joints with oil-free compressed air loose particles resulting from grinding, abrading, or blast cleaning prior to sealant application.

4. Do not apply sealant to masonry joints where water repellent, ant-graffiti coating, or masonry preservative has been applied. Apply water repellents or waterproofing treatments after sealants have fully cured. Coordinate with Section 07 19 19.
- C. Mechanically or chemically clean nonporous surfaces such as metal and glass. Remove temporary protective coatings on metallic surfaces using solvents that leave no residue as recommended by metal surface manufacturer. When masking tape or strippable films are used, remove the tape or film and clean any residual adhesive. Apply and wipe-dry cleaning solvents using clean, lint-free cloths or paper towels, do not allow solvent to air dry without wiping.
- D. Protect elements surrounding the work of this Section from damage or disfiguration. Apply masking tape to adjacent surfaces to prevent damage to finishes from sealant installation.

3.3 APPLICATION

- A. Apply sealants in accordance with ASTM C1193, manufacturer's written instructions, and accepted shop drawings.
- B. Apply acoustical sealants in accordance with ASTM C919, manufacturer's written instructions, except where more stringent requirements are specified herein, and accepted shop drawings.
- C. Apply sealant where indicated on the Drawings and at all exterior joints and openings in the building envelope that are observable sources of air or water infiltration.
- D. Measure joint dimensions and size materials to achieve required width-to-depth ratios. Acceptable joint width-to-depth ratios:

Material	Joint Width	Joint Depth	
		Minimum	Maximum
Metal or other nonporous surfaces.	1/4 inch (minimum)	1/4 inch	1/4 inch
	Over 1/4 inch	1/2 of width	1/2 inch
Wood, concrete, masonry, or other porous surfaces.	1/4 inch (minimum)	1/4 inch	1/4 inch
	Over 1/4 inch	1/2 of width	1/2 inch
	Over 1/2 to 2 inches	1/2 inch	1/2 inch
	Over 2 inches	As recommended by sealant manufacturer.	

- E. Install joint backing to achieve desired joint width-to-depth ratio. Roll the material into the joint to avoid lengthwise stretching. Do not twist or braid rod stock.
- F. Install bond breaker where joint backing is not used to prevent three-sided adhesion.
- G. Apply primer where required and where recommended by sealant manufacturer for sealant adhesion.
- H. Install sealants within recommended application temperature ranges. Consult manufacturer when sealant cannot be applied within these temperature ranges.
- I. Install sealants immediately after joint preparation.
- J. Install sealants free of air pockets, foreign embedded matter, ridges, and sags.

- K. Produce uniform, cross sectional shapes and depths relative to joint width that allow optimum sealant movement capability.
- L. Tool joints concave. Use dry tooling method.
- M. Cure sealants in compliance with their manufacturer's instructions to obtain high early bond strength, internal cohesive strength, and durability. Do not disturb seals until completely cured.

3.4 CLEANING AND REPAIRING

- A. Immediately clean work under provisions of Division 01.
- B. Clean adjacent soiled surfaces. Use a cleaning agent as recommended in writing by the sealant manufacturer. Remove any masking tape immediately after tooling joints, leaving finished work in neat and clean condition.
- C. Repair or replace defaced or disfigured caused by work of this Section.

3.5 PROTECTION OF FINISHED WORK

- A. Protect finished installation under provisions of Division 01.
- B. Protect sealant until cured.
- C. Do not paint sealants until sealant is fully cured.
- D. Do not paint silicone sealant.
- E. Protect joint sealants from contact with contaminating substances and from damage. Cut out, remove and replace contaminated or damaged sealants, immediately, so that they are without contamination or damage at time of Project Completion.

END OF SECTION

SECTION 08 11 13
HOLLOW METAL DOORS AND FRAMES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Standard hollow metal doors and frames.
 - 1. Hollow metal doors, rated and non-rated.
 - 2. Hollow metal frames, rated and non-rated.
- B. Door glazing.
- C. Door louvers.
- D. Finish: Field-painted, color as indicated on Drawings; if not indicated, to be selected by Architect. Provide exterior paint system on both interior and exterior faces, four edges, and frames of exterior doors.

1.2 RELATED SECTIONS

- A. Section 06 10 00 – Rough Carpentry.
- B. Section 07 25 00 – Weather Barriers.
- C. Section 07 92 00 – Joint Sealants.
- D. Section 08 14 00 – Wood Doors.
- E. Section 08 81 00 – Glass Glazing.
- F. Section 08 88 13 – Fire Rated Glazing.
- G. Section 09 29 00 – Gypsum Board.
- H. Section 09 91 00 – Painting.
- I. Division 26 Sections for electrical connections including conduit and wiring for door controls and operators.

1.3 REFERENCES

- A. The publications listed below form a part of this Section to the extent referenced. The publications are referred to in the text by the basic designation only. Refer to Division 01 for definitions, acronyms, and abbreviations.
- B. Standards, manuals, and codes refer to the latest edition of such standards, manuals, and codes in effect as of the date of issue of this Project Manual, unless indicated otherwise in CBC Chapter 35 and CFC Chapter 80.

C. Referenced Standards:

1. ANSI/SDI A250.6	– Recommended Practice for Hardware Reinforcing on Standard Steel Doors and Frames.
2. ANSI/SDI A250.8	– Standard Steel Doors and Frames.
3. ASTM A653/A653M	– Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
4. ASTM A1008/A1008M	– Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable.
5. ASTM A1011/A1011M	– Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength.
6. ASTM C578	– Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation.
7. ASTM E283	– Standard Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen.
8. ANSI/NAAMM HMMA 861	– Guide Specifications for Commercial Hollow Metal Doors and Frames.
9. 2022 California Building Code, Section 716 “Opening Protectives,” Paragraph 716.5 “Fire Door and Shutter Assemblies”.	
10. California Code of Regulations, Title 24, Part 12, 2022 California Referenced Standards Code – Chapter 12-7-4, Fire-Resistive Standards.	
11. NAAMM HMMA 840	– Guide Specification for Installation and Storage of Hollow Metal Doors and Frames.
12. NFPA 80	– Standard for Fire Doors and Other Opening Protectives.
13. NFPA 105	– Standard for the Installation of Smoke Door Assemblies and Other Opening Protectives.
14. NFPA 252	– Standard Methods of Fire Tests of Door Assemblies.
15. NFRC 400	– Procedure for Determining Fenestration Product Air Leakage.
16. UL 10B	– Fire Tests of Door Assemblies.
17. UL 10C	– Positive Pressure Fire Tests of Door Assemblies.
18. UL 1784	– Air Leakage Tests for Door Assemblies.

1.4 SUBMITTALS

- A. Submit under provisions of Division 01.
- B. Shop Drawings: Include illustrations and schedule of finish hardware, door and frame size, type, material, fire ratings, construction, finishing, anchoring, glazing, louvers, accessories, and preparation for installing hardware.

1. Method of attachment of frames to structure shall be reviewed by Architect for acceptance or rejection.
2. Details of conduit and preparations for power, signal, and control systems.
- C. Templates: Furnish hardware templates to fabricator of frames to be factory prepared for installation of hardware. Refer to Drawings for hardware requirements.
- D. Submit product data for type of metal primer proposed for use.

1.5 DEFINITIONS

- A. Minimum Thickness: Minimum thickness of base metal without coatings.
- B. Standard Hollow Metal Work: Hollow metal work fabricated according to ANSI/SDI A250.8.

1.6 QUALITY ASSURANCE

- A. Steel door and frame manufacturer shall be SDI certified.
- B. Provide doors and frames complying with ANSI A250.8, ANSI/NAAMM-HMMA 861, and as specified herein.

1.7 REGULATORY REQUIREMENTS

- A. Fire-Rated Doors and Frames: Provide doors and frames complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at positive pressure according to NFPA 252 or UL 10C.
 1. Oversize Fire-Rated Door Assemblies: For units exceeding sizes of tested assemblies, provide certification by a qualified testing agency that doors comply with standard construction requirements for tested and labeled fire-rated door assemblies except for size.
 2. Temperature-Rise Limit: At exit passageways, provide doors that have a maximum transmitted temperature end point of not more than 450 degrees F above ambient after thirty minutes of standard fire-test exposure.
- B. Testing of Fire-Rated Door and Frame Assembly: Conform to applicable requirements of NFPA 252 or UL 10C and State Fire Marshal Standard 12-7-4, "Fire Door Assembly Tests," as referenced in 2022 California Referenced Standards Code, Chapter 12-7-4, "Fire-Resistive Standards".
- C. Doors and Frames for Smoke-Control Door Assemblies: Comply with applicable requirements of NFPA 105 or UL 1784.
- D. Fire-Rated Door and Frame Labels: All fire rated doors and frames shall have metal labels (including "S" labels) permanently fastened to the jamb indicating the fire rating and Testing Agency name.
 1. Do not apply primer or paint over fire rating labels.
- E. Exterior door assemblies shall meet air infiltration requirements of California Energy Code, California Code of Regulations, Title 24, Part 6, Section 110.6, as referenced in 2022 California Building Code, Chapter 13, "Energy Efficiency".
 1. Air Leakage Limits: Manufactured exterior door assemblies shall have air infiltration rates not exceeding 0.3 cubic feet per minute per square foot of door area for

nonresidential single doors (swinging and sliding), and 1.0 cubic feet per minute per square foot for nonresidential double doors (swinging), when tested according to NFRC 400 or ASTM E283 at a pressure differential of 75 pascals or 1.57 pounds per square foot.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver all materials under protective cover and store in upright position within a dry enclosed space in a manner that will prevent rust and damage. Do not create a humidity chamber by using a plastic or canvas shelter that is not adequately vented.
- B. Deliver fully-welded frames with two removable spreader bars across bottom of door frames, tack welded to jambs and mullions.

1.9 PROJECT CONDITIONS

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

1.10 COORDINATION

- A. Coordinate installation of anchorages for hollow metal frames. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors. Deliver such items to Project site in time for installation.

1.11 WARRANTY

- A. For a period of one year from the date of delivery to the original direct purchaser, manufacturer warrants to the original direct purchaser that it will at its option, either repair, replace or otherwise correct any product acknowledged by the manufacturer to be defective in materials or workmanship.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Acceptable Manufacturers, Hollow Metal Doors and Frames:
 - 1. Ceco Door Products, Milan, TN; 888-232-6366, www.cecodoor.com.
 - 2. Curries Company, Mason City, IA; 800-377-3948, www.curries.com.
 - 3. Steelcraft, Cincinnati, OH; 877-671-7011, www.steelcraft.com.
 - 4. Door Components Inc., Fontana, CA; 866-989-3667, www.dcihollowmetal.com.
- B. Substitutions: Under provisions of Division 01.

2.2 MATERIALS

- A. Cold-Rolled Steel Sheets for Doors and Frames: Commercial Steel (CS), Type B, complying with ASTM A1008/A1008M.
 - 1. Use cold-rolled steel for door frames and exposed-to-view surfaces.
- B. Hot-Rolled Steel Sheets and Strip for use at Door Frames: Commercial Steel (CS), Type B; complying with ASTM A1011/A1011M.

1. Steel shall be free of mill scales, pitting, or surface defects; pickled and oiled.
2. Use hot-rolled steel for reinforcement and concealed components only.
- C. Factory-Applied Primer: Manufacturer's standard primer, thickness: two mils minimum, and compatible with ferrous and galvanized metal primers specified in Section 09 91 00.
- D. Refer to Section 08 81 00 and Section 08 88 13 for glass glazing requirements.
- E. Refer to Drawings for hardware requirements.

2.3 STANDARD HOLLOW METAL DOOR FABRICATION

- A. General: Fabricate to sizes shown, providing necessary clearances and bevels to permit operation without binding. Doors shall be free from warp, wave, buckle or other defect. Doors shall be 1-3/4 inches thick, unless otherwise indicated on Drawings.
- B. Flush Door Construction: Door shall be Grade III, Model 2, fabricated with face sheets of 16 gauge steel in accordance with ANSI/SDI A250.8 and galvanized to ASTM A653/A653M A60 at exterior locations and interior wet locations. Door shall be flush with edge seams, weld filled and ground smooth. Bevel lock edge 1/8 inch in 2 inches. Door shall be provided with 16 gauge steel top flush cap welded and ground smooth, and bottom inverted 14 gauge steel channels welded within the door. Door shall be reinforced, stiffened, and sound deadened with impregnated kraft honeycomb core completely filling door cavity, and laminated to the inside faces of panels.
 1. Exterior doors shall be insulated with an expanded polystyrene or polyurethane core, or as standard with manufacturer. Completely fill door cavity with insulation. Expanded polystyrene to be ASTM C578, Type 1 or Type 2, with minimum one pound per cubic foot density.
- C. Preparation of Hardware: Per ANSI/SDI A250.6, door shall be mortised, reinforced, drilled and tapped at the factory from templates for all mortise hardware listed in the Hardware Schedule. Door shall be reinforced for surface applied hardware such as closers, checks, escutcheons and kick plates; drilling and tapping to be done in the field by door installer. Reinforcement to be 12 gauge for locksets and latchsets, and 14 gauge for surface applied hardware, except use 3/16-inch thick plate for butt hinges. Door shall be provided with reinforcing unit as recommended by lock manufacturer.
- D. Hardware Mounting Heights and Door Clearances: In accordance with 2022 California Building Code.

2.4 STANDARD HOLLOW METAL FRAME FABRICATION

- A. General:
 1. Provide fully-welded frames.
 2. Hollow metal frames shall be formed to shapes and sizes shown.
- B. Full Profile Welded Frames: Head and jamb splices shall be fabricated with mitered, coped and continuously welded inside and outside corners and be finished on the outside face to present a smooth surface for painting.
- C. Frames shall be fabricated from 16 gauge steel, and shall be designed with integral stop and trim. All corners shall be reinforced with 18 gauge "L" shaped reinforcements welded on the inside face of the frame.

- D. Reinforce frames wider than 48 inches with roll formed steel channels fitted tightly into frame head, flush with top.
- E. Frames shall be galvanized to ASTM A653/A653M A60 at exterior locations and interior wet locations.
- F. Preparation for Hardware: Per ANSI/SDI A250.6, frame shall be prepared at the factory for all hardware using templates furnished by hardware supplier. Locations of miscellaneous hardware shall conform to the recommendations for the Door and Hardware Institute. Mortise, reinforce, drill and tap for mortise type hardware. Reinforce frames for surface applied hardware; drilling and tapping to be done in the field by door installer.
 - 1. Hardware cutouts shall have steel plate reinforcements with tapped holes fillet welded to frame on all four sides of the plate. Fillet welds shall be minimum 1 inch long. Reinforcement shall include 3/16 inch butt reinforcement; 12 gauge lock strike; 14 gauge for surface applied items.
 - 2. Provide strike stops at frames to receive hollow metal or wood doors with holes for three rubber door silencers. On double door frames, provide for two silencers per door at head. Omit holes at frames to receive unitized gasketing.

2.5 ANCHORS

- A. Frame shall be anchored to structure with anchors appropriate for use with type of adjacent construction. Anchorage shall securely fasten frames to wall construction involved. Provide a minimum three anchors, including one adjustable floor clip, at each door jamb. Frames taller than eight feet in height will require additional anchors at each jamb. Anchors shall be minimum 16 gauge steel and shall provide stiffness and rigidity to keep frames square, in accurate position without twisting, buckling or warping. Floor clips shall be anchored to the concrete slab using concrete screws by Hilti, Simpson, or accepted equal. Fasteners to wall framing substrate shall be the following minimums; greater as required by the frame manufacturer or as conditions warrant:
 - 1. Wood Framing: Four #10 wood screws per strap anchor (two each side), length as required; fastener to penetrate a minimum of 1-1/2 inches into framing member.

2.6 PRIMING

- A. Doors and frames shall be leveled and welds ground smooth. Apply mineral filler to eliminate weld scars and other blemishes.
- B. Shop Priming: All surfaces shall be cleaned, phosphatized, and given one coat of baked-on rust-inhibiting primer in accordance with the Steel Door Institute Specification "Test Procedure and Acceptance Criteria for Primer Painted Steel Doors and Frames".
 - 1. Do not prime paint over fire-rated door and frame labels.

2.7 ACCESSORIES

- A. Glazing Stops: LoPro by Anemostat or Slimline by Air Louvers, Inc. Galvanized steel; mitered corners; prepared for countersink style screws. Sizes as indicated on Drawings. Install glazing stop fasteners on the non-secure side of doors. Finish shall be factory primed to receive site paint finish, color as selected by Architect.
 - 1. At fire-rated assemblies, fire-rating of glazing stops shall match fire-rating of opening. Fire-rated glazing stops shall bear the listing mark of Underwriters Laboratories and/or Warnock Hersey, and shall be visible without removal of the frame from the door.

- B. Glass Glazing: As specified in Section 08 81 00 and Section 08 88 13.
- C. Non-Rated Door Louvers: AFDL by Anemostat or Model 800 A1 by Air Louvers, Inc. Fabricate from galvanized cold rolled steel sheet. Frame shall be 18 gauge and blades shall be 22 gauge. Permanent interlocking construction shall be used to secure blades to frame on stationary louvers. Frames shall have mitered and flush welded corners. Factory install screens, aluminum wire mesh. Louvers shall have fifty percent free area minimum; sizes as indicated on Drawings. Finish shall be factory primed to receive site paint finish, color as selected by Architect.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that opening sizes and tolerances are acceptable.

3.2 INSTALLATION

- A. Install doors and frames in accordance with ANSI A250.8, ANSI/NAAMM-HMMA 861, and NFPA 80, as applicable.
- B. Set frames level and plumb, and brace adequately to prevent damage or distortion. Secure to structure with minimum of three anchors at each jamb. Field joints shall be welded, body puttied and ground smooth.
 - 1. Removable Spreaders: Wherever possible, leave frame spreaders intact until frames are set perfectly square and plumb, and anchors are securely attached.
- C. Door Installation in Hollow Metal Frames: Fit hollow metal and wood doors accurately in frames.
- D. Coordinate installation of doors and frames with installation of doors specified in Section 08 14 00, hardware indicated on Drawings, and glazing as specified in Section 08 81 00 and Section 08 88 13, and louvers as specified in this Section.

3.3 ERECTION TOLERANCES

- A. Maximum Diagonal Distortion: 1/16 inch measured with straight edge, corner to corner.

3.4 ADJUST AND CLEAN

- A. Prime Coat Touch-Up: Immediately after erection, sand smooth all rusted or damaged areas of prime coat and apply touch-up of compatible air-drying primer. Touch-up shall not be obvious.
- B. Cleaning and Finishing: Upon completion of the work, clean all exposed surfaces, removing any discoloration or foreign matter, and touch up all abraded or cut areas and exposed edges with finishing material recommended by the manufacturer. Touch-up of finish shall not be obvious.
- C. Final Adjustments: Adjust door for smooth and balanced door movement. Check and readjust operating finish hardware in hollow metal work immediately prior to final inspection. Leave work in complete and proper operating condition.

- D. Defective Work: Remove and replace defective work, including doors and frames which are warped, bowed or otherwise damaged, as directed by Architect, at no cost to Owner.
- E. Protection: Protect installed hollow metal work against damage from other construction work.

3.5 CLEAN-UP

- A. Upon completion of the work of this Section, remove all excess materials, rubbish, and debris from the premises.

END OF SECTION

SECTION 08 14 00

WOOD DOORS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Rated and Non-Rated Flush Wood Doors.
- B. Door Glazing.

1.2 RELATED SECTIONS

- A. Section 08 11 13 – Hollow Metal Doors and Frames.
- B. Section 08 81 00 – Glass Glazing.
- C. Section 08 88 13 – Fire Rated Glazing.
- D. Section 09 91 00 – Painting.

1.3 REFERENCES

- A. The publications listed below form a part of this Section to the extent referenced. The publications are referred to in the text by the basic designation only. Refer to Division 01 for definitions, acronyms, and abbreviations.
- B. Standards, manuals, and codes refer to the latest edition of such standards, manuals, and codes in effect as of the date of issue of this Project Manual, unless indicated otherwise in CBC Chapter 35 and CFC Chapter 80.
- C. Referenced Standards:
 - 1. ANSI/WDMA I.S.1-A – Architectural Wood Flush Doors.
 - 2. ASTM F152 – Standard Test Methods for Tension Testing of Nonmetallic Gasket Materials.
 - 3. 2022 California Building Code, Section 716 “Opening Protectives”, Paragraph 716.2 “Fire Door Assemblies”.
 - 4. California Referenced Standard Code – SFM Standard 12-7-4, Fire Door Assembly Tests.
 - 5. ITS Directory of Listed Products.
 - 6. NFPA 80 – Fire Doors and Windows.
 - 7. NFPA 252 – Standard Test Methods for Fire Door Assemblies.
 - 8. UL 10C – Standard for Positive Pressure Fire Tests of Door Assemblies.
 - 9. WI/AWMAC North American Architectural Woodwork Standards, including WI Supplemental Text.

1.4 SUBMITTALS

- A. Submit under provisions of Division 01.
- B. Shop Drawings: Illustrate door opening criteria, elevations, sizes, types, fire ratings, swings, undercuts required, special beveling, special blocking for hardware, and identify cutouts for glazing.
- C. Product Data: Submit product data for each product specified in this Section with the product and selected attributes clearly identified, including veneer species and cut, factory machining criteria, and factory finishing criteria.

1.5 QUALITY ASSURANCE

- A. Single Source Responsibility: All doors specified in this Section shall be manufactured and provided by a single manufacturer to ensure door compatibility and quality.
- B. Perform work in accordance with WI/AWMAC, Section 9, Custom Grade.
- C. Other requirements shall conform to WDMA I.S. 1A-04 as follows:

Performance Attribute	Duty Level
	Extra Heavy Duty
Adhesive Bond Durability WDMA TM-6, 1988	Type I
Cycle Slam WDMA TM-7, 1990	1, 000,000 cycles
Hinge-Loading WDMA TM-8, 1990	550 pounds
Screwholding WDMA TM-10, 1990	
Door Face Unblocked	550 pounds
Door Face (with optional blocking)	700 pounds
Vertical Door Edge	550 pounds
Horizontal Door Edge (applies when hardware attached)	300 pounds
Telegraph WDMA T-1	Maximum 0.010 inch per 3-inch span
Warp Tolerance WDMA T-2	Maximum 0.25 inch per 3 foot 6 inches by 7 foot door section
Squareness WDMA T-3	Diagonal Variance 0.125 inch

1.6 REGULATORY REQUIREMENTS

- A. Fire-Rated Wood Doors: Doors complying with 2022 California Building Code (CBC), Section 716 "Opening Protectives", Paragraph 716.2 "Fire Door Assemblies", and NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at positive pressure according to NFPA 252 or UL 10C, as applicable.
- B. Fire Door Construction: Conform to NFPA 252 and California State Fire Marshal Standard 12-7-4.

- C. Fire-Rated Doors: All fire rated doors shall have metal labels (including "S" labels) permanently fastened to the hinge stile indicating the fire rating and Testing Agency name. Do not apply primer or paint over fire rating labels.

1.7 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing the products specified in this Section.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, protect and handle products to site under provisions of Division 01.
- B. Accept doors on site in manufacturer's packaging. Inspect for damage.
- C. Comply with requirements in ANSI/WDMA I.S.1A: How to store, handle, finish, install and maintain wood doors.
- D. In the event of damage, immediately make all repairs and replacements necessary at no additional cost to Owner.
- E. Store flat on a level surface in a dry, well-ventilated building. Cover to keep clean but allow air circulation.
- F. Handle with clean gloves and do not drag doors across one another or across other surfaces.
- G. Do not subject door to abnormal heat, dryness or humidity.
- H. Deliver in clean trucks and, in wet weather, under cover.

1.9 FIELD MEASUREMENTS

- A. Verify that field measurements are as indicated on shop drawings.

1.10 COORDINATION

- A. Coordinate the work with door opening construction, doorframe, door hardware, and door glazing installation.

1.11 WARRANTY

- A. Provide warranty under provisions of Division 01.
- B. Warranty Period:
 - 1. Interior Solid Core Standard Doors: Life of installation.
 - 2. Include coverage for delamination of veneer, warping or twisting (not to exceed 1/4 inch in any face including diagonal) or other defects. Warranty shall cover replacement of door plus costs of hanging and finishing.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Acceptable Manufacturers:
 - 1. Oregon Door, Winston, OR; 541-679-6791, www.oregondoor.com.

2. VT Industries, Holstein, IA; 800-827-1615, www.vtindustries.com.
3. Lynden Door, Inc, Lynden, WA; 800-631-3667, www.lyndendoor.com.

B. Substitutions: Under provisions of Division 01.

2.2 DOOR CONSTRUCTION

- A. All doors shall be 1-3/4 inch thickness, unless noted otherwise.
- B. Solid, non-rated particleboard core: WI/AWMAC Section 9, 5-ply; Custom Grade.
- C. Solid, 20-minute rated particleboard core: WI/AWMAC Section 9, 5-ply, Custom Grade.
- D. Solid, 45-minute rated mineral core: WI/AWMAC Section 9. Stile edges shall be a minimum of 1 inch before trim on hinge side and 3/4 inch on lock side, including 1/4 inch outer edge band of hardwood.
- E. Faces: Paint grade birch veneer for opaque finish. Use solid stock for exposed edges. Face veneers shall not be less than 1/50 inch at 12 percent moisture content after factory sanding. Crossbanding shall be one-piece high density fiberboard (HDF), MDF will not be allowed as a veneer substrate (crossband). Thin veneers are not acceptable.
- F. Provide solid blocking on doors with surface mounted hardware or closers, for attachment with screws in lieu of through-bolts.
- G. Top and bottom rails shall be a minimum of 2-1/4 inch before trimming, mill option species structural composite lumber for 20 minute rated and non-rated doors.
- H. Fire Resistive Doors with 20 Minute Fire Rating (positive pressure): Construction shall have fire rating of not less than 20 minutes when tested in accordance with NFPA 252 or UL 10C and SFM Standard 12-7-4.
- I. Fire Resistive Doors with 45 Minute or Longer Fire Ratings (positive pressure): Meet requirements of SFM Standard 12-7-4, UL 10 (b)-80, and ASTM F152 for fire rating noted.

2.3 ADHESIVE

- A. Facing Adhesive: Type I – waterproof.

2.4 ACCESSORIES

- A. Glazing Stops: LoPro by Anemostat or Slimline by Air Louvers, Inc. Galvanized steel; mitered corners; prepared for countersink style screws. Sizes as indicated on Drawings. Install glazing stop fasteners on the non-secure side of doors. Factory paint finish in custom color as selected by Architect.
 1. At fire-rated assemblies, fire-rating of glazing stops shall match fire-rating of opening. Fire-rated glazing stops shall bear the listing mark of Underwriters Laboratories and/or Warnock Hersey, and shall be visible without removal of the frame from the door.

B. Glass Glazing: As specified in Section 08 81 00 and Section 08 88 13.

2.5 FABRICATION

- A. Fabricate non-rated doors in accordance with WI/AWMAC North American Architectural Woodwork Standards requirements.

- B. Provide blocking at top of door for closer for attachment with screws.
- C. Bond edge banding to cores.
- D. Factory machine doors for finish hardware in accordance with hardware requirements and dimensions. Do not machine for surface hardware.
- E. Undercut doors where indicated on Drawings.
- F. Glass Cutouts: Provide cutouts for glass of size and shape indicated. Glass for doors is specified under Section 08 81 00 and Section 08 88 13.
- G. Factory seal top and bottom rails before shipment.
- H. Bevel both stiles 1/8 inch in 2 inches (3 degree bevel) and undersize doors 1/4 inch in width so that they swing freely and do not hinge bind.

2.6 FINISH

- A. All doors shall be site paint finished under provisions of Section 09 91 00. Apply finish at all faces and edges of doors. Colors as selected by Architect.
 - 1. Do not paint over fire rated door labels.

PART 3 EXECUTION

3.1 EXAMINATION

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

3.2 INSTALLATION

- A. Install rated and non-rated doors in accordance with WI/AWMAC Section 9 requirements, SFM Standard 12-7-4, and UL or Intertek Testing Services (ITS) requirements.
- B. Pre-adjust door height, supply doors with factory undercut.
- C. Where required, trim non-rated door width by cutting equally on both jamb edges.
- D. Where required, trim door height by cutting bottom edge to a maximum of 1/2 inch above finished floor or threshold.
- E. Pilot drill screw and bolt holes.
- F. Machine cut for hardware. Core for handsets and cylinders.
- G. Coordinate installation of doors with installation of frames specified in Section 08 11 13, hardware indicated on Drawings, and glazing as specified in Section 08 81 00 and Section 08 88 13.

3.3 INSTALLATION TOLERANCES

- A. Maximum Diagonal Distortion (Warp): 1/4 inch measured with straight edge or taut string, corner to corner, over an imaginary 36 inch x 84 inch surface area.
- B. Maximum Vertical Distortion (Bow): 1/4 inch measured with straight edge or taut string, top to bottom, over an imaginary 36 inch x 84 inch surface area.

3.4 ADJUSTING

- A. Adjust work under provisions of Division 01.
- B. Adjust door for smooth and balanced door movement, and wipe clean.

END OF SECTION

SECTION 08 31 00
ACCESS DOORS AND PANELS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Fire rated access doors.
- B. Non-fire rated access doors.

1.2 RELATED SECTIONS

- A. Section 06 10 00 – Rough Carpentry.
- B. Section 09 29 00 – Gypsum Board.
- C. Section 09 91 00 – Painting.

1.3 REFERENCES

- A. The publications listed below form a part of this Section to the extent referenced. The publications are referred to in the text by the basic designation only. Refer to Division 01 for definitions, acronyms, and abbreviations.
- B. Standards, manuals, and codes refer to the latest edition of such standards, manuals, and codes in effect as of the date of issue of this Project Manual, unless indicated otherwise in CBC Chapter 35 and CFC Chapter 80.
- C. Referenced Standards:
 - 1. ITS Directory of Listed Products.
 - 2. UL Building Materials Directory.
 - 3. NFPA 80.

1.4 SUBMITTALS

- A. Submit under provisions of Division 01.
- B. Product Data: Include sizes, finish, and hardware.
- C. Shop Drawings: Show scheduled locations and details of adjoining work.

1.5 REGULATORY REQUIREMENTS

- A. Conform to requirements of CBC Section 1208 for access to unoccupied spaces.
- B. Labeling of fire-rated assemblies:
 - 1. Fire rated access doors shall be labeled per CBC Section 716.2.9 and Title 24, Part 12, 2022 California Referenced Standards Code – Chapter 12-7-4, Fire-Resistive Standards; Section 12-7-407.

1.6 PRE-INSTALLATION MEETINGS AND COORDINATION

- A. Conduct pre-installation meeting in accordance with provisions of Division 01.
- B. Convene pre-installation meeting prior to commencing work of this Section.
- C. Coordinate work in this Section with work in related Sections.

1.7 WARRANTY

- A. Manufacturer warrants for one year that products will be free from defects in materials and workmanship, with liability expressly to replacement of product not complying with this warranty.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Acceptable Manufacturers:
 - 1. Nystrom Building Products, Minneapolis, MN; 800-547-2635, www.nystrom.com.
 - 2. Karp Associates, Inc., Maspeth, NY; 718-784-2105, www.karpinc.com.
 - 3. J.L. Industries Inc., Bloomington, MN; 952-835-6850, www.jlindustries.com.
 - 4. Milcor, Inc., Holland, OH; 800-528-4144, www.milcorinc.com.
- B. Substitutions: Under provisions of Division 01.

2.2 ACCESS DOORS

- A. Fire Rated Access Doors for Gypsum Board:
 - 1. Product: UL rating 1.5 hours (B label); ITS rating 3 hours in ceiling.
 - a. Nystrom, Model IW.
 - b. Karp, Model KRP-350FR.
 - 2. Components:
 - a. Sizes: As shown on the Drawings.
 - b. Frame: 16 gauge steel.
 - c. Door: 20 gauge steel.
 - d. Hinge: Continuous piano hinge (Karp), concealed pin hinge (Nystrom).
 - e. Latch: Bolt type, key operated, self-latching with automatic closer and interior latch release.
 - f. Insulation: 2 inch thick fire rated mineral fiber.
 - g. Finish: Phosphate dipped, prime coat of rust inhibitive primer, and white powder coat finish.
- B. Non-Rated Access Doors for Gypsum Board:
 - 1. Product:
 - a. Nystrom, Model NW.
 - b. Karp, Model KDW.

2. Components:

- a. Sizes: As shown on the Drawings.
- b. Frame: 16 gauge steel.
- c. Door: 16 gauge steel.
- d. Hinge: Concealed continuous piano hinge.
- e. Latch: Key operated, stainless steel cam and stud.
- f. Finish: Phosphate dipped, prime coat of rust inhibitive primer, and white powder coat finish.

2.3 FABRICATION

- A. Welded construction.
- B. Manufacture each access panel assembly as an integral unit ready for installation.
- C. Furnish with a sufficient quantity of 1/4 inch diameter mounting holes to secure access panels to types of supports indicated on Drawings.
- D. Furnish number of latches required to hold panel in flush, smooth plane when closed.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine job site conditions and verify field dimensions. Verify structure is plumb, level, and parallel. Verify rough openings for door and frame are correctly sized and located.
- B. Report unacceptable conditions to the Architect. Begin installation only when unacceptable conditions have been corrected.

3.2 INSTALLATION

- A. Install in accordance with manufacturer's printed instructions and approved shop drawings.
- B. Install units plumb, level, and square, and free from warp or twist while maintaining dimensional tolerances and alignment with surrounding construction. Secure rigidly in place.
- C. Position unit to provide convenient access to concealed work requiring access.
- D. Install fire-rated units in accordance with NFPA 80 and requirements for fire listing.

3.3 ADJUSTING AND REPAIRING

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

END OF SECTION

SECTION 08 32 13

SLIDING ALUMINUM-FRAMED GLASS DOORS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Thermally broken aluminum framed sliding doors with insulating glazing units (IGU) and accessories.

1.2 RELATED SECTIONS

- A. Section 06 10 00 – Rough Carpentry.
- B. Section 07 25 00 – Weather Barriers.
- C. Section 07 62 00 – Sheet Metal Flashing and Trim.
- D. Section 07 92 00 – Joint Sealants.
- E. Section 08 81 00 – Glass Glazing.

1.3 REFERENCES

- A. The publications listed below form a part of this Section to the extent referenced. The publications are referred to in the text by the basic designation only. Refer to Division 01 for definitions, acronyms, and abbreviations.
- B. Standards, manuals, and codes refer to the latest edition of such standards, manuals, and codes in effect as of the date of issue of this Project Manual, unless indicated otherwise in CBC Chapter 35 and CFC Chapter 80.
- C. Referenced Standards:
 - 1. AAMA/WDMA/CSA101/I.S.2/A440 – North American Fenestration Standard/Specification for Windows, Doors, and Skylights.
 - 2. AAMA 502-12 – Voluntary Specification for Field Testing of Newly Installed Fenestration Products.
 - 3. AAMA 609 – Cleaning and Maintenance Guide for Architecturally Finished Aluminum.
 - 4. AAMA 611 – Voluntary Specification for Anodized Architectural Aluminum.
 - 5. AAMA 2605 – Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels.
 - 6. ASTM E283 – Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen.
 - 7. ASTM E330 – Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference.

- 8. ASTM E547 – Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Cyclic Static Air Pressure Difference.
- 9. ASTM E2068 – Standard Test Method for Determination of Operating Force of Sliding Windows and Doors.
- 10. ASTM F842 – Standard Test Methods for Measuring the Forced Entry Resistance of Sliding Door Assemblies, Excluding Glazing Impact.
- 11. GANA 01-0300 – Proper Procedures for Cleaning Architectural Glass Products.
- 12. NFRC 100 – Procedure for Determining Fenestration Product U-Factors.
- 13. NFRC 200 – Procedure for Determining Fenestration Product Solar Heat Gain Coefficient and Visible Transmittance at Normal Incidence.

1.4 SUBMITTALS

- A. Submit under provisions of Division 01.
- B. Shop Drawings: For each installation and for special components not dimensioned or detailed in manufacturer's product data.
 - 1. Provide shop drawings indicating details of construction and installation including but not limited to door location chart, door schedule, size, muntin type and design, sections and details of multiple door assemblies, hardware, glazing details, frame type, STC, glass types, screens and handing operation. Show locations.
- C. Product Data: Submit product data for each product specified in this Section with the product and selected attributes clearly identified.
- D. Certified test laboratory reports to show compliance with requirements.
 - 1. Doors with sizes exceeding the gateway sizes do not qualify under these tests.
 - 2. Doors manufactured with configurations different from the tested configurations do not qualify under these tests.
 - 3. Doors can be tested for performance outside the already tested gateway sizes.
 - 4. Doors with hardware not referenced on the test reports do not qualify under these tests.
- E. Submit manufacturer's installation and maintenance instructions.

1.5 PERFORMANCE REQUIREMENTS

- A. Design pressure, air infiltration and water penetration to AAMA/WDMA/CSA 101/I.S.2/A440 C-30.
- B. Uniform Load Deflection and Uniform Load Structural to ASTM E330.
- C. Air Leakage to ASTM E283 at 1.57 psf: 0.3 cfm/ft² maximum.
- D. Water Penetration to ASTM E547 at 4.59 psf: No leakage.
- E. Forced Entry Resistance to ASTM F842.
- F. Operating Force to ASTM E2068.
- G. U-Value 0.24 – 0.29.

H. Solar Heat Gain Coefficient (SHGC) 0.30.

1.6 REGULATORY REQUIREMENTS

A. Exterior windows shall be certified under provisions of the 2022 California Energy Code, Section 110.6.

1. A window's U-factor shall be rated in accordance with NFRC 100, using the specific glazing and window system assemblies to be installed on the Project.
2. A window's Solar Heat Gain Coefficient (SHGC) shall be rated in accordance with NFRC 200, using the specific glazing and window system assemblies to be installed on the Project.
3. Provide factory-applied temporary NFRC labels, not to be removed before inspection by the enforcement agency, listing the certified U-factor and SHGC, and certifying that the air leakage requirements specified in this Section are met for each type of window, and have a factory-applied permanent NFRC label if the product is rated using NFRC procedures.

OR

Provide label certificate (Bid Report) for each type of window product indicating compliance with the U-factors listed in Table 110.6-A, SHGC values listed in Table 110.6-B, and air leakage requirements specified in this Section.

Fenestration products may only be installed when documentation indicating compliance with the above has been provided.

4. A Certificate of Acceptance shall be submitted to the enforcement agency that certifies that the window product meets the acceptance requirements.

1.7 QUALITY ASSURANCE

A. Manufacturer Qualifications: Minimum ten years' experience in producing aluminum doors of the type specified.

B. Installer Qualifications:

1. Licensed with a minimum 3 years' experience installing similar doors.

C. Mock-ups: Provide and install at job site a mock-up using acceptable products and manufacturer approved installation methods.

D. Obtain Owner's and Architect's acceptance of finish color and workmanship standard.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Delivery:

1. Deliver materials in accordance with manufacturer's written instructions.
2. Deliver materials in manufacturer's original, unopened, undamaged containers or packaging with identification labels intact, product name and manufacturer clearly visible.
3. Deliver in sizes to suit project.

B. Material Storage:

1. Store materials protected from exposure to harmful environmental conditions, clean, dry, frost-free and at manufacturer's recommended temperature and humidity levels.

C. Handling:

1. Exercise care during off-loading and installation to avoid damage and marring of finishes.
2. Handle in a manner to distribute material load evenly to prevent twisting, bending and cracking of windows, doors and associated parts.
3. Replace any products damaged during handling with new materials.

1.9 WARRANTY

A. Manufacturer's Warranty

1. Submit, for Owner's acceptance, manufacturer's standard warranty document executed by authorized company official.
2. Manufacturer's warranty is in addition to and not intended to limit other rights.
3. Replace any products damaged during handling.

PART 2 PRODUCTS

2.1 MANUFACTURER

A. Acceptable Manufacturers:

1. Basis of Design: All Weather Architectural Aluminum, Vacaville, CA; 707-452-1600, www.allweatheraa.com. Product: Series 8000 Thermally Broken Aluminum Sliding Doors.
2. C.R. Laurence. Product; Model 3040 Sliding Doors.

B. Substitutions: Under provisions of Division 01.

2.2 DESCRIPTION

A. Aluminum Framed Sliding Door: Thermally broken aluminum framed sliding doors with insulating glazing units (IGU) and accessories.

1. Door Dimensions: See drawings for door types and configurations.

2.3 MATERIALS

A. Frames: 4-15/16 inch Thermal Strut, thermally broken extruded aluminum Type 6063 age hardened to T-6 rating for strength and durability.

1. Finish Type: 70 percent Kynar paint system, in custom color indicated on Drawings.

B. Glazing: 1 inch insulating glass units, refer to Section 08 81 00.

C. Head and Sill Track: Extruded aluminum with polyamide thermal strut to suit door configuration.

D. Rollers: 3 inch diameter stainless steel precision bearing rollers.

1. Roller track: PVC with stainless steel cap.

2.4 FABRICATION

A. Fabricator: Use only fabricators who have training and three years minimum experience of work similar to work of this Section.

- B. Fabricate sliding door frame, stile, rails and track from thermally broken extruded aluminum sections to sizes and profiles indicated.

- 1. Prepare knock-down frames to receive glazed, fixed, and vent panels on site.

2.5 ACCESSORIES

- A. Hardware:

- 1. Lock: Interior thumb turn locking mechanism with keyed exterior locking device.
 - 2. Handles: Manufacturer's standard pull handle complying with ADA and CBC Chapter 11B accessibility requirements.
 - 3. Panel stops: Aluminum with rubber bumper.

- B. Screens:

- 1. Extrude aluminum to match door frames for door configurations.

- C. Weatherstripping:

- 1. Pile weatherstripping.
 - 2. Triple fin and Quiet fin technology.

2.6 SOURCE QUALITY CONTROL

- A. Use only fabricators who have training and experience similar to work of this Section.
- B. Ensure all door framing materials come from single manufacturer.

PART 3 EXECUTION

3.1 INSTALLER

- A. Use only licensed installers who have training and experience of similar work of this section.

3.2 EXAMINATION

- A. Verification of Conditions: Verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for aluminum door installation in accordance with manufacturer's written recommendations.

- 1. Visually inspect substrate.
 - 2. Verify openings are dimensionally correct and within allowable tolerances, and substrates are plumb, level and clean.
 - 3. Verify in the presence of the Architect that anchoring surface is in accordance with approved shop drawings.
 - 4. Inform Architect of unacceptable conditions immediately upon discovery.
 - 5. Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Architect.
 - 6. Starting door installation implies substrate conditions are acceptable for Work of this Section.

3.3 INSTALLATION

- A. Install aluminum doors in accordance with manufacturer's written recommendations.

3.4 SEALANTS

- A. Apply sealant in accordance with manufacturer's written guidelines.

3.5 FIELD QUALITY CONTROL

- A. Comply with AAMA 502-12.
- B. Field Testing Performance:
 - 1. To AAMA 502-12, Section 1.1.
- C. Proper Execution of Field Test:
 - 1. Ensure door is plumb, level and square.
 - a. If conditions fall outside the +/-1/8 inch tolerance, do not test the product.
 - b. Test at a pressure greater than 2/3 the fenestration product laboratory test pressure.
- D. Qualification of the agency performing the test:
 - 1. Ensure AAMA accreditation by independent testing agency.
- E. Site Visits:
 - 1. Schedule site visits to review work at stages listed:
 - a. After delivery and storage of aluminum doors and when preparatory work on which work of this section depends is complete, but before application begins.
 - b. Twice during progress of work at 25 percent and 60 percent complete.
 - c. Upon completion of work, after cleaning is carried out.
 - 2. Obtain reports within three days of review and submit immediately to Architect.

3.6 CLEANING

- A. Clean sealants, caulking and other materials from surfaces, including adjacent work.
- B. Clean frames, casings and glass using materials and methods recommended by the manufacturer.
- C. Clean using methods which comply with AAMA 609.
- D. Clean glass using methods which comply with GANA 01-0300
- E. Protect installed products until completion of project.

3.7 PROTECTION

- A. Protect installed aluminum doors from damage during construction.
- B. Repair or replace adjacent materials damaged by installation of aluminum doors.

END OF SECTION

SECTION 08 33 23.13
HIGH SPEED ROLL-UP DOORS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Insulated high-speed overhead coiling service doors, motor operation.

1.2 RELATED SECTIONS

- A. Section 05 40 00 – Cold-Formed Metal Framing.
- B. Section 06 10 00 – Rough Carpentry.
- C. Section 08 71 00 – Door Hardware: Cylinder locks.
- D. Division 26 – Electrical: Motor and Controls Connections.

1.3 REFERENCES

- A. The publications listed below form a part of this Section to the extent referenced. The publications are referred to in the text by the basic designation only. Refer to Division 01 for definitions, acronyms, and abbreviations.
- B. Standards, manuals, and codes refer to the latest edition of such standards, manuals, and codes in effect as of the date of issue of this Project Manual, unless indicated otherwise in CBC Chapter 35 and CFC Chapter 80.
- C. Referenced Standards:
 - 1. ASCE 7 – Minimum Design Loads and Associated Criteria for Buildings and Other Structures.
 - 2. ASTM A653 – Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

1.4 SUBMITTALS

- A. Submit under provisions of Division 01.
- B. Shop Drawings: Indicate pertinent dimensioning, anchorage methods, hardware locations, electrical connections and controls, and installation details. Method of attachment to structure shall be acceptable to Architect.
- C. Product Data: Submit product data for each product specified in this Section with the product and selected attributes clearly identified.
- D. Samples: Provide 2 minimum 6 inch x 6 inch samples of selected finish color on specified substrate.
- E. Manufacturer's Written Installation Instructions: Indicate installation sequence and procedures, and adjustment and alignment procedures.

1.5 PERFORMANCE REQUIREMENTS

- A. Comply with structural design criteria for the project location in accordance with 2025 California Building Code (CBC) and as noted in the Structural Drawings.

1.6 SYSTEM DESCRIPTION

- A. High-speed motor operated overhead coiling door unit.
- B. Face-of-wall surface mounted.

1.7 MAINTENANCE DATA

- A. Submit under provisions of Division 01.
- B. Maintenance Data: Indicate lubrication requirements and frequency, and periodic adjustments required.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials and products in labeled protective packages. Store and handle in strict compliance with manufacturer's written installation instructions and recommendations. Protect from damage from weather, excessive temperatures, and construction operations.

1.9 FIELD MEASUREMENTS

- A. Verify that field measurements are as indicated on shop drawings.

1.10 WARRANTY

- A. Door Assembly: Provide manufacturer's two year limited warranty.
- B. Finish: PowderGuard Premium finish applied to curtain, guides, bottom bar, headplates: Manufacturer's limited Premium Finish warranty for two years.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Acceptable Manufacturers:
 - 1. Overhead Door, 800-929-3667, www.overheaddoor.com. Product: Model 998 high-speed metal roll-up industrial door
 - 2. CornellCookson, LLC., Mountain Top, PA; 800-233-8366, www.cornellcookson.com.
- B. Substitutions: Under provisions of Division 01.

2.2 HIGH-SPEED METAL DOORS

- A. Aluminum Panels: Double-wall insulated construction with metal hinge system and integral weather seal between slats, designed to allow removal of individual slats.
- B. Door sizes: As indicated on Drawings.
- C. Mounting: Surface-mounted on interior side.

- D. Performance Standards: DASMA 403 requirements for high-performance doors.
- E. Opening Speed: Door to operate at variable speed up to 80 inches per second.
- F. Closing Speed: Door to operate at variable speed up to 20 inches per second.
- G. Operation Cycles: Drive motor and gearbox capable of operating for not less than one million cycles. One operation cycle is complete when door is opened from closed position to fully open position and returned to closed position.
- H. Usage Classification: Heavy duty. No chain and sprocket allowed.
- I. Durability: Doors shall operate at minimum of one million cycles when selected, installed, operated, and maintained.
- J. Wind Load: Design door assembly to withstand ultimate static wind load of 50 psf in accordance with ASTM E330/E330M on door 15 feet wide.
- K. Curtain Material: insulated double-walled 6063-T6 aluminum, 5.8 inches wide by 1.2 inches thick, with 6063-T6 aluminum for hinge system. Doors using hinges not made of metal not acceptable. Provide UV-resistant weather seal between aluminum panel sections.
 - 1. Finish: PowderGuard Premium powder coat.
 - a. Color: As selected by Architect.
- L. Vision Panels: Polycarbonate sheet with proprietary abrasion- and UV-resistant surfaces.
 - a. Number and size of vision panels: As indicated on Drawings.
- M. Bottom Bar: 6063-T6 aluminum with integrated wireless sensing edge.
 - 1. Finish: PowderGuard Premium powder coat.
 - a. Color: As selected by Architect.
- N. Weatherstripping and Seals: Vinyl seal located at guide edges and vinyl brush seal where curtain enters hood enclosure. Bottom seal is rubber astragal.
- O. Side Guides, Channels: Constructed of high-strength steel with members fully bolted together. Guides have full-height weather seal.
 - 1. Finish: PowderGuard Premium powder coat.
 - a. Color: As selected by Architect.
- P. Door Header: Top-roll assembly fabricated of high-strength steel barrel, supported with powder-coated, high-strength steel brackets at each end with self-aligning bearings.
 - 1. Drum Barrel System: ASTM A500/A500M Grade B, high-strength steel pipe; minimum 6-5/8 inches diameter.
 - 2. Brackets: ASTM A36/A36M hot-rolled steel with heavy-duty, self-aligning bearings with cast iron housings; minimum 1/4 inch thick.
 - 3. Head frame provided with single brush seal along lintel.
 - 4. Finish: PowderGuard Premium powder coat.
 - a. Color: As selected by Architect.
- Q. Fascia and motor cover: Galvanized steel: 22 gauge, 0.03 inch.

1. Finish: Powder coated to match door.
- R. Obstruction Safety Detection:
 1. Dual infrared sensors mounted in-plane to door curtain at 18 inches and 50 to 54 inches above finished floor.
 2. Light curtain in-plane to travelling path of door curtain. Size: 6 feet.
- S. Reversing Safety Edge: Door shall be provided with monitored failsafe electric safety edge. Controller indicates inoperable safety edge.
 1. Connections between safety edge and controller shall be wireless. No coil cords allowed.
 2. Replacement of bottom bar wireless system battery shall be performed at ground level.
 3. Provide belt tension sensor with monitored communication. Door operating with belt system requires tension monitoring.
- T. Operation: Direct drive motor and gearbox system with field-changeable universal handing and gearbox safety device.
- U. Control Panel: Variable frequency drive NEMA 4X cULus listed, onboard self-diagnostic and service reminder, built-in padlockable fused disconnect, and easy-to-read LCD text screen for troubleshooting.
- V. Control system shall be capable of monitoring and reporting on various operating conditions, including current operating status, current command status, current error status, hoist interlock status, service reminder status, and 24 VDC status.
- W. Manual Override: Provide pull switch and hand chain to allow manual door operation during installation and in the event of power outage.
- X. Limit System: Magnetic type providing absolute positioning with push-to-set and remote-setting capabilities. Limit system shall synchronize with door during manual operation and supply power interruptions.
- Y. Timer to Close: Each door shall have automatic closing controlled by adjustable hold-open time delay.
- Z. Operation Supply Voltage: 230 VAC three-phase.
- AA.Actuation Device Options: Provide one of the following operating device types as directed by Owner:
 1. Push button; key switch; pull cord; loop detector; motion detector; treadle switch; radio control; wireless connection.
- BB.LED Lighting System: Programmable light bar, 3 feet tall with red, yellow, green lighting.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that opening sizes, tolerances, and conditions are acceptable.

3.2 INSTALLATION

- A. Install coiling door unit assembly in accordance with manufacturer's written installation instructions.
- B. Use anchorage devices to securely fasten assembly to wall construction and building framing without distortion or stress.
- C. Securely brace components suspended from structure. Secure guides to structural members only.
- D. Fit and align assembly including hardware level and plumb, to provide smooth operation.
- E. Install enclosure and perimeter trim.
- F. Connect motor and actuation device to electrical service.

3.3 ERECTION TOLERANCES

- A. Maintain dimensional tolerances and alignment with adjacent work.
- B. Maximum Variation from Plumb: 1/16 inch.
- C. Maximum Variation from Level: 1/16 inch.
- D. Longitudinal or Diagonal Warp: Plus or minus 1/8 inch in 10 feet.

3.4 ADJUSTING

- A. Adjust work under provisions of Division 01.
- B. Test for proper operation and adjust as necessary to provide proper operation without binding or distortion.
- C. Adjust hardware and operating assemblies for smooth and noiseless operation.
- D. Lubricate bearings and sliding parts as recommended by manufacturer.
- E. Adjust seals to provide weathertight fit around entire perimeter.

3.5 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain overhead coiling doors.

3.6 CLEANING

- A. Clean work under provisions of Division 01.
- B. Clean door and components.
- C. Remove labels and visible markings.
- D. Touch-up, repair, or replace damaged products.

END OF SECTION

SECTION 08 36 13
SECTIONAL OVERHEAD DOORS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Sectional Overhead Doors.

1.2 RELATED SECTIONS

- A. Section 06 10 00 – Rough Carpentry.
- B. Division 26 – Electrical.

1.3 SUBMITTALS

- A. Shop Drawings: Detailed plans, elevations, details of framing members, required clearances, anchors, and accessories. Include relationship with adjacent materials.
- B. Manufacturer's Product Data and installation procedures. Include both published data and specific data prepared for this project.

1.4 QUALITY ASSURANCE

- A. Manufacturer: Sectional doors shall be manufactured by a firm with a minimum of five years' experience in the fabrication and installation of sectional doors. Submit evidence of performance and fabrication requirements that meet or exceed those provided by the named manufacturer. Include a list of five projects of similar design and complexity completed within the past five years.
- B. Installer shall be an authorized representative of the manufacturer.
- C. Provide doors, tracks, motors, and accessories from one manufacturer. Provide secondary components from source acceptable to manufacturer of primary components.
- D. Schedule and convene a pre-installation conference just prior to commencement of field operations, to establish procedures to maintain optimum working conditions and to coordinate this work with related and adjacent work.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Each door shall be individually wrapped and marked. Do not unwrap until immediately before installation. Protect doors during transit. Store and handle to prevent damage, soiling and deterioration. Store in a location on-site, protected from weather.

PART 2 PRODUCTS

2.1 MANUFACTURER

- A. Basis of Design: Overhead Door Corporation. Product: Series 521 Aluminum Sectional Door.
- B. Substitutions: Under provisions of Division 01.

2.2 OVERHEAD SECTIONAL DOOR

- A. Sectional Door Assembly: Stile and rail assembly secured with 1/4 inch diameter through rods.
 - 1. Panel thickness: 1-3/4 inches.
 - 2. Insulated aluminum panels: 0.050 inch thick, 6063-T6 Alloy.
 - 3. High cycle springs, 50,000 cycles.
 - 4. Glazing: Aluminum Full View Glazing section; 1/8 inch double strength glass.
 - 5. Track size: 3 inches.
 - 6. Door Size as shown and scheduled on drawings.
- B. Finish: Custom color as indicated on Drawings.
- C. Hardware: Galvanized steel hinges and fixtures. Ball bearing rollers with hardened steel races.
- D. Full weather stripping.
- E. Provide standard lift track configuration, as recommended by manufacturer to suit loading required and clearances available.
- F. Provide Low Headroom track configuration at all Apparatus Bay overhead doors (6 doors total), with springs located to the front, as recommended by manufacturer to suit loading required and clearances available. Provide track extension, as required, for vertical support bracing from ceiling.

2.3 OPERATOR

- A. Electric Motor Operation: Jack Shaft Mount Configuration, provide UL Listed electric operator, size and type as recommended by manufacturer to move door in either direction at not less than 2/3 foot or more than 1 foot per second. Provide with manual chain override at each door.

2.4 ACCESSORIES AND CONTROLS

- 1. Interior Push-Button Station: Flush-mounted three-button OPEN/CLOSE/STOP station, NEMA 1. See Drawings for locations.
- B. Programmable Door timer With Override: Two minute delay adjustable.
- C. Radio Control Systems: Comply with FCC rules, Part 15, three channels for fully open/close/stop control: Two transmitters per door.
- D. Sensors:
 - 1. Pneumatic Safety Edge: A combination compressible neoprene weatherseal and sealed air chamber, extending the full width of the door and securely fastened to the edge of the door. Automatic reversing/stop option.
 - 2. Photo Electric Eyes: Omron Model #3K-R10K4 or approved substitute.
- E. Wall mounted control panel.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Inspect all surfaces to receive mountings and verify conditions for installation of doors.

3.2 INSTALLATION

- A. Install the doors and controls in accordance with Manufacturer's written instruction and standards, using an authorized Manufacturer's distributor.
- B. Install operators in accordance with Manufacturer's recommendations, verifying mounting clearances are met in the field prior to installation.
- C. Install track support bracing in a vertical fashion, utilizing the ceiling attachment grid only, as shown on the drawings.
- D. Provide sway bracing as required to stabilize door tracks, utilizing the ceiling attachment grid only, as shown on Drawings.

END OF SECTION

SECTION 08 41 13

ALUMINUM-FRAMED ENTRANCES AND STOREFRONTS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Aluminum storefront system, thermally broken.
- B. Aluminum and glass doors.
- C. Operable windows.
- D. Vision glass.
- E. Perimeter sealant.

1.2 RELATED SECTIONS

- A. Section 06 10 00 – Rough Carpentry.
- B. Section 07 25 00 – Weather Barriers.
- C. Section 07 92 00 – Joint Sealants.
- D. Section 08 81 00 – Glass Glazing.

1.3 REFERENCES

- A. The publications listed below form a part of this Section to the extent referenced. The publications are referred to in the text by the basic designation only. Refer to Division 01 for definitions, acronyms, and abbreviations.
- B. Standards, manuals, and codes refer to the latest edition of such standards, manuals, and codes in effect as of the date of issue of this Project Manual, unless indicated otherwise in CBC Chapter 35 and CFC Chapter 80.
- C. Referenced Standards:
 - 1. AA – Designation System for Aluminum Finishes.
 - 2. AAMA SFM-1 – Aluminum Store Front and Entrance Manual.
 - 3. AAMA 2605 – Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels.
 - 4. ASTM A36/A36M – Standard Specification for Carbon Structural Steel.
 - 5. ASTM B209/B209M – Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
 - 6. ASTM B221/B221M – Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
 - 7. ASTM E283 – Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen.

- 8. ASTM E331 – Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls, by Uniform Static Air Pressure Difference.
- 9. NFRC 100 – Procedure for Determining Fenestration Product U-Factors.
- 10. NFRC 200 – Procedure for Determining Fenestration Product Solar Heat Gain Coefficient and Visible Transmittance at Normal Incidence.
- 11. NFRC 400 – Procedure for Determining Fenestration Product Air Leakage.

1.4 SUBMITTALS

- A. Submit under provisions of Division 01.
- B. Shop Drawings: Indicate system dimensions, framed opening requirements and tolerances, affected related Work, expansion and contraction joint location and details, and anchor type, size, and spacing.
- C. Product Data: Submit product data for each product specified in this Section with the product and selected attributes clearly identified.
- D. Provide windload and deadload charts to verify that the system meets all design loads and meets the minimum pounds per square foot required at the location of the Project.

1.5 SYSTEM DESCRIPTION

- A. Aluminum storefront system includes shop fabricated, factory pre-finished tubular aluminum sections and doors, glass, related flashings, anchorage, and attachment devices.

1.6 PERFORMANCE REQUIREMENTS

- A. Air leakage of window system shall not exceed 0.06 cubic feet per minute per square foot of window area at a pressure differential of 6.2 pounds per square foot when tested according to NFRC 400 or ASTM E283.
- B. Water resistance of window system shall show no leakage at a minimum static air pressure differential of 8.0 pounds per square foot when tested according to ASTM E331.
- C. Air leakage of each single entrance door shall not exceed 0.3 cubic feet per minute per square foot of door area at a pressure differential of 1.57 pounds per square foot when tested according to NFRC 400 or ASTM E283.
- D. Air leakage of each set of double entrance doors shall not exceed 1.0 cubic feet per minute per square foot of door area at a pressure differential of 1.57 pounds per square foot when tested according to NFRC 400 or ASTM E283.

1.7 REGULATORY REQUIREMENTS

- A. Window systems and exterior doors shall be certified under provisions of the 2022 California Energy Code (CEC), Section 110.6.
 - 1. A fenestration product's U-factor shall be rated in accordance with NFRC 100, using the specific glazing, window system, and door assemblies to be installed on the project.
 - a. If there is less than 10,000 square feet of site-built fenestration on the project, the default U-factor may be calculated as set forth in Reference Nonresidential Appendix NA6.

2. A fenestration product's Solar Heat Gain Coefficient (SHGC) shall be rated in accordance with NFRC 200, using the specific glazing, window system, and door assemblies to be installed on the project.
 - a. If there is less than 10,000 square feet of site-built fenestration on the project, the default SHGC may be calculated as set forth in Reference Nonresidential Appendix NA6.
 3. Provide label certificate for each type of window and door product indicating compliance of the assembly with the U-factors listed in Table 110.6-A, SHGC values listed in Table 110.6-B, and air leakage requirements specified in this Section. Field-fabricated fenestration and exterior doors may only be installed when documentation indicating compliance with the above has been provided.
 4. A Certificate of Acceptance certifying that the fenestration product meets the acceptance requirements of 2022 CEC Section 110.6 shall be completed, signed, and submitted to the enforcement agency.
- B. Per CBC Section 11B-229.1, where glazed openings are provided in accessible rooms or spaces for operation by occupants, at least one opening shall comply with CBC Section 11B-309. Window hardware shall be capable of being operated with one hand and shall not require tight grasping, pinching, or twisting of the wrist, and the force required to activate operable parts shall be five pounds maximum per CBC Section 11B-309.4.

1.8 QUALITY ASSURANCE

- A. Perform Work in accordance with AAMA SFM-1.
- B. These requirements establish standards of design and quality for material, construction and workmanship. When substitute products of equal quality are to be submitted, Contractor shall submit for consideration supporting technical literature, samples, drawings and performance data so these items may be evaluated.
- C. The approved manufacturer's recommended installation procedures will become the basis for inspecting or rejecting actual installation procedures used on the work.
- D. Single Source Responsibility: Provide storefront system, doors, operable windows, and accessories produced as standard products of one single manufacturer.

1.9 QUALIFICATIONS

- A. Manufacturer and Installer: Company specializing in manufacturing aluminum glazing systems.

1.10 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, protect and handle products to site under provisions of Division 01.
- B. Protect pre-finished aluminum surfaces with strippable coating. Do not use adhesive papers or sprayed coatings that bond when exposed to sunlight or weather.

1.11 WARRANTIES

- A. Storefront System, Doors, and Operable Windows:
 1. Provide written warranty in form acceptable to Owner jointly signed by manufacturer, installer and Contractor warranting work to be watertight, free from defective materials,

- defective workmanship, glass breakage due to defective design, and agreeing to replace components which fail within two years from date of Project Completion.
2. Warranty shall cover following:
 - a. Complete watertight and airtight system installation within specified tolerances.
 - b. System is structurally sound and free from distortion.
- B. Finish:
1. Finished coating system specified in this Section, as applied over aluminum extrusions, shall be warrantied for a period of ten years from date of Project Completion.
 2. Warranty shall cover the following:
 - a. Finish will not peel, crack, flake or blister.
 - b. Finish will not chalk in excess of number eight rating, as determined by the procedure identified in ASTM D4214 specification test.
 - c. Finish will not fade or change color more than five Hunter Delta E units as determined by ASTM D2244. Surfaces to be measured shall be cleaned of any external deposits and/or chalk.
 - d. Finish will not lose gloss more than fifty percent of original gloss when measured in accordance with ASTM D523. Measurement shall be made using a glossmeter set at a sixty degree geometry.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Acceptable Manufacturers:
1. Kawneer North America, Norcross, GA; 770-449-5555, www.kawneer.com. Products:
 - a. Trifab VG 451T storefront, center loaded.
 - b. Series 500 Wide Stile doors.
 - c. GLASSvent casement windows.
 2. Oldcastle Building Envelope, Terrell, TX; 800-869-4567, www.obe.com.
 3. Arcadia Incorporated, Vernon, CA; 323-269-7300, www.arcadiainc.com.
 4. EFCO Corporation, Monett, MO; 800-221-4169. www.efcocorp.com.
- B. Substitutions: Under provisions of Division 01.

2.2 MATERIALS

- A. Extruded Aluminum: ASTM B221; 6063 alloy, T6 temper. Wall thickness shall provide structural strength to meet specified performance requirements.
- B. Sheet Aluminum: ASTM B209.
- C. Fasteners: Stainless steel.
- D. Perimeter Anchors: Stainless steel.

2.3 DOORS

- A. Doors: Corner construction shall consist of mechanical clip fastening, SIGMA deep penetration and minimum 1-1/8 inch long fillet welds. Glazing stops shall be snap-in type with EPDM flashing gaskets. Refer to Drawings for stile and rail sizes.
 - 1. Hardware: As indicated on Drawings. Hardware shall be installed at the factory prior to shipment.
 - 2. Thresholds: Thresholds shall be one piece thresholds in a bed of mastic. Threshold shall set no higher than 1/2 inch from the lowest floor surface. When complete, threshold shall be accessible.
- B. Weather-strip: Door manufacturer's standard felt insert strip designed into door system along perimeter door edges.

2.4 OPERABLE WINDOWS

- A. ANSI/AAMA/NWDA 101/I.S.2 Rating: P-HC-70.
- B. Material: Aluminum, ASTM B221, G.S. 10A-T5; 6063-T5 alloy and temper.
- C. Frame Wall Thickness: Nominal 0.090 inch.
- D. Total Frame Depth: 2-3/4 inches.
- E. Frame and Ventilator:
 - 1. Corner construction shall consist of a 45 degree mitered corner joint with an internal clip, sealed and mechanically staked.
 - 2. Frame shall have a continuous primary weather seal of polyethylene clad urethane foam, the rainscreen weather stripping shall be dual durometer Santoprene. Each corner shall be neatly mitered.
 - 3. Shall be factory fabricated and assembled.
- F. Fasteners: 300 Series stainless steel.
- G. Hardware:
 - 1. Cast white bronze cam locking handle.
 - 2. Concealed stainless steel four-bar hinges. Window shall be capable of opening 60 degrees from the closed position.
- H. Accessories:
 - 1. Insect Screens:
 - a. Frame: Extruded aluminum frames, 6063-T6 alloy and temper, joined at corners, finished to match window frames.
 - b. Screen mesh: 18 x 16 mesh fiberglass screen cloth.
 - c. Splines: Extruded vinyl, removable to permit rescreening.

2.5 ACCESSORIES

- A. Flashings and Closures: 0.050 inch thick aluminum, finish to match window wall system finish where exposed.

2.6 GLASS AND GLAZING MATERIALS

A. Glass and Glazing Materials:

1. Storefront System, Doors, and Operable Windows: 1 inch insulated glass units as specified in Section 08 81 00.

B. Glazing gaskets and seals used for aluminum work shall be an integrated glazing system designed by the aluminum work manufacturer to produce a watertight assembly, and shall be physically and chemically compatible with each other and with adjacent materials.

1. Neoprene and EPDM materials shall not come in contact with silicone sealant materials.
2. Gaskets shall be designed, when in final compression form, to be compressed a minimum of 25 percent and a maximum of 40 percent, and to exert a pressure of between four pounds and ten pounds pressure per linear inch.
3. All side light and transom glass shall be set with the same type and size of glazing gasket material.

C. Contractor shall provide and set silicone setting blocks for all window systems installed. Each glass panel supplied shall display a factory mark certifying each glass panel is manufactured of tempered glass. Plate glass and laminated glass will not be acceptable.

1. All setting blocks shall be silicone, of 80 - 90 durometer, and be set at 1/4 points of glass.

2.7 FLEXIBLE FLASHING MATERIALS

A. Flexible Flashing Materials: As specified in Section 07 25 00.

2.8 SEALANT MATERIALS

A. Sealant and Backing Materials: As specified in Section 07 92 00.

2.9 FABRICATION

A. Fabricate components with minimum clearances and shim spacing around perimeter of assembly, yet enabling installation and dynamic movement of perimeter seal.

B. Accurately fit and secure joints and corners. Make joints flush, hairline, and weatherproof. Sealant will not be allowed at exposed joints.

C. Prepare components to receive anchor devices. Fabricate anchors.

D. Arrange fasteners and attachments to conceal from view.

E. Prepare components with internal reinforcement of 1/4 inch thick galvanized steel mounting backing plates for door hardware and hinge hardware as per ASTM A36.

F. Exposed work shall be carefully matched to produce continuity of line, design and finish. Joints in exposed work, unless otherwise shown or required for thermal movement, shall be accurately fitted, rigidly secured with hairline contacts and sealed watertight.

G. Removable members such as glass stops shall be extruded and securely engaged into adjacent components as indicated by product manufacturer.

H. Face clearances between glass and stop shall comply with code requirements and glass manufacturer's recommendations.

- I. All fasteners shall be of sufficient strength to support both horizontal wind load and vertical dead load, with a Factor of Safety of 1.5. They shall be spaced and be sized to develop the maximum strength of the members they secure or support. Washers, where required, shall be of the same material as the fastener. Unless otherwise shown or approved, fastening systems shall be concealed.
- J. Install internal steel stiffeners within the storefront system as required to meet the windload/deflection requirements at the location of this project.
- K. Sealants, gaskets, setting blacks, tapes, and separators, where used, shall be physically and chemically compatible with each other and with adjacent materials. Items shall be installed so that they will not become dislodged during or after assembly of units.

2.10 SPECIAL REQUIREMENTS

- A. Dissimilar Materials Protection: Use chromate gasketing to separate aluminum surfaces in contact with other metals, plaster or concrete, or heavy coat of alkali resistant bituminous paint. Aluminum need not be separated from stainless steel or galvanized steel.

2.11 FINISH

- A. All aluminum extrusions shall have a high performance fluorocarbon organic coating as follows:
 - 1. Comply with requirements of AAMA 2605.
 - 2. Surfaces shall be cleaned and given conversion coating pre-treatment prior to application of 0.3 mil dry film thickness of epoxy or acrylic primer following recommendations of finish coat manufacturer.
 - 3. Finish coat of 70 percent minimum fluorocarbon resin fused to primed surfaces at temperature recommended by manufacturer, 1.0 mil minimum dry film thickness.
 - 4. Acceptable Coatings: Trinar by Akzo Coatings, Inc.; Nubelar by Glidden Company; Fluoroceram by Morton International, Inc.; Duranar by PPG Industries Inc.; and Fluropon by Valspar Corporation.
 - 5. Provide finish in a four coat system consisting of primer, barrier, color, and clear coat.
 - 6. Custom color as indicated on Drawings.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify dimensions, tolerances, and method of attachment with other work.
- B. Verify wall openings and adjoining air and vapor seal materials are ready to receive work of this Section.

3.2 INSTALLATION

- A. Install window wall system, doors, and operable windows in accordance with accepted shop drawings, manufacturer's instructions and AAMA SFM-1. Manufacturer shall provide installation instructions and installer shall comply with these instructions.
- B. Align assembly plumb and level, free of warp or twist. Maintain assembly dimensional tolerances, aligning with adjacent work.

- C. Attach to structure to permit sufficient adjustment to accommodate construction tolerances and other irregularities.
- D. Provide alignment attachments and shims to permanently fasten system to building structure.
- E. Frames shall be anchored to structure with concealed fasteners appropriate for use with type of adjacent construction. Fasteners shall securely fasten frames to wall construction involved. Fasteners shall provide stiffness and rigidity to keep frames square, in accurate position without twisting, buckling or warping. Fasteners to framing substrate shall be the following minimums; greater as required by the storefront manufacturer or as conditions warrant:
 - 1. Wood Framing: #14 stainless steel wood screws at 12 inches on center all around with 2 inches minimum penetration into the framing member.
- F. Install perimeter flexible flashing membrane around all window openings in accordance with manufacturers' installation instructions and under provisions of Section 07 25 00.
- G. Install perimeter metal flashings.
- H. Install perimeter sealant to method required to achieve performance criteria and installation criteria described in Section 07 92 00.
- I. Set thresholds in bed of mastic and secure with mechanical fasteners, minimum three per threshold.
- J. Refer to Drawings for door hardware installation requirements.
- K. Install glass in accordance with Section 08 81 00, to glazing method required to achieve performance criteria.

3.3 TOLERANCES

- A. Maximum Variation from Plumb: 0.06 inch every 3 feet non-cumulative or 0.06 inch per 10 feet, whichever is less.
- B. Maximum Misalignment of Two Adjoining Members Abutting in Plane: 1/32 inch.

3.4 CLEARANCES

- A. Top and sides of door shall have a minimum of 1/16 inch to a maximum of 1/8 inch clearance.
- B. Bottom of door and threshold shall have a minimum of 1/8 inch to a maximum of 1/4 inch clearance.
- C. All doorframes shall be measured with the minimum clearance of exact size or a maximum of 1/4 inch overall clearance to fit sides of opening to 1/8 inch at top of opening.
- D. All installation clearances for door frame and door shall be strictly adhered to. No other minimum or maximum clearances will be acceptable and will prove cause for total replacement of the opening at the sole expense to Contractor.
- E. Mortise hardware shall fit flush with finished trim moldings and applied directly to recessed sidewalls of the door and or frame system. Cutouts in door or frame moldings shall require

separate screw applied tabs or straps on which to mount concealed hardware per manufacturer's templates as detailed on Drawings. Where shims and spaces are required for finished appearance, they shall provide full and solid bearing for the hardware.

3.5 ADJUSTING

- A. Adjust work under provisions of Division 01.
- B. Adjust operating hardware and sash for smooth operation.

3.6 CLEANING

- A. Clean work under provisions of Division 01.
- B. Remove protective material from pre-finished aluminum surfaces.
- C. Wash down surfaces with a solution of mild detergent in warm water, applied with soft, clean wiping cloths. Take care to remove dirt from corners. Wipe surfaces clean.
- D. Remove excess sealant by method acceptable to sealant manufacturer.

3.7 PROTECTION OF FINISHED WORK

- A. Protect finished Work under provisions of Division 01.
- B. Protect finished Work from damage.

END OF SECTION

SECTION 08 62 23
TUBULAR SKYLIGHTS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Tubular Skylights.
- B. Integral Counter-Flashing.
- C. Pre-Manufactured Curbs.

1.2 RELATED SECTIONS

- A. Section 06 10 00 – Rough Carpentry.
- B. Section 07 41 13 – Metal Roof Panels.
- C. Section 07 62 00 – Sheet Metal Flashing and Trim.
- D. Section 09 29 00 – Gypsum Board.

1.3 REFERENCES

- A. The publications listed below form a part of this Section to the extent referenced. The publications are referred to in the text by the basic designation only. Refer to Division 01 for definitions, acronyms, and abbreviations.
- B. Standards, manuals, and codes refer to the latest edition of such standards, manuals, and codes in effect as of the date of issue of this Project Manual, unless indicated otherwise in CBC Chapter 35 and CFC Chapter 80.
- C. Reference Standards:
 - 1. AAMA/WDMA/CSA 101/I.S.2/A440-08 – North American Fenestration Standard Specification for Windows, Doors, and Skylights.
 - 2. ASTM A463/A463M – Standard Specification for Steel Sheet, Aluminum Coated, by the Hot Dip Process.
 - 3. ASTM A653/A653M – Standard Specification for Steel Sheet, Zinc Coated (Galvanized), by the Hot Dip Process.
 - 4. ASTM D635 – Standard Test Method for Rate of Burning and/or Extent of Time of Burning of Self-supporting Plastics in a Horizontal Position.
 - 5. ASTM D1929 – Standard Test Method for Ignition Properties of Plastics.
 - 6. ASTM E84 – Standard Test Method for Surface Burning Characteristics of Building Materials.
 - 7. ASTM E283 – Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen.
 - 8. ASTM E308 – Standard Practice for Computing the Colors of Objects by Using the CIE System.

- 9. ASTM E330 – Structural Performance of Exterior Windows, Curtain Walls and Doors.
- 10. ASTM E547 – Test Method for Water Penetration of Exterior Windows, Skylights, Doors and Curtain Walls by Cyclic Air Pressure Difference.
- 11. FS TT-C-494B – Coating Compound, Bituminous, Solvent Type, Acid Resistant.
- 12. ICC AC-16 – Acceptance Criteria for Plastic Skylights.
- 13. UL 181 – Factory Made Air Ducts and Air Connectors
- 14. UL 790 – Standard for Tests for Fire Resistance of Roof Covering Materials.

1.4 SUBMITTALS

- A. Submit shop drawings and product data under provisions of Division 01.
 - 1. Provide configurations, dimensions, locations, fastening methods, and installation details.
 - 2. Include characteristics of light admitted, transparency and insulating value of unit.
 - 3. Submit manufacturer's installation instructions under provisions of Division 01.

1.5 PERFORMANCE REQUIREMENTS

- A. Per CBC Section 2405.5, tubular skylights shall be tested and labeled as complying with AAMA/WDMA/CSA 101/I.S.2/A440. The label shall state the name of the manufacturer, the approved labeling agency, the product designation, and the performance grade rating as specified in AAMA/WDMA/CSA 101/I.S.2/A440.
- B. Light-transmitting plastic skylight glazing shall comply with CBC Section 2610.
- C. Completed tubular skylight assemblies shall be capable of meeting the following performance requirements:
 - 1. Air Infiltration Test: Air infiltration shall not exceed 0.30 cubic feet per minute per square foot aperture with a pressure delta of 1.57 pounds per square foot across the tube when tested in accordance with ASTM E283.
 - 2. Water Resistance Test: No uncontrolled water leakage at 10.5 pounds per square foot pressure differential with water rate of five gallons per hour per square foot when tested in accordance with ASTM E547.
 - 3. Uniform Load Test:
 - a. No breakage, permanent damage to fasteners, hardware parts, or damage to make tubular skylight system inoperable or cause excessive permanent deflection of any section when tested at a positive load of 150 pounds per square foot or negative load of 70 pounds per square foot.
 - b. All units shall be tested and labeled with a safety factor of three for positive pressure and two for negative pressure, acting normal to plane of roof in accordance with AAMA/WDMA/CSA 101/I.S.2/A440-08.
 - 4. Flammability:
 - a. When used with the Dome Edge Protection Band, all domes shall meet fire rating requirements as described in the 2022 California Building Code (CBC).
 - b. Self-ignition Temperature – Greater than 650 degrees F per ASTM D1929.

- c. Smoke Density – Rating no greater than 450 per ASTM E84 in way intended for use, Classification C.
- d. Rate of Burn and/or Extent – Maximum Burning Rate: 2.5 inches per minute per ASTM D635, Classification CC-2.
- e. Rate of Burn and/or Extent – Maximum burn Extent: 1 inch per ASTM D635, Classification CC-1.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications. Factory authorized installer.
- B. Manufacturer Qualifications: Engaged in manufacture of tubular skylights for minimum fifteen years.

1.7 SEQUENCING AND SCHEDULING

- A. Coordinate work of this Section with the work of other trades.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Store products in manufacturer's unopened packaging until ready for installation.

1.9 PROJECT CONDITIONS

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

1.10 WARRANTY

- A. Tubular Skylight Assembly: Manufacturer's standard ten year warranty.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Basis of Design: Solatube International, Inc., Vista, CA; 888-765-2882, www.solatube.com. Products:
 - 1. SolaMaster Series 21 inch Solatube Model S750DS-C Closed Ceiling Daylighting System.
 - a. ATI Evaluation Service Code Compliance Research Report Number CCRR-0131.
- B. No known equal.

2.2 TUBULAR SKYLIGHT ASSEMBLIES

- A. General: Transparent roof-mounted skylight dome and curb, reflective tube, and ceiling level diffuser assembly, transferring sunlight to interior spaces; complying with ICC AC-16.
 - 1. Roof Dome Assembly: Transparent, UV and impact resistant dome with flashing base supporting dome and top of tube.
 - a. Outer Dome Glazing: Type DA, 0.125 inch minimum thickness injection molded acrylic classified as CC2 material; UV inhibited, impact modified acrylic blend.

2. Raybender 3000: Variable prism optic molded into outer dome to capture low angle sunlight and limit high angle sunlight.
3. Roof Flashing Base: One piece, seamless, leak-proof flashing functioning as base support for dome and top of tube.
 - a. Base Material: Sheet steel, corrosion resistant conforming to ASTM A653/A653M or ASTM A463/A463M, 0.028 inch thick.
 - 1) Flashing Base Style: Type FC curb cap with inside dimensions of 27 inches by 27 inches to cover base curb.
 - 2) Dome Edge Protection Band: Type PB. Galvanized steel; nominal thickness of 0.039 inches.
4. Curb: Model RPC-3 as manufactured by Roof Products, Inc. with the following characteristics:
 - a. Frame Material: 18 gauge ASTM A653 G90 hot-dipped galvanized steel.
 - b. Corners: Mitered and welded with welds sealed and prime painted after fabrication.
 - c. Mounting Flange: 2 inches wide, integral to frame, and welded.
 - d. Wood Nailers: Factory installed, 2 x 4 pressure treated, continuous around top perimeter of frame.
 - e. Insulation: Factory installed 1-1/2 inch thick three pound density fiberglass insulation continuous around inside of frame.
 - f. Size and Height: As indicated on Drawings.
5. Tube Ring: Attached to top of base section; 0.090 inch nominal thickness injection molded high impact PVC to prevent thermal bridging between base flashing and tubing and channel condensed moisture out of tubing.
6. Dome Seal: Adhesive backed weatherstrip 0.63 inch tall by 0.28 inch.
7. Reflective Tubes: Aluminum sheet, thickness 0.015 inch.
 - a. Interior Finish: Spectralight Infinity with INFRAREDuction Technology combining ultra-high visible light reflectance with ultra-low infrared reflectance.
 - b. Color: a^* and b^* (defined by CIE L a^*b^* color model) shall not exceed plus 2 or be less than minus 2 as determined in accordance to ASTM E308.
 - c. Top Tube Angle Adapter and Bottom Tube Angle Adapter Kit, Type AK; reflective forty-five degree adjustable top and bottom angle adapters (one each) 16 inches long.
 - d. Extension Tubes:
 - 1) Type EXX; Reflective extension tubes, 0.015 inch thick aluminum sheet, for length of runs as indicated on Drawings.
 - 2) Reflective Ninety Degree Adjustable Tube: Provide manufacturer's standard extension tube angle adapters for applications requiring two Type A2 zero degree to ninety degree extension tube angle adapters.
 - e. Diffuser Assemblies for Tubes Penetrating Ceilings:
 - 1) Type TP ceiling mounted box transitioning from round tube to square ceiling assembly, supporting light transmitting surface at bottom termination of tube; 23.8 inches by 23.8 inches square frame to fit standard suspended ceiling grid.
 - 2) Box shall be fabricated of opaque polymeric material, classified as CC2, Class C, 0.110 inch thick.

f. Diffuser Lens:

- 1) Type L1, OptiView Fresnel lens designed to maximize light output and diffusion with extruded aluminum frame and EPDM foam seal to minimize condensation and bug, dirt and air infiltration per ASTM E283. Visible Light Transmission shall be greater than 90 percent at 0.022 inch thick. Classified as CC2.

8. Accessories:

- a. Thermal Insulation Panel: TIP, high-performance dual-glazed, tube insulation system.
- b. Wire Suspension Kit: Type E, Use the wire suspension kit when additional bracing to the structure is required.

2.3 ACCESSORIES

- A. Fasteners: Same material as metals being fastened, non-magnetic steel, non-corrosive metal of type recommended by manufacturer.
- B. Suspension Wire: Steel, annealed, galvanized finish, size and type for application and ceiling system requirement.
- C. Sealant: Polyurethane or copolymer based elastomeric sealant as recommended by manufacturer.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Do not begin installation until substrates have been properly prepared.
- B. Immediately notify Architect if substrate conditions are unsatisfactory. Do not proceed with work until unsatisfactory conditions are corrected.

3.2 PREPARATION

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

3.3 INSTALLATION

- A. Install in accordance with manufacturer's printed instructions.
- B. After installation of first unit, field test to determine adequacy of installation. Conduct water test in presence of Owner, Architect, Contractor, or their designated representative. Correct unsatisfactory conditions before proceeding with installation of subsequent units.

3.4 PROTECTION

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

END OF SECTION

SECTION 08 71 00
DOOR HARDWARE

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. BHMA finish door hardware for hollow metal doors and aluminum doors.
- B. Accessories including, but not limited to, door stops, kickplates, and push/pull plates.
- C. Weatherstripping, seals, and thresholds.

1.2 PRODUCTS SUPPLIED BUT NOT INSTALLED UNDER THIS SECTION

- A. Hardware templates for doors and frames.

1.3 RELATED SECTIONS

- A. Section 06 10 00 – Rough Carpentry.
- B. Section 07 92 00 – Joint Sealants.
- C. Section 08 11 13 – Hollow Metal Doors and Frames.
- D. Section 08 14 00 – Wood Doors.
- E. Section 08 41 13 – Aluminum Framed Entrances and Storefronts.
- F. Divisions 26 through 28: Electrical rough in, wiring and connectors for electrified hardware including, but not limited to:
 - 1. Wire and connectivity from ceiling through frame to electrified hardware devices including non-Section 08 71 00 task of providing wiring inside of doors.

1.4 REFERENCES

- A. The publications listed below form a part of this Section to the extent referenced. The publications are referred to in the text by the basic designation only.
 - 1. Refer to Division 01 for definitions, acronyms, and abbreviations.
 - 2. Unless otherwise noted; standards, manuals, and codes refer to the latest edition as of the issue date of this Project Manual.
- B. Conform to the following Referenced Standards and Requirements:
 - 1. CBC – 2022 California Building Code.
 - 2. ADA – Americans with Disabilities Act - 2010 Standards for Accessible Design.
 - 3. NFPA 101 – Life Safety Code.
 - 4. ANSI/BHMA 156.19 American National Standard for power high and low energy operated doors.
 - 5. ANSI A156 Series – Builders Hardware Manufacturers Association (BHMA) Standards Set.

1.5 QUALITY ASSURANCE

A. Supplier Qualifications and Documentation:

1. A recognized architectural finish hardware supplier, with warehousing facilities, who has been furnishing school projects of this size and scope in the Northern California for a period of not less than five years. The firm shall employ (or consult with) an architectural hardware consultant (or someone of equal qualifications) who is available at reasonable times during the course of the project, for consultation regarding the project's hardware requirements, to the owner, architect, and contractor. The firm shall have extensive field experience solving hands-on solutions to field problems. They must be able to demonstrate the ability to successfully complete a school project of this type.

B. Manufacturer of Submitted Devices - Qualifications and Documentation:

1. Manufacturer Qualifications: Manufacturer specializing in manufacturing institutional and commercial door hardware with a minimum five years with the following documented experience. Furnish list of at least ten past, finished projects. Include date completed, project location, and references. Past project contact information will determine if Builders Hardware is acceptable.

C. Installer of Submitted Devices - Qualifications and Documentation:

1. Installer of assembly shall be trained in the trade of hanging commercial doors on commercial frames with commercial hardware. Supplier and Installer of door assemblies shall be authorized representative of manufacturers and have minimum of five years successful experience in detailing, supplying, and installing door assemblies specified on projects of similar size, complexity, and type to this Project. Provide written documentation to show closers will be installed by an individual with successful experience installing closers to meet 5-pound opening force for non-rated door complexity.

1.6 SUBMITTALS

- A. The hardware groups/sets specified in Section 08 71 00 - Part 3 are intended to establish type and design standard when used together with the requirements of this Section, Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections. Examine Contract Documents and furnish proper hardware for door openings. Refer to specifications for clarification and detailed requirements and provide products and services in specifications even if not written in hardware groups/sets in Section 08 71 00 - Part 3.
- B. For each opening submit coordinated (means and methods) requirements in accordance with Division 01 and a detailed door, frame and hardware schedule. See pre-hardware and hardware scheduling requirements below. Submittals that do not meet means and methods, including missing related doors/frames submittal/shop drawings, will be returned for correction before checking.
- C. Pre-Hardware Scheduling Tasks:
 1. Coordinate work of this Section with other directly affected Sections and scope.
 2. Provide required Division 08, means and method type work in accordance with Contract Documents at no additional cost to project, including Division 01 and language below. This Section supplier shall be provided with full documents, not just Section 08 71 00 Part 3 hardware group/sets as that process does not meet Contract requirements.

3. Means and method type work includes, but is not limited to, coordination with plans and other specifications, templating, Section 08 71 00, and other Division 08 Section engineering and coordination. Starting submittal work or labor before means and method type work is completed does not constitute change orders.
4. Provide RFIs (request for information) for clarification items before submittals. This Section is not to be a stand-alone submittal but requires multiple Sections and Drawings coordination before submittals will be reviewed.
 - a. Coordinate length and sizes for hardware devices before submittals, Verify the door hardware is compatible for use with the doors and door/frames.
 - b. Report all prevailing conditions that will adversely affect satisfactory execution of work before submittals.
 - 1) Example 1: If door stiles would inhibit the use of specified hardware, provide RFIs before starting detailed hardware headings or group submittal process.
 - 2) Example 2: Coordinate length and sizes for hardware devices before ordering materials including, but not limited to, special templates and sizes of devices. Verify the door hardware is compatible for use with the doors and/or door frames.
 - c. This Section clarification items (RFIs) shall be reviewed by a non-design team coordinator before sending to Architect for review.
 - 1) For clarification items that are means and methods (directed to or from one vendor to another vendor, framer/installer), Contractor shall coordinate and answer or list questions that are not design scope.

D. Hardware Schedule:

1. Submit required vendor qualification letters and documentation (see above "QUALITY ASSURANCE").
2. Non-design team coordination and requirements:
 - a. Submittals for coordinated door/frame/hardware items, shall be submitted at the same time for review of total opening requirements. Do not submit Section 08 71 00 scope without coordinated door and frame packages and above RFI/clarification process tasks completed. Submittals that do not include related doors/frames will be returned for correction before reviewing.
 - b. Section submittals and/or shop drawings shall be reviewed and have comments by non-design team (Contractor) before sending to Architect. If submittals do not meet Contract requirements, return to hardware vendor for re-submittal. In many cases, unacceptable submittals are passed though without non-design team (Contractor) comments (coordinate per Contract).
3. Submit hard copies of hardware schedule (number of copies per Division 01) as well as submit editable, PDF files via electronic email of ftp site process in Vertical Format as illustrated by the Sequence of Format for the Hardware Schedule as published by the Door and Hardware Institute. Horizontal-type schedules will be returned for correction before reviewing.
 - a. Shop drawings / hardware schedule shall clearly indicate each hardware group specified and manufacturer of each item proposed as well as each door number that the hardware is assigned to.

b. Vertical schedule format sample:

Heading Number 1 (Door Schedule or Architectural Assigned Hardware Group/Set number from part 3 = HW # __)				
1 Single Door #1 - Exterior from Corridor 101		Opening Size	90°	RH
Quantity	Device Description	Device # (include specification language)		Finish
4	Hinges	4.5 x 4.5 NRP x fasteners		630
1	Lockset			630
1	I/C Cylinders	Rim or Mortise x appropriate cam x blocking rings as required (rim or mortise type and quantity as required by locking device)		626
1	Permanent Core			626
1	Door Silencers	SR64 or SR65 (as required)		GR
				IV

4. Illustrations from manufacturer's catalogs and product data:
 - a. Provide cut sheets and product data with vertical format hardware submittal (same timeframe) as well as door and frame information to be reviewed as one submittal package. Manufacturer's hard copy as well as PDF catalog cut sheets and product data shall not be submitted before editable, PDF files vertical format hardware submittal. See above Sequence of Format requirement. Catalog cut sheets and product data sent as submittals before the typed out nomenclature of hardware part numbers (vertical format hardware submittal) will be returned without review.
5. Provide hardware schedule and hardware templates to door and frame manufacturer. Provide two templates to those manufacturers who are not currently registered template book holders.
6. To detail submittals and nomenclature for electrified hardware, review and coordinate electrical specifications and drawings for scope that could affect hardware selections:
 - a. Scope includes, but not limited to, auto operator locations if related to project and/or access control if related to project and/or electrical Divisions 25-28 and applicable Drawings.
 - b. For electrified hardware interface with non-Division 08 access control or electrified tasks, the non-Division 08 access control or security vendor task shall provide a written agenda/plan how access control or security scope will be installed for a complete and operational system. Written agenda shall include power requirements and additional relays at no additional cost.
 - c. Provide manufacturers' wiring information including manufacturers' door elevation diagrams for electrified hardware based on Door Hardware Institute (DHI) core class "Electrified Architectural Hardware" DHI class #COR133. Openings where only magnetic hold-opens or door position switches are specified do not require wiring information. Provide information with hardware schedule submittal for review. Provide detailed wiring diagrams with hardware delivery to jobsite.

E. Vendor meetings or coordination prior to purchasing materials:

- a. Convene coordination meeting between all opening vendors and installers at least two weeks prior to purchasing doors, frames, and door hardware required for complete systems. Attendance includes, but is not limited to, hardware supplier and/or installer, door supplier and/or installer, and frame supplier and/or installer. If hardware changes are required due to these meetings, communicate changes to Architect before ordering materials.

F. Templates:

1. Provide listing of manufacturer's template numbers for each item of hardware in hardware schedule.
2. Submit templates and "Reviewed Hardware Schedule" to door and frame supplier and others as applicable to enable proper and accurate sizing and locations of cutouts and reinforcing.

G. Installation Instructions:

1. Provide manufacturer's written installation and adjustment instructions for finish hardware.
2. Send installation instructions to site with hardware.

H. Contract Closeout Submittals: Include specific requirements indicated below.

1. Operating and maintenance manuals: Submit three sets containing the following:
 - a. Complete information in care, maintenance, and adjustment, data on repair and replacement parts, and information on preservation of finishes.
 - b. Catalog pages for each product.
 - c. Name, address, and phone number of local representative for each manufacturer.
 - d. Parts list for each product.
 - e. Copy of final accepted hardware schedule, edited to reflect "As installed".
 - f. Copy of final keying schedule.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Comply with requirements of Division 01.
- B. Deliver products in manufacturer's original containers, dry and undamaged, with seals and labels intact.
- C. Storage: Store materials in a cool and dry location, elevated from the ground and protected from the elements, and secured from theft or pilferage.

1.8 WARRANTY

- A. Comply with provisions of Division 01.
- B. Warranty installed units shall be free from defects in material and workmanship as follows:
 1. Hinges: Lifetime Warranty (Life of Building).
 2. Locksets and Exit Devices: Three years.
 3. All other hardware: Two years.

1.9 MAINTENANCE

- A. Provide special wrenches and tools applicable to each special hardware component.
- B. Provide maintenance tools and accessories supplied by hardware manufacturer.

PART 2 PRODUCTS

2.1 FINISHES

- A. Typical BHMA finish designation references:
 - 1. Typical BHMA finish designation references:
 - a. BHMA 626– Satin chromium plated brass or bronze.
 - b. BHMA 628– Satin or dull aluminum, clear anodized (uncoated).
 - c. BHMA 630– Satin stainless steel.
 - 2. Closers:
 - a. BHMA 693 - Sprayed black paint finish (typical/basis of design for project).
 - b. BHMA 689 - Sprayed aluminum paint finish (back of house where specified).
 - 3. Nomenclature and specifications for antimicrobial finish as shown in hardware groups/sets (Part 3 below):
 - a. Antimicrobial Finish nomenclature example: Healthy Hardware™ antimicrobial surface or Antimicrobial finish nomenclature example: BHMA 626MA antimicrobial finish.
 - b. Provide antimicrobial finish that is an FDA recognized, antimicrobial coating with built in protection to prevent the growth of a broad range of bacteria, mold, and mildew.
 - c. Provide full warranty of locking manufacturer and other devices in both 630 and 626 base finishes with added antimicrobial finish.

2.2 HARDWARE TEMPLATE

- A. Make templates for hardware to be applied to metal doors or pre-finished doors.
- B. Hinge templates shall conform to ANSI A156.7.
- C. Promptly furnish template information or templates to door and frame manufacturers.
- D. Coordinate hardware items to prevent interference with each other.

2.3 EXIT DOORS

- A. Where hardware groups/sets have different information, refer to the following for clarification. Provide hardware groups/sets devices along with added devices as indicated on drawings and detailed requirements for each type of device. Provide all specifications even if not written in hardware sets/groups.
- B. Provide all hardware necessary to meet the requirements of CBC for exit doors, as well as to other requirements specified, even if such hardware is not specifically mentioned under Article “Hardware Schedule” of this Section.

2.4 SCREWS, BOLTS, AND FASTENING DEVICES

- A. All exposed fasteners to be stainless steel or zinc plated.
- B. Exposed head oval Phillips type screws in countersunk holes unless otherwise specified.
 - 1. Use screws, bolts, washers, grommets, nuts, and other fastening devices of appropriate length, type, head, metal, and finish as necessary for proper match and application of hardware.
 - 2. For all protection plates (armor-plates, kick-plates and mop-plates) provide smooth, unobstructed surface with counter sunk fasteners with no sharp edges or an approved adhesive per below (no raised fasteners allowed).
 - a. 3M adhesive #4032 that includes in its testing the following: Double coated polyurethane foam adhesive:
 - 1) Foam Density: 20 lb/ft³.
 - 2) Tensile Strength: 240lbs/ in².
 - 3) Elongation at Break: 90%.
 - 4) Short temperature resistance: 380 °F.
 - 5) Dielectric Strength: 8 to 21 V/μm.
 - 6) Thermal Conductivity: 0.062 W/m/K.
 - b. In addition to UL testing standard testing practices the 3M adhesive when used with protection plates shall have gone through Thermogravimetric Analysis and Fourier Transform Infrared (FT-IR) Spectroscopy.
- C. Closer and exit/panic devices:
 - 1. Install using concealed fasteners. Where there is insufficient blocking in the door or reinforcement in the door and/or frames (see related Sections as design should have blocking in the door or reinforcement in the door and/or frames) utilize through bolts or SNB devices.
- D. Threshold anchors shall be Flat Sleeve Anchors plated expansion anchor screw in one unit.

2.5 SUBSTITUTIONS

- A. Products referenced by specific brand names and model numbers have been identified by Owner to match other products in use either completed or in the course of completion. No substitutions permitted per Public Contract Code Section 3400.
 - 1. Otherwise refer to Division 01 for substitutions.

2.6 HANGING HARDWARE

- A. Butt Hinges and Self-Closing Hinges:
 - 1. Acceptable Manufacturers:
 - a. McKinney Products Co.
 - b. Ives Manufacturing by Allegion.
 - c. Stanley Works.
 - d. Hager Manufacturing.

2. Where hardware groups/sets have different information (number of hinges and sizing), refer to the following for clarification. Provide hardware groups/sets devices along with added devices as indicated on Drawings and detailed requirements for each type of device.
 - a. Butt hinges shall be manufactured in accordance with ANSI/BHMA A156.1.
 - b. Self-closing hinges and pivots shall be manufactured in accordance with ANSI/BHMA A156.17.
 - c. Provide wide throw hinges where required:
 - 1) Whether new or existing openings (existing doors or frames to remain), submit and provide hinge widths sufficient to clear trim projection when door swings 180 degrees. All doors shall swing 180 degrees if wall allows.
 - 2) Utilize wide throw type hinges to clear frame or wall obstructions/cladding in order for doors to completely open. See 180-degree language above.
 - 3) Where a door closer device is specified and will be installed on pull side/hinged side of doors (i.e. closers will hit walls or other surfaces when door is completely open), provide wide throw type hinges to give sufficient pocket depth to hide closer behind door. Do not pinch or crush closer between the door and wall surface.
 - 4) Confirm hinge sizing with frame and wall details.
 - d. Provide "weight/strength" as specified in hardware groups/sets in Part 3 (hinge nomenclature basis-of-design weight/strength).
 - e. For doors 1-3/4 inches thick and up to 36 inches wide, provide hinge height of 4-1/2 inches.
 - f. For doors 1-3/4 inches thick and 37 inches to 48 inches wide, provide heavy duty, four ball bearing hinges and height of 5 inches.
 - g. If hardware sets specify height (example: 5 inches tall at 36 inch wide door), provide height as specified for project standards at these locations.
 - h. Provide two butts for doors up to 60 inches high and one additional butt for each 30 inches of height or fraction thereof.
 - i. Provide non-removable pins at exterior doors.
 - j. Provide ball-bearing hinges. Non-ball-bearing hinges are not acceptable.

B. Aluminum Continuous Hinges:

1. Acceptable Manufacturers:
 - a. Select Hinge Manufacturing.
 - b. Ives Manufacturing by Allegion.
 - c. Roton by Hager Manufacturing
2. Where hardware groups/sets have different information, refer to the following for clarification. Provide hardware groups/sets devices along with added devices as indicated on Drawings and detailed requirements for each type of device:
 - a. Provide widths sufficient to clear trim projection when door swings 180 degrees. Confirm hinge sizing with frame details. All doors shall swing 180 degrees if opening will allow. Provide wide throw hinges where required.
 - b. Provide continuous hinge that meet cycle testing in accordance with ANSI/BHMA Standard A156.26, Grade 1.

- c. Stainless steel hinges shall meet abuse test per ASTM F1450.
- d. Aluminum material: Extruded tempered aluminum. Material Standard: 6063-T6 alloy. Configuration: Three interlocking extrusions in pinless assembly, installed to full height of door frame.

2.7 SECURING DEVICES (LATCHING SYSTEMS)

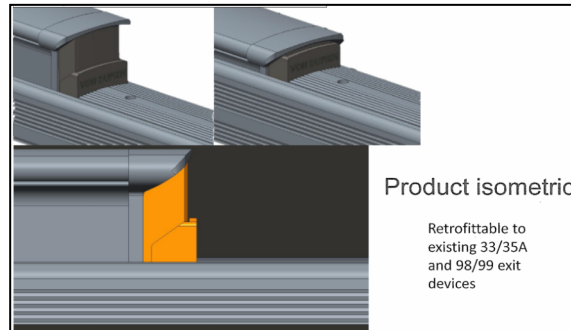
A. Cylindrical Locksets and Latchsets:

- 1. Acceptable Manufacturers:
 - a. Schlage Lock Co. ND Series.
- 2. Levers:
 - a. Provide levers to return to door within 1/2 inch i.e. levers that have return to door within 1/2 inch to meet California State Fire Marshal mandates: no space/gap greater than 1/2 inch between face of door and lever return.
 - b. Lever Style: Traditional Square Style RHO.
- 3. Where hardware groups/sets have different information, refer to the following for clarification. Provide hardware groups/sets devices along with added devices as indicated on Drawings and detailed requirements for each type of device:
 - a. Cylindrical locksets shall be a BHMA Certified Product, meeting requirements per ANSI A156.2, 1996.
 - b. Backsets: 2-3/4 inches.
 - c. Strikes:
 - 1) Provide ANSI 4-7/8 inch standard strike.
 - 2) Provide curved lip-type strike at all locations if possible to prevent catching clothing or other objects on strike. Where required, provide detail and flat strike.
 - 3) Where required, provide extended lip strike so that the lock or latchset latch will not come in contact with frame or added trim on or adjacent to the frame. Example: Don Jo device #MEST-104, but provide submitted manufacturer equivalent extended lip strike.

B. Exit Devices:

- 1. Acceptable Manufacturers:
 - a. Von Duprin.
- 2. Where hardware groups/sets have different information, refer to the following for clarification. Provide hardware groups/sets devices along with added devices as indicated on Drawings and detailed requirements for each type of device.
 - a. The unlatching force of panic hardware shall not exceed 5 pounds, applied in the direction of travel, certified by UL to meet requirements of CBC Section 11B-309.4 (Von Duprin nomenclature "AX").
 - b. Exit devices shall be ANSI A156.3, Grade 1; UL Listed.
 - c. All exit devices shall be UL listed for panic. Exit devices for labeled doors shall be UL listed.
 - d. Trim:
 - 1) Where lever trim is specified, provide lever design to match lockset lever #06.

- 2) Provide exit device lever trim with vandal resistant feature (heavy duty lever trim designed to with stand abuse and vandalism):
 - a) Von Duprin 996 R/V.
- e. All exit devices shall be shipped to project site with exit device, isometric cap as to not catch items on panic device push bar (Von Duprin nomenclature "PA").



C. Flush Bolts and Dust Proof Strikes:

1. Acceptable Manufacturers:
 - a. Ives Manufacturing.
 - b. Triangle Brass Manufacturing Company, Inc. (Trimco).
 - c. Rockwood.
 - d. Hager Manufacturing.
2. Where hardware groups/sets have different information, refer to the following for clarification. Provide hardware groups/sets devices along with added devices as indicated on Drawings and detailed requirements for each type of device.
 - a. Non-rated Openings: Where not specified in hardware sets, provide two flush bolts for inactive leaf of pairs of locked and latched doors. Locate centerline of top bolt not more than 78 inches from finished floor. Provide dustproof strike for bottom bolts, type as required for floor condition.

2.8 KEY SYSTEMS (CYLINDERS, CORES, AND KEYS)

- A. Where hardware groups/sets have different information, refer to the following for clarification. Provide hardware groups/sets devices along with added devices as indicated on drawings and detailed requirements for each type of device. Keying specifications below override hardware set/group nomenclature.
- B. For all locking or dogging devices, provide complete cylinder system and coordination whether or not specified in Section 08 71 00, Part 3 hardware sets as required by locking device.
 1. Different locking devices require a set of different requirements including, but not limited to, appropriate cams for mortise-type cylinders, appropriate tail pieces and size for rim-type cylinders, blocking rings as required for locking and cylinder devices to not rattle and meet manufacturers' warranties, as well as cylinders that are to be coordinated with construction cores/cylinders and final pinned cores/cylinders shipped to Owner by Registered Mail per below to meet system requirements.

2. Scope is means and method type work by a certified locksmith and/or DHI individual to engineer rim or mortise cylinders and blocking rings or tail-piece components as required for submitted locking devices. Since there could be as many as 500 options for rim or mortise cylinders with the locking devices and different manufactures that may be submitted, this means/methods-type work is required (similar to templating doors and frames to accept hardware). Coordinate as required.

C. Key Systems (Cylinders, Cores, and Keys):

1. Manufacturers:
 - a. Schlage Lock Co.
2. For all locking or dogging devices, provide complete keying system whether or not specified in Section 08 71 00, Part 3 hardware sets including lock cores, mortise cylinders, and rim cylinders keyed as directed by Owner in submittal process. Key System shall be:
 - a. Patented Schlage Lock Co. Restricted Keyway.
3. Keyway: Provide as instructed by Owner during submittal process.

D. Keying Requirements:

1. Provide keyed, construction cores and keys during the construction period.
 - a. Provide full sized cylinders or brass construction cores and brass keys at all interior and exterior doors. Plastic cores are not permitted.
 - b. Construction control and operating keys and core shall not be part of the Owner's permanent keying system or furnished in the same keyway or key section as the Owner's permanent keying system. Permanent cores and keys prepared according to the accepted keying schedule shall be furnished to the Owner.
2. Keying Meeting and Programming Schedule:
 - a. Do not provide keying matrix in original hardware submittals. After hardware has been submitted and reviewed in accordance with Division 01 and Section 08 71 00 requirements, arrange a keying matrix/programming meeting with Owner Representative and various hardware suppliers/vendors representing both the cylinders/keying system and different, reviewed submittals (design team not required).
 - 1) Copies of the reviewed door and frame submittals shall be brought to the meeting with card reader and keyed doors highlighted for review.
 - 2) Follow procedures for keying meeting and programming schedule as outlined by the Door Hardware Institute. DHI procedures are based on Door Hardware Institute core class entitled Masterkeying class #AHC200.
 - 3) At doors for Pharmacy or Medication dispensing rooms provide keying with patented keyway not utilized by the rest of the facility.
 - b. Keying meeting to produce a programming schedule/matrix based on the following:
 - 1) Furnish keys in the following quantities (total quantity of keys part of bid package):
 - a) 5 each Grand master-keys per set.
 - b) 6 each Masterkeys per set.
 - c) 3 each Change keys each lock, core or cylinder.
 - d) 5 each Permanent Extractor keys.

- e) 9 each Construction masterkeys.
- f) 2 each Construction Core Extractor keys.
- 2) Provide keying system expansion parameters.
 - a) Plan twenty changes directly under the grand.
 - b) Plan ten master keys.
 - c) Plan fifty changes each for each master.
- 3) Permanent keys and cores shall be stamped with the applicable key mark for identification. The visual key control marks or codes shall not include the actual key cuts.
- 4) Permanent keys shall be stamped "Do Not Duplicate".
- c. Furnish typed programming meeting matrix and notes in PDF, editable electronic format as well as mailed, hard copy to Owner Representative for final review.
- d. Furnish keying and programming schedule to key/core/cylinder manufacturing factory for production of key/core/cylinder devices.
- e. Transmit pinned cores/cylinders as well as cut grand masterkeys, masterkeys, change keys and other security keys to Owner locksmith, by Registered Mail, return receipt requested. All permanent cores and keys shall be sent directly from the factory to client for ID and verification.
 - 1) General Contractor shall install all permanent cylinders and/or cores in permanent locking or keying housings only while accompanied by County or Correctional representatives during all installations. Installation of permanent cylinders and/or cores in permanent locking or cylinder housings shall occur after substantial completion and prior to final completion. General Contractor shall also be responsible for preparing locking systems, installation ready for final cylinders and/or cores, free from dirt, debris or overtightening of locking devices that may cause binding of keyed devices.
 - 2) Provide instructions for adjustments and maintenance of hardware and hardware finishes.

2.9 CLOSING DEVICES

A. Surface Mounted Closers:

1. Rack and Pinion Manufacturers:

- a. LCN Manufacturing – 4040XP Series as scheduled.
- b. Norton Door Controls – 7500 Series.
- c. Dorma – 8916 Series.

B. Where hardware groups/sets have different information, refer to the following for clarification. Provide hardware groups/sets devices along with added devices as indicated on Drawings and detailed requirements for each type of device:

- 1. ANSI A156.4, Grade 1; UL Listed.
- 2. Closers shall have multi-size spring power adjustment to permit setting of spring from 1 through 6 with additional spring power available. Provide ADA compliant setting nomenclature during submittals as recommended by closer manufacturer.

3. Submit correct closer type as to be able to install closers on non-public side of doors. Examples include, but are not limited to, 1) interior side of storage/electrical type rooms; 2) not in corridors/public areas; and at exterior locations, install closers inside of building (in conditioned spaces).
4. Installation Plates, Brackets, and Miscellaneous Adapters:
 - a. Furnished and installed all door closers with thru bolts.
 - b. Provide drop plates, brackets, or adapters for arms as required to suit details and install as directed by manufacturer's templates.
 - 1) Furnish and install drop plates at reverse bevel doors and at doors with 170 degrees to 180 degrees swing.
 - 2) Furnish and install blade, angle or applied stops as required where frame does not permit installation of the standard soffit plate (see example LCN #419 Flush Panel Adapter to be shown in submittals below). If LCN or equal manufacturer #419 Flush Panel Adapter is not in submittals as required for transom panel applications or if other drop plates, blade, angle or applied stops are not in submittals the submittal will be marked revise and resubmit. After doors are installed, hardware Vendor to field verify additional brackets and shims required before installing closers. Provide written language in submittals for how areas requiring special applications will be installed.

2.10 STOPS AND HOLDERS

A. Overhead Door Holder/Stops:

1. Acceptable Manufacturers:
 - a. Rixson Manufacturing.
 - b. ABH Manufacturing.
 - c. Glynn Johnson.
2. Where hardware groups/sets have different information, refer to the following for clarification. Provide hardware groups/sets devices along with added devices as indicated on Drawings and detailed requirements for each type of device.
 - a. Overhead Stops and/or Holders shall meet the requirements of BHMA A156.8, Type 1, Grade 1.
 - b. If overhead stops are specified in hardware groups/sets, do not provide wall or floor stops as alternative method of stopping door.

B. Floor and Wall Door Stops/Holders and Bumpers:

1. Acceptable Manufacturers:
 - a. Ives Manufacturing.
 - b. Triangle Brass Manufacturing Company, Inc. (Trimco).
 - c. Rockwood.
 - d. Hager Manufacturing.
2. Where hardware groups/sets have different information, refer to the following for clarification. Provide hardware groups/sets devices along with added devices as indicated on Drawings and detailed requirements for each type of device:
 - a. Stops, Bumpers and/or Holders shall meet the requirements of BHMA A156.16, Grade 1.

- b. Coordinate with specifications in Section 06 10 00 for required wall backing.

2.11 ACCESSORIES

A. Kick/Mop Plates:

1. Acceptable Manufacturers:

- a. Ives Manufacturing.
- b. Triangle Brass Manufacturing Company, Inc. (Trimco).
- c. Hager Manufacturing.

B. Where hardware groups/sets have different information, refer to the following for clarification. Provide hardware groups/sets devices along with added devices as indicated on Drawings and detailed requirements for each type of device

- 1. Coordinate length and sizes for hardware devices before ordering materials (verify the door hardware is compatible for use with the doors and door/frames). Protection plate example: LDW nomenclature in Part 3 means "less door width". A 48 inch wide door would have a 46 inch wide protection plate. Width shall be one inch less than door width unless doors have protective edge guards or center mullions. Coordinate before submittals.

C. Push/Pull Plates:

1. Acceptable manufacturers, if meeting specifications below (provide samples for review).

- a. Ives Manufacturing.
- b. Trimco.
- c. Hager Manufacturing.

D. Smoke Seals, Sound Seals, and/or Weatherstripping.

1. Acceptable Manufacturers:

- a. Pemko Manufacturing, Inc.
- b. National Guard Products (NGP).
- c. Zero International.

E. Door Silencers:

1. Acceptable Manufacturers:

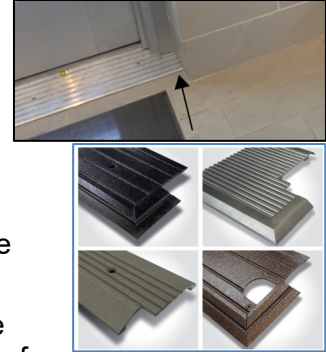
- a. Ives Manufacturing.
- b. Triangle Brass Manufacturing Company, Inc. (Trimco).
- c. Rockwood.
- d. Hager Manufacturing.

F. Astragals, Door Bottoms, and Thresholds:

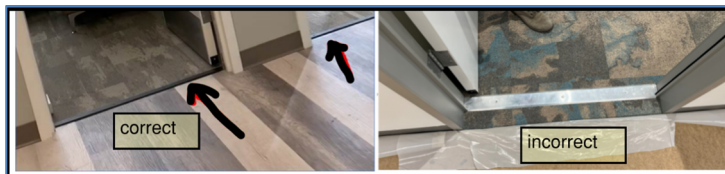
1. Acceptable Manufacturers:

- a. Pemko Manufacturing, Inc.
- b. National Guard Products (NGP).
- c. Zero International.

2. Whether or not specified below in hardware sets, thresholds shall be detailed as part of engineering/shop drawings/means and methods before submittals.



- a. Thresholds shall comply with CBC 2022 Section 11B-404.2.5 (shall not exceed 1/2 inch in height) and shall comply with Sections 11B-303 (beveled requirements stating changes in level between 1/4 inch high minimum and 1/2 inch high maximum shall be beveled with a slope not steeper than 1:2.).
- b. Thresholds that extend past door frame shall wrap frame stops. Cut around stops, then continue into rabbets, face of frame and wall conditions if wall conditions are in same application (see example of where threshold meet adjacent walls in snippet below):
- c. Whether or not specified below, where thresholds are longer/wider than 6" thresholds to have beveled miter ends. 45-degree miter cut and a closed end, welded with returns to door/frame. Example: NGP manufacturing nomenclature RCE throughout (see example snippet).
- d. Whether or not marked throughout, verify the poured sill condition and/or interior sill or flooring transitions before ordering devices, materials or doors (door undercut will be affected by flooring transitions, see Part 3 below for undercut requirements):
 - 1) Typical exterior conditions: Often in projects, Contractor pours or installs a sill condition that is different from the design team sill detail. Per specification provide coordinated threshold as required by current sill condition (coordination between sub/Vendor and Contractor in field). Contractor to coordinate.
 - 2) Typical interior conditions: Whether or not marked throughout, verify the sill condition. Often in projects, Contractor does not prep the floor to have the transition between flooring materials in the correct place (where interior thresholds occur sill conditions to be coordinated so auto door bottom or bottom of doors should sit directly above thresholds and the finishes of floors are to be aligned under to door - coordination between sub/Vendor and Contractor in field - see example picture below of correct verses non-correct flooring transitions - coordinate as required, means and methods):



G. Drip Guard:

1. Provide at exterior doors exposed to rain.
2. Size: Full Frame Width (FFW).
3. Provide devices painted to match adjacent frame. See Section 09 91 00 for paint and primer requirements.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine doors and frames and verify mounting locations as indicated on shop drawings.
- B. Report unacceptable conditions to the Architect. Begin installation only when unacceptable conditions have been corrected.

3.2 INSTALLATION

- A. Install in accordance with manufacturer's printed instructions and accepted shop drawings.
- B. Door-Floor Clearances:
 - 1. Unless otherwise shown, provide the following door-floor clearance:
 - a. Maximum 3/8 inch.
 - 2. Undercut doors so that the sweeps still fit tight against the sill or threshold condition, but as the door opens and sweeps away from sill or threshold, the door bottoms do not rub on the floor. Metal installation parts of door bottoms are typically part of the door assembly and only the gap between the metal part and sill/threshold are seen as the undercut. Means and methods: coordinate as required for door and hardware with finish floors, toppings, thresholds and performance ratings.
- C. Hardware Placement:
 - 1. Unless otherwise shown or required by CBC 2022, ADA Act - 2010 Standards for Accessible Design and/or Title 24, place hardware at the following heights:
 - a. Hinges: Door and frame manufacturer's standard scope per additional specifications and plans.
 - b. Lever handles for latchsets, locksets, and panic/exit devices pull, lever trim:
 - 1) 38 inches above finish floor/surface.
 - 2) Verify manufacturer's template with door design.
 - c. Panic devices push bar:
 - 1) Panic hardware shall be so mounted / centered between 36 inches and 44 inches above finished floor or ground.
 - 2) Verify manufacturer's template with door design to meet CBC 2022 exterior, pull side trim.
 - d. Door Pulls and Push Bars (centerline): mounted / centered 42 inches above finished floor or ground.
 - e. Door Push Plates (centerline): mounted / centered 42 inches above finished floor or ground.
 - f. Closers:
 - 1) To meet opening force requirements
 - 2) See installation below.
 - 2. Hardware for door handles, pulls, latches, locks, and other operating devices for use on means of egress doors shall comply with SFM Standard 12-10-2, Section 12-10-202 as contained in CCR Title 24, Part 12.

D. Installation:

1. Except for hinges, do not install hardware until painting and finishing work is completed.
2. Pre-drill pilot holes in wood for screws. Drill and tap for surface mounted hardware on metal.
3. Hinges: Set hinges snug and flat in mortises. Hand turn screws to flat seat – do not drive.
4. Locksets: Install locks with keyways in proper position. Install levers, roses, and escutcheons firmly affixed.
5. Closers:
 - a. Meet non-rated opening/exterior opening force requirements as well as close and latch non-smoke non-fire rated doors:
 - 1) Closers are to be installed as close to the hinge side of door as possible by a trained installer per this Section, Part 1 “Quality Assurance, Installer Qualifications”, installer an authorized representative of manufacturers, minimum of five years successful experience installing closers to meet 5-pound opening force for non-rated door complexity.
 - 2) For non-smoke or non-fire rated doors, before installation of closers install one mockup door for each kind of closer application. Example: parallel, regular arm, stop arm and/or top-jamb arm application if specified. Confirm doors meet 5-pound opening force and still close door. This will ensure proper installation for doors to open at 5 pounds opening force before remaining non-rated opening closers are installed. The closer the closer is installed to the hinge, the better performance for 5 pound opening force, but still close and latch door.
 - b. Mount door closers for maximum swing but at non-rated doors to meet 5-pound opening force. At all possible openings, mount door closers for maximum swing of door before setting stops.
 - c. Mount door closers for maximum swing, but at non-rated doors to meet 5-pound opening force. Drawings may show doors open to only 90 degrees (Revit or CAD system set up), but unless noted or specified with limiter (stop arm devices below), all doors to open for maximum swing against adjacent 180 wall if nothing inhibits door from doing so. Include wide-throw hinges per specs and installation for 170 degree to 180 degree or maximum swing of door before installing stops.
6. Floor Stops: See notes on closers and hinges above. After closer devices are installed, and door is opened as far as possible without #1) occupant excessive force on closer; and #2) door does not hit adjacent wall or other surfaces, stops shall be installed at substantial completion a maximum of 4 inches from adjacent walls and as far away from the hinge point as possible. Preference is to have stops installed just below lever or pull locations.
7. Auto Door Bottom shall not be adjusted until substantial completion. Door bottoms shall be raised to highest position while construction occurs so to not have rubber seal torn or damaged by debris under the door. At substantial completion, adjust door bottom to fully engage and touch the floor for proper sound dampening.
8. Silencers: Set in place before adjusting strikes.
9. Thresholds and Raindrips: Set in waterproof sealant and fasten anchors in pre-drilled countersunk holes 18 inch on center maximum spacing and within 3 inches of each end. Minimum three anchors per threshold.

3.3 PAINT OR FIELD FINISHES

- A. Coordinate with Contact Documents including, but not limited to, Section 09 91 00 for paint and primer requirements.

3.4 ADJUSTING

- A. Adjust parts for smooth, uniform operation.
- B. Lubricate moving parts with manufacturer recommended lubricant.
- C. Replace units that cannot be adjusted and lubricated to operate freely and smoothly as intended for the application.
- D. Adjust door closer devices:
 - 1. Adjust closer operating.
 - a. Interior and Exterior Doors: Not to exceed 5.0 pounds force.
 - 2. Adjust closer delay and operating speeds to comply with requirements of 2022 CBC Section 11B-404.2.8.1 and ADA – Americans with Disabilities Act - 2010 Standards for Accessible Design.
 - a. Doors closers, when provided, shall have sweep period adjusted: minimum of 5 seconds for a door to close from the 90 degree position to the 12 degree position.
 - b. Doors with spring hinges require a minimum of 1.5 seconds to close from the 70 degree to the closed position.

3.5 CLEANING

- A. Clean as recommended by manufacturer. Do not use materials or methods which may damage finish or surrounding construction.

3.6 HARDWARE SCHEDULE

A. Manufacturers Legend:

<u>Code</u>	<u>Name</u>
MC	McKinney Manufacturing
SE	Select Manufacturing
IV	Ives Manufacturing
SC	Schlage Manufacturing
VO	Von Duprin Manufacturing
LC	LCN Closers
PE	Pemko Manufacturing
TR	Trimco Manufacturing
RX	Rixson Manufacturing
CR	Crown Industrial Manufacturing
LO	Locinox Manufacturing

B. Hardware Columns - Example (Legend):

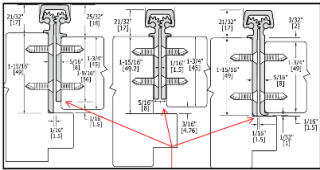
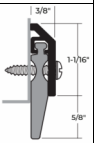
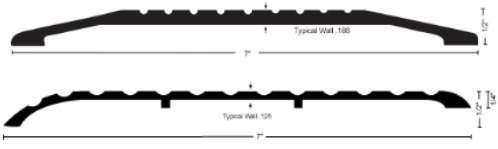
Qty	Device Description	Device # (include specification language)	Finish	Manu
1	-----	-----	--	--

- C. The following hardware sets are intended to establish type and standard of quality when used together with the requirements of this Section (see above Section and related Sections including Division 01). Examine Contract Documents and furnish proper hardware for door openings. Refer to Door Schedule on the Drawings for Hardware Group/Set assignments for each opening.

Blank space below and after a Group/Set is intentional to avoid, if possible, splitting a Hardware Group/Set onto two pages

Exterior Hardware Sets (Typically Two-Digit Set Numbers)

Hardware Group/Set #01

1	Ea.	Continuous Hinge Electrified Wire Transfer 	Select manufacturing SL11-HD device (120 inch or length as required for door height) x #ATW accessible through wire transfer. Different door thicknesses and frame dimensions will affect hinge type. Per specifications whether or not marked throughout all, verify for proper hinge type before submittals. Do not submit hinges until verified for correct hinge application per opening (means and methods with Select factory). For all other pre-approved aluminum hinge manufacturers their hinge must be pre-templated at the factory to use the Securiton or equal power transfer below. 	AL	SE
1	Ea.	Alternate Power Transfer	#CEPT	630	SN
1	Ea.	Electric Latch Retraction Rim-Type Exit/Panic Devices x Key Override	QELX x RX PA 99NL x 110NL series	626	VO
1	Ea.	Offset Pull	AP423-J-36" x BHMA 710CU (Healthy Hardware Antimicrobial) finish. Do not block emergency key override	710 CU	TR
1	Ea.	I/C Cylinders (Rim or Mortise)	20-757 or 20-763 x appropriate cam x blocking rings as required (rim or mortise type and quantity as required by locking device)	626	SC
1	Ea.	Permanent Core	20-740	626	SC
1	Ea.	Surface Closer	4040XP parallel (installed push-side)	689	LC
1	Ea.	Stop (installed only after substantial completion).	Auxiliary Stop 1209. After closer is opened as far as possible install floor stop per 08 71 00.Part 3	630	TR
1	Ea.	Seal	Seals (head, jambs) by door and frame manufacturer		
1	Ea.	Door Bottom	202NA by NGP or approved manufacturer. Note: Install threshold and sweep so that when door is closed, sweep sit tightly against threshold 		
1	Ea.	Aluminum Threshold	427 flush condition or 659 offset as required per sill condition (7" flat or quarter inch offset sill, coordinate before submittals) x wrap frame stops x beveled miter ends x mastic x by NGP or equal 		
1	Ea.	Door Position Switch (Alarm Contact)	#679-05-HM by Schlage manufacturing (coordinate with Divisions 26-28 and applicable drawings).		
1	Ea.	QELX Power Supply	Furnish and install #1) single gang power drop located above or near door (not in corridor or public view, but above ceiling line where possible); #2) provide power supply # PS904 4 RL with 900-BB (battery backup for additional opening cycles when there		

			is power loss); #3) run conduit from hinge through frame and complete wiring as required to meet manufacturer warranties
1	Ea.	REX Device	If REX is required, coordinate with security (sensor is built into above locking device if required). Coordinate with Divisions 25-28 and applicable drawings. The "REX" feature as described below is a security feature that announces/tells the security system if occupant is leaving the building interior area and similar to a motion-sensor the "REX" switch or device does not affect egress of the doors. All project doors and hardware group/sets are free egress at all times with no special knowledge to exit.
1	Ea.	Coordination task for security and/or electrical design and additional non-Division 08 Section scope (including but not limited to wire / connectivity from ground or ceiling through frame to electrified hardware)	By security or electrical as required per Contract Documents: - The electrified hardware specified above can be utilized for #1) non-card reader, remote access control applications (unlocked / locked remotely for open during business hours / locked after-hours) and #2) local card readers at openings as directed by architectural drawings, security or electrical. - Coordinate with security or electrical Divisions 26-28 and applicable drawings as hardware does not include card reader locations.
Note 1: Balance of perimeter seals and meeting stiles by door manufacturer. Note 2: Furnish all devices and components for hardware groups/set above in accordance with Contract Documents (including but not limited to additional hardware devices requirements in the above specification language, architectural plans and full specification documents).			

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Hardware Group/Set #02

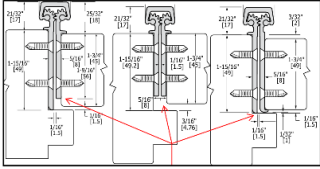
1	Ea.	Continuous Hinge Electrified Wire Transfer	Select manufacturing SL11-HD device (120 inch or length as required for door height) x #ATW accessible through wire transfer. For all other pre-approved aluminum hinge manufacturers their hinge must be pre-templated at the factory to use the Securitron or equal power transfer below	AL	SE
1	Ea.	Alternate Power Transfer	#CEPT	630	SN
1	Ea.	Electric Latch Retraction Rim-Type Exit/Panic Devices x Key Override	QELX x RX PA 99NL x 110NL series	626	VO
1	Ea.	Offset Pull	AP423-J-36" x BHMA 710CU (Healthy Hardware Antimicrobial) finish. Do not block emergency key override	710 CU	TR
1	Ea.	I/C Cylinders (Rim or Mortise)	20-757 or 20-763 x appropriate cam x blocking rings as required (rim or mortise type and quantity as required by locking device)	626	SC
1	Ea.	Permanent Core	20-740	626	SC
1	Ea.	Closer x Stop Arm	4040XP CUSH (push-side application)	689	LC
1	Ea.	Seal	Seals (head, jambs) by door and frame manufacturer		
1	Ea.	Door Bottom	202NA by NGP or approved manufacturer		
1	Ea.	Aluminum Threshold	427 flush condition or 659 offset as required per sill condition (7" flat or quarter inch offset sill, coordinate before submittals) x wrap frame stops x beveled miter ends x mastic x by NGP		
1	Ea.	Door Position Switch (Alarm Contact)	#679-05-HM by Schlage manufacturing (coordinate with Divisions 26-28 and applicable drawings).		
1	Ea.	QELX Power Supply	Furnish and install #1) single gang power drop located above or near door (not in corridor or public view, but above ceiling line where possible); #2) provide power supply # PS904 4 RL with 900-BB (battery backup for additional opening cycles when there is power loss); #3) run conduit from hinge through frame and complete wiring as required to meet manufacturer warranties		
1	Ea.	REX Device	If REX is required, coordinate with security (sensor is built into above locking device if required). Coordinate with Divisions 25-28 and applicable drawings		
1	Ea.	Coordination task for security and/or electrical design and additional non-Division 08 Section scope (including but not limited to wire / connectivity from ground or ceiling through frame to electrified hardware)	By security or electrical as required per Contract Documents: - The electrified hardware specified above can be utilized for #1) non-card reader, remote access control applications (unlocked / locked remotely for open during business hours / locked after-hours) and #2) local card readers at openings as directed by architectural drawings, security or electrical. - Coordinate with security or electrical Divisions 26-28 and applicable drawings as hardware does not include card reader locations.		
Note: Furnish all devices and components for hardware groups/set above in accordance with Contract Documents (including but not limited to additional hardware devices requirements in the above specification language, architectural plans and full specification documents).					

Hardware Group/Set #03

	Ea.	Hinge	T4A3386 x NRP (size & quantity per 08 71 00)	630	MC
1	Ea.	Electrified Hinge	T4A3386 x 8-Wire (size per 08 71 00)	630	MC
1	Ea.	Rim-Type Exit/Panic Devices x Electrified Lever	RX PA 99L x M996L-R/V x 06 Lever	626	VO
1	Ea.	I/C Cylinders (Rim or Mortise)	20-757 or 20-763 x appropriate cam x blocking rings as required (rim or mortise type and quantity as required by locking device)	626	SC
1	Ea.	Permanent Core	20-740	626	SC
1	Ea.	Surface Closer	4040XP parallel (installed push-side)	689	LC
1	Ea.	Kick Plate	KO050 16" tall x 2" LDW (less door width) x B4E (beveled edges) x counter sunk or approved adhesive per 08 71 00.Part 2 (no raised fasteners)	630	TR
1	Ea.	Stop	1209 install floor stop per 08 71 00.Part 3	630	TR
1	Ea.	Seal	5050B seals (head and jambs) by NGP or approved		
1	Ea.	Door Bottom	202NA by NGP or approved manufacturer		
1	Ea.	Aluminum Threshold	427 flush condition or 659 offset as required per sill condition (7" flat or quarter inch offset sill, coordinate before submittals) x wrap frame stops x beveled miter ends x mastic x by NGP		
1	Ea.	Overhead Rain Drip	Provide #17 x FFW (fill frame width) by NGP or approved		
1	Ea.	Door Position Switch (Alarm Contact)	#679-05-HM by Schlage manufacturing (coordinate with Divisions 26-28 and applicable drawings).		
1	Ea.	Power Supply – at next printing verify security will provide the power to doors with #902 devices	Furnish and install #1) single gang power drop located above or near door (not in corridor or public view, but above ceiling line where possible); #2) provide power supply # PS902; #3) run conduit from hinge through frame and complete wiring as required to meet manufacturer warranties		
1	Ea.	REX Device	If REX is required, coordinate with security (sensor is built into above locking device if required). Coordinate with Divisions 25-28 and applicable drawings		
1	Ea.	Coordination task for security and/or electrical design and additional non-Division 08 Section scope (including but not limited to wire / connectivity from ceiling through frame to electrified hardware)	By security or electrical as required per Contract Documents: - The electrified hardware specified above can be utilized for #1) non-card reader, remote access control applications (unlocked / locked remotely for open during business hours / locked after-hours) and #2) local card readers at openings as directed by architectural drawings, security or electrical. - Coordinate with security or electrical Divisions 26-28 and applicable drawings as hardware does not include card reader locations.		

Note: Furnish all devices and components for hardware groups/set above in accordance with Contract Documents (including but not limited to additional hardware devices requirements in the above specification language, architectural plans and full specification documents).

Hardware Group/Set #04

1	Ea.	Continuous Hinge Electrified Wire Transfer 	Select manufacturing SL11-HD device (120 inch or length as required for door height) x #ATW accessible through wire transfer. Different door thicknesses and frame dimensions will affect hinge type. Per specifications whether or not marked throughout all, verify for proper hinge type before submittals. Do not submit hinges until verified for correct hinge application per opening (means and methods with Select factory). For all other pre-approved aluminum hinge manufacturers their hinge must be pre-templated at the factory to use the Securitron or equal power transfer below. 	AL	SE
1	Ea.	Alternate Power Transfer	#CEPT	630	SN
1	Ea.	Rim-Type Exit/Panic Devices x Electrified Lever	RX PA 99L x M996L-R/V x 06 Lever	626	VO
1	Ea.	I/C Cylinders (Rim or Mortise)	20-757 or 20-763 x appropriate cam x blocking rings as required (rim or mortise type and quantity as required by locking device)	626	SC
1	Ea.	Permanent Core	20-740	626	SC
1	Ea.	Surface Closer	4040XP parallel (installed push-side)	689	LC
1	Ea.	Armor Plate	KA050 34" tall x 2" LDW (less door width) x B4E (beveled edges) x counter sunk or approved adhesive per 08 71 00.Part 2 (no raised fasteners)	630	TR
1	Ea.	Stop	1209 install floor stop per 08 71 00.Part 3	630	TR
1	Ea.	Seal	5050B seals (head and jambs) by NGP or approved		
1	Ea.	Door Bottom	202NA by NGP or approved manufacturer		
1	Ea.	Aluminum Threshold	427 flush condition or 659 offset as required per sill condition (7" flat or quarter inch offset sill, coordinate before submittals) x wrap frame stops x beveled miter ends x mastic x by NGP		
1	Ea.	Overhead Rain Drip	Provide #17 x FFW (fill frame width) by NGP or approved		
1	Ea.	Door Position Switch (Alarm Contact)	#679-05-HM by Schlage manufacturing (coordinate with Divisions 26-28 and applicable drawings).		
1	Ea.	Power Supply	Furnish and install #1) single gang power drop located above or near door (not in corridor or public view, but above ceiling line where possible); #2) provide power supply # PS902; #3) run conduit from hinge through frame and complete wiring as required to meet manufacturer warranties		
1	Ea.	REX Device	If REX is required, coordinate with security (sensor is built into above locking device if required). Coordinate with Divisions 25-28 and applicable drawings		
1	Ea.	Coordination task for security and/or electrical design and additional non-Division 08 Section scope (including but not limited to wire /	By security or electrical as required per Contract Documents: - The electrified hardware specified above can be utilized for #1) non-card reader, remote access control applications (unlocked / locked remotely for open during business hours / locked after-hours) and #2) local card readers at openings as directed by architectural drawings, security or electrical.		

		connectivity from ceiling through frame to electrified hardware)	- Coordinate with security or electrical Divisions 26-28 and applicable drawings as hardware does not include card reader locations.
Note: Furnish all devices and components for hardware groups/set above in accordance with Contract Documents (including but not limited to additional hardware devices requirements in the above specification language, architectural plans and full specification documents).			

Hardware Group/Set #04.1

	Ea.	Hinge	T4A3386 x NRP (size & quantity per 08 71 00)	630	MC
1	Ea.	Electrified Hinge	T4A3386 x 8-Wire (size per 08 71 00)	630	MC
1	Ea.	Electrified Lockset	RX ND80T EU x RHO x 10-025	630	SC
1	Ea.	I/C Cylinders (Rim or Mortise)	20-757 or 20-763 x appropriate cam x blocking rings as required (rim or mortise type and quantity as required by locking device)	626	SC
1	Ea.	Permanent Core	20-740	626	SC
1	Ea.	Closer x Stop Arm	4040XP CUSH (push-side application)	689	LC
1	Ea.	Kick Plate	KO050 16" tall x 2" LDW (less door width) x B4E (beveled edges) x counter sunk or approved adhesive per 08 71 00.Part 2 (no raised fasteners)	630	TR
1	Ea.	Seal	5050B seals (head and jambs) by NGP or approved		
1	Ea.	Door Bottom	202NA by NGP or approved manufacturer		
1	Ea.	Aluminum Threshold	427 flush condition or 659 offset as required per sill condition (7" flat or quarter inch offset sill, coordinate before submittals) x wrap frame stops x beveled miter ends x mastic x by NGP		
1	Ea.	Overhead Rain Drip	Provide #17 x FFW (fill frame width) by NGP or approved		
1	Ea.	Door Position Switch (Alarm Contact)	#679-05-HM by Schlage manufacturing (coordinate with Divisions 26-28 and applicable drawings).		
1	Ea.	Power Supply – at next printing verify security will provide the power to doors with #902 devices	Furnish and install #1) single gang power drop located above or near door (not in corridor or public view, but above ceiling line where possible); #2) provide power supply # PS902; #3) run conduit from hinge through frame and complete wiring as required to meet manufacturer warranties		
1	Ea.	REX Device	If REX is required, coordinate with security (sensor is built into above locking device if required)		
1	Ea.	Coordination task for security and/or electrical design and additional non-Division 08 Section scope (including but not limited to wire / connectivity from ceiling through frame to electrified hardware)	By security or electrical as required per Contract Documents: - The electrified hardware specified above can be utilized for #1) non-card reader, remote access control applications (unlocked / locked remotely for open during business hours / locked after-hours) and #2) local card readers at openings as directed by architectural drawings, security or electrical. - Coordinate with security or electrical Divisions 26-28 and applicable drawings as hardware does not include card reader locations.		

Note: Furnish all devices and components for hardware groups/set above in accordance with Contract Documents (including but not limited to additional hardware devices requirements in the above specification language, architectural plans and full specification documents).

Hardware Group/Set #05

	Ea.	Hinge	TA2314 x NRP (size & quantity per 08 71 00)	630	MC
1	Ea.	Electrified Hinge	TA2314 x 8-Wire (size per 08 71 00)	630	MC
1	Ea.	Rim-Type Exit/Panic x Electrified Lever	RX PA 99L x M996L-R/V x 06 Lever	626	VO
1	Ea.	I/C Cylinders (Rim or Mortise)	20-757 or 20-763 x appropriate cam x blocking rings as required (rim or mortise type and quantity as required by locking device)	626	SC
1	Ea.	Permanent Core	20-740	626	SC
1	Ea.	Closer x Stop Arm	4040XP CUSH (push-side application)	689	LC
1	Ea.	Seal	5050B seals (head and jambs) by NGP or approved		
1	Ea.	Door Bottom	202NA by NGP or approved manufacturer		
1	Ea.	Aluminum Threshold	427 flush condition or 659 offset as required per sill condition (7" flat or quarter inch offset sill, coordinate before submittals)		
1	Ea.	Overhead Rain Drip	Provide #17 x FFW (fill frame width) by NGP or approved		
1	Ea.	Door Position Switch (Alarm Contact)	#679-05-HM by Schlage manufacturing (coordinate with Divisions 26-28 and applicable drawings).		
1	Ea.	Power Supply – at next printing verify security will provide the power to doors with #902 devices	Furnish and install #1) single gang power drop located above or near door (not in corridor or public view, but above ceiling line where possible); #2) provide power supply # PS902; #3) run conduit from hinge through frame and complete wiring as required to meet manufacturer warranties		
1	Ea.	REX Device	If REX is required, coordinate with security (sensor is built into above locking device if required)		
1	Ea.	Coordination task for security and/or electrical design and additional non-Division 08 Section scope (including but not limited to wire / connectivity from ceiling through frame to electrified hardware)	By security or electrical as required per Contract Documents: - The electrified hardware specified above can be utilized for #1) non-card reader, remote access control applications (unlocked / locked remotely for open during business hours / locked after-hours) and #2) local card readers at openings as directed by architectural drawings, security or electrical. - Coordinate with security or electrical Divisions 26-28 and applicable drawings as hardware does not include card reader locations.		
Note: Furnish all devices and components for hardware groups/set above in accordance with Contract Documents (including but not limited to additional hardware devices requirements in the above specification language, architectural plans and full specification documents).					

Blank space below and after a Group/Set is intentional to avoid, if possible, splitting a Hardware Group/Set onto two pages

Hardware Group/Set #06

	Ea.	Hinge	TA2314 x NRP (size & quantity per 08 71 00)	630	MC
1	Ea.	Electrified Hinge	TA2314 x 8-Wire (size per 08 71 00)	630	MC
1	Ea.	Electrified Lockset	RX ND80T EU x RHO x 10-025	630	SC
1	Ea.	I/C Cylinders (Rim or Mortise)	20-757 or 20-763 x appropriate cam x blocking rings as required (type as required by locking device)	626	SC
1	Ea.	Permanent Core	20-740	626	SC
1	Ea.	Closer x Stop Arm	4040XP CUSH (push-side application)	689	LC
1	Ea.	Seal	5050B seals (head and jambs) by NGP or approved		
1	Ea.	Door Bottom	202NA by NGP or approved manufacturer		
1	Ea.	Aluminum Threshold	427 flush condition or 659 offset as required per sill condition (7" flat or quarter inch offset sill, coordinate before submittals)		
1	Ea.	Overhead Rain Drip	Provide #17 x FFW (fill frame width) by NGP or approved		
1	Ea.	Door Position Switch (Alarm Contact)	#679-05-HM by Schlage manufacturing (coordinate with Divisions 26-28 and applicable drawings).		
1	Ea.	Power Supply – at next printing verify security will provide the power to doors with #902 devices	Furnish and install #1) single gang power drop located above or near door (not in corridor or public view, but above ceiling line where possible); #2) provide power supply # PS902; #3) run conduit from hinge through frame and complete wiring		
1	Ea.	REX Device	If REX is required, coordinate with security (sensor is built into above locking device if required)		
1	Ea.	Coordination task for security and/or electrical design and additional non-Division 08 Section scope (including but not limited to wire / connectivity from ceiling through frame to electrified hardware)	By security or electrical as required per Contract Documents: - The electrified hardware specified above can be utilized for #1) non-card reader, remote access control applications (unlocked / locked remotely for open during business hours / locked after-hours) and #2) local card readers at openings as directed by architectural drawings, security or electrical. - Coordinate with security or electrical Divisions 26-28 and applicable drawings as hardware does not include card reader locations.		
Note: Furnish all devices and components for hardware groups/set above in accordance with Contract Documents (including but not limited to additional hardware devices requirements in the above specification language, architectural plans and full specification documents).					

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Hardware Group/Set #07

1	Ea.	Continuous Hinge Electrified Wire Transfer	Select manufacturing SL11-HD device (120 inch or length as required for door height) x #ATW accessible through wire transfer. For all other pre-approved aluminum hinge manufacturers their hinge must be pre-templated at the factory to use the Securitron or equal power transfer below	AL	SE
1	Ea.	Alternate Power Transfer	#CEPT	630	SN
1	Ea.	Fire Rated Rim Panic Devices x Electrified Lever	RX PA 99L-F x M996L-R/V x 06 Lever	626	VO
1	Ea.	I/C Cylinders (Rim or Mortise)	20-757 or 20-763 x appropriate cam x blocking rings as required (rim or mortise type and quantity as required by locking device)	626	SC
1	Ea.	Permanent Core	20-740	626	SC
1	Ea.	Closer x Stop Arm	4040XP CUSH (push-side application)	689	LC
1	Ea.	Stop	1209 install floor stop per 08 71 00.Part 3	630	TR
1	Ea.	Seal	Seals (head, jambs) by door and frame manufacturer		
1	Ea.	Door Bottom	202NA by NGP or approved manufacturer		
1	Ea.	Aluminum Threshold	427 flush condition or 659 offset as required per sill condition (7" flat or quarter inch offset sill, coordinate before submittals) x wrap frame stops x beveled miter ends x mastic x by NGP		
1	Ea.	Door Position Switch (Alarm Contact)	#679-05-HM by Schlage manufacturing (coordinate with Divisions 26-28 and applicable drawings).		
1	Ea.	QELX Power Supply	Furnish and install #1) single gang power drop located above or near door (not in corridor or public view, but above ceiling line where possible); #2) provide power supply # PS904 4 RL with 900-BB (battery backup for additional opening cycles when there is power loss); #3) run conduit from hinge through frame and complete wiring as required to meet manufacturer warranties		
1	Ea.	REX Device	If REX is required, coordinate with security (sensor is built into above locking device if required). Coordinate with Divisions 25-28 and applicable drawings		
1	Ea.	Coordination task for security and/or electrical design and additional non-Division 08 Section scope (including but not limited to wire / connectivity from ground or ceiling through frame to electrified hardware)	By security or electrical as required per Contract Documents: - The electrified hardware specified above can be utilized for #1) non-card reader, remote access control applications (unlocked / locked remotely for open during business hours / locked after-hours) and #2) local card readers at openings as directed by architectural drawings, security or electrical. - Coordinate with security or electrical Divisions 26-28 and applicable drawings as hardware does not include card reader locations.		
Note: Furnish all devices and components for hardware groups/set above in accordance with Contract Documents (including but not limited to additional hardware devices requirements in the above specification language, architectural plans and full specification documents).					

Hardware Groups/Set #08

1	Ea.	I/C Cylinders (Rim or Mortise)	20-757 or 20-763 x appropriate cam x blocking rings as required (type as required by locking device)	626	SC
1	Ea.	Permanent Core	20-740	626	SC

Note 1: For doors/openings assigned this hardware group/set, the cylinder is for unit-type pricing. At each opening assigned this hardware group/set, provide final keying as required per locking and/or key control devices (examples include but are not limited to Coiling Door locking devices and/or control switches that activate or control the on/off switches). After the door is installed, if door or doors assigned this hardware set require a key for locking or for turning on/off motors (like an off switch, just keyed), utilize the Unit Price cylinder and order the and install the required keyed cylinder at time of door is tested (fully functional doors at substantial completion).

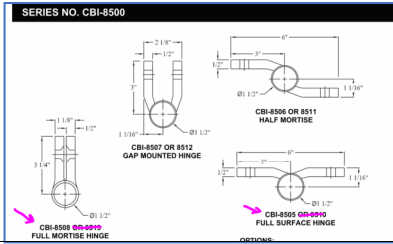
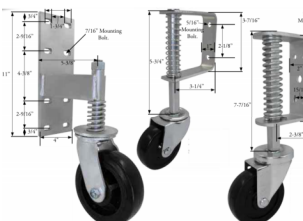
Note 2: Furnish all devices & components for hardware groups/set above in accordance with Contract Documents (including but not limited to notes below, additional hardware devices requirements in the above specification language, architectural plans & full specification documents).

Hardware Group/Set #09

4	Ea.	Hinges	TA2314 4.5" x 4.5"	630	MC
4	Ea.	UL Rated Spring Hinges	1552 4.5" x 4.5". Note: these are not structural hinges. Install spring hinges at two bottom hinge locations with TA2314 hinges at top two positions.	630	MC
1	Ea.	Auto Flush Bolt	#3810 x #3850 (no dust proof strike)	626/ 630	TR
1	Ea.	Classroom-Type Lockset	L9070T EU x 06 Lever x A Rose (in shop drawings / submittals, these locks are to installed as close to bottom of the door that the fire department personnel could reach the lever from the ladder – as doors are off the ground near second floor)	630	SC
1	Ea.	I/C Cylinders (Rim or Mortise)	20-757 or 20-763 x appropriate cam x blocking rings as required (rim or mortise type and quantity as required by locking device)	626	SC
1	Ea.	Permanent Core	20-740	626	SC
1	Ea.	Coordinator	#3094 series x filler plates x mounting brackets as required for coordinated hardware		TR
2	Ea.	Overhead Stop	10 series (-336 or size as required per door width)	630	RX
1	Ea.	Seal	5050B seals (head and jambs) by NGP or approved		
2	Ea.	Door Bottom	202NA by NGP or approved manufacturer		
1	Ea.	Overlapping Astragal	158V by NGP or approved equal.		
1	Ea.	Aluminum Threshold	427 flush condition or 659 offset as required per sill condition (7" flat or quarter inch offset sill, coordinate before submittals) x wrap frame stops x beveled miter ends x mastic x by NGP		
1	Ea.	Overhead Rain Drip	Provide #17 x FFW (fill frame width) by NGP or approved		

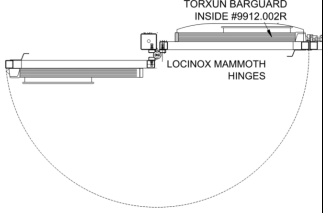
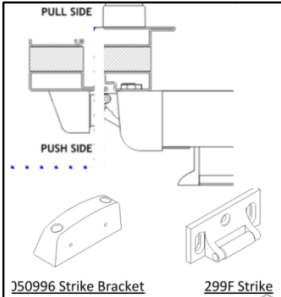
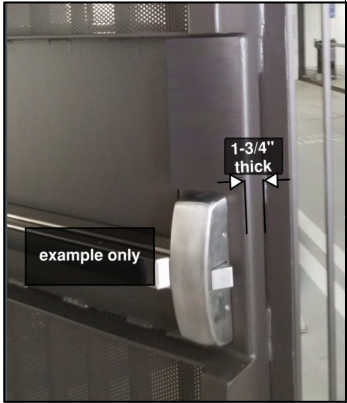
Note: Furnish all devices and components for hardware groups/set above in accordance with Contract Documents (including but not limited to additional hardware devices requirements in the above specification language, architectural plans and full specification documents).

Hardware Group/Set #10

2	Ea.	Gate Hinge/Hanging Devices (Precision Engineered High Capacity by Crown industrial manufacturing or approved equal manufacturer and type)	Surface x surface (CBI-8505) or full mortise (CBI-8508) as required per details, final to be selected (final quantity per manufacturer's recommendations).			CR			
1	Ea.	Lockset	LV9070T x 06A (free egress out of areas)	626	SC				
1	Ea.	Lockset Weldable Box Keedex Inc • 510 Cameron Street • Placentia, Ca • 92807 Phone (714) 993-4300 • Fax (714) 993-4303 Email- gates@keedex.com • Web- www.keedex.com	<table><tr><th>Lock Manufacturer Part Number</th><th>OUR BOX PART #</th></tr><tr><td>L SERIES MORTISE</td><td>K-BXMOR1 / K-BXMOR1-10G</td></tr></table>	Lock Manufacturer Part Number	OUR BOX PART #	L SERIES MORTISE	K-BXMOR1 / K-BXMOR1-10G		
Lock Manufacturer Part Number	OUR BOX PART #								
L SERIES MORTISE	K-BXMOR1 / K-BXMOR1-10G								
1	Ea.	Lock Guard (inside)	TORXUN manufacturing – see www.torxun.com part #9912.001R (or equal devices as required by architectural details, and language in Section 08 71 00)						
1	Ea.	I/C Cylinders (Rim or Mortise)	20-757 or 20-763 x appropriate cam x blocking rings as required (rim or mortise type and quantity as required by locking device)	626	SC				
1	Ea.	Permanent Core	20-740	626	SC				
1	Ea.	Stop and Holder	1804	630	AB H				
2	Ea.	Bottom of doors to be greater than 10" Clear, Unobstructed & Smooth Surface	Per above specifications and by gate manufacturer (push-side, ground smooth, primed and painted to match gate).						
1	Ea.	Painted Full Height Astragal	Per above specifications and by gate manufacturer and per specifications (utilized as a positive stop – when gate closes against the astragals the opening cannot swing back in toward the egress side)						
2	Ea.	Heavy Duty Gate Caster Bracket 	G3 Series #G327ZZ60JZ83YY x coordinated/correct sized wheel (consult factory representative for help in determining the right bracket series, caster series, wheel diameter, wheel type and bearing to use. Factors to be considered are gate size, gate weight, floor condition, working environment and floor slope, etc. Custom casters are available with varying spring types, deflection ranges and capacities).						

Note: Furnish all devices & components for hardware groups/set above in accordance with Contract Documents (including but not limited to additional hardware devices requirements in the above specification language, architectural plans & full specification documents).

Hardware Group/Set #11

1	Ea.	Hydraulic Closers / Hinges Sets 	Locinox manufacturing #Mammoth 180 Hydraulic Closers/Hinges Set: Heavy duty 180° hydraulic gate closer and hinge for gates up to 330 lbs. x Black Finish (note: if round post similar to chain-link, provide additional Locinox brackets part #CLB Mammoth). At gates weighing over 330 pounds, provide Ultra heavy duty 180° hydraulic gate closer and hinge for gates up to 440 lbs gate leafs.		LO
1	Ea.	Rim-Type Exit/Panic Device x Lever	#WH-AX-PA-99L x 996L-R/V x 06 Lever	626	VO
1	Ea.	Strikes and Weldable Boxes (template as required by all furnished hardware, see Section 08 71 00, Part 1 for templating requirements and full specs which call for fully welded, no seams, ground smooth, prime and finishes per architectural drawings and welding/paint specifications) 	Furnish and install: #1) Welded, templated areas for devices (requires 1-3/4" thick gate stile and/or boxes as required where device is installed (templates to have custom welded areas preferred yet contact technicians at www.keedex.com for alternate weldable boxes if necessary - means and methods no-designer, show detailed templating in submittals and shop drawings). #2) Provide welded areas and brackets as required for condition for either special strike #1609 or combo devices #050996 strike bracket with 299F (means and methods no-designer, show detailed templating in submittals and shop drawings). 		
1	Ea.	Bar Guard (inside)	TORXUN Guard (inside) Part #9912.002R		TO
1	Ea.	I/C Cylinders (Rim or Mortise)	20-757 or 20-763 x appropriate cam x blocking rings as required (rim or mortise type and quantity as required by locking device)	626	SC
1	Ea.	Permanent Core	20-740	626	SC
1	Ea.	Stop	FS18L (installed only after punch walk/ substantial completion)	630	IV
1	Ea.	Bottom of doors to be greater than 10" Clear, Unobstructed & Smooth Surface	Per above specifications and by gate manufacturer (push-side, ground smooth, primed and painted to match gate).		
1	Ea.	Painted Full Height Astragal	Per above specifications and by gate manufacturer and per specifications (utilized as a positive stop – when gate closes against the astragals the opening cannot swing back in toward the egress side)		

Note: Furnish all devices & components for hardware groups/set above in accordance with Contract Documents (including but not limited to additional hardware devices requirements in the above specification language, architectural plans & full specification documents).

Interior Hardware Sets (Typically Three-Digit Set Numbers)

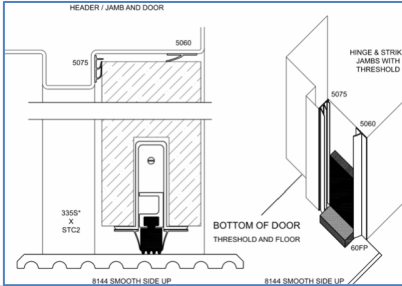
Hardware Group/Set #101

	Ea.	Hinge	T4A3786 (size & quantity per 08 71 00)	652	MC
1	Ea.	Electrified Hinge	T4A3786 x 8-Wire (size per 08 71 00)	652	MC
1	Ea.	Fire Rated Rim Panic Devices x Electrified Lever	RX PA 99L-F x M996L-R/V x 06 Lever	626	VO
1	Ea.	I/C Cylinders (Rim or Mortise)	20-757 or 20-763 x appropriate cam x blocking rings as required (rim or mortise type and quantity as required by locking device)	626	SC
1	Ea.	Permanent Core	20-740	626	SC
1	Ea.	Surface Closer	4040XP parallel (installed push-side)	689	LC
1	Ea.	Kick Plate	KO050 16" tall x 2" LDW (less door width) x B4E (beveled edges) x counter sunk or approved adhesive per 08 71 00.Part 2 (no raised fasteners)	630	TR
1	Ea.	Stop	1214 install floor stop per 08 71 00.Part 3	630	TR
1	Ea.	Seal	5050B seals (head and jambs) by NGP or approved		
1	Ea.	Door Position Switch (also known as Alarm Contact, Door Contacts)	#679-05-WD or #679-05-HM (as required per door material) by Schlage manufacturing (coordinate with Divisions 26-28 and applicable drawings).		
1	Ea.	Power Supply – at next printing verify security will provide the power to doors with #902 devices	Furnish and install #1) single gang power drop located above or near door (not in corridor or public view, but above ceiling line where possible); #2) provide power supply # PS902; #3) run conduit from hinge through frame and complete wiring as required to meet manufacturer warranties		
1	Ea.	REX Device	If REX is required, coordinate with security (sensor is built into above locking device if required). Coordinate with Divisions 25-28 and applicable drawings		
1	Ea.	Coordination task for security and/or electrical design and additional non-Division 08 Section scope (including but not limited to wire / connectivity from ceiling through frame to electrified hardware)	By security or electrical as required per Contract Documents: - The electrified hardware specified above can be utilized for #1) non-card reader, remote access control applications (unlocked / locked remotely for open during business hours / locked after-hours) and #2) local card readers at openings as directed by architectural drawings, security or electrical. - Coordinate with security or electrical Divisions 26-28 and applicable drawings as hardware does not include card reader locations.		
Note: Furnish all devices and components for hardware groups/set above in accordance with Contract Documents (including but not limited to additional hardware devices requirements in the above specification language, architectural plans and full specification documents).					

Hardware Group/Set #102

Note 1: In addition to the devices specified in hardware group/set below, coordinate for opening to have STC core doors, STC rating (based on VT Wood Doors at <https://www.vtindustries.com/webres/File/architectural-doors/Acoustical/SG5%2043%2048%2049.pdf>).

- Refer to seals below, Sections 08 14 00, 08 11 13 as well as STC doors and frame spec Sections, frames filled with acoustic batting sufficient for sound attenuation. Cam-lift hinges are not allowed; provide heavy weight level swing hinges per below to meet ADA opening force.
- Furnish and install doors, frames and related scope per complete Contract Documents.

	Ea.	Hinge	T4A3786 (size & quantity per 08 71 00)	652	MC																								
1	Ea.	Electrified Hinge	T4A3786 x 8-Wire (size per 08 71 00)	652	MC																								
1	Ea.	Electrified Lockset	RX ND80T EU x RHO x 10-025	630	SC																								
1	Ea.	Permanent Core	20-740	626	SC																								
1	Ea.	Closer	4040XP REG (installed pull-side)	689	LC																								
1	Ea.	Kick Plate	KO050 16" tall x 2" LDW (less door width) x B4E (beveled edges) x counter sunk or approved adhesive per 08 71 00.Part 2 (no raised fasteners)	630	TR																								
1	Ea.	Stop	1214 install floor stop per 08 71 00.Part 3	630	TR																								
1	Ea.	Seals 	5075C (head & jambs) x 5060B (head & jambs) x corner pad + 335SxSTC2 door bottom (or as required by door manufacturer per chart below) and 8144S inverted, installed upside down, flat face up in full bed of mastic by NGP (or equal seal set to be furnished by STC door and frame manufacturer at time of submittals – final to be selected to meet STC rating as called out on door schedule)	 <table><thead><tr><th>STC Rating</th><th>Perimeter Seals at Heads & Jambs</th><th>Corner Pads</th><th>Threshold</th></tr></thead><tbody><tr><td>33</td><td>5050 & 2525</td><td>60FP (2 req.)</td><td>8144S*</td></tr><tr><td>45</td><td>5075 & 5060</td><td>60FP (2 req.)</td><td>8144S*</td></tr><tr><td>52</td><td>5075 & 5060</td><td>60FP (2 req.)</td><td>8144S*</td></tr><tr><td>52</td><td>5075 & 5060</td><td>60FP (2 req.)</td><td>8144S*</td></tr><tr><td>52</td><td>5075 & 5060</td><td>60FP (2 req.)</td><td>8144S*</td></tr></tbody></table>	STC Rating	Perimeter Seals at Heads & Jambs	Corner Pads	Threshold	33	5050 & 2525	60FP (2 req.)	8144S*	45	5075 & 5060	60FP (2 req.)	8144S*	52	5075 & 5060	60FP (2 req.)	8144S*	52	5075 & 5060	60FP (2 req.)	8144S*	52	5075 & 5060	60FP (2 req.)	8144S*	
STC Rating	Perimeter Seals at Heads & Jambs	Corner Pads	Threshold																										
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52	5075 & 5060	60FP (2 req.)	8144S*																										
52	5075 & 5060	60FP (2 req.)	8144S*																										
1	Ea.	Door Position Switch (also known as Alarm Contact, Door Contacts)	#679-05-WD or #679-05-HM (as required per door material) by Schlage manufacturing (coordinate with Divisions 26-28 and applicable drawings).																										
1	Ea.	Power Supply – at next printing verify security will provide the power to doors with #902 devices	Furnish and install #1) single gang power drop located above or near door (not in corridor or public view, but above ceiling line where possible); #2) provide power supply # PS902; #3) run conduit from hinge through frame and complete wiring as required to meet manufacturer warranties																										
1	Ea.	REX Device	If REX is required, coordinate with security (sensor is built into above locking device if required). Coordinate with Divisions 25-28 and applicable drawings																										

1	Ea.	Coordination task for security and/or electrical design and additional non-Division 08 Section scope (including but not limited to wire / connectivity from ceiling through frame to electrified hardware)	By security or electrical as required per Contract Documents: - The electrified hardware specified above can be utilized for #1) non-card reader, remote access control applications (unlocked / locked remotely for open during business hours / locked after-hours) and #2) local card readers at openings as directed by architectural drawings, security or electrical. - Coordinate with security or electrical Divisions 26-28 and applicable drawings as hardware does not include card reader locations.
Note: Furnish all devices and components for hardware groups/set above in accordance with Contract Documents (including but not limited to additional hardware devices requirements in the above specification language, architectural plans and full specification documents).			

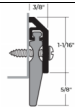
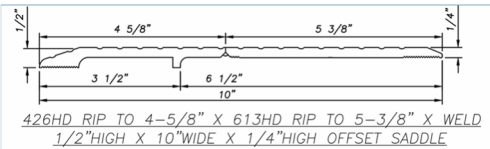
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Hardware Group/Set #103

	Ea.	Hinge	T4A3786 (size & quantity per 08 71 00)	652	MC
1	Ea.	Passage Latchset	ND10S RHO x 10-025	626	SC
1	Ea.	Permanent Core	20-740	626	SC
1	Ea.	Closer	4040XP REG (installed pull-side)	689	LC
1	Ea.	Kick Plate	KO050 16" tall x 2" LDW (less door width) x B4E (beveled edges) x counter sunk or approved adhesive per 08 71 00.Part 2 (no raised fasteners)	630	TR
1	Ea.	Stop	1214 install floor stop per 08 71 00.Part 3	630	TR
1	Ea.	Seal	5050B seals (head and jambs) by NGP or approved		
Note: Furnish all devices and components for hardware groups/set above in accordance with Contract Documents (including but not limited to additional hardware devices requirements in the above specification language, architectural plans and full specification documents).					

Blank space below and after a Group/Set is intentional to avoid, if possible, splitting a Hardware Group/Set onto two pages

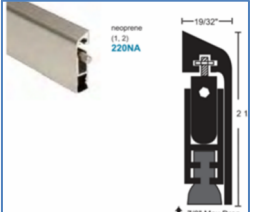
Hardware Group/Set #104

	Ea.	Hinge	T4A3386 (size & quantity per 08 71 00)	630	MC
1	Ea.	Electrified Hinge	T4A3786 x 8-Wire (size per 08 71 00)	652	MC
1	Ea.	Fire Rated Rim Panic Devices x Electrified Lever	RX PA 99L-F x M996L-R/V x 06 Lever	626	VO
1	Ea.	Surface Closer	4040XP parallel (installed push-side)	689	LC
1	Ea.	Kick Plate	KO050 16" tall x 2" LDW (less door width) x B4E (beveled edges) x counter sunk or approved adhesive per 08 71 00.Part 2 (no raised fasteners)	630	TR
1	Ea.	Stop	1214 install floor stop per 08 71 00.Part 3	630	TR
1	Ea.	Seal	5050B seals (head and jambs) by NGP or approved		
1	Ea.	Door Bottom	202NA by NGP or approved manufacturer. Note: Install threshold and sweep so that when door is closed, sweep sit tightly against threshold		
1	Ea.	If the door sill condition is flush: provide the following aluminum threshold	325HDx325HD Welded flush condition x SIA x RCE 45-degree miter cut and closed ends per above 087110, welded returns to door/frame x mastic per specifications by NGP 		
1	Ea.	If the door sill condition is offset: provide the following aluminum threshold Heavy Duty Thresholds  • For use where forklift or • Recommended for delivery • BHMA certified to ANSI • Optional "SIA" slip-resist	Offset Saddle #426HD RIP to 4-5/8" x 613HD RIP to 5-3/8" x Weld 1/2" High x 10" Wide x 1/4" High x SIA x RCE 45-degree miter cut and closed ends per above 087110, welded returns to door/frame x mastic per specifications by NGP 		
1	Ea.	Door Position Switch (also known as Alarm Contact, Door Contacts)	#679-05-WD or #679-05-HM (as required per door material) by Schlage manufacturing (coordinate with Divisions 26-28 and applicable drawings).		
1	Ea.	Power Supply – at next printing verify security will provide the power to doors with #902 devices	Furnish and install #1) single gang power drop located above or near door (not in corridor or public view, but above ceiling line where possible); #2) provide power supply # PS902; #3) run conduit from hinge through frame and complete wiring as required to meet manufacturer warranties		
1	Ea.	REX Device	If REX is required, coordinate with security (sensor is built into above locking device if required). Coordinate with Divisions 25-28 and applicable drawings		
1	Ea.	Coordination task for security and/or electrical design and additional non-Division 08 Section scope (including but not limited to wire / connectivity from ceiling through frame to electrified hardware)	By security or electrical as required per Contract Documents: - The electrified hardware specified above can be utilized for #1) non-card reader, remote access control applications (unlocked / locked remotely for open during business hours / locked after-hours) and #2) local card readers at openings as directed by architectural drawings, security or electrical. Coordinate with security or electrical Divisions 26-28 and applicable drawings as hardware does not include card reader locations.		

Note: Furnish all devices and components for hardware groups/set above in accordance with Contract Documents (including but not limited to additional hardware devices requirements in the above specification language, architectural plans and full specification documents).

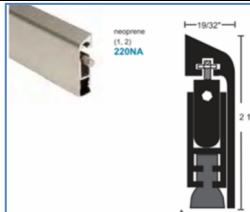
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splitting a Hardware Group/Set onto two pages

Hardware Group/Set #104.1

	Ea.	Hinge	T4A3786 (size & quantity per 08 71 00)	652	MC
1	Ea.	Exit/Panic Device	On push side provide Von Duprin #350 Dummy Touch Bar  Dummy pushpad	626	VO
1	Ea.	Pull Plate	1017-3 (4" x 16") x BHMA 710CU (Healthy Hardware Antimicrobial)	710 CU	TR
1	Ea.	Closer	4040XP REG (installed pull-side)	689	LC
1	Ea.	Kick Plate	KO050 16" tall x 2" LDW (less door width) x B4E (beveled edges) x counter sunk or approved adhesive per 08 71 00.Part 2 (no raised fasteners)	630	TR
1	Ea.	Stop	1214 install floor stop per 08 71 00.Part 3	630	TR
1	Ea.	Seal	5050B seals (head and jambs) by NGP or approved		
1	Ea.	Surface Auto Door Bottom	220NA by NGP manufacturing (no substitution since we need the sloped surface to meet code) 		

Note: Furnish all devices and components for hardware groups/set above in accordance with Contract Documents (including but not limited to additional hardware devices requirements in the above specification language, architectural plans and full specification documents).

Hardware Group/Set #105

	Ea.	Hinge	T4A3786 (size & quantity per 08 71 00)	652	MC
1	Ea.	Passage Latchset	ND10S RHO x 10-025	626	SC
1	Ea.	Closer	4040XP REG (installed pull-side)	689	LC
1	Ea.	Kick Plate	KO050 16" tall x 2" LDW (less door width) x B4E (beveled edges) x counter sunk or approved adhesive per 08 71 00.Part 2 (no raised fasteners)	630	TR
1	Ea.	Stop	1214 install floor stop per 08 71 00.Part 3	630	TR
1	Ea.	Seal	5050B seals (head and jambs) by NGP or approved		
1	Ea.	Surface Auto Door Bottom (sound dampening)	220NA by NGP manufacturing (no substitution since we need the sloped surface to meet code) 		

Note: Furnish all devices and components for hardware groups/set above in accordance with Contract Documents (including but not limited to additional hardware devices requirements in the above specification language, architectural plans and full specification documents).

Hardware Group/Set #106

	Ea.	Hinge	T4A3786 (size & quantity per 08 71 00)	652	MC
1	Ea.	Privacy Latchset	ND40S RHO x 10-025	626	SC
1	Ea.	Closer x Stop Arm	4040XP CUSH (push-side application)	689	LC
1	Ea.	Kick Plate	KO050 16" tall x 2" LDW (less door width) x B4E (beveled edges) x counter sunk or approved adhesive per 08 71 00.Part 2 (no raised fasteners)	630	TR
1	Ea.	Mop Plate	KM050 6" tall x 2" LDW (less door width) x B4E (beveled edges) x counter sunk or approved adhesive per 08 71 00.Part 2 (no raised fasteners)	630	TR
1	Ea.	Seal	5050B seals (head and jambs) by NGP or approved		
Note: Furnish all devices and components for hardware groups/set above in accordance with Contract Documents (including but not limited to additional hardware devices requirements in the above specification language, architectural plans and full specification documents).					

Hardware Group/Set #106.1

	Ea.	Hinge	T4A3786 (size & quantity per 08 71 00)	652	MC
1	Ea.	Privacy Latchset	ND40S RHO x 10-025	626	SC
1	Ea.	Closer	4040XP REG (installed pull-side)	689	LC
1	Ea.	Kick Plate	KO050 16" tall x 2" LDW (less door width) x B4E (beveled edges) x counter sunk or approved adhesive per 08 71 00.Part 2 (no raised fasteners)	630	TR
1	Ea.	Mop Plate	KM050 6" tall x 2" LDW (less door width) x B4E (beveled edges) x counter sunk or approved adhesive per 08 71 00.Part 2 (no raised fasteners)	630	TR
1	Ea.	Wall Stop	1270CV	630	TR
1	Ea.	Seal	5050B seals (head and jambs) by NGP or approved		
Note: Furnish all devices and components for hardware groups/set above in accordance with Contract Documents (including but not limited to additional hardware devices requirements in the above specification language, architectural plans and full specification documents).					

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Hardware Group/Set #107

1	Ea.	Continuous Hinge	Select manufacturing SL11-HD device (120 inch or length as required for door height)	AL	SE
1	Ea.	Passage Latchset	ND10S RHO x 10-025	626	SC
1	Ea.	Armor Plate	KA050 34" tall x 2" LDW (less door width) x B4E (beveled edges) x counter sunk or approved adhesive per 08 71 00.Part 2 (no raised fasteners)	630	TR
1	Ea.	Stop	1214 install floor stop per 08 71 00.Part 3	630	TR
1	Ea.	Seal	5050B seals (head and jambs) by NGP or approved		
Note: Furnish all devices and components for hardware groups/set above in accordance with Contract Documents (including but not limited to additional hardware devices requirements in the above specification language, architectural plans and full specification documents).					

Hardware Group/Set #107.1

1	Ea.	Continuous Hinge	Select manufacturing SL11-HD device (120 inch or length as required for door height)	AL	SE
1	Ea.	Passage Latchset	ND10S RHO x 10-025	626	SC
1	Ea.	Closer	4040XP REG (installed pull-side)	689	LC
1	Ea.	Kick Plate	KO050 16" tall x 2" LDW (less door width) x B4E (beveled edges) x counter sunk or approved adhesive per 08 71 00.Part 2 (no raised fasteners)	630	TR
1	Ea.	Floor Stop	1214 install floor stop per 08 71 00.Part 3	630	TR
1	Ea.	Seal	5050B seals (head and jambs) by NGP or approved		
Note: Furnish all devices and components for hardware groups/set above in accordance with Contract Documents (including but not limited to additional hardware devices requirements in the above specification language, architectural plans and full specification documents).					

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Hardware Group/Set #108

	Ea.	Hinge	T4A3386 (size & quantity per 08 71 00)	630	MC
1	Ea.	Electrified Hinge	T4A3386 x 8-Wire (size per 08 71 00)	630	MC
1	Ea.	Electrified Lockset	RX ND80T EU x RHO x 10-025	630	SC
1	Ea.	I/C Cylinders (Rim or Mortise)	20-757 or 20-763 x appropriate cam x blocking rings as required (rim or mortise type and quantity as required by locking device)	626	SC
1	Ea.	Permanent Core	20-740	626	SC
1	Ea.	Closer	4040XP REG (installed pull-side)	689	LC
1	Ea.	Kick Plate	KO050 16" tall x 2" LDW (less door width) x B4E (beveled edges) x counter sunk or approved adhesive per 08 71 00.Part 2 (no raised fasteners)	630	TR
1	Ea.	Floor Stop	1214 install floor stop per 08 71 00.Part 3	630	TR
1	Ea.	Seal	5050B seals (head and jambs) by NGP or approved		
1	Ea.	Door Bottom	202NA by NGP or approved manufacturer		
1	Ea.	Aluminum Threshold	427 flush condition or 659 offset as required per sill condition (7" flat or quarter inch offset sill, coordinate before submittals) x wrap frame stops x beveled miter ends x mastic x by NGP		
1	Ea.	Door Position Switch (also known as Alarm Contact, Door Contacts)	#679-05-WD or #679-05-HM (as required per door material) by Schlage manufacturing (coordinate with Divisions 26-28 and applicable drawings).		
1	Ea.	Power Supply – at next printing verify security will provide the power to doors with #902 devices	Furnish and install #1) single gang power drop located above or near door (not in corridor or public view, but above ceiling line where possible); #2) provide power supply # PS902; #3) run conduit from hinge through frame and complete wiring as required to meet manufacturer warranties		
1	Ea.	REX Device	If REX is required, coordinate with security (sensor is built into above locking device if required)		
1	Ea.	Coordination task for security and/or electrical design and additional non-Division 08 Section scope (including but not limited to wire / connectivity from ceiling through frame to electrified hardware)	By security or electrical as required per Contract Documents: - The electrified hardware specified above can be utilized for #1) non-card reader, remote access control applications (unlocked / locked remotely for open during business hours / locked after-hours) and #2) local card readers at openings as directed by architectural drawings, security or electrical. - Coordinate with security or electrical Divisions 26-28 and applicable drawings as hardware does not include card reader locations.		

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Hardware Group/Set #108.1

	Ea.	Hinge	T4A3386 (size & quantity per 08 71 00)	630	MC
1	Ea.	Electrified Hinge	T4A3386 x 8-Wire (size per 08 71 00)	630	MC
1	Ea.	Electrified Lockset	RX ND80T EU x RHO x 10-025	630	SC
1	Ea.	I/C Cylinders (Rim or Mortise)	20-757 or 20-763 x appropriate cam x blocking rings as required (rim or mortise type and quantity as required by locking device)	626	SC
1	Ea.	Permanent Core	20-740	626	SC
1	Ea.	Closer	4040XP parallel (installed push-side)	689	LC
1	Ea.	Kick Plate	KO050 16" tall x 2" LDW (less door width) x B4E (beveled edges) x counter sunk or approved adhesive per 08 71 00.Part 2 (no raised fasteners)	630	TR
1	Ea.	Floor Stop	1214 install floor stop per 08 71 00.Part 3	630	TR
1	Ea.	Seal	5050B seals (head and jambs) by NGP or approved		
1	Ea.	Door Bottom	202NA by NGP or approved manufacturer		
1	Ea.	Aluminum Threshold	427 flush condition or 659 offset as required per sill condition (7" flat or quarter inch offset sill, coordinate before submittals) x wrap frame stops x beveled miter ends x mastic x by NGP		
1	Ea.	Door Position Switch (also known as Alarm Contact, Door Contacts)	#679-05-WD or #679-05-HM (as required per door material) by Schlage manufacturing (coordinate with Divisions 26-28 and applicable drawings).		
1	Ea.	Power Supply – at next printing verify security will provide the power to doors with #902 devices	Furnish and install #1) single gang power drop located above or near door (not in corridor or public view, but above ceiling line where possible); #2) provide power supply # PS902; #3) run conduit from hinge through frame and complete wiring as required to meet manufacturer warranties		
1	Ea.	REX Device	If REX is required, coordinate with security (sensor is built into above locking device if required)		
1	Ea.	Coordination task for security and/or electrical design and additional non-Division 08 Section scope (including but not limited to wire / connectivity from ceiling through frame to electrified hardware)	By security or electrical as required per Contract Documents: - The electrified hardware specified above can be utilized for #1) non-card reader, remote access control applications (unlocked / locked remotely for open during business hours / locked after-hours) and #2) local card readers at openings as directed by architectural drawings, security or electrical. - Coordinate with security or electrical Divisions 26-28 and applicable drawings as hardware does not include card reader locations.		
Note: Furnish all devices and components for hardware groups/set above in accordance with Contract Documents (including but not limited to additional hardware devices requirements in the above specification language, architectural plans and full specification documents).					

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Hardware Group/Set #109

	Ea.	Hinge	TA2714 (size & quantity per 08 71 00)	652	MC
1	Ea.	Electrified Hinge	TA2714 x 8-Wire (size per 08 71 00)	652	MC
1	Ea.	Electrified Lockset	RX ND80T EU x RHO x 10-025	630	SC
1	Ea.	Permanent Core	20-740	626	SC
1	Ea.	Closer	4040XP 180-degree arm (installed push-side)	689	LC
1	Ea.	Wall Stop	1270CV	630	TR
1	Ea.	Seal	5050B seals (head and jambs) by NGP or approved		
1	Ea.	Door Position Switch (also known as Alarm Contact, Door Contacts)	#679-05-WD or #679-05-HM (as required per door material) by Schlage manufacturing (coordinate with Divisions 26-28 and applicable drawings).		
1	Ea.	Power Supply – at next printing verify security will provide the power to doors with #902 devices	Furnish and install #1) single gang power drop located above or near door (not in corridor or public view, but above ceiling line where possible); #2) provide power supply # PS902; #3) run conduit from hinge through frame and complete wiring as required to meet manufacturer warranties		
1	Ea.	REX Device	If REX is required, coordinate with security (sensor is built into above locking device if required). Coordinate with Divisions 25-28 and applicable drawings		
1	Ea.	Coordination task for security and/or electrical design and additional non-Division 08 Section scope (including but not limited to wire / connectivity from ceiling through frame to electrified hardware)	By security or electrical as required per Contract Documents: - The electrified hardware specified above can be utilized for #1) non-card reader, remote access control applications (unlocked / locked remotely for open during business hours / locked after-hours) and #2) local card readers at openings as directed by architectural drawings, security or electrical. - Coordinate with security or electrical Divisions 26-28 and applicable drawings as hardware does not include card reader locations.		
Note: Furnish all devices and components for hardware groups/set above in accordance with Contract Documents (including but not limited to additional hardware devices requirements in the above specification language, architectural plans and full specification documents).					

END OF SECTION

SECTION 08 81 00

GLASS GLAZING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Glass and glazing for windows and doors.
- B. Mirrors.

1.2 RELATED SECTIONS

- A. Section 07 92 00 – Joint Sealants: Sealant and back-up material.
- B. Section 08 11 13 – Hollow Metal Doors and Frames: Glazed doors.
- C. Section 08 14 00 – Wood Doors: Glazed doors.
- D. Section 08 41 13 – Aluminum Framed Entrances and Storefronts.
- E. Section 08 88 13 – Fire Rated Glazing.

1.3 REFERENCES

- A. The publications listed below form a part of this Section to the extent referenced. The publications are referred to in the text by the basic designation only. Refer to Division 01 for definitions, acronyms, and abbreviations.
- B. Standards, manuals, and codes refer to the latest edition of such standards, manuals, and codes in effect as of the date of issue of this Project Manual, unless indicated otherwise in CBC Chapter 35 and CFC Chapter 80.
- C. Referenced Standards:
 - 1. American National Standards Institute (ANSI) – ANSI Z97.1: Standard for Safety Glazing Materials Used in Buildings.
 - 2. ASTM C920 – Standard Specification for Elastomeric Joint Sealants.
 - 3. ASTM C1036 – Standard Specification for Flat Glass.
 - 4. ASTM C1048 – Standard Specification for Heat-Treated Flat Glass – Kind HS, Kind FT Coated and Uncoated Glass.
 - 5. ASTM C1279 – Standard Test Method for Non-Destructive Photoelastic Measurement of Edge and Surface Stresses in Annealed, Heat-Strengthened, and Fully Tempered Flat Glass.
 - 6. ASTM C1376 – Standard Specification for Pyrolytic and Vacuum Deposition Coatings on Flat Glass.
 - 7. ASTM C1503 – Standard Specification for Silvered Flat Glass Mirror.
 - 8. ASTM E546 – Standard Test Method for Frost Point of Sealed Insulating Glass Units.
 - 9. ASTM E576 – Standard Test Method for Frost Point of Sealed Insulating Glass Units in the Vertical Position.

10. ASTM E1300 – Standard Practice for Determining Load Resistance of Glass in Buildings.
11. ASTM E2190 – Standard Specification for Insulating Glass Unit Performance and Evaluation.
12. Consumer Product Safety Commission (CPSC) – CPSC 16 CFR 1201: Safety Standard for Architectural Glazing Materials.
13. GANA Glazing Manual.
14. GANA Sealant Manual.
15. IGMA North American Glazing Guidelines for Sealed Insulating Glass Units for Commercial and Residential Use.
16. NFRC 100 – Procedure for Determining Fenestration Product U-Factors.
17. NFRC 200 – Procedure for Determining Fenestration Product Solar Heat Gain Coefficient and Visible Transmittance at Normal Incidence.
18. NFRC 300 – Standard Test Method for Determining the Solar Optical Properties of Glazing Materials and Systems.
19. SGCC – Safety Glazing Certification Council – Certified Products Directory.

1.4 SUBMITTALS

- A. Submit under provisions of Division 01.
- B. Product Data:
 1. Provide structural, physical and environmental characteristics, size limitations, and special handling or installation requirements for each type of glazing specified.
 2. Product Data on Glazing Compounds: Provide chemical, functional, and environmental characteristics, limitations, and special handling or installation requirements. Identify available colors.
- C. Submit documentation indicating that all tempered glazing to be installed on this project is certified by the Safety Glazing Certification Council.

1.5 PERFORMANCE / DESIGN CRITERIA

- A. Glass Strength: Analysis shall comply with ASTM E1300, Determining Load Resistance of Glass in Buildings. Provide glass products in the thickness and strengths (annealed or heat treated) required to meet or exceed the following criteria based on project loads and in-service conditions.
 1. Minimum thickness of annealed or heat-treated glass products to be selected so the worst case probability of failure does not exceed the following:
 - a. Eight breaks per thousand for glass installed vertically or not fifteen degrees or more from the vertical plane and under wind action.
 - b. One break per thousand for glass installed fifteen degrees or more from the vertical plane and under action of wind and/or snow.
 2. Deflection must be limited to prevent disengagement from the frame and be less than or equal to 3/4 inch or L/175.

B. Thermal and Optical Performance: Provide glass products with performance properties specified in this Section. Performance properties shall be manufacturer's published data as determined according to the following procedures:

1. Center of glass U-Value: NFRC 100 methodology using LBNL WINDOW 5.2 computer program.
2. Center of glass solar heat gain coefficient: NFRC 200 methodology using LBNL-35298 WINDOW 5.2 computer program.
3. Solar optical properties: NFRC 300.

1.6 QUALITY ASSURANCE

- A. Perform Work in accordance with GANA Glazing Manual, IGMA North American Glazing Guidelines for Sealed Insulating Glass Units for Commercial and Residential Use, and GANA Sealant Manual for glazing installation methods.
- B. Installer's Qualifications: The installation shall be performed only by an installation firm normally engaged in this business. All work shall be performed by qualified mechanics that specialize in glazing and glass installation.
- C. Safety glazing shall meet the requirements of 2022 CBC Section 2406 and shall be identified in accordance with 2022 CBC Sections 2403.1 and 2406.3, with identification etched in glass.
- D. Glass installation in frames shall comply with the Minimum Glazing Requirements in CBC Table 2403.2.1.

1.7 JOB AND ENVIRONMENTAL CONDITIONS

- A. Do not install glazing when ambient temperature is less than 40 degrees F.
- B. Maintain minimum ambient temperature before, during and 48 hours after installation of glazing compounds.

1.8 FIELD MEASUREMENTS

- A. Verify that field measurements are as indicated on shop Drawings.

1.9 COORDINATION

- A. Coordinate Work with glazing frames, wall openings, and adjacent Work.

1.10 WARRANTY

- A. Provide five year limited warranty from date of manufacture for insulating units that are glazed in accordance with manufacturer's glazing instructions.

PART 2 PRODUCTS

2.1 GENERAL

- A. All glass shall be graded and meet requirements of ASTM C1036 and ASTM C1048, Type 1, quality q3. Each light of glass delivered and installed shall have affixed thereto the manufacturer's grade label.

- B. All Low-E coated glass shall have a permanent marking affixed at the spacer identifying the coated surface.
- C. Glazing material installed in Hazardous Locations subject to human impact shall be certified and permanently labeled as meeting applicable requirements referenced in NFPA 80 and 2022 CBC Section 2406.
 - 1. CPSC 16 CFR 1201, Category I and II.

2.2 GLASS TYPES

A. Float Glass:

- 1. Acceptable Manufacturers:
 - a. Vitro Architectural Glass.
 - b. Oldcastle Glass.
 - c. Viracon.
 - d. Guardian.
 - e. Substitutions: Under provisions of Division 01.
- 2. Material: 1/4 inch thick clear glass, tempered where required by CBC and where indicated on Drawings.

B. Low-E Insulating Glass:

- 1. Acceptable Manufacturers:
 - a. Vitro Architectural Glass. Product: Solarban 70 (2) Optigray+ Clear.
 - b. Oldcastle Glass.
 - c. Viracon.
 - d. Guardian.
 - e. Substitutions: Under provisions of Division 01.
- 2. Material: 1 inch thick hermetically sealed assembly consisting of 1/4 inch thick Low-E Optigray glass on the outboard surface (coating on the #2 surface), 1/2 inch air space and 1/4 inch thick clear glass on the inboard surface with the following center-of-glass values: Winter Nighttime U-value of 0.28 or less, Solar Heat Gain Coefficient (SHGC) of 0.23 or less, and Visible Light Transmittance of 46 percent. Glass shall be heat strengthened; tempered where required by CBC and where indicated on Drawings.

C. Mirrors:

- 1. Acceptable Manufacturers:
 - a. Vitro Architectural Glass. Product: Platia Mirror Glass.
 - b. Oldcastle Glass.
 - c. Viracon.
 - d. Guardian.
 - e. Substitutions: Under provisions of Division 01.
- 2. Material, Mirror Glass: 1/4 inch thick clear float glass produced with the application of chemical reagents with an automated manufacturing process which, through different stages, transforms conventional glass into high-quality mirror glass in conformance with ASTM C1503. Edges shall be eased. Sizes as indicated on Drawings.
 - a. Product shall be copper-free.

2.3 GLAZING SEALANT

- A. Glazing Sealants: ASTM C920, Type S, Grade NS, Uses "G" and "A". Dow Corning 795, Tremco "Proglaze" or GE Silicone Sealants; Tremco "Mono" acrylic sealant or accepted equal. All sealants shall be compatible with the type of glazing and window frame to which they are applied.

2.4 GLAZING ACCESSORIES

- A. Setting Blocks: Neoprene EPDM blocks with a Shore A durometer hardness of 85, ± 5 percent, chemically compatible with sealant used.
- B. Spacer Shims: Neoprene, 50-60 Shore A durometer hardness, minimum 3 inches long by one half the height of the glazing stop by thickness to suit application.
- C. Glazing Tape: 100 percent solids by weight, highly adhesive and elastic, cross-linked butyl rubber preformed tape with a continuous integral EPDM shim; 57 Shore 00 durometer hardness; black color; Tremco POLYshim II Tape or accepted equal.
- D. Glazing Splines: Resilient polyvinyl chloride extruded shape to suit glazing channel retaining slot; black color.
- E. Miscellaneous: Furnish all primers-sealers, setting blocks, shims, spacers, compression seals, etc., as required for a first class workmanlike job.

2.5 FABRICATION

A. Flat Glass:

- 1. Comply with ASTM C1036 Standard Specification for Flat Glass, Type 1, Class 1 (clear) or Class 2 (tinted, heat-absorbing and light reducing) and Quality q3.
- 2. ASTM C1048 Heat Treated Flat Glass, Kind HS (heat-strengthened) or FT (fully tempered), Condition A (uncoated), or C (other coated glass).
 - a. Heat Treated Flat Glass shall be produced by horizontal (roller hearth) process with inherent rollerwave distortion parallel to the bottom edge of the glass as installed.
 - b. Maximum peak to valley rollerwave 0.003 inch in the central area and 0.008 inch within 10.5 inches of the leading and trailing edge.
 - c. Maximum bow and warp 1/32 inch per lineal foot.
 - d. All heat strengthened glass shall have a surface compression of 3,500 psi to 7,500 psi. The surface compression shall be verified to meet ASTM C1279 requirements.
 - e. All tempered architectural safety glass shall have a minimum surface compression of 10,000 psi, an edge compression of not less than 9,700 psi, or conform to the requirements of ANSI Z97.1 and CPSC 16CFR-1201.

B. Insulating Glass:

- 1. Comply with ASTM E2190 Standard Specification for Insulating Glass Unit Performance and Evaluation.
 - a. Units shall be certified for compliance by the IGCC in accordance with the above ASTM test method.
- 2. The unit overall thickness tolerance shall be -1/16 inch / +1/32 inch.

3. Comply with ASTM E546 Standard Test Method for Frost Point of Sealed Insulating Glass Units.
 4. Comply with ASTM E576 Standard Test Method for Frost Point of Sealed Insulating Glass Units in the Vertical Position.
 5. Sealed Insulating Glass Units to be double sealed with a primary seal of black polyisobutylene and a secondary seal of silicone.
 - a. The minimum thickness of the secondary seal shall be 1/16 inch.
 - b. The target width of the primary seal shall be 5/32 inch.
 - c. There shall be no voids or skips in the primary seal.
 - d. Up to a maximum of 3/32 inch of the airspace may be visible above the primary polyisobutylene sealant.
 - e. Gaps or skips between primary and secondary sealant are permitted to a maximum width of 1/16 inch by maximum length of 2 inches with gaps separated by at least 18 inches. Continuous contact between the primary seal and the secondary seal is desired.
 6. Provide a hermetically sealed and dehydrated space. Lites shall be separated by an aluminum spacer with three bent corners and one keyed-soldered corner or four bent corners and one straight butyl injected zinc plated steel straight key joint.
- C. Coated Vision Glass:
1. Comply with ASTM C1376 Standard for Pyrolytic and Vacuum Deposition Coatings on Glass.
 2. Coated products shall be magnetically sputtered vacuum deposition (MSVD).
 3. Edge Deletion: When Low-E coatings are used within an insulating unit, coating shall be edge deleted to completely seal the coating within the unit.
 - a. The edge deletion should be uniform in appearance (visually straight) and remove at least 95 percent of the coating.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify prepared openings for adequacy to receive glass.
- B. Verify that openings for glazing are correctly sized and within tolerance.
- C. Verify that surfaces of glazing channels or recesses are clean, free of obstructions, and ready to receive glazing.
- D. Report in writing any conditions that may be detrimental to the Work.

3.2 PREPARATION

- A. Clean contact surfaces with solvent and wipe dry.
- B. Seal porous glazing channels or recesses with substrate compatible primer or sealer.
- C. Check that glass is free of edge damage or face imperfections.

3.3 INSTALLATION

- A. General: Install glazing types at locations indicated on Drawings, according to glazing manufacturer's recommendations and as specified herein.
- B. Glass Glazing:
 - 1. Positioning Glass: Orient pattern and draw of glass pieces in same direction. Set all sheet glass so that any waves, etc. are horizontal.
 - 2. Orient heat-treated glass so that the roller wave is parallel to the window sill/header.
 - 3. Do not cut, nip or abrade tempered glass.
 - 4. Watershed: Gunnable sealants, when applied as a cap head, shall form a bevel or watershed away from the glass. When tape is used to the sightline, it shall form a watershed when compressed. Do not undercut a sealant, compound, or tape below the sightline. Tool and finish sealant as required. Used tooling solution recommended by the sealant manufacturer.
 - 5. Positive Contact:
 - a. When applying a heel bead, lap onto the glass a minimum of 3/16 inch.
 - b. When applying a toe bead, whether continuous or a corner seal, make certain it is large enough to contact both the glass and sash. Install the sealant prior to glass placement.
 - 6. Setting blocks shall be 1/16 inch less than the full rabbet width, minimum length of 4 inches and high enough to provide the recommended minimum bite and edge clearance for the glass. Center blocks at 1/4 points unless otherwise recommended by the glass manufacturer.
 - 7. Provide spacer-shims at a maximum of 24 inches on center.
 - 8. Clearances: Observe minimum face clearances, edge clearance and glass bite as recommended by the glass and sealant manufacturers.
 - 9. Tape Installation: Do not install glazing tapes more than one day ahead of glass placement. Remove the paper backing from the tape only when the lite is ready to be installed. Do not stretch the tape to make it fit. Do not overlap the ends of the tape. Instead, butt ends together, and when corners are butted together, daub with sealant to assure a positive seal.
 - 10. Glazing tapes must be kept under proper compression.
 - 11. Glazing stops shall be installed so that stop or frame does not bear directly against glass.
 - 12. All glazing channels/rabbets shall be weeped so there is no standing water in contact with the insulating glass perimeter seal.

3.4 CLEANING

- A. Clean work under provisions of Division 01.
- B. Remove glazing materials from finish surfaces.
- C. Remove temporary labels after work is complete.
- D. Clean glass.

3.5 PROTECTION OF FINISHED WORK

- A. Protect finished Work under provisions of Division 01.
- B. Replacement: At completion of construction and prior to its acceptance, all broken, cracked, excessively scratched, or otherwise imperfect glazing materials included under this Section shall be replaced with new glazing materials of the type specified, as directed by the Architect, and at no additional cost to the Owner.

END OF SECTION

SECTION 08 88 13
FIRE RATED GLAZING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Fire rated glass and glazing for windows and doors.

1.2 RELATED SECTIONS

- A. Section 07 92 00 – Joint Sealants: Sealant and back-up material.
- B. Section 08 11 13 – Hollow Metal Doors and Frames.
- C. Section 08 14 00 – Wood Doors.
- D. Section 08 81 00 – Glass Glazing.

1.3 REFERENCES

- A. The publications listed below form a part of this Section to the extent referenced. The publications are referred to in the text by the basic designation only. Refer to Division 01 for definitions, acronyms, and abbreviations.
- B. Standards, manuals, and codes refer to the latest edition of such standards, manuals, and codes in effect as of the date of issue of this Project Manual, unless indicated otherwise in CBC Chapter 35 and CFC Chapter 80.
- C. Referenced Standards:
 - 1. American National Standards Institute (ANSI) – ANSI Z97.1: Standard for Safety Glazing Materials Used in Buildings.
 - 2. ASTM C920 – Standard Specification for Elastomeric Joint Sealants.
 - 3. ASTM C1036 – Standard Specification for Flat Glass.
 - 4. ASTM C1048 – Standard Specification for Heat-Treated Flat Glass – Kind HS, Kind FT Coated and Uncoated Glass.
 - 5. ASTM E119 – Standard Test Methods for Fire Tests of Building Construction and Materials.
 - 6. ASTM E2010 – Standard Test Method for Positive Pressure Fire Tests of Window Assemblies.
 - 7. ASTM E2074 – Standard Test Method for Fire Tests of Door Assemblies, Including Positive Pressure Testing of Side-Hinged and Pivoted Swinging Door Assemblies.
 - 8. Consumer Product Safety Commission (CPSC) – CPSC 16 CFR 1201: Safety Standard for Architectural Glazing Materials.
 - 9. GANA Glazing Manual.
 - 10. GANA Sealant Manual.
 - 11. NFPA 80 – Fire Doors and Windows.

- 12. NFPA 252 – Standard Methods of Fire Tests of Door Assemblies.
- 13. NFPA 257 – Fire Tests of Window Assemblies.
- 14. SGCC – Safety Glazing Certification Council – Certified Products Directory.
- 15. UL 9 – Fire Tests of Window Assemblies.
- 16. UL 10B – Fire Tests of Door Assemblies.
- 17. UL 10C – Positive Pressure Fire Tests of Door Assemblies.
- 18. UL 263 – Fire Tests of Building Construction and Materials.

1.4 SUBMITTALS

- A. Submit under provisions of Division 01.
- B. Product Data on Glass Types Specified: Provide structural, physical and environmental characteristics, size limitations, and special handling or installation requirements.
- C. Product Data on Glazing Compounds: Provide chemical, functional, and environmental characteristics, limitations, and special handling or installation requirements.

1.5 QUALITY ASSURANCE

- A. Perform Work in accordance with GANA Glazing Manual, FGMA Sealant Manual for glazing installation methods.
- B. Installer's Qualifications: The installation shall be performed only by an installation firm normally engaged in this business. All work shall be performed by qualified mechanics that specialize in glazing and glass installation.
- C. Safety glazing shall meet the requirements of 2022 CBC Section 2406 and shall be identified in accordance with 2022 CBC Sections 2403.1 and 2406.3, with identification etched in glass.
- D. Fire Protective Rated Glass:
 - 1. Fire rated glazing shall be under current follow-up service by a nationally recognized independent testing laboratory and maintain a current listing or certification. Assemblies shall be labeled in accordance with limits of listings.
 - a. Each lite shall bear permanent, non-removable label certifying it for use in tested and rated fire protective assemblies.
 - 2. Fire Protective Glazing Products for Door Assemblies: Products identical to those tested per ASTM E2074 and UL 10B, labeled and listed by UL.

1.6 DEFINITIONS

- A. Fire-Rated Glazing Assembly Identification Markings per CBC Sections 703.4 and 716.3:

Fire Test Standard	Marking	Definition of Marking
ASTM E119 or UL 263	W	Meets wall assembly criteria.
NFPA 257 or UL 9	OH	Meets fire window assembly criteria including the hose stream test.

NFPA 252 or UL 10B or UL 10C	D	Meets fire door assembly criteria
	H	Meets fire door assembly hose stream test.
	T	Meets 450 degree F temperature rise criteria for 30 minutes.
	XXX	The time in minutes of the fire resistance or fire protection rating of the glazing assembly.

1.7 JOB AND ENVIRONMENTAL CONDITIONS

- A. Do not install glazing when ambient temperature is less than 40 degrees F.
- B. Maintain minimum ambient temperature before, during and 48 hours after installation of glazing compounds.

1.8 FIELD MEASUREMENTS

- A. Verify that field measurements are as indicated on shop Drawings.

1.9 COORDINATION

- A. Coordinate Work with glazing frames, wall openings, and adjacent Work.

1.10 WARRANTY

- A. Manufacturer's Warranty: Submit, for Owner's acceptance, manufacturer's standard warranty document. Manufacturer's warranty is not intended to limit other rights that the Owner may have under the Contract Documents.
 - 1. Warranty Period for Fire Protective Glazing: Lifetime warranty from date of shipping.

PART 2 PRODUCTS

2.1 GENERAL

- A. All glass shall be graded and meet requirements of ASTM C1036 and ASTM C1048, Type I, quality q3. Each light of glass delivered and installed shall have affixed thereto the manufacturer's grade label.
- B. Glazing material installed in Hazardous Locations, subject to human impact, shall be certified and permanently labeled as meeting applicable requirements referenced in NFPA 80.
 - 1. CPSC 16 CFR 1201, Category I and II.
- C. Each piece of fire-rated glazing material shall be labeled with a permanent logo including name of product, manufacturer, testing laboratory, fire rating period, and safety glazing standards.

2.2 GLASS TYPES

- A. Fire Protective Rated Glass in 45 minute assemblies:
 - 1. Acceptable Manufacturers:
 - a. Safti First. Product: SuperClear 45-HS-LI.
 - b. Technical Glass Products (TGP).

- c. McGrory Glass.
 - d. Pilkington.
 - e. Vetrotech Saint-Gobain.
 - f. Substitutions: Under provisions of Division 01.
- 2. Material: 3/4 inch thick, 45 minute rated assembly consisting of clear low-iron glass marked in accordance with CBC Sections 703.4 and 716.3. Product shall meet the requirements of ANSI Z97.1, CPSC 16 CFR 1201 Category I and II, and UL 10C.
 - 3. Use this glass type when the amount of glazing in the wall is less than 25 percent of the wall area it is in.

2.3 GLAZING SEALANT

- A. Fire-Rated Glazing Tape: UL 10B and UL 10C compliant, high performance fire-rated glazing tape; Pemko FG3000 or accepted equal. Glazing tape shall be installed on both sides of frame at all vision lites in fire-rated doors. Tape shall be compatible with and acceptable for use with the type of glazing and window frame to which they are applied.

2.4 GLAZING ACCESSORIES

- A. Setting Blocks: Fire-Rated: Calcium silicate blocks, chemically compatible with sealant used.
- B. Spacer Shims: Neoprene, 50 to 60 Shore A durometer hardness, minimum 3 inches long by one half the height of the glazing stop by thickness to suit application.
- C. Glazing Tape: 100 percent solids by weight, highly adhesive and elastic, cross-linked butyl rubber preformed tape with a continuous integral EPDM shim; 57 Shore 00 durometer hardness; black color; Tremco POLYshim II Tape or accepted equal.
- D. Glazing Splines: Resilient polyvinyl chloride extruded shape to suit glazing channel retaining slot; black color.
- E. Miscellaneous: Furnish all primers-sealers, setting blocks, shims, spacers, compression seals, etc., as required for a first class workmanlike job.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify prepared openings for adequacy to receive glass.
- B. Verify that openings for glazing are correctly sized and within tolerance.
- C. Verify that surfaces of glazing channels or recesses are clean, free of obstructions, and ready to receive glazing.
- D. Report in writing any conditions that may be detrimental to the Work.

3.2 PREPARATION

- A. Clean contact surfaces with solvent and wipe dry.
- B. Seal porous glazing channels or recesses with substrate compatible primer or sealer.
- C. Check that glass is free of edge damage or face imperfections.

3.3 INSTALLATION

- A. General: Install glazing types at locations indicated on Drawings, according to glazing manufacturer's recommendations and as specified herein.
- B. Glass Glazing:
 - 1. Positioning Glass: Orient pattern and draw of glass pieces in same direction. Set all sheet glass so that any waves, etc. are horizontal.
 - 2. Do not cut, nip or abrade tempered glass.
 - 3. Watershed: Gunnable sealants, when applied as a cap head, shall form a bevel or watershed away from the glass. When tape is used to the sightline, it shall form a watershed when compressed. Do not undercut a sealant, compound, or tape below the sightline. Tool and finish sealant as required. Used tooling solution recommended by the sealant manufacturer.
 - 4. Positive Contact:
 - a. When applying a heel bead, lap onto the glass a minimum of 3/16 inch.
 - b. When applying a toe bead, whether continuous or a corner seal, make certain it is large enough to contact both the glass and sash. Install the sealant prior to glass placement.
 - 5. Setting blocks shall be 1/16 inch less than the full rabbet width, minimum length of 4 inches and high enough to provide the recommended minimum bite and edge clearance for the glass. Center blocks at 1/4 points unless otherwise recommended by the glass manufacturer.
 - 6. Provide spacer-shims at a maximum of 24 inches on center.
 - 7. Clearances: Observe minimum face clearances, edge clearance and glass bite as recommended by the glass and sealant manufacturers.
 - 8. Tape Installation: Do not install glazing tapes more than one day ahead of glass placement. Remove the paper backing from the tape only when the lite is ready to be installed. Do not stretch the tape to make it fit. Do not overlap the ends of the tape. Instead, butt ends together, and when corners are butted together, daub with sealant to assure a positive seal.
 - 9. Glazing tapes must be kept under proper compression.
 - 10. Glazing stops shall be installed so that stop or frame does not bear directly against glass.
 - 11. Install glazing in fire-rated assemblies to requirements of NFPA 80.
 - a. Install so that appropriate UL markings remain permanently visible.

3.4 CLEANING

- A. Clean work under provisions of Division 01.
- B. Remove glazing materials from finish surfaces.
- C. Remove temporary labels after work is complete.
- D. Clean glass.

3.5 PROTECTION OF FINISHED WORK

- A. Protect finished Work under provisions of Division 01.
- B. Replacement: At completion of building construction and prior to its acceptance, all broken, cracked, excessively scratched, or otherwise imperfect glazing materials included under this Section shall be replaced with new glazing materials of the type specified, as directed by the Architect, and at no additional cost to the Owner.

END OF SECTION

SECTION 08 91 19
FIXED LOUVERS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Continuous wall louvers.

1.2 RELATED WORK

- A. Section 06 10 00 – Rough Carpentry.
- B. Section 07 25 00 – Weather Barriers.
- C. Section 07 46 46 – Mineral-Fiber Cement Siding.
- D. Section 07 62 00 – Sheet Metal Flashing and Trim.
- E. Section 07 92 00 – Joint Sealants.
- F. Section 09 24 00 – Portland Cement Plastering.

1.3 REFERENCES

- A. The publications listed below form a part of this Section to the extent referenced. The publications are referred to in the text by the basic designation only. Refer to Division 01 for definitions, acronyms, and abbreviations.
- B. Standards, manuals, and codes refer to the latest edition of such standards, manuals, and codes in effect as of the date of issue of this Project Manual, unless indicated otherwise in CBC Chapter 35 and CFC Chapter 80.
- C. Referenced Standards:
 - 1. AAMA 2605 – Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels.
 - 2. AMCA 500-L – Laboratory Methods of Testing Louvers for Rating.
 - 3. ASTM A653 – Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process

1.4 SUBMITTALS

- A. Submit shop drawings and product data under provisions of Division 01.
- B. Indicate on shop drawings layout, elevations, dimensions and tolerances; head, jamb, and sill details, blade configuration, screening, and frames.
- C. Submit manufacturer's installation instructions under provisions of Division 01.

1.5 QUALITY ASSURANCE

- A. Manufacturer: Company specializing in manufacture of AMCA certified louvers with sufficient documented experience.

- B. Louvers shall bear Air Movement and Control Association (AMCA) Certified Ratings Seals for air performance and water penetration ratings.

1.6 COORDINATION

- A. Coordinate work of this Section with installation of framing, flashings, joint sealants, and interior and exterior wall finishes.

1.7 WARRANTY

- A. Product shall be free of defective materials or workmanship for a period of one year from date of installation.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Acceptable Manufacturers:
 - 1. WMC Architectural, Redding, CA; 800-366-5877, www.wondermetals.com. Product: Model SDL-4.
 - 2. C/S Group, Cranford, NJ; 800-526-6930, www.c-sgroup.com.
 - 3. The Airolite Company, LLC, Schofield, WI; 715-841-8757, www.airolite.com.
- B. Substitutions: Under provisions of Division 01.

2.2 MATERIAL

- A. Steel Sheet: ASTM A653, G90 galvanized.

2.3 COMPONENTS

- A. Louver Blades:
 - 1. Slope: 45 degrees.
 - 2. Blade Type: Fixed, drainable.
 - 3. Steel Thickness: 16 gauge.
- B. Frame:
 - 1. Shape: Channel.
 - 2. Head, jamb and sill material thickness: 16 gauge steel.
 - 3. Corners: Boxed.
- C. Fasteners and Anchors: Stainless steel or type as recommended by manufacturer.

2.4 ACCESSORIES

- A. Flashings: Of same material as louver frame.
- B. Insect Screen and Frame: Galvanized steel frame with 18 x 14 galvanized insect mesh, fabricated by louver manufacturer. Install on interior side of louver.
- C. Flexible Flashing Materials: As specified in Section 07 25 00.

- D. Sealants: As specified in Section 07 92 00.
- E. Neoprene isolation pads for installation between dissimilar metals.

2.5 FABRICATION

- A. Louver Size: 4 inches deep, face measurements as indicated on Drawings, but not to exceed 40 square feet per panel. Nominal free area opening percentage of 48 percent, with storm-proof blades.
- B. Head and Sill Members: Roll formed to required shape, one piece per location.
- C. All welded construction.
- D. Screens: Screw to louver frame.

2.6 FINISHES

- A. Factory Finish: Prime paint finish.
- B. Site Finish: Paint finish under provisions of Section 09 91 00. Color as selected by Architect.
- C. Provide factory finished louvers. Finish louvers after assembly.
 - 1. High-Performance Organic Finish: Two-coat fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions. Custom color as selected by Architect.

PART 3 EXECUTION

3.1 INSPECTION

- A. Verify that prepared openings and flashings are ready to receive work and opening dimensions are as indicated on shop drawings.
- B. Beginning of installation means acceptance of existing conditions.

3.2 INSTALLATION

- A. Install louver assembly in accordance with manufacturer's instructions.
- B. Install louvers level and plumb.
- C. Secure louvers in opening framing with concealed fasteners.
- D. Louver frame shall be anchored to structure with concealed fasteners appropriate for use with type of adjacent construction. Fasteners shall securely fasten louver frame to wall construction involved. Fasteners shall provide stiffness and rigidity to keep frames square, in accurate position without twisting, buckling or warping. Fasteners to framing substrate shall be the following minimums; greater as required by the louver manufacturer or as conditions warrant:
 - 1. Wood Framing: #14 stainless steel wood screws at 12 inches on center all around with 2 inches minimum penetration into the framing member.

- E. Install perimeter flexible flashing membrane around all louver openings in accordance with manufacturers' installation instructions and under provisions of Section 07 25 00.
- F. Install metal flashings and align louver assembly to ensure moisture shed from flashings and diversion of moisture to exterior.
- G. Install insect screen on the interior face of the louver frame with mechanical fasteners.
- H. Install perimeter sealant to method required to achieve performance criteria and installation criteria described in Section 07 92 00.

3.3 CLEANING

- A. Clean surfaces and components per manufacturer's recommendations.

END OF SECTION

SECTION 09 22 26.23
METAL SUSPENSION SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Suspended gypsum board ceiling metal framing system.

1.2 RELATED SECTIONS

- A. Section 06 10 00 – Rough Carpentry.
- B. Section 09 29 00 – Gypsum Board.
- C. Divisions 21 - 23 – Mechanical.
- D. Divisions 26 - 28 – Electrical.

1.3 REFERENCES

- A. The publications listed below form a part of this Section to the extent referenced. The publications are referred to in the text by the basic designation only. Refer to Division 01 for definitions, acronyms, and abbreviations.
- B. Standards, manuals, and codes refer to the latest edition of such standards, manuals, and codes in effect as of the date of issue of this Project Manual, unless indicated otherwise in CBC Chapter 35 and CFC Chapter 80.
- C. Referenced Standards:
 - 1. ASTM A641/A641M – Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire.
 - 2. ASTM A653/A653M – Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 - 3. ASTM C645 – Standard Specification for Nonstructural Steel Framing Members.
 - 4. ASTM C754 – Standard Specification for Installation of Steel Framing Members to Receive Screw-Attached Gypsum Panel Products.
 - 5. ASTM C840 – Standard Specification for Application and Finishing of Gypsum Board.

1.4 SUBMITTALS

- A. General: Submit in accordance with Division 01.
- B. Product Data: Submit manufacturer's descriptive literature and product specification for each product.
- C. Shop Drawings:
 - 1. Indicate typical layout including dimensions.
 - 2. Submit drawings showing field measured dimensions.
 - 3. Submit detail drawings of special accessory components not included in manufacturer's product data.

1.5 SYSTEM DESCRIPTION

- A. Suspended metal framing system for single layer suspended gypsum board ceiling.
- B. Alternative systems conforming to CBC Table 2508.1 may be proposed. Conform to substitution requirements per Division 01. Include in proposal specifications and shop drawings showing framing layout, member sizes, hanger locations, fastening, and attachment details.
- C. Alternative suspended gypsum board ceiling framing systems may be submitted with appropriate current ICC-ES Report. Install in accordance with manufacturer's instructions and ICC-ES Report. Conform to substitution requirements per Division 01.
- D. Substitutions are subject to agency approval.

1.6 QUALITY ASSURANCE

- A. Qualifications:
 - 1. Manufacturer Qualifications: Firm specializing in manufacturing products specified in this Section with a minimum five years' experience.
 - 2. Installer Qualifications: Firm specializing in installing work specified in this Section with experience on at least five projects of similar nature in past three years.
- B. Coordinate work in this Section with work in related Sections.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Comply with requirements of Division 01.
- B. Deliver products in manufacturer's original containers, dry and undamaged, with seals and labels intact.
- C. Storage and Protection:
 - 1. Store materials in a dry secure place. Protect from weather, surface contaminants, corrosion, construction traffic, and other potential damage.
 - 2. If materials are stored outdoors, stack materials off ground, supported on a level platform, and fully protected from the weather.
- D. Handling: Handle materials carefully to prevent damage. Remove damaged materials and provide new items.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Galvanized or galvanized steel conforming to ASTM A653/A653M, minimum G40 or Z120.
- B. Grade:
 - 1. 16 gauge and heavier, $F_y = 50$ ksi
 - 2. 18 gauge and lighter, $F_y = 33$ ksi minimum.

2.2 COMPONENTS

A. Frame Members: ASTM C645.

1. Main Runners: Cold-rolled steel channels; 1-1/2 inch by 16 gauge; 0.475 pounds per foot, minimum.
2. Cross-Furring: Cold-rolled steel hat channels: 7/8 inch by 22 gauge.

B. Wire Hangers: ASTM A641/A641M, zinc-coated wire, Class 1, soft temper, pre-stretched.

PART 3 EXECUTION

3.1 EXAMINATION

- #### A. Examine job site conditions and verify field dimensions. Verify hangers will not interfere with other work.

3.2 INSTALLATION

- #### A. Install ceiling metal suspension system in accordance with accepted shop drawings, and as specified in this Section.
- #### B. Install ceiling metal suspension system after major above ceiling work is complete. Coordinate location of hangers with other work.
- #### C. Hang suspension system independent of walls, columns, ducts, pipes and conduits.
- #### D. Install cross furring as recommended by gypsum board manufacturer to prevent sagging at 16 inches on center maximum for single layer of 5/8 inch gypsum board, saddle tied to main runners using one strand of No. 16 gauge or two strands of No. 18 gauge tie wire.
- #### E. Use No. 8 gauge hanger wires saddle tied to main runners as follows:
1. 3 feet-0 inches on center maximum, where main runners are spaced 4 feet-0 inches on center.
 2. 3 feet-6 inches on center maximum, where main runners are spaced 3 feet-6 inches on center.
 3. 4 feet-0 inches on center maximum, where main runners are spaced 3 feet-0 inches on center.
- #### F. Splice main runners by lapping and interlocking flanges 12 inches minimum and tying near each end double loops of No. 16 gauge tie wire.
- #### G. Splice cross-furring by lapping and interlocking pieces 8 inches minimum and tying near each ends with double loops of No. 16 gauge tie wire.
- #### H. Fasten hanger wires with not less than three tight turns. Fasten bracing wires with four tight turns. Make all tight turns with a distance of 1-1/2 inch. Hanger or bracing wire anchors to the structure should be installed in such a manner that the direction of the wire aligns as closely as possible with the direction of the forces acting on the wire. Wire turns made by machine where both strands have been deformed or bent in wrapping can waive the 1-1/2 inch requirement, but the number of turns should be maintained, and as tight as possible.

- I. Separate all ceiling hanging and bracing wires at least 6 inches from all unbraced ducts, pipes, conduit, etc. It is acceptable to attach lightweight items, such as single electrical conduit not exceeding 3/4 inch nominal diameter, to hanger wires using connectors acceptable to Architect.
- J. Provide trapeze or other supplementary support members at obstructions to typical hanger spacing. Provide additional hangers, struts or braces as required at all ceiling breaks, soffits, or discontinuous areas. Where hanger wires are more than one in six out of plumb, provide counter-sloping wires.

3.3 BRACING ASSEMBLIES

- A. Provide bracing assemblies consisting of a compression strut and four 12 gauge splayed bracing wires oriented 90 degrees from each other. Splayed bracing wires shall be taut and shall not exceed 45 degrees from the ceiling plane. Splices in bracing wires are not permitted. Space bracing assemblies as follows:
 - 1. Not more than 12 feet by 12 feet on center.
 - 2. Not more than 1/2 of the spacing given above from the perimeter wall and at the edge of vertical ceiling offsets.
- B. Ceiling grid members may be attached to no more than two adjacent walls, and at least 1/2 inch free of other walls. Where walls run diagonally to ceiling grid system runners, one end of main and cross runner should be free, and a minimum 1/2 inch clear of wall.
- C. Suspended ceiling systems with a ceiling area of 144 square feet or less surrounded by walls which connect directly to the structure above, do not require bracing assemblies when attached to two adjacent walls.

3.4 SUPPORT AND ANCHORAGE OF LIGHT FIXTURES AND MECHANICAL SERVICES

- A. Support drop-in light fixtures and ceiling mounted mechanical air terminals and services directly by main runners or by supplemental framing which is supported by main runners and positively attached with screws or other approved connectors.
- B. Attach surface mounted fixtures to main runners with a positive clamping device made of minimum 14 gauge material. Rotational spring clamps do not comply.

3.5 TOLERANCES

- A. Maximum Variation from True Plane: 1/4 inch in 10 feet in any direction.

END OF SECTION

SECTION 09 24 00
PORTLAND CEMENT PLASTERING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Metal furring and lathing.
- B. Building wrap (weather-resistive barrier) under metal lath, and over plywood sheathing.
 - 1. Provide a two-layer building wrap system as follows:
 - a. One layer of kraft building paper over one layer of HDPE product.
 - b. Flashing as recommended by building wrap manufacturer.
- C. Two-coat (scratch and brown) Portland cement plaster system as base for adhered manufactured stone veneer.
- D. Two-coat (brown and finish) Portland cement plaster system over CMU with integral color acrylic finish coat. No lath required.
- E. Three-coat Portland cement plaster system with integral color acrylic finish coat.

1.2 RELATED SECTIONS

- A. Section 04 22 00 – Concrete Unit Masonry.
- B. Section 04 73 00 – Manufactured Stone Masonry.
- C. Section 06 10 00 – Rough Carpentry.
- D. Section 07 25 00 – Weather Barriers.
- E. Section 07 92 00 – Joint Sealants.
- F. Section 09 91 00 – Painting.

1.3 REFERENCES

- A. The publications listed below form a part of this Section to the extent referenced. The publications are referred to in the text by the basic designation only. Refer to Division 01 for definitions, acronyms, and abbreviations.
- B. Standards, manuals, and codes refer to the latest edition of such standards, manuals, and codes in effect as of the date of issue of this Project Manual, unless indicated otherwise in CBC Chapter 35 and CFC Chapter 80.
- C. Referenced Standards:
 - 1. ASTM A641/A641M – Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire.
 - 2. ASTM A653/A653M – Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

3. ASTM A924/A924M – Standard Specification for General Requirements for Sheet Steel, Metallic Coated by the Hot-Dip Process.
4. ASTM A1011/A1011M – Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High Strength Low-Alloy with Improved Formability, and Ultra-High Strength.
5. ASTM B117 – Standard Practice for Operating Salt Spray (Fog) Apparatus.
6. ASTM C150 – Standard Specification for Portland Cement.
7. ASTM C206 – Standard Specification for Finishing Hydrated Lime.
8. ASTM C841 – Standard Specification for Installation of Interior Lathing and Furring.
9. ASTM C897 – Standard Specification for Aggregate for Job-Mixed Portland Cement-Based Plasters.
10. ASTM C926 – Standard Specification for Application of Portland Cement-Based Plaster.
11. ASTM C954 – Standard Specification for Steel Drill Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Steel Studs From 0.033 in. (0.84 mm) to 0.112 in. (2.84 mm) in Thickness.
12. ASTM C1002 – Standard Specification for Steel Self-Piercing Tapping Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs.
13. ASTM C1063 – Standard Specification for Installation of Lathing and Furring to Receive Interior and Exterior Portland Cement-Based Plaster.
14. ASTM D412 – Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers – Tension.
15. ASTM D779 – Standard Test Method for Water Resistance of Paper, Paperboard, and Other Sheet Materials by the Dry Indicator Test Method.
16. ASTM D828 – Standard Test Method for Tensile Properties of Paper and Paperboard Using Constant-Rate-of-Elongation Apparatus.
17. ASTM D1308 – Standard Test Method for Effect of Household Chemicals on Clear and Pigmented Organic Finishes.
18. ASTM D1653 – Standard Test Methods for Water Vapor Transmission of Organic Coating Films.
19. ASTM D4060 – Standard Test Method for Abrasion Resistance of Organic Coatings by the Taber Abraser.
20. ASTM D4541 – Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers.
21. ASTM E84 – Standard Test Method for Surface Burning Characteristics of Building Materials.
22. ASTM E96 – Water Vapor Transmission of Materials.
23. ASTM G155 – Standard Practice for Operating Xenon Arc Light Apparatus for Exposure of Non-Metallic Materials.
24. FS TT-C-555 – Coating, Textured (for Interior and Exterior Masonry Surfaces).
25. PCA Portland Cement Plaster (Stucco) Manual.

1.4 SUBMITTALS

- A. Submit product data under provisions of Division 01.
- B. Provide product data on building wrap, furring and lathing components, plaster materials, characteristics and limitations of products specified, and plastering accessories.
- C. Samples: Provide two 12 inch x 12 inch samples of plaster system for each type of color and texture scheduled for installation.
- D. Submit manufacturer's installation instructions under provisions of Division 01.

1.5 QUALITY ASSURANCE

- A. Applicator: Company specializing in cement plaster work sufficient documented experience.
- B. Apply cement plaster system in accordance with ASTM C926.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Delivery, storage, and handling in accordance with provisions of Division 01.
 - 1. Deliver manufactured products to job site in their original unopened containers with labels intact and legible at the time of use.
 - 2. Do not permit scattering of materials or equipment but use necessary means to ensure neatness of the site and structure at all times.
 - 3. Perform cleaning of tools and equipment only in the area designated for that purpose.
- B. Protection: Use means necessary to protect lath and plaster materials before, during and after installation and to protect the installed work and materials of other trades.
- C. Replacements: In the event of damage, immediately make repairs and replacements necessary to the approval of the Architect and at no additional cost to Owner.

1.7 ENVIRONMENTAL REQUIREMENTS

- A. Do not apply plaster when substrate or ambient air temperature is less than 35 degrees F nor more than 90 degrees F. If freezing is expected within the next twelve hours, do not apply plaster.
- B. Maintain minimum ambient temperature of 35 degrees F during and after installation of plaster.
- C. Protect plaster from uneven and excessive evaporation during any weather conditions.

PART 2 PRODUCTS

2.1 PLASTER MATERIALS

- A. Cement: ASTM C150, Normal – Type I or Type II, low alkali; gray color; Portland Cement.
- B. Lime:
 - 1. ASTM C206, Type S.

2. Plasticity Agents to Replace Lime: Conform to CBC Section 2507 with Current ICC-ES Report. Acceptable Products: Gibco DRY admixture and PRF Liquid admixture by Gibco Industries, Pozalite by Stockton Products, or accepted equal.

- C. Aggregate: In accordance with ANSI/ASTM C897, except that gradation shall meet the following requirements:

<u>Sieve Size</u>	<u>Percent Retained on each sieve (by weight)</u>	
	<u>Maximum</u>	<u>Minimum</u>
No. 4	0	—
No. 8	10	0
No. 16	40	10
No. 30	65	30
No. 50	90	70
No. 100	100	90-95

1. The sand shall have more than 50 percent retained between any two consecutive sieves nor more than 25 percent between Nos. 50 and 100 sieves.

- D. Water: Clean, fresh, potable and free of mineral or organic matter that can affect plaster system components.

- E. Bonding Agent (used over CMU substrate): Polyvinyl Acetate, rewettable type (use only in areas not subject to moisture). Acceptable products:

1. "Weldcrete" – The Larsen Company.
2. "Euco Weld" – The Euclid Chemical Company.

- F. Acrylic Finish Coat: Vapor permeable, 100 percent acrylic polymer finish coat with crushed mineral aggregates, meeting the following performance criteria:

<u>Property</u>	<u>Test Method</u>	<u>Results</u>
Adhesion to concrete	ASTM D4541	100 psi
Vapor permeability	ASTM D1653 Method A Method B	3.0 dry perms 9.7 wet perms
Abrasion resistant (1000 cy)	ASTM D4060	6.8 percent weight loss
Tensile strength Nontextured film Textured film	ASTM D412	200 psi 20 psi
Elongation Nontextured film	ASTM D412	30 percent
Wind driven rain	Federal Spec TT-C-555B	Pass
Accelerated weathering 2000 hours	ASTM G155	No cracking, blistering, checking or adhesion loss
Freeze-thaw resistance of dry film (25 cy)	Lab method	Pass
Dirt pickup	Lab method	None

Chemical resistance	ASTM D1308	Good resistance to mild acids, alkalis and salts
Flame Spread	ASTM E84	15 maximum
Smoke Developed	ASTM E84	10 maximum

1. Acceptable Manufacturers:
 - a. Dryvit Weatherlastic.
 - b. Omega Akroflex.
 - c. ParexLaHabra DPR Finish.
 - d. Substitutions: Under provisions of Division 01.
2. Color and Texture: As selected by Architect.
3. Accessories: Leveler and primer as manufactured by the finish coat manufacturer.

2.2 LATH AND LATH ACCESSORIES

- A. General: Conforming to ASTM C1063; fabricated from prime galvanized steel with G60 zinc coating by the hot-dipped method conforming to ASTM A653/A653M, 26 gauge minimum.
- B. Metal Lath: Self furred, grooved, galvanized expanded metal flat diamond mesh; weighing 3.4 pounds per square yard; continuous horizontal grooves 1/4 inch deep at 6 inches on center as manufactured by ClarkDietrich Building Systems, Cemco, Amico or accepted equal.
 1. Acceptable Alternative Metal Lath: Structa Mega Lath as manufactured by Structa Wire Corporation with the following characteristics:
 - a. Weight: 1.95 pounds per square yard.
 - b. No. 17 gauge x No. 16 gauge galvanized cold-rolled steel wire welded to form 0.7 inch x 1.5 inch openings.
 - c. Six secondary cold-rolled flat longitudinal wires spaced nominally every 5-3/8 inches to form a twin track.
 - d. Furring:
 - 1) Width of Furring Leg: 1/4 inch.
 - 2) Furring Height: 1/4 inch to underside of cross wire.
 - 3) Furring Spacing: 2-1/8 inch on center.
 - 4) Every cross wire is furred.
- C. Exterior Corner Reinforcement: Class 1 galvanized 17.5 gauge wire with nine wire construction and five nose wire configuration; No. 10CA as manufactured by Stockton Products, ClarkDietrich Building Systems, Cemco, Amico, or accepted equal.
- D. Casing Beads: Formed steel, minimum 26 gauge thick; of longest possible length; sized and profiled to suit application; galvanized finish; No. 66N casing bead (with No. 66X expanded flange at CMU only) as manufactured by ClarkDietrich Building Systems, Cemco, Amico, Brand X Metals Inc., or accepted equal.

- E. Weep Screeds: Formed steel, minimum 26 gauge thick; square flange, 3-1/2 inch high leg, of longest possible length; sized and profiled to suit application; galvanized finish; Model: WS78-350U weep screed as manufactured by ClarkDietrich Building Systems, Cemco, Amico, Brand X Metals Inc., or accepted equal.
- F. J-Weeps: Formed steel, minimum 26 gauge thick; of longest possible length; sized and profiled to suit application; galvanized finish; Model: JWLB J-weep with 2 inch nailing flange and weep holes as manufactured by ClarkDietrich Building Systems, Cemco, Amico, Brand X Metals Inc., or accepted equal.
- G. Control Joints: Formed steel; minimum 26 gauge accordion profile, 1/2 inch ground with expanded metal flanges each side; of longest possible length; sized and profiled to suit application; galvanized finish; No. XJ 15, as manufactured by ClarkDietrich Building Systems, Cemco, Amico, Brand X Metals Inc., or accepted equal.
- H. Soffit Vent: 26 gauge, ASTM: A653 LFQ galvanized finish, perforated with 1/8 inch Vent Holes, Series SVR Soffit Vent/Reveal Screed as manufactured by Stockton Products, Amico, Brand X Metals Inc., or accepted equal.
- I. Soffit Drip Mold: No. 5 stucco drip, galvanized finish with 3-1/2 inch long vertical leg and 1/2 inch diameter key holes, as manufactured by Stockton Products, ClarkDietrich Building Systems, Cemco, Amico, Brand X Metals Inc., or accepted equal. Provide matching factory miter cut, solid soldered inside and outside corners.
- J. Substitutions: Under provisions of Division 01.

2.3 LATH ANCHORAGES

- A. Anchorages at wood framing: Install ASTM C1002 galvanized # 8 wafer head screws at 6 inches on center vertically at each stud with minimum 3/4 inch embedment into framing members. Minimum 500 hour corrosion resistant finish per ASTM B117.

2.4 BUILDING WRAP (WEATHER RESISTIVE BARRIER)

- A. Kraft Building Paper: Asphalt-saturated kraft Grade D breather type sheathing paper exceeding ASTM E2556 Type II performance requirements.
 - 1. Manufacturer and Product: Henry Super Jumbo Tex 60 Minute Weather-Resistive Barrier as manufactured by Henry Company or accepted equal; ICC ESR-1027.
 - 2. Properties:
 - a. Water Vapor Transmission: 75 grams, 11 perms (MVT) per ASTM E96 (A).
 - b. Water Resistance: Greater than 60 minutes per ASTM D779.
 - c. Tensile Strength: Tested in accordance with ASTM D828.
 - 1) Cross Machine Direction: 30 lbf per inch.
 - 2) Machine Direction: 80 lbf per inch.
 - d. Surface Burning Characteristics:
 - 1) Flame Spread: Less than 100 per ASTM E84.
 - 2) Smoke Developed: Less than 450 per ASTM E84.
- B. HDPE Product: Refer to Section 07 25 00.

2.5 CEMENT PLASTER MIXES

- A. Mix and proportion cement plaster in accordance with ASTM C926 and PCA Portland Cement/Stucco Manual. Mix plasticity agents (lime replacement admixtures) in accordance with manufacturer's written instructions and ICC-ES Report.
- B. Mix and proportion cement plaster as follows:
 - 1. Scratch Coat Proportions: One part Portland cement, four parts aggregate and three ounces PRF admixture.
 - 2. Brown Coat Proportions: One part Portland cement, five parts aggregate and three ounces PRF admixture.
 - 3. Finish Coat Proportions: Per manufacturer's recommendations.
- C. Mix only as much plaster as can be used in one hour.
- D. Mix materials dry, to uniform color and consistency, before adding water.
- E. Protect mixtures from frost, contamination, and evaporation.
- F. Do not retemper mixes after initial set has occurred.

2.6 SEALANTS

- A. Sealants used in conjunction with the scratch, brown, and finish coats shall only be the type recommended by the product manufacturer(s).

PART 3 EXECUTION

3.1 INSPECTION

- A. Verify that surfaces and site conditions are ready to receive work.
- B. Inspect the installed work of other trades and verify that such work is complete to the point work of this Section may begin.
- C. Verify that substrate is plumb, level, square and aligned.
- D. Report in writing conditions which might adversely affect the performance of installed lath and plaster to the Architect.
- E. Beginning of installation means acceptance of existing conditions.

3.2 PREPARATION

- A. Protect surfaces near the work of this Section from damage or disfiguration.

3.3 BUILDING WRAP (WEATHER RESISTIVE BARRIER) INSTALLATION

- A. At all areas of Portland cement plaster system, apply two-layers of building wrap (weather resistive barrier). Install one layer of kraft building paper over one layer of HDPE product.
- B. HDPE and Flexible Flashing Product Installation: Refer to Section 07 25 00.

C. Kraft Building Paper Installation: Apply kraft building paper over HDPE product, horizontally with a 3-inch overlap and a 6-inch end lap and fasten in place. Joints shall be staggered over HDPE product joints.

1. Extend into jambs of openings and seal corners with tape.
2. Seal fasteners and penetrations with compatible sealing tape.

3.4 LATH AND LATH ACCESSORIES INSTALLATION

- A. Install metal plaster bases and accessories in conformance with ASTM C1063. All vertically placed accessories shall be installed continuously; breaks shall occur only at horizontally placed accessories where they intersect vertically placed accessories.
- B. Lath shall be installed as specified in CBC Sections 2507.3 and 2510 and CBC Table 2507.2 for wire fabric lath. The lath shall be installed with the cross wires parallel to the framing and shall be attached with fasteners at the furring crimps.
- C. Apply metal lath with the long dimension across the supports with true, even surfaces, and without sags or buckles in accordance with ASTM C841. Orient metal lath on vertical surfaces to provide maximum mechanical bond with plaster. Apply upper sheets to overlap lower sheets.
- D. Attach metal lath to framing members at maximum 6 inches on center.
- E. Lath shall stand off substrate immediately behind the lath a minimum of 1/4 inch.
- F. Install control joints and expansion joints on top of metal lath and wire tie to metal lath on each side.
- G. Continuously reinforce internal angles with additional layer of lath, 6 inches wide minimum, except where the metal lath returns 3 inches from corner to form the angle reinforcement. Fasten at perimeter edges only.
- H. Place corner bead with mesh at corners. Attach with fasteners as recommended by manufacturer, spaced not more than 18 inches on center. Fasten at outer edges only.
- I. Place minimum 4 inch wide strip mesh diagonally at corners of lathed openings. Secure rigidly in place. Extend minimum 8 inches diagonally each direction from point of corner.
- J. Place casing beads at terminations of plaster finish. Butt and align ends. Secure rigidly in place.
- K. Install accessories to lines and levels.

3.5 MASONRY PREPARATION

- A. Verify that joints have been struck flush at all areas to receive cement plaster finish.
- B. Place casing beads at terminations of plaster finish. Butt and align ends. Secure rigidly in place.
- C. Apply bonding agent per manufacturer's recommendations prior to application of brown coat.
- D. Install accessories to lines and levels.

3.6 CONTROL JOINTS

- A. At stud framing, locate exterior control joints every twelve feet maximum in each direction, or as indicated on the Drawings. Vertical control joints shall be continuous; terminate horizontal control joints at vertical control joints. Attach by wiring to metal lath.
- B. At masonry walls, locate plaster control joints over masonry control joints.

3.7 PLASTERING

- A. Apply plaster in accordance with CBC Section 2512 and ASTM C926.
- B. Control plaster thickness and surface evenness using grounds or screeds. Use temporary screeds or plaster screeds within plastered areas to supplement fixed grounds and screeds.
- C. Apply scratch coat to a nominal thickness of 3/8 inch over metal reinforcement. Use sufficient material to form good keys, to completely embed the lath, and to allow for scoring of cement plaster surface.
 - 1. After application, lightly score scratch coat horizontally.
 - 2. If brown coat cannot be applied within four hours, keep scratch coat moist for a minimum of 48 hours before applying brown coat.
- D. At masonry walls: Apply brown coat to a nominal thickness of 3/8 inch directly over bonding agent. Rod brown coat straight and true in all directions.
- E. Apply brown coat to a nominal thickness of 3/8 inch over scratch coat. Use sufficient material and pressure to ensure a tight, uniform bond to scratch coat. Rod brown coat straight and true in all directions.
- F. Moist cure brown coat for a minimum of seven days before applying finish coat.

3.8 CURING OF BASE COAT (SCRATCH AND BROWN COATS)

- A. Moist cure base coat when ambient temperature is 77 degrees F or higher and/or when relative humidity is below 70 percent and conditions are windy.
- B. Moist cure base coat as follows:
 - 1. Only when base coat has set and is hard,
 - 2. In the morning and late afternoon for at least two days,
 - 3. With a fine mist of clean water; do not saturate,
 - 4. Cover with polyethylene sheets to retard evaporation during extreme weather conditions,
 - 5. Do not cure base coat that is subject to freezing.

3.9 ACRYLIC FINISH COAT

- A. Surface Preparation:
 - 1. Surfaces to receive acrylic finishes must be structurally sound, clean and dry. Cement plaster base coats must be properly cured and free of all grease, mildew, fungus, efflorescence, and any other contaminant.
 - 2. Contaminants must be removed by wire brush, pressure washing or sandblasting. Efflorescence shall be removed by a diluted acid wash and rinse.

3. Loose deteriorated stucco must be removed and repaired. Soft, dry dusty surfaces must be properly treated to insure adhesion of acrylic finish.
4. Verify that basecoat pH level is below 10.
5. Verify that ambient temperature is at least 40 degrees F and rising during application and for at least 24 hours after application.
6. Apply sealant as recommended by finish coat manufacturer where appropriate at terminations and the junctions of dissimilar materials.
7. Apply a leveler as necessary to achieve a flat surface prior to the application of the finish coat. The leveler shall be manufactured by the same manufacturer as the finish coat and shall be compatible for use with the plaster brown coat, the primer and the acrylic finish coat.

B. Priming:

1. Apply primer to all repaired, patched or chalking surfaces.
2. For improved finish coverage and workability, apply primer over Portland cement base coats.
3. Allow 24 hours for primer to dry before application of acrylic finish coats.
4. Primer shall be from the same manufacturer as the finish coat manufacturer.

C. Application:

1. Refer to manufacturer's instructions for application of leveler, primer, and acrylic finish.
2. The finish coat shall be applied and leveled to the minimum required thickness in the same application.
 - a. The finish coat shall be applied and textured continually over the wall surface in order to maintain a wet edge and provide a uniform appearance.
 - b. Work to corners or joints and do not allow the partially applied material to set up within a distinct wall area.
 - c. Achieve the final texture by using trowels or floats with a variety of motions to create the specified texture and to match approved samples.
 - d. At exterior corners, the finish coat shall be applied so that the nose wire is covered with a minimum of 1/8 inch of plaster.

3.10 TOLERANCES

- A. Maximum Variation from True Flatness: 1/8 inch in 8 feet, properly meeting adjacent surfaces and materials.

3.11 CLEAN-UP

- A. Promptly remove and clean plaster from all surfaces not scheduled to receive this finish. Verify cleaning recommendations from each substrate manufacturer prior to proceeding with any cleaning operations.
- B. Clean up and remove from the site all excess and waste materials generated by the installation of the plaster system.

END OF SECTION

SECTION 09 29 00

GYPSUM BOARD

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Gypsum board:
 - 1. Type X gypsum board.
 - 2. Moisture resistant gypsum board.
- B. Cementitious backer board.
- C. Accessories.

1.2 RELATED SECTIONS

- A. Section 06 10 00 – Rough Carpentry.
- B. Section 07 21 00 – Thermal Insulation.
- C. Section 07 84 00 – Firestopping.
- D. Section 07 92 00 – Joint Sealants.
- E. Section 08 11 13 – Hollow Metal Doors and Frames.
- F. Section 09 22 26.23 – Metal Suspension Systems.
- G. Section 09 30 00 – Tiling.
- H. Section 09 65 00 – Resilient Flooring.
- I. Section 09 77 10 – Sanitary Wall and Ceiling Finishes.
- J. Section 09 81 00 – Acoustic Insulation.
- K. Section 09 94 33 – Acoustical Wall and Ceiling Treatment.
- L. Section 09 91 00 – Painting.

1.3 REFERENCES

- A. The publications listed below form a part of this Section to the extent referenced. The publications are referred to in the text by the basic designation only. Refer to Division 01 for definitions, acronyms, and abbreviations.
- B. Standards, manuals, and codes refer to the latest edition of such standards, manuals, and codes in effect as of the date of issue of this Project Manual, unless indicated otherwise in CBC Chapter 35 and CFC Chapter 80.
- C. Referenced Standards:
 - 1. ANSI A108.11 – Interior Installation of Cementitious Backer Units.
 - 2. ANSI A118.1 – Dry-Set Portland Cement Mortar.

3. ANSI A118.4 – Latex-Portland Cement Mortar.
4. ANSI A118.9 – Test Methods and Specifications for Cementitious Backer Units.
5. ASTM B117 – Standard Practice for Operating Salt Spray (Fog) Apparatus.
6. ASTM C473 – Standard Test Method for Physical Testing of Gypsum Panel Products.
7. ASTM C475/C475M – Standard Specification for Joint Compound and Joint Tape for Finishing Gypsum Board.
8. ASTM C840 – Standard Specification for Application and Finishing of Gypsum Board.
9. ASTM C1002 – Standard Specification for Steel Self-Piercing Tapping Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs.
10. ASTM C1047 – Standard Specification for Accessories for Gypsum Wallboard and Gypsum Veneer Base.
11. ASTM C1325 – Standard Specification for Non-Asbestos Fiber-Mat Reinforced Cement Interior Substrate Sheets.
12. ASTM C1396/C1396M – Standard Specification for Gypsum Board.
13. ASTM D3273 – Standard Test Method for Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber.
14. GA-214 – Recommended Levels of Gypsum Board Finish.
15. GA-216 – Application and Finishing of Gypsum Board.
16. GA-600 – Fire Resistance Design Manual.
17. UL Fire Resistance Directory.

1.4 SUBMITTALS

- A. Submit under provisions of Division 01.
- B. Product Data: Submit product data for each product specified in this Section with the product and selected attributes clearly identified.

1.5 QUALITY ASSURANCE

- A. Qualifications:
 1. Manufacturer Qualifications: Firm specializing in manufacturing products specified in this Section with a minimum five years' experience.
 2. Installer Qualifications: Firm specializing in installing work specified in this Section acceptable to manufacturer with experience on at least five projects of similar nature in past three years.
- B. Regulatory Requirements: Comply with requirements of CBC Chapter 25.
- C. Coordinate work in this Section with work in related Sections.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Comply with requirements of Division 01.

- B. Deliver products in manufacturer's original containers, dry and undamaged, with seals and labels intact.
- C. Storage and Protection: Store materials in a dry secure place; neatly stacked to prevent sagging or damage to edges, ends, and surfaces. Protect from weather, surface contaminants, corrosion, construction traffic, and other potential damage.

1.7 ENVIRONMENTAL REQUIREMENTS

A. Interior Environmental Requirements:

- 1. Maintain room temperature at not less than 40 degrees F during application of gypsum board. Maintain room temperature at not less than 50 degrees F for joint treatment, texturing, and decoration for 48 hours prior to and continuously thereafter until completely dry.
- 2. Provide adequate ventilation during installation and curing period.
- 3. Prevent exposure to excessive or continuous moisture before, during, and continuously after installation. Eliminate sources of moisture immediately.
- 4. Protect gypsum board from direct exposure to rain, snow, sunlight, or excessive weather conditions.

PART 2 PRODUCTS

2.1 SUSTAINABLE BUILDING DESIGN REQUIREMENTS

- A. Provide sealants that meet VOC requirements of South Coast Air Quality Management District (SCAQMD) Rule 1168. Information is available at www.aqmd.gov.

2.2 MANUFACTURERS

A. Acceptable Manufacturers:

- 1. USG – United States Gypsum Company, Chicago, IL; 312-606-4000, www.usg.com.
- 2. National Gypsum Co., Charlotte, NC; 704-365-7300, www.nationalgypsum.com.
- 3. GP-Gypsum – Georgia-Pacific Corp., Atlanta, GA; 404-652-4000, www.gp.com.
- 4. CertainTeed Corporation, Malvern, PA; 800-233-8990, www.certainteed.com.
- 5. PABCO Gypsum, Newark, CA; 510-792-9555, www.pabco gypsum.paccoast.com.

- B. Substitutions: Under provisions of Division 01.

2.3 GYPSUM BOARD

- A. Type X Gypsum Board: ASTM C1396/1396M; 5/8-inch thick; 2.2 pounds per square foot; fire resistant core; maximum permissible length; ends square cut, tapered edges.
 - 1. Acceptable Products:
 - a. Sheetrock Brand Firecode X manufactured by USG,
 - b. Gold Bond Brand XP Fire-Shield Gypsum Board manufactured by National Gypsum,
 - c. ToughRock Fireguard manufactured by G-P Gypsum,
 - d. CertainTeed Type X manufactured by CertainTeed Corporation,
 - e. FLAME CURB Type X Gypsum Board manufactured by PABCO Gypsum,
 - f. or accepted equal.

- B. Moisture Resistant Gypsum Board: ASTM C1396/C1396M; 5/8 inch thick Type X, moisture and mold resistant core, encased in moisture resistant paper facers; maximum permissible length; ends square cut, tapered edges.
 - 1. Average water absorption after two-hour immersion per ASTM C473: 5 percent or less.
 - 2. Mold and mildew resistance per ASTM D3273: Minimum average score 8.
 - 3. Acceptable Products:
 - a. Sheetrock Brand Mold Tough Gypsum Panels manufactured by USG,
 - b. Gold Bond Brand XP Gypsum Board manufactured by National Gypsum,
 - c. ToughRock Mold Guard manufactured by G-P Gypsum,
 - d. M2Tech Type X manufactured by CertainTeed Corporation,
 - e. MOLD CURB PLUS Type X Mold and Water Resistant Gypsum Board manufactured by PABCO Gypsum,
 - f. or accepted equal.

2.4 ACCESSORIES

- A. Resilient Furring Channels: 1/2 inch deep, sheet steel members designed to reduce sound transmission.
- B. Corner Bead, Edge Trim, and Decorative Dividers: ASTM C1047; zinc-coated sheet steel. Acceptable product: 103 Deluxe Corner Bead manufactured by Clark Dietrich, or accepted equal.
- C. Control Joints: ASTM C1047; roll-formed zinc joint with removable protected opening; provided in accordance with UL fire rated assemblies. Acceptable product: Zinc Control Joint No. 093 manufactured by Clark Dietrich, or accepted equal.
- D. Screws:
 - 1. ASTM C1002, Type S or Type A; bugle head; self-drilling and self-tapping screws for light gauge steel framing (less than 0.033 inch thick).
 - 2. ASTM C1002 Type W or Type A; bugle head; provide sufficient length to provide a minimum 3/4 inch penetration into wood framing members.
- E. Jointing Tape: ASTM C475/C475M; 2 inch wide heavy duty paper joint tape.
- F. Joint Compound: ASTM C475/C475M.
- G. Primer-Surfacer (used in lieu of skim coat in a Level 5 finish): High-build interior coating finish applied with an airless sprayer. Products: Sheetrock Brand Primer-Surfacer Tuff-Hide manufactured by USG, ProForm Brand Surfacer/Primer manufactured by National Gypsum, or accepted equal. Note: Walls applied with primer-surfacer do not require drywall paint primer prior to application of finish coats.
- H. Acoustical Sealant: Refer to Section 07 92 00.
- I. Firestop Putty Pads for Electrical Boxes: Intumescent moldable firestop putty pad. Acceptable products: SSP4S 7.25 inches by 7.25 inches or SSP9S 9 inches by 9 inches manufactured by Specified Technologies Inc. (STI), Somerville, NJ; 800-992-1180, www.stifiirestop.com, or accepted equal.

2.5 CEMENTITIOUS BACKER BOARD

- A. Cement Board: ANSI A118.9 and ASTM C1325; polymer-modified cementitious board, with alkali-resistant fiberglass mesh reinforcing facers (front and back); long edges wrapped.
 - 1. Thickness: 5/8 inch.
 - 2. Acceptable Products:
 - a. Durock Brand Cement Board with Edgeguard by United States Gypsum Co.,
 - b. PermaBase Brand Cement Board by National Gypsum Co.,
 - c. or accepted equal.
- B. Accessories:
 - 1. Screws: No. 6 gauge by sufficient length to penetrate 3/4 inch into wood framing, self-drilling, ribbed wafer head screws or ribbed bugle head screws; minimum 500 hour corrosion resistant finish per ASTM B117.
 - 2. Jointing Tape: Alkali-resistant fiberglass mesh tape; 2 inches wide.
 - 3. Bonding and Jointing Materials: ANSI A118.1, dry-set Portland cement mortar; or ANSI A118.4, polymer modified latex Portland cement mortar.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine job site conditions and verify field dimensions.
- B. Verify framing for acceptable placement, spacing, and tolerance (alignment and plumb).
- C. Verify that framing and furring are securely attached.
- D. Verify that resilient channels have been installed where indicated on Drawings.
- E. Verify that all blocking, headers, and supports are in place to support plumbing fixtures, casework, grab bars, shelves, and similar items.
- F. Verify that insulation is secured.
- G. Verify firestopping work, refer to Section 07 84 00.
- H. Report unacceptable conditions to the Architect. Begin installation only when unacceptable conditions have been corrected.

3.2 FIRESTOPPING AND SEALANTS

- A. Install intumescent moldable pads over backs and sides of all electrical junction and utility boxes at fire rated walls.
- B. Apply acoustical sealant at partitions per sealant manufacturer's instructions. Refer to Section 07 92 00.

3.3 GYPSUM BOARD INSTALLATION

- A. Install gypsum board to framing and furring members in accordance with manufacturer's recommendations, GA-216 or ASTM C840, and as specified in this Section.

1. Install gypsum board to resilient channels where indicated on Drawings and as required for increased acoustical performance.
- B. Install gypsum board with separate panels in moderate contact, do not force in place. Stagger end joints of adjoining panels. Neatly fit abutting end and edge joints.
 1. Where two layers of gypsum board are installed, stagger all joints in top layer over joints in first layer.
- C. Install gypsum board in most economical direction, using maximum practical lengths, with edges occurring over firm bearing. Install 1/4 inch (nominal) above rough floor or curb. Cut out gypsum board as required to make neat close joints around openings.
- D. In vertical applications, provide lengths required to reach full height of vertical surfaces in one continuous piece.
- E. Where gypsum board is carried full height to structure above, provide for deflection of structure by undercutting board 3/8 inch (nominal) and sealing top edge of board to substrate with a continuous bead of sealant to form an elastic closure.
- F. Use screws to fasten gypsum board to framing.
- G. Treat cut edges and holes in moisture resistant gypsum board per manufacturer's recommendations.
- H. Place corner beads at all exterior corners. Use longest practical length. Place edge trims where gypsum board abuts dissimilar materials.
- I. Control Joints: Install control joints where indicated on the Drawings. Where not specifically indicated, install consistent with lines of building spaces as directed by Architect; and as a minimum, install as follows:
 1. Where a partition, wall, or ceiling traverses a construction joint (expansion, seismic, or building control element) in the base building structure.
 2. Where a wall or partition runs in an uninterrupted straight plane exceeding 30 linear feet.
 3. In interior ceilings without perimeter relief so that linear dimensions between control joints do not exceed 30 feet and total area between control joints does not exceed 900 square feet.
 4. Where ceiling framing members change direction.
 5. Where a partition transitions from floor-supported framing to overhead hung framing.
- J. Attach metal corner beads, edge trim, decorative dividers, and control joints to the supporting construction at 9 inches on center maximum spacing using same fasteners used to attach gypsum board panels.

3.4 FIRE-RESISTANT ASSEMBLIES

- A. Install fire rated assemblies using materials, application methods including gypsum panel orientation, types and spacing of fasteners, and framing in accordance with the specified UL Fire Resistive Design Number, GA-600 File Number, or CBC Table 721.1.
- B. Completely seal joints of fire-rated gypsum board enclosures in accordance with UL or GA listed assembly requirements. Seal penetrations through rated partitions and ceilings in accordance with tested systems. Refer to Section 07 84 00.

3.5 CEMENTITIOUS BACKER BOARD INSTALLATION

- A. Install cementitious backer boards in accordance with ANSI A108.11 and manufacturer's instructions.
- B. Install moisture retarding membrane. Place and fasten boards per manufacturer's instructions.
- C. Apply boards with ends and edges closely butted but not forced together. Center end or edge joints on framing and stagger joints in adjacent rows.
- D. Fasten boards to framing using specified fasteners. Drive fasteners into field of board first, working toward ends and edges. Hold boards in firm contact with framing while driving fasteners. Space fasteners maximum 8 inches on center with perimeter fasteners at least 3/8 inch from ends and 5/8 inch from edges.
- E. Drive screws so bottoms of heads are flush with surface of boards to provide firm panel contact with framing. Do not overdrive screws and replace any screws that are stripped.
- F. Provide additional blocking where required to permit proper attachment. Edges or ends of unit parallel to framing shall be continuously supported.

3.6 JOINT TREATMENT AND FINISH TEXTURE

- A. Finish gypsum board surfaces in accordance with ASTM C840, GA-214, and GA-216.
- B. Remove dirt, oil, and other materials that may cause lack of bond from all surfaces to receive joint compound.
- C. Set mechanical fasteners below the plane of the board.
- D. Tape, fill, and sand all joints, edges and corners to produce smooth surface ready to receive finishes. Fill all dents, gouges, recesses, or other depressions with joint compound to produce a monolithic surface.
- E. Feather coats onto adjoining surfaces so that camber is maximum 1/32-inch.
- F. Spray apply texture on all gypsum board surfaces, unless noted otherwise.
 - 1. Texture: Imperfect smooth.
- G. Levels of Finish: Finish gypsum board surfaces in accordance with GA-214 as follows:

Area	Finish
Plenum areas above ceilings.	Level 1 finish, no texture.
Standard and moisture resistant gypsum backing board (substrate for adhesive applied finish material such as ceramic tile).	Level 2 finish, no texture.
FRP wall covering.	Level 3 finish, no texture.
Light texture (imperfect smooth).	Level 4 finish.
Smooth finish; satin/eggshell paint finish.	Level 4 finish.

	Level 5 finish where critical (severe) lighting condition occurs (refer to GA-214 for description of critical lighting).
Smooth finish; semi-gloss paint finish.	Level 5 finish.

3.7 TOLERANCES

- A. Maximum variation from true flatness: 1/4 inch in 10 feet in any direction.
- B. Maximum surface variation of substrate for walls to receive ceramic tile: Refer to Section 09 30 00.

3.8 CLEANING AND PROTECTION

- A. Cleaning and Repair: Clean surfaces that have been spotted or soiled during wallboard application.
- B. Defective Work: Remove and replace defective work that cannot be satisfactorily repaired, at the direction of the Architect, with no additional cost to the Owner.
- C. Protection: Protect installed work against damage from other construction work.
- D. Upon completion of the work under this Section, remove all surplus material, rubbish and debris from the premises and leave floors broom clean.

END OF SECTION

SECTION 09 30 00

TILING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Ceramic tile.
- B. Setting materials including adhesives and mortar.
- C. Tile grout.
- D. Sealants.
- E. Membranes:
 - 1. Crack isolation.
 - 2. Waterproofing.
- F. Accessories.

1.2 RELATED SECTIONS

- A. Section 03 30 00 – Cast-In-Place Concrete.
- B. Section 07 92 00 – Joint Sealants.
- C. Section 09 29 00 – Gypsum Board.
- D. Section 10 28 13 – Toilet Accessories.

1.3 REFERENCES

- A. The publications listed below form a part of this Section to the extent referenced. The publications are referred to in the text by the basic designation only. Refer to Division 01 for definitions, acronyms, and abbreviations.
- B. Standards, manuals, and codes refer to the latest edition of such standards, manuals, and codes in effect as of the date of issue of this Project Manual, unless indicated otherwise in CBC Chapter 35 and CFC Chapter 80.
- C. Referenced Standards and Manuals:
 - 1. ANSI A108.1B – Installation of Ceramic Tile on a Cured Portland Cement Mortar Setting Bed with Dry-Set or Latex-Portland Cement Mortar.
 - 2. ANSI A108.5 – Installation of Ceramic Tile with Dry-Set Portland Cement Mortar or Latex-Portland Cement Mortar.
 - 3. ANSI A108.6 – Installation of Ceramic Tile with Chemical Resistant, Water Cleanable Tile-Setting and Grouting Epoxy.
 - 4. ANSI A108.10 – Installation of Grout in Tilework.
 - 5. ANSI A108.11 – Interior Installation of Cementitious Backer Units.

- 6. ANSI A108.13 – Installation of Load Bearing, Bonded, Waterproof Membranes for Thin-Set Ceramic Tile and Dimension Stone.
- 7. ANSI A108.17 – Installation of Crack Isolation Membranes.
- 8. ANSI A118.3 – Chemical Resistant, Water Cleanable Tile-Setting and Grouting Epoxy and Water Cleanable Tile Setting Epoxy Adhesive.
- 9. ANSI A118.4 – Latex-Portland Cement Mortar.
- 10. ANSI A118.9 – Cementitious Backer Units.
- 11. ANSI A118.10 – Load Bearing, Bonded, Waterproof Membranes for Thin-Set Ceramic Tile and Dimension Stone Installations.
- 12. ANSI A118.12 – American National Standard Specifications for Crack Isolation Membranes for Thin-Set Ceramic Tile and Dimension Stone Installation.
- 13. ANSI A137.1 – Ceramic Tile.
- 14. ASTM A82 – Standard Specifications for Steel Wire, Plain, for Concrete Reinforcement.
- 15. ASTM A185 – Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete.
- 16. ASTM C144 – Standard Specification for Aggregate for Masonry Mortar.
- 17. ASTM C150 – Standard Specification for Portland Cement.
- 18. ASTM C206 – Standard Specification for Finishing Hydrated Lime.
- 19. ASTM C207 – Standard Specification for Hydrated Lime for Masonry Purposes.
- 20. ASTM C373 – Standard Test Method for Water Absorption, Bulk Density, Apparent Porosity, and Apparent Specific Gravity of Fired Whiteware Products.
- 21. ASTM C648 – Standard Test Method for Breaking Strength of Ceramic Tile.
- 22. ASTM C920 – Standard Specification for Elastomeric Joint Sealants.
- 23. ASTM C1027 – Standard Test Method for Determining Visible Abrasion Resistance of Glazed Ceramic Tile.
- 24. MIA Design Manual.
- 25. TCNA Handbook for Ceramic, Glass, and Stone Tile Installation by Tile Council of North America, Inc.

1.4 SUBMITTALS

- A. General: Submit in accordance with Division 01.
- B. Product Data: Submit product data for each product specified in this Section with the product and selected attributes clearly identified.
- C. Submit instructions for installing membranes, adhesives, and grouts.
- D. Samples: Submit two samples of each type and color of ceramic tile and trim.
- E. Closeout Submittals: Cleaning and maintenance data.

1.5 QUALITY ASSURANCE

A. Qualifications:

1. Manufacturer Qualifications: Firm specializing in manufacturing products specified in this Section with a minimum ten years' experience.
2. Installer Qualifications: Firm specializing in installing work specified in this Section acceptable to manufacturer with experience on at least five projects of similar nature in past three years.

B. Single Source Responsibility: Provide setting, grouting, membrane, and sealant products from a single manufacturer to ensure system compatibility and quality, and to comply with manufacturer's warranty requirements.

C. Perform work in accordance with TCNA Handbook for Ceramic Tile Installation and ANSI A108 Series. Provide a copy of TCNA Handbook for Ceramic Tile Installation and ANSI A108 Series at the job site.

D. Pre-Installation Meetings:

1. Conduct pre-installation meeting in accordance with Division 01.
2. Convene pre-installation meeting prior to commencing work of this Section.
3. Coordinate work in this Section with work in related Sections.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Comply with requirements of Division 01.

B. Deliver products in manufacturer's original containers, dry and undamaged, with seals and labels intact.

C. Storage and Protection: Store materials in a dry secure place. Protect from weather, surface contaminants, corrosion, construction traffic, and other potential damage. Protect adhesives from freezing or overheating in accordance with manufacturer's instructions.

1.7 ENVIRONMENTAL REQUIREMENTS

A. Perform ceramic tile work when the ambient temperature is at least 50 degrees F and rising. Maintain temperature above 50 degrees F while the work is being performed for at least seven days after completion of the work.

B. Do not install adhesives in a closed, unventilated environment.

1.8 WARRANTY

A. Comply with provisions of Division 01.

B. Provide manufacturer's standard performance warranties that extend beyond a one-year period.

1.9 MAINTENANCE

A. Extra Materials: Provide five percent extra of the total square footage of each type and color of tile installed. Comply with provisions of Division 01.

B. Operation and Maintenance Data: Submit cleaning and maintenance data in accordance with Division 01.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers - Tile:

1. Daltile Corp., Dallas, TX; 800-933-8453, www.daltile.com.
2. American Olean Tile Co., Dallas, TX; 888-268-8453, www.aotile.com.
3. Crossville Inc., Crossville, TN; 931-484-2110, www.crossvilleinc.com.
4. Interceramic, Garland, TX; 800-688-5671, www.interceramic.com.
5. Emser Tile, Los Angeles, CA; 323-650-2000, www.emser.com.

B. Acceptable Manufacturers - Setting Materials:

1. Custom Building Products, Seal Beach, CA; 209-518-1153, www.custombuildingproducts.com.
2. Laticrete International, Inc., Bethany, CT; 800-243-4788, www.laticrete.com.
3. Mapei Corp., Deerfield Beach, FL; 800-426-2734, www.mapei.com.

C. Acceptable Manufacturers - Grout:

1. Custom Building Products.
2. Laticrete International, Inc.
3. Mapei Corp.

D. Acceptable Manufacturers - Sealants:

1. Custom Building Products.
2. Laticrete International, Inc.
3. Mapei Corp.
4. Color Caulk, Inc.

E. Acceptable Manufacturers - Crack Isolation and Waterproofing Membranes:

1. Custom Building Products.
2. Laticrete International, Inc.
3. Mapei Corp.

F. Acceptable Manufacturers - Accessories:

1. Schlüter-Systems L.P., Plattsburgh, NY; 800-472-4588, www.schluter.com.
2. Custom Building Products, Seal Beach, CA; 209-518-1153, www.custombuildingproducts.com.

G. Substitutions: Under provisions of Division 01.

2.2 CERAMIC TILE

- #### A. General: ANSI A137.1, Standard Grade. Packaging shall be grade sealed. Seals shall be marked to correspond with the marks on the signed master grade certificate.

B. Properties:

1. Impact resistant with a minimum breaking strength of 90 pounds for wall tiles and 250 pounds for floor tiles in accordance with ASTM C648.
2. Water absorption shall be 0.50 percent maximum in accordance with ASTM C373.
3. Tile flooring shall be stable, firm, and slip resistant per CBC Section 11B-302.1. Floor tiles shall have a minimum dynamic coefficient of friction of 0.42 wet in accordance with the DCOF AcuTest.
4. Floor tiles shall be minimum Class IV – Heavy Traffic durability when tested in accordance with ASTM C1027 for abrasion resistance as related to foot traffic.

C. Products:

1. Colorbody Porcelain Wall and Floor Tiles: Daltile Corp., Dignitary Series.
 - a. Nominal Size: 12 inches by 24 inches.
 - b. Thickness: 5/16 inch.
 - c. Surface Finish: Matte.
 - d. Color: As indicated on Drawings.
2. Colorbody Porcelain Mosaic Shower Floor Tiles: Daltile Corp., Haut Monde Series.
 - a. Nominal Size: 2 inches by 2 inches mounted on 12 inch x 12 inch sheets.
 - b. Thickness: 5/16 inch.
 - c. Surface Finish: Matte.
 - d. Color: As indicated on Drawings.
3. Glazed Ceramic Wall Tiles: Daltile Corp., Color Wheel Linear Series.
 - a. Nominal Size: 4 inches by 12 inches.
 - b. Thickness: 5/16 inch.
 - c. Surface Finish: Semi-gloss.
 - d. Color: As indicated on Drawings.

D. Special Shapes (trimmers, angles, bases, caps, stops, and returns): Same nominal size as field tile; rounded concave and convex surfaces; same properties as field tile (moisture absorption, surface finish, and color). Provide radius at all outside vertical and horizontal corner tile. Provide base at wall tile.

E. Wall Base: Unless otherwise indicated, wall base shall be 6 inches high with 3/8 inch minimum cove radius.

2.3 SETTING MATERIALS

A. Latex Portland Cement Mortar: Prepackaged, one-part, high performance, latex polymer modified dry-set, thin-set mortar. Meets or exceeds ANSI A118.4.

1. Products:

- a. Custom Building Products MegaLite Crack Prevention Mortar.
- b. Laticrete 254 Platinum Multipurpose Thin-Set Mortar.
- c. Mapei Ultraflex 3.
- d. Or accepted equal.

- B. Latex Portland Cement Mortar for Large Format Tile: Prepackaged, one-part, high performance, latex polymer modified dry-set, thin-set mortar. Meets or exceeds ANSI A118.4.

1. Products:

- a. Custom Building Products ProLite Tile & Stone Mortar.
- b. Laticrete 4-XLT.
- c. Mapei Ultraflex LFT.
- d. Or accepted equal.

C. Mortar Bed:

1. Materials:

- a. Cement: Portland cement, ASTM C150 Type I.
- b. Aggregate: ASTM C144, clean, graded, and passes a 16-mesh screen.
- c. Hydrated Lime: ASTM C206, Type S or ASTM C207, Type S.
- d. Water: Clean and potable.

2. Mortar Mix: Comply with ANSI A108.1A Section A-4.1a.2.

2.4 GROUTING MATERIALS

- A. Epoxy Grout: 100 percent solids epoxy grout; stainless, non-sagging, water cleanable; conforming to ANSI A118.3.

1. Products:

- a. Custom Building Products CEGLite Commercial Epoxy Grout.
- b. Laticrete Spectralock Pro Premium.
- c. Mapei Kerapoxy CQ
- d. Or accepted equal.

2. Colors as selected by Architect.

2.5 SEALANTS

- A. Latex siliconized sealant, non-sanded, in conformance with ASTM C920, Type S, Grade NS, Class 25, Uses NT, M and G. Color to match grout color.

1. Products:

- a. Custom Building Products 100% Silicone Commercial Caulk.
- b. Laticrete Latasil.
- c. Mapei Keracaulk.
- d. Color Caulk, Inc. Latex Siliconized Sealant.
- e. Or accepted equal.

2.6 MEMBRANES

- A. Crack Isolation Membrane: Trowel applied or self-adhering sheet membrane; load bearing; bonded; conforming to ANSI A118.12.

1. Products:

- a. Custom Building Products Fracture Free.

- b. Laticrete Blue 92.
 - c. Mapei Mapelastic 2, Crack Isolation Membrane, flexible thin, 40-mil lightweight, load-bearing, fabric-reinforced "peel-and-stick" crack-isolation membrane.
 - d. Or accepted equal.
- B. Waterproofing Membrane: Trowel applied, liquid, load bearing; bonded; conforming to ANSI A118.10.
1. Products:
- a. Custom Building Products Custom 9240 Waterproofing and Crack Prevention Membrane. Self-curing liquid elastomeric membrane with reinforcing fabric.
 - b. Laticrete 9235 Waterproofing Membrane with Microban. Self-curing liquid elastomeric membrane with reinforcing fabric forming a flexible, seamless waterproof membrane bonded to the substrate. Contains an antimicrobial protection to inhibit growth of mold and mildew.
 - c. Mapei Mapelastic 400, premixed, flexible, thin, ultra fast-drying waterproofing membrane.
 - d. Or accepted equal.

2.7 ACCESSORIES

- A. Mortar Bed Reinforcing Mesh: ASTM A82 and ASTM A185; galvanized welded wire fabric; 16 gauge wire; 2 inch by 2 inch mesh.
- B. Expansion Joints: DILEX-AKWS surface joint profile with aluminum anchoring legs and 1/4 inch wide PVC movement zone manufactured by Schlüter-Systems L.P., Custom Building Products, or accepted equal. PVC color as selected by Architect from manufacturer's full range of standard colors.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine job site conditions and verify field dimensions. Verify substrate is plumb, level, true to line and square.
- B. Substrate surface conditions shall conform to the requirements of ANSI A108 for the type of substrate specified and for workmanship.
- C. Maximum surface variation of substrate shall not exceed maximum limits as specified in specific TCNA Methods or as follows, whichever is more stringent.

Type	Walls	Floors
Latex Portland Cement Mortar	1/8 inch in 8 feet	1/8 inch in 10 feet
Mortar Bed	Not Applicable	1/4 inch in 10 feet

- D. Tile work shall not be started until roughing in for mechanical and electrical work has been completed and tested, and built-in items requiring waterproofing membrane have been installed and tested.
- E. Report unacceptable conditions to Architect. Begin installation only when unacceptable conditions have been corrected.

3.2 INSTALLATION

A. General:

1. Install in accordance with TCNA Handbook for Ceramic Tile Installation and ANSI A108.
2. Install crack isolation and waterproofing membranes per manufacturer's recommendations.
3. Do not interrupt tile pattern through openings.
4. In areas requiring floor and wall tiles, floor tile installation shall not begin until after wall tiles have been installed.
5. Cut and fit tile tight to penetrations through tile. Form corners and bases neatly. Align floor, base and wall joints.
6. Place tile joints uniform in width, subject to variance in tolerance allowed in tile size. Make joints watertight, without voids, cracks, excess mortar or excess grout.
7. Provide grout joint spacing in accordance with tile manufacturer's recommendations.
8. Install movement joints where indicated on Drawings and as specified in this Section.
9. Install accessories per manufacturer's recommendations and as detailed on Drawings.
10. Sound tile after setting. Replace hollow sounding units.
11. Allow tile to set prior to grouting: Minimum of 48 hours for thin-set methods and 78 hours for mortar bed methods.

B. Installation Methods – Interior Walls:

Method	Substrate/Application	Setting Material
TCNA Method W243, ANSI A108.5, and A108.6.	Moisture resistant gypsum board; thin set application; epoxy grout.	Latex Portland cement mortar.

C. Installation Methods – Interior Floors:

Method	Substrate/Application	Setting Material
TCNA Method F125-Full; ANSI A108.5, A108.6, and A108.17.	On-ground concrete; crack isolation membrane; thin set application; epoxy grout.	Latex Portland cement mortar.

D. Installation Methods – Shower Receptors:

Method	Substrate/Application	Setting Material
TCNA Method B415 with W244C, ANSI A108.5, A108.6, A108.11, and A108.13.	Wall – Cementitious backer board; bonded waterproofing membrane; thinset application; epoxy grout. Floor – Concrete slab-on-grade and mortar bed with bonded waterproofing membrane; thinset application; epoxy grout.	Wall and Floor: Latex Portland cement mortar.

3.3 JOINTS

- A. Joint Widths at Walls and Floors: Install tile on walls and floors in the joint widths recommended by the tile manufacturer.
- B. Expansion Joints:
 - 1. Provide expansion joints at locations shown on the Drawings or where Drawings do not indicate location, provide in the following locations as a minimum requirement:
 - a. Provide and install expansion joints per TCNA EJ171.
 - b. At control joints and expansion joints in substrate material,
 - c. Where substrate material changes to separate different materials,
 - d. Over construction joints,
 - e. Where tile abuts restraining surfaces, such as perimeter walls, curbs, and columns and at intervals of 24 to 36 feet each way in interior floor areas.
 - 2. Expansion joints shall extend through setting-beds and fill.

3.4 INSTALLATION - GROUT

- A. Epoxy Grout: Install in accordance with manufacturer's printed instructions and ANSI A108.6.
 - 1. Before grouting, ensure all tiles are firmly in place. Clean tile surfaces; remove paper and glue from face of mounted tiles. Remove spacers, strings, ropes, and pegs.
 - 2. Clean open tile joints. Remove excess setting materials present in the open grout joints.
 - 3. Mix grout in accordance with manufacturer's instructions.
 - 4. Apply grout firmly into open joints using a hard rubber float.
 - 5. Remove all excess epoxy grout from the tile surface with a rubber squeegee or rubber trowel before it loses plasticity and begins to set.
 - 6. Immediately perform final clean up in accordance with manufacturer's instructions.

3.5 CLEANING AND PROTECTING

- A. Clean as recommended by manufacturer. Do not use materials or methods which may damage finish surface or surrounding construction.
- B. Provide protective covering as recommended by tile manufacturer and as required to ensure installed tile finish will not be damaged by work of other trades. Protect installed tile finish surfaces from damage until Project Completion.

END OF SECTION

SECTION 09 51 13
ACOUSTICAL PANEL CEILINGS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Suspended metal grid ceiling system.
- B. Lay-in acoustical panels.
- C. Accessories.

1.2 RELATED SECTIONS

- A. Section 06 10 00 – Rough Carpentry.
- B. Section 09 29 00 – Gypsum Board.
- C. Divisions 21 – 23 – Mechanical.
- D. Divisions 26 – 28 – Electrical.

1.3 REFERENCES

- A. The publications listed below form a part of this Section to the extent referenced. The publications are referred to in the text by the basic designation only. Refer to Division 01 for definitions, acronyms, and abbreviations.
- B. Standards, manuals, and codes refer to the latest edition of such standards, manuals, and codes in effect as of the date of issue of this Project Manual, unless indicated otherwise in CBC Chapter 35 and CFC Chapter 80.
- C. Referenced Standards:
 - 1. ASCE 7-22 – Minimum Design Loads for Buildings and Other Structures.
 - 2. ASTM A641/A641M – Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire.
 - 3. ASTM C635 – Standard Specification for the Manufacture, Performance, and Testing of Metal Suspension Systems for Acoustical Tile and Lay-in Panel Ceilings.
 - 4. ASTM C636 – Standard Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-in Panels.
 - 5. ASTM E84 – Standard Test Method for Surface Burning Characteristics of Building Materials.
 - 6. ASTM E580 – Standard Practice for Installation of Ceiling Suspension Systems for Acoustical Tile and Lay-In Panels in Areas Subject to Earthquake Ground Motions.
 - 7. ASTM E1264 – Standard Classification for Acoustical Ceiling Products.
 - 8. UL Fire Resistance Directory and Building Material Directory.

1.4 SUBMITTALS

- A. General: Submit in accordance with Division 01.
- B. Product Data: Provide data on metal grid system components, compression struts, and acoustical units with the specified products and selected attributes clearly identified.
- C. Manufacturer's Installation Instructions: Indicate special procedures and perimeter conditions requiring special attention.

1.5 SYSTEM DESCRIPTION

- A. Performance Requirements: Rigidly secure suspended acoustical ceiling system, including integral mechanical and electrical components with maximum deflection of 1/360.

1.6 QUALITY ASSURANCE

- A. Qualifications:
 - 1. Metal Suspension Grid Manufacturer Qualifications: Firm specializing in manufacturing products specified in this Section with a minimum ten years' experience.
 - 2. Lay-in Acoustical Tile Manufacturer Qualifications: Firm specializing in manufacturing products specified in this Section with a minimum ten years' experience.
- B. Single Source Responsibility: Provide metal suspension systems and lay-in acoustical panels from a single manufacturer to ensure system compatibility and quality, and to comply with manufacturer's warranty requirements.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Comply with requirements of Division 01.
- B. Deliver products in manufacturer's original containers, dry and undamaged, with seals and labels intact.
- C. Storage and Protection: Store materials in a dry secure place. Protect from weather, surface contaminants, construction traffic, and other potential damage.

1.8 ENVIRONMENTAL REQUIREMENTS

- A. Maintain 60 degrees F minimum uniform temperature and 20 percent to 40 percent relative humidity prior to, during, and after installation of acoustical lay-in tiles.

1.9 SEQUENCING

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

1.10 MAINTENANCE

- A. Extra Materials:
 - 1. Furnish in accordance with Division 01.
 - 2. Provide ten percent extra of each type of panel.

1.11 WARRANTIES

- A. Metal Suspension Systems: Suspension system shall be warranted to be free from defects in materials or factory workmanship and warranted against the occurrence of 50 percent red rust as designated by ASTM D610 test procedures for a period of ten years from the date of installation.
- B. Acoustical Panels: Panels shall be warranted to be free from defects in materials or factory workmanship, or sagging and warping as a result thereof, for one year from the date of installation.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Acceptable Manufacturers – Metal Suspension Systems:
 - 1. Armstrong World Industries, Inc., Lancaster, PA; 888-234-5464, www.armstrong.com. Refer to ICC ESR-1308.
 - 2. USG Interiors, Inc., Chicago, IL; 800-950-3839, www.usg.com. Refer to ICC ESR-1222.
 - 3. CertainTeed Corporation, Malvern, PA; 800-233-8990, www.certainteed.com. Refer to ICC ESR-3336
- B. Acceptable Manufacturers – Lay-in Acoustical Panels:
 - 1. Armstrong World Industries, Inc.
 - 2. USG Interiors, Inc.
 - 3. CertainTeed Corporation
- C. Substitutions: Under provisions of Division 01.

2.2 METAL SUSPENSION SYSTEM

- A. Metal Suspension Grid: ASTM C635, heavy duty classification in compliance with ASCE 7-22 13.5.6.2; hot-dipped galvanized steel (minimum G30); 9/16 inch face; structural tee main and cross members; capped with steel, coated with factory applied baked-on white enamel paint.
 - 1. Main runners, cross runners, splices, expansion devices, and intersection connectors shall be designed to carry a mean ultimate test load of not less than 180 pounds in compression and tension per ASTM E580.

- B. Products, Suspension System:

	Main Runner	Cross Tees
1. Armstrong Suprafine XL	7501	XL7540
2. USG Donn Centricitee DXT	DXT26	DXT424
3. CertainTeed Elite Narrow Stab	ES12-12-18	ES2-12-12 and ES4-12-12

C. Products, Suspension System Accessories:

	Wall Angle	Seismic Clip at Wall Angle
1. Armstrong	7800	BERC2
2. USG Donn	M9	ACM7
3. CertainTeed	WA15-9	CTSPC-2

2.3 ACCESSORIES – METAL SUSPENSION SYSTEM

- A. Metal suspension system accessories as required for a complete system including but not limited to moldings, stabilizer bars, splices, hold down clips, and light fixture clips.
- B. Wire Hangers: ASTM A641/A641M, zinc-coated wire, Class 1, soft temper, pre-stretched, with a yield stress of at least three times the design load; sizes and gauges as shown on the Drawings and as specified in this Section.
- C. Support channels and hangers: Galvanized primed steel (minimum G30); size and type to suit application and to meet seismic requirements and as specified in this Section.

2.4 ACOUSTICAL LAY-IN PANELS

A. Panel Type ACT1:

- 1. ASTM E1264, Type III, Form 1; Pattern EIK.
- 2. Material: Wet-formed mineral fiber with factory-applied latex paint finish.
- 3. Properties:
 - a. Color: White.
 - b. Light Reflectance: Minimum 0.85.
 - c. NRC: Minimum 0.65.
 - d. Fire Resistance: CBC Class A (NFPA Class A); Flame Spread: 25 or under; Smoke Developed: 50 or under per ASTM E84.
- 4. Products:

	Size (ft x ft x in thick)	Edge
Armstrong Cirrus Second Look, No. 510	2 x 4 x 3/4	Beveled Tegalur
USG Eclipse Illusion, No. 78085	2 x 4 x 3/4	Interline Tapered
CertainTeed Cashmere Customline, No. CDSN-224	2 x 4 x 3/4	Cashmere Style

B. Panel Type ACT2:

- 1. ASTM E1264, Type III, Form 1; Pattern EIC.
- 2. Material: Wet-formed mineral fiber with factory-applied latex paint finish.
- 3. Properties:
 - a. Color: White.
 - b. Light Reflectance: Minimum 0.84.
 - c. NRC: Minimum 0.75.

- d. Fire Resistance: CBC Class A (NFPA Class A); Flame Spread: 25 or under; Smoke Developed: 50 or under per ASTM E84.

4. Products:

	Size (ft x ft x in thick)	Edge
Armstrong Cirrus High NRC, No. 558	2 x 2 x 3/4	Beveled Tegular
USG Eclipse High-NRC, No. 76524	2 x 2 x 3/4	Fineline
CertainTeed Cashmere High NRC, No. CM-450NRCP	2 x 4 x 3/4	Cashmere Style

C. Accessories – Acoustical Lay-in Panels:

1. Touch-up Paint: Type and color to match acoustical and grid units.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine job site conditions and verify field dimensions. Verify hangers will not interfere with other work.

3.2 INSTALLATION – SUSPENDED CEILING METAL GRID

- A. Install in accordance with manufacturer's instructions, CBC Section 808.1, ASTM C635, ASTM C636, ASTM E580, ASCE 7-22 13.5.6.2, accepted shop drawings, and as specified in this Section.
- B. Install ceiling metal suspension system after major above ceiling work is complete. Coordinate location of hangers with other work.
- C. Hang suspension system independent of walls, columns, ducts, cable trays, pipes, and conduits.
- D. Use minimum 12 gauge hanger wires for up to and including four foot by four foot grid spacing attached to main runners.
- E. Provide 12 gauge hanger wires at the perimeter ends of all main and cross runners within 8 inches of the support or within 1/4 of the length of the end tee, whichever is least. End connections for runners which are designed and detailed to resist the applied vertical and horizontal forces may be used in lieu of the 12 gauge hanger wires.
- F. Provide trapeze or other supplementary support members at obstructions to typical hanger spacing. Provide additional hangers, struts or braces as required at all ceiling breaks, soffits, or discontinuous areas. Where hanger wires are more than one in six out of plumb, provide counter-sloping wires.
- G. Ceiling grid members shall be attached to two adjacent walls using seismic clips, and at least 3/4 inch free of other walls. Where walls run diagonally to ceiling grid system runners, one end of main and cross runner should be free, and a minimum 3/4 inch clear of wall.

- H. At ceiling perimeter area, where main or cross runners are not connected to adjacent walls, provide interconnection between runners at the free end to prevent lateral spreading. A metal strut or a 16 gauge wire with positive mechanical connection to the runner may be used. Interlock is not required where perpendicular distance from the wall to the first parallel runner is 8 inches or less.
- I. Wall angles shall be positively attached to wall studs or blocking.
- J. Seismic clips shall be attached to wall angles with a minimum of two screws, and shall be installed around the entire ceiling perimeter.
 - 1. Pop rivets may be used in lieu of seismic clips at fixed sides where permitted by Evaluation Report.
- K. Expansion joints shall be provided in the ceiling at the intersections of corridors and at junctions of corridors and lobbies or other similar areas.
- L. Where ceiling areas exceed 2500 square feet, a seismic separation joint shall be provided to divide the ceiling into areas not exceeding 2500 square feet. Alternatively, comply with ASTM E580.
- M. Penetrations through the ceiling for fire sprinkler heads and other similar devices that are not integrally tied to the ceiling system in the lateral direction shall have a 2 inch oversized ring, sleeve, or adapter through the ceiling panel to allow free movement of 1 inch in all directions. Alternatively, a flexible fire sprinkler hose fitting that can accommodate 1 inch of ceiling movement per ASTM E580 may be used.
- N. Provide bracing assemblies consisting of a compression strut and four 12 gauge splayed bracing wires oriented 90 degrees from each other. Splayed bracing wires shall be taut and shall not exceed 45 degrees from the ceiling plane. Splices in bracing wires are not permitted. Space bracing assemblies as follows:
 - 1. Not more than 12 feet by 12 feet on center.
 - 2. Not more than 1/2 of the spacing given above from the perimeter wall and at the edge of vertical ceiling offsets.
 - 3. Suspended acoustical ceiling systems with a ceiling area of 144 square feet or less surrounded by walls which connect directly to the structure above, do not require bracing assemblies when attached to two adjacent walls.
- O. Compression struts shall be adequate to resist the vertical component induced by the bracing wires, and shall not be more than one horizontal in six vertical out of plumb.
- P. Fasten hanger wires with not less than three tight turns in 3 inches. Fasten bracing wires with four tight turns in 1-1/2 inches. Install hanger or bracing wire anchors to the structure in a manner that the direction of the wire aligns as closely as possible to the direction of the forces acting on the wire.
- Q. Separate all ceiling hanging and bracing wires at least 6 inches from all unbraced ducts, pipes, conduit, etc.
- R. Attach all light fixtures, ceiling mounted air terminals or services, light-weight miscellaneous devices, such as strobe lights, speakers, etc., and all other devices to the ceiling grid runners to resist a horizontal force equal to the weight of the fixtures. Screw or approved fasteners are required. A minimum of two attachments are required per ASTM E580.

1. Devices weighing less than or equal to ten pounds shall have a 12 gauge slack safety wire anchored to the structure above.
- S. Flush or recessed light fixtures, air terminals or services, and flexible fire sprinkler hose fittings weighing more than 10 pounds and less than 56 pounds, shall be supported directly on the runners of a heavy duty grid system. In addition, provide two 12 gauge slack safety wires attached to the fixture at diagonal corners and anchored to the structure above. Four foot by four foot light fixtures shall have slack safety wires at each corner.
- T. Flush or recessed light fixtures, air terminals or services, and flexible fire sprinkler hose fittings weighing 56 pounds or more shall be independently supported by not less than four taut 12 gauge wires attached to the fixture and to the structure above. The four taut 12 gauge wires, including their attachment to the structure above must be capable of supporting four times the weight of the unit.
- U. Surface-mounted fixtures shall be attached to the main runner with at least two positive clamping devices made of minimum 14 gauge material. Rotational spring catches are not allowed. A 12 gauge suspension wire shall be attached to each clamping device and be attached to the structure above. Provide additional supports when light fixtures are eight feet or longer. Maximum spacing between supports shall not exceed eight feet.
- V. Support pendant mounted light fixtures directly from structure above with hanger wires or cables passing through each pendant hanger and capable of supporting two times the weight of the fixture. A bracing assembly is required where the pendant hanger penetrates the ceiling. Attach pendant hanger to bracing assembly in a manner to transmit horizontal force. Where the pendant mounted light fixture is directly and independently braced below the ceiling, such as with aircraft cables to walls, the brace assembly is not required above the ceiling.
- W. Do not eccentrically load suspended ceiling grid system or produce rotation of runners.
- X. Install edge molding at intersection of ceiling and vertical surfaces, using longest practical lengths. Miter corners; provide edge moldings at junctions with other interruptions.

3.3 INSTALLATION – LAY-IN CEILING PANELS

- A. Install units in accordance with manufacturer's instructions.
- B. Fit units in place, free from damaged edges or other defects detrimental to appearance and function.
- C. Cut units to fit irregular grid and perimeter edge trim. Double cut and field paint exposed edges of tegular units in matching color.
- D. Lay directional patterned units one way with pattern parallel to longest room axis. Fit border trim neatly against abutting surfaces.
- E. Install units after above ceiling work is complete.
- F. Install units level, in uniform plane, and free from twist, warp and dents.
- G. Install hold-down clips to retain units tight to grid system within ten feet of all exterior doors.

3.4 ERECTION TOLERANCES

- A. Maximum variation from flat and level surface: 1/8 inch in 10 feet.

- B. Variation from plumb of grid members caused by eccentric loads: Two degrees maximum.

3.5 CLEANING

- A. Clean as recommended by manufacturer. Do not use materials or methods which may damage finish surface or surrounding construction.

END OF SECTION

SECTION 09 65 00
RESILIENT FLOORING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Luxury vinyl tile flooring.
- B. Rubber sports flooring.
- C. Resilient wall base, rubber.
- D. Resilient molding accessories.

1.2 RELATED SECTIONS

- A. Section 03 30 00 – Cast-In-Place Concrete; for concrete substrate.
- B. Section 07 26 50 – Vapor Emission Control System.
- C. Section 09 29 00 – Gypsum Board; for wall materials to receive resilient base.

1.3 REFERENCES

- A. The publications listed below form a part of this Section to the extent referenced. The publications are referred to in the text by the basic designation only. Refer to Division 01 for definitions, acronyms, and abbreviations.
- B. Standards, manuals, and codes refer to the latest edition of such standards, manuals, and codes in effect as of the date of issue of this Project Manual, unless indicated otherwise in CBC Chapter 35 and CFC Chapter 80.
- C. Referenced Standards:
 - 1. ASTM D1308 – Standard Test Method for Effect of Household Chemicals on Clear and Pigmented Organic Finishes.
 - 2. ASTM D2047 – Standard Test Method for Static Coefficient of Friction of Polish-Coated Floor Surfaces as Measured by the James Machine.
 - 3. ASTM D3389 – Standard Test Method for Coated Fabrics Abrasion Resistance (Rotary Platform Abrader).
 - 4. ASTM E648 – Standard Test Method for Critical Radiant Flux of Floor-Covering Systems Using a Radiant Heat Energy Source.
 - 5. ASTM E662 – Standard Test Method for Specific Optical Density of Smoke Generated by Solid Materials.
 - 6. ASTM F137 – Standard Test Method for Flexibility of Resilient Flooring Materials with Cylindrical Mandrel Apparatus.
 - 7. ASTM F710 – Standard Practice for Preparing Concrete Floors to Receive Resilient Flooring.
 - 8. ASTM F970 – Standard Test Method for Static Load Limit.
 - 9. ASTM F1700 – Standard Specification for Solid Vinyl Floor Tile.

- 10. ASTM F1861 – Standard Specification for Resilient Wall Base.
- 11. ASTM F2170 – Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs Using in situ Probes.
- 12. ASTM F3041 – Standard Specification for Bonded Rubber Crumb Floor Coverings.
- 13. NFPA 253 – Standard Method of Test for Critical Radiant Flux of Floor Covering Systems Using a Radiant Heat Energy Source.
- 14. NFPA 258 – Recommended Practice for Determining Smoke Generation of Solid Materials.

1.4 SUBMITTALS

- A. Submit under provisions of Division 01.
- B. Provide product data on specified products, describing physical and performance characteristics, sizes, patterns, and colors with the product and selected attributes clearly identified.
- C. Samples: The following physical sample requirements shall be waived if the products specified in Part 2 are submitted.
 - 1. Submit two samples, 6 inches by 12 inches in size, illustrating color and pattern for each flooring material specified.
 - 2. Submit two 4-inch long samples of wall base material of each color specified; include preformed or job-formed corners, as applicable.
- D. Submit manufacturer's installation instructions under provisions of Division 01.

1.5 QUALITY ASSURANCE

- A. Resilient flooring shall comply with the requirements of CBC Section 804.
- B. Concrete slabs to receive resilient flooring shall conform to applicable requirements of ASTM F710.
- C. Installer Qualifications: Installer to have at least three years' experience of installing flooring products in similar facilities.

1.6 SLIP RESISTANCE

- A. Resilient flooring shall be stable, firm, and slip resistant per CBC Section 11B-302.1. The static coefficient of friction (COF) shall not be less than 0.5 for level surfaces and 0.8 for ramps, per ASTM D2047.

1.7 JOB AND ENVIRONMENTAL CONDITIONS

- A. Store materials for three days prior to installation in area of installation to achieve temperature stability.
- B. Maintain ambient temperature required by adhesive manufacturer three days prior to, during and 24 hours after installation of materials.

1.8 OPERATION AND MAINTENANCE DATA

- A. Submit cleaning and maintenance data under provisions of Division 01.

- B. Include maintenance procedures, recommended maintenance materials, and suggested schedule for cleaning, sealing and re-finishing.

1.9 EXTRA MATERIALS

- A. Provide 40 square feet of flooring and 20 lineal feet of non-integral wall base of each material and color specified, under provisions of Division 01.

PART 2 PRODUCTS

2.1 MANUFACTURERS AND PRODUCTS, LUXURY VINYL TILE FLOORING

A. Acceptable Manufacturers:

1. Shaw Contract. Product: Abide #4107V.
2. Armstrong World Industries, Inc.
3. Mannington Commercial.
4. Tarkett, Inc.
5. Substitutions: Under provisions of Division 01.

B. Luxury Vinyl Tile Materials:

1. Heavy commercial luxury vinyl tile, ASTM F1700, Class III, Type B.
2. Size: 7 inches by 47 inches.
3. Overall Thickness: 0.098 inch.
4. Wear Layer Thickness: 0.020 inch.
5. Edge: Square.
6. Finish: ExoGuard+.
7. Slip Resistance: ASTM D2047, coefficient of friction exceeding 0.6.
8. Static Load Limit: 1500 psi per ASTM F970 (Modified).
9. Fire-Test-Response Characteristics:
 - a. Smoke Developed: 450 or less, ASTM E662.
 - b. Critical Radiant Flux Classification: Class 1, 0.45 watts per square centimeter or greater, ASTM E648.
10. Color and Pattern: As indicated on Drawings.
11. Adhesive: Water-resistant type, as recommended by flooring manufacturer for substrates indicated.

2.2 MANUFACTURERS AND PRODUCTS, RUBBER SPORTS FLOORING

A. Acceptable Manufacturers:

1. Mannington Commercial. Product: Reset sports flooring
2. Substitutions: Under provisions of Division 01.

B. Rubber Tile Materials:

1. Recycled rubber sports floor interlocking tiles, ASTM F3041 Class A, Type II.
2. Size: 24 inches by 24 inches.

3. Overall Thickness: 3/8 inch (9 mm).
4. Slip Resistance: ASTM D1028 (dry), coefficient of friction exceeding 0.5.
5. Static Load Limit: 400 psi with 0.005 inch residual indent per ASTM F970 (Modified).
6. Fire-Test-Response Characteristics:
 - a. Smoke Developed: 450 or less, ASTM E662.
 - b. Critical Radiant Flux Classification: Class 1, 0.45 watts per square centimeter or greater, ASTM E648.
7. Color and Pattern: As indicated on Drawings.

2.3 MANUFACTURERS AND PRODUCTS, RESILIENT WALL BASE

A. Acceptable Manufacturers:

1. Flexco.
2. Roppe Corporation.
3. Mannington Commercial.
4. Tarkett.
5. Substitutions: Under provisions of Division 01.

B. Wall Base Materials:

1. Wall Base: ASTM F1861, Type TS, (rubber, vulcanized, thermoset).
2. Style: Cove (base with toe), top set; or straight (flat or toeless), as indicated on Drawings.
3. Height: 4 inches, unless otherwise indicated.
4. Thickness: 1/8 inch, minimum.
5. Lengths: Coils in manufacturer's standard length.
6. Colors: As indicated on Drawings.

C. Wall Base Accessories:

1. Preformed end stops, and outside corners, of the same material, manufacturer, size, and color as wall base.
2. Adhesive: Water-based type, as recommended by base manufacturer for substrates indicated.

2.4 MANUFACTURERS AND PRODUCTS, ACCESSORIES

A. Subfloor Filler: Portland cement type at concrete substrate as recommended by flooring material manufacturer.

1. Acceptable Manufacturers and Products:

- a. UZIN products provided by UFLOOR Systems, Inc.
- b. Ardex Feather Finish.

B. Primers and Adhesives: Water-resistant type, as recommended by flooring and wall base manufacturers. Flooring adhesives shall be compatible for use over the vapor emission control system installed under Section 07 26 50.

C. Resilient Molding Accessories:

1. Molding Accessories: Rubber, unless otherwise indicated on Drawings. Provide where required or indicated.
 - a. Carpet edge or nosing.
 - b. Nosing for resilient flooring.
 - c. Transition strips.
 - d. Reducer strip for resilient flooring.
2. Acceptable Manufacturers:
 - a. Flexco.
 - b. Roppe Corporation.
 - c. Mannington Commercial.
 - d. Tarkett.
 - e. Substitutions: Under provisions of Division 01.
3. Colors: As selected by Architect.

D. Cleaners, Sealers, and Finishes: All cleaners, sealers, and finishes to be products of one manufacturer. Use products approved by flooring manufacturers in writing.

1. Products for Luxury Vinyl Tile Flooring:
 - a. Cleaner: Neutral detergent, Armstrong S-485 or accepted equal.
 - b. Floor Polish: Commercial floor polish, Armstrong S-480 or accepted equal.
2. Products for Rubber Sports Flooring:
 - a. As recommended by flooring manufacturer.
3. Substitutions: Under provisions of Division 01.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that surfaces are smooth and flat with maximum variation of 3/16 inch in 10 feet, and are ready to receive Work.
- B. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for concrete relative humidity and alkalinity range, installation tolerances, and other conditions affecting resilient flooring performance. Examine resilient flooring products for type, color, pattern, and potential defects.
- C. Contractor shall verify that concrete floors are dry and exhibit negative alkalinity, carbonization or dusting. The concrete relative humidity and alkalinity tests required in Section 07 26 50 shall be performed and documented prior to installation of resilient flooring.
- D. Install vapor emission control system per Section 07 26 50.
- E. Resilient flooring shall not be installed when the atmospheric relative humidity exceeds sixty percent. Contractor shall provide dehumidifiers as required to maintain sixty percent maximum atmospheric relative humidity for the duration of the resilient flooring installation.

F. Beginning of installation means acceptance of existing substrate and site conditions.

3.2 PREPARATION

- A. Prepare substrate in accordance with ASTM F710 and flooring manufacturer's recommendations.
- B. Remove sub-floor ridges and bumps. Fill low spots, cracks, joints, holes, and other defects with subfloor filler.
- C. Apply, trowel, and float filler to leave a smooth, flat, hard surface. Repair all floor irregularities.
- D. Fill or level cracks, holes and depressions 1/8 inch wide or wider, and protrusions more than 1/32 inch, unless more stringent requirements are required by manufacturer's written instructions.
- E. Prohibit traffic from area until filler is cured.
- F. Broom and vacuum clean substrates to be covered immediately before installing resilient flooring.
- G. When required by manufacturer, apply primer to concrete surfaces.

3.3 INSTALLATION

- A. General:
 - 1. Install all resilient flooring products and accessories under this Section in accordance with manufacturers' printed instructions.
 - 2. Terminate flooring at centerline of door openings where adjacent floor finish is dissimilar.
 - 3. Install edge strips at unprotected or exposed edges of flooring including terminations at thresholds and where flooring abuts a dissimilar finished floor material.
 - 4. Scribe flooring to walls, columns, cabinets, floor outlets, and other appurtenances to produce tight joints.
- B. Luxury Vinyl Tile Flooring:
 - 1. Straight lay planks starting from center of room.
 - 2. Lay out planks such that:
 - a. Width of planks at walls shall not be less than one half of full plank width.
 - b. Length of planks shall not be less than nine inches.
 - 3. Do not place cut edges against beveled edges.
 - 4. Adhere planks to substrate using a full spread of adhesive applied to substrate to produce a uniform installation without voids, joint deformation, telegraphing of adhesive spreader marks, and other surface imperfections.
- C. Rubber Sports Flooring:
 - 1. Install tiles per manufacturer's installation instructions.

D. Resilient Wall Base:

1. Install resilient wall base on entire wall perimeter including toe spaces and open ends of cabinets. Set all bases in adhesive as recommended by the manufacturer. All joints in bases, including those at any preformed corners, shall be plumb, flush, tight and inconspicuous. Seat top edge and back of base firmly against the wall.
2. Fit joints tight and vertical. Maintain minimum measurement of 18 inches between joints.
3. Corners and Ends:
 - a. At external corners, use preformed units. Install preformed corners before installing straight pieces.
 - b. Interior corners shall be mitered and tightly fitted. Use straight pieces of maximum lengths possible.
4. At exposed ends use preformed units.
5. Install base on solid backing. Bond tight to wall and floor surfaces.
6. Scribe and fit to door frames and other interruptions.
7. Do not stretch resilient base during installation.

- E. Resilient Molding Accessories: Butt to adjacent materials and tightly adhere to substrates throughout length of each piece. Install reducer strips at edges of floor covering that would otherwise be exposed.

3.4 CLEANING, SEALING, AND POLISHING

- A. Remove excess adhesive from floor, base, and wall surfaces without damage. Sweep and vacuum surfaces thoroughly.
- B. Clean, seal, and finish floor and wall base surfaces in accordance with manufacturer's written instructions.
1. Luxury Vinyl Tile Flooring:
 - a. Cleaning: Damp mop with dilute detergent solution, as recommended by flooring manufacturer.
 - b. Finish: Three coats of commercial polish, as recommended by flooring manufacturer.
 2. Rubber Sports Flooring: Clean, seal, and finish per flooring manufacturer's recommendations.
 3. Wall Base, Rubber: Clean by wiping with soft cloth dampened with warm water.

3.5 PROTECTION

- A. Comply with manufacturer's written instructions for protection of resilient flooring.
- B. Protect flooring from damage during construction operations for the remainder construction period. After allowing drying film to disappear, cover flooring until Project Completion.

END OF SECTION

SECTION 09 77 10
SANITARY WALL AND CEILING FINISHES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Fiberglass Reinforced Plastic Panels.
- B. Accessories.

1.2 RELATED SECTIONS

- A. Section 07 92 00 – Joint Sealants.
- B. Section 09 29 00 – Gypsum Board.
- C. Section 09 91 00 – Painting.

1.3 REFERENCES

- A. The publications listed below form a part of this Section to the extent referenced. The publications are referred to in the text by the basic designation only. Refer to Division 01 for definitions, acronyms, and abbreviations.
- B. Standards, manuals, and codes refer to the latest edition of such standards, manuals, and codes in effect as of the date of issue of this Project Manual, unless indicated otherwise in CBC Chapter 35 and CFC Chapter 80.
- C. Referenced Standards:
 - 1. ASTM D256 – Standard Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics.
 - 2. ASTM D570 – Standard Test Method for Water Absorption of Plastics.
 - 3. ASTM D638 – Standard Test Method for Tensile Properties of Plastics.
 - 4. ASTM D790 – Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
 - 5. ASTM D2583 – Standard Test Method for Indentation Hardness of Rigid Plastics by Means of a Barcol Impressor.
 - 6. ASTM D5319 – Standard Specification for Glass-Fiber Reinforced Polyester Wall and Ceiling Panels.
 - 7. ASTM E84 – Standard Test Method for Surface Burning Characteristics of Building Materials.

1.4 SUBMITTALS

- A. Submit under provisions of Division 01.
- B. Indicate on shop drawings, detail dimensions and trim and panel attachment details.
- C. Product Data: Submit product data for each product specified in this Section with the product and selected attributes clearly identified.

- D. Samples: Submit two samples, 6 inches x 6 inches in size, illustrating panel material, color, and finish.
 - 1. Physical sample requirements shall be waived if the product specified by manufacturer and product number is submitted.
- E. Submit manufacturer's installation and maintenance instructions.

1.5 WARRANTY

- A. Furnish one-year warranty against defects in material and workmanship.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Marlite. Product: Standard FRP.
- B. Panolam Industries International, Inc., Shelton, CT, 888-375-9255, www.panolam.com. Product: Classic Collection.
- C. Substitutions: Under provisions of Division 01.

2.2 MATERIALS

- A. Fiberglass Reinforced Plastic Panels (FRP): Surface texture and color as indicated on Drawings, four feet x nine feet x 3/32 inch. Class A Fire Rated; Flame Spread less than 25; Smoke Developed less than 450 per ASTM E84.
 - 1. Sheet size shall be one piece vertical orientation. "Piecing" of sheets to achieve full height finish will not be allowed.
- B. Accessories and Adhesives: Manufacturer's standard adhesive and aluminum joinery trim system that conceals each vertical joint and exposed edges. Trim color as selected by Architect.

PART 3 EXECUTION

3.1 PREPARATION

- A. All surfaces to receive FRP shall be properly prepared in strict accordance with manufacturer's specifications and as specified herein. Fill all pinholes, cracks and other surface imperfections with spackle and scrape off surface splatters and imperfections to leave substrate surfaces smooth and free of damage. Gypsum board surfaces scheduled to receive adhesive-applied panels shall be prime coat painted under provisions of Section 09 91 00 prior to installation of panels.
- B. All other trade work that penetrates substrate shall be completed before beginning FRP application.

3.2 APPLICATION

- A. Install FRP panels according to manufacturer's instructions. No horizontal seams will be permitted.

- B. FRP shall be installed with adhesive supplied by or recommended by the FRP manufacturer.
- C. Install trim in longest practicable lengths. "Piecing" of trim will not be allowed.
- D. Remove excessive adhesive from surfaces immediately.
- E. Ensure positive contact of FRP to adhesive material with all wall surfaces. Remove or replace damaged or improperly applied FRP.

3.3 CLEAN-UP

- A. Upon completion of the work of this Section, remove all surplus material, and debris from the premises.

END OF SECTION

SECTION 09 81 00
ACOUSTIC INSULATION

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Acoustic insulation in interior wall and ceiling construction.

1.2 RELATED SECTIONS

- A. Section 06 10 00 – Rough Carpentry.
- B. Section 07 21 00 – Thermal Insulation.
- C. Section 09 29 00 – Gypsum Board.

1.3 REFERENCES

- A. The publications listed below form a part of this Section to the extent referenced. The publications are referred to in the text by the basic designation only. Refer to Division 01 for definitions, acronyms, and abbreviations.
- B. Standards, manuals, and codes refer to the latest edition of such standards, manuals, and codes in effect as of the date of issue of this Project Manual, unless indicated otherwise in CBC Chapter 35 and CFC Chapter 80.
- C. Referenced Standards:
 - 1. ASTM C665 – Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing.
 - 2. ASTM E84 – Standard Test Method for Surface Burning Characteristics of Building Materials.
 - 3. UL 723 – Test for Surface Burning Characteristics of Building Materials.

1.4 SUBMITTALS

- A. Submit under provisions of Division 01.
- B. Product Data: Provide data on product characteristics, performance criteria and limitations.
- C. Manufacturer's Certificate: Certify that products meet or exceed California Quality Standards.

1.5 SYSTEM DESCRIPTION

- A. Materials of this Section: Provide continuity of acoustic barriers and separations at building interior elements.

1.6 COORDINATION

- A. Coordinate work with other trades under provisions of Division 01.

PART 2 PRODUCTS

2.1 GLASS FIBER BATT INSULATION

A. Acceptable Manufacturers:

1. Knauf Insulation, Shelbyville, IN; 317-398-4434, www.knaufusa.com. Product: EcoBatt.
2. Owens-Corning, Toledo, OH; 800-438-7465, www.owenscorning.com.
3. Certainteed Corp., Valley Forge, PA; 800-233-8990, www.certainteed.com.
4. Johns Manville, Denver, CO; 800-654-3103, www.specJM.com.
5. Thermafiber, Inc., Wabash, IN; 888-834-2371, www.thermafiber.com.
6. Substitutions: Under provisions of Division 01.

B. Batt Insulation: ASTM C665 Type I; preformed glass fiber batt; conforming to the following:

1. Facing: Acoustic insulation shall be unfaced.
2. Flame Spread and Smoke Density Properties: 25/450 maximum in accordance with 2022 CBC Section 720, California Referenced Standard Code Chapter 12-13, ASTM E84, and UL 723.
3. Provide formaldehyde-free thermal insulation products.
4. Recycled Content: Minimum twenty percent post-consumer.

PART 3 EXECUTION

3.1 EXAMINATION

- #### A. Verify existing site conditions.
- #### B. Verify that substrate, adjacent materials, and insulation are dry and ready to receive insulation.

3.2 INSTALLATION – BATT INSULATION

- #### A. Install insulation in accordance with insulation manufacturer's instructions and with the flame spread rating and smoke density requirements of CBC Section 720, ASTM E84, and UL 723.
- #### B. Install in interior walls and ceiling spaces, full width, depth, and height of cavity, without gaps or voids. Do not compress insulation.
- #### C. Trim insulation neatly to fit spaces. Insulate miscellaneous gaps and voids.
- #### D. Fit insulation tight in spaces and tight to exterior side of mechanical and electrical services within the plane of insulation.
- #### E. Securely fasten and anchor insulation in place to prevent displacement or sagging of material in all areas.
1. At wood stud walls, the insulation shall be wired in place with two #14 spring steel wires, one within 12 inches of the top and one at the mid-point of each stud bay.
 2. At wood joists, install insulation using wire and clips and anchor as recommended by manufacturer to securely hold insulation in place.

END OF SECTION

SECTION 09 84 33

ACOUSTICAL WALL AND CEILING TREATMENT

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Cementitious wood fiber plank acoustical wall panel system and installation accessories.

1.2 RELATED SECTIONS

- A. Section 09 29 00 – Gypsum Board.

1.3 REFERENCES

- A. The publications listed below form a part of this Section to the extent referenced. The publications are referred to in the text by the basic designation only. Refer to Division 01 for definitions, acronyms, and abbreviations.
- B. Standards, manuals, and codes refer to the latest edition of such standards, manuals, and codes in effect as of the date of issue of this Project Manual, unless indicated otherwise in CBC Chapter 35 and CFC Chapter 80.
- C. Referenced Standards:
 - 1. ASTM E84 Standard Test Method for Surface Burning Characteristics of Building Materials.
 - 2. Ceilings and Interior Systems Construction Association (CISCA) Code of Practices:

1.4 SUBMITTALS

- A. General: Submit listed submittals in accordance with Conditions of the Contract and Division 1 Submittal Procedures Section.
 - 1. Product Data: Submit manufacturer's product data and installation instructions.
 - 2. Recommended procedures for normal cleaning and removal of stains including precautions in use of cleaning materials that may be detrimental to surfaces.
- B. Samples: Submit selection and verification samples: 3 - 6 inch × 6 inch (152 × 152 mm) sample for each wall panel unit required, showing full range of exposed texture to be expected in completed work sample for each fabric color is available.
- C. Quality Assurance/Control Submittals: Submit the following:
 - 1. Certificates: Submit manufacturer's certificate that products meet or exceed specified requirements.

1.5 SYSTEM DESCRIPTION

- A. Performance Requirements:
 - 1. Provide acoustical wall panel assembly designed and tested to provide surface burning characteristics (ASTM E84) as follows:
 - a. Flamespread: 0.

- b. Smoke Developed: 0.
- 2. Provide acoustical wall panel system which has been manufactured, fabricated and installed to provide Noise Reduction Coefficient (NRC) rating.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: Utilize an installer having demonstrated experience on projects of similar size and complexity.
- B. Regulatory Requirements and Approvals: Comply with requirements below.
 - 1. State of California:
 - a. DSA Number PA-008.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. General: Comply with Division 1 Product Requirement Section.
- B. Storage and Protection: Store materials protected from exposure to harmful environmental conditions and at temperature and humidity conditions recommended by the manufacturer.
 - 1. Prevent soiling, physical damage or wetting.
 - 2. Store cartons open at each end to stabilize moisture content and temperature.

1.8 PROJECT/SITE CONDITIONS

- A. Environmental Requirements:
 - 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:
 - 4. Relative Humidity: 65 percent to 75 percent.
 - a. Uniform Temperature: 55 degrees F to 70 degrees F.

1.9 MAINTENANCE

- A. Extra Materials: Provide 10% additional material for use by owner in building maintenance and repair.
- B. Provide new unopened cartons of extra materials, packaged with protective covering for storage, identified with appropriate labels.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Basis of Design Manufacturer: Armstrong World Industries. Product: Tectum Standard Interior Wall and Ceiling Panels.
- B. Substitutions: Under provisions of Division 01.

2.2 ACOUSTICAL WALL PANEL AND CEILING PANEL SYSTEM

A. Acoustical wall and ceiling panel systems, with the following characteristics:

1. Material: Aspen wood fibers bonded with inorganic hydraulic cement.
2. Thickness: 1-1/2 inches.
3. Edge: Beveled at perimeter; Flush butt joints at adjoining panels.
4. Sizes: As indicated on Drawings.
5. Colors: As indicated on Drawings.

2.3 ACCESSORIES

A. Provide accessories as follows:

1. Tectum Painted Head Drywall Screws with plate washers:
 - a. Material: Steel.
 - b. Length: 3 inches.
 - c. Color: White.
2. Tectum Touch-Up Paint:
 - a. Colors: match panel colors.

PART 3 EXECUTION

3.1 MANUFACTURER'S INSTRUCTIONS

- A. Comply with the instructions and recommendations of the acoustical wall panel system manufacturer.
- B. Install materials in accordance with governing regulations, fire resistance rating requirements and industry standards applicable to work.
 1. Comply with CISCA Code of Practices.

3.2 EXAMINATION

A. Site Verification of Conditions:

1. Examine surfaces scheduled to receive attached acoustical units for unevenness, irregularities and dampness that would affect quality and execution of work.
2. Do not proceed with installation of wall panel system until unacceptable conditions are corrected.

3.3 INSTALLATION

- A. Install panels per manufacturer's installation instructions and as shown on Drawings.
- B. Screw head and plate washers shall be flush with panel surface.

3.4 CLEANING

- A. Clean exposed surfaces of acoustical panel, trim, moldings and suspension members to comply with manufacturer's instructions for cleaning.

- B. Touch up any minor finish damage.
- C. Remove and replace work that cannot be successfully cleaned and repaired to permanently eliminate evidence of damage.

3.5 PROTECTION

- A. Protect installed work from damage due to subsequent construction activity, including temperature and humidity limitations and dust control, so that the work will be without damage and deterioration at the time of acceptance by the Owner.

END OF SECTION

SECTION 09 91 00

PAINTING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Surface preparation.
- B. Painting schedules, including painting of exposed surfaces, interior and exterior, except as otherwise specified or indicated.

1.2 RELATED SECTIONS

- A. Section 05 50 00 – Metal Fabrications.
- B. Section 07 46 46 – Mineral-Fiber Cement Siding.
- C. Section 07 62 00 – Sheet Metal Flashing and Trim.
- D. Section 08 11 13 – Hollow Metal Doors and Frames.
- E. Section 08 31 00 – Access Doors and Panels.
- F. Section 09 24 00 – Portland Cement Plastering.
- G. Section 09 29 00 – Gypsum Board.
- H. Divisions 21 – 23 – Mechanical.
- I. Divisions 26 – 28 – Electrical.

1.3 REFERENCES

- A. The publications listed below form a part of this Section to the extent referenced. The publications are referred to in the text by the basic designation only. Refer to Division 01 for definitions, acronyms, and abbreviations.
- B. Standards, manuals, and codes refer to the latest edition of such standards, manuals, and codes in effect as of the date of issue of this Project Manual, unless indicated otherwise in CBC Chapter 35 and CFC Chapter 80.
- C. Referenced Standards, Manuals and Codes:
 - 1. ASTM D523 – Standard Test Method for Specular Gloss.
 - 2. The Master Painters Institute, MPI Gloss and Sheen Levels.

1.4 SUBMITTALS

- A. Submit product data under provisions of Division 01.
- B. Provide product data on all painting products and accessories.
- C. Submit four brush-out samples 8 inches by 10 inches in size illustrating color and gloss level selected for each surface finishing product scheduled.

- D. During the Contract Closeout period, provide two copies of coating maintenance manual including, but not limited to, location of manufacturer's paint store closest to the project site, area summary with finish schedule, area detail designating where each product, color, and finish was used, product data sheets and material safety data sheets for each product used, color formulations for each color used, cleaning instructions, touch-up procedures, and color samples of each color and finish used.

1.5 QUALITY ASSURANCE

- A. Product Manufacturer: Company specializing in manufacturing quality paint and finish products with sufficient documented experience.
- B. Applicator: Company specializing in commercial painting and finishing with sufficient documented experience.
- C. Gloss Levels: Per Master Painters Institute (MPI) gloss standards "MPI Gloss and Sheen Levels," measured in accordance with ASTM D523.

GLOSS LEVEL	DESCRIPTION	GLOSS AT 60 DEGREES ASTM D523	SHEEN AT 85 DEGREES ASTM D523
G1	A traditional matte finish – flat.	5 units, maximum	and 10 units, maximum
G2	A high side sheen flat - "a velvet-like" finish.	10 units, maximum	and 10 - 35 units
G3	A traditional "eggshell-like" finish.	10 - 25 units	and 10 - 35 units
G4	A "satin-like" finish.	20 - 35 units	and 35 units, minimum
G5	A traditional semi-gloss.	35 - 70 units	-
G6	A traditional gloss.	70 - 85 units	-
G7	A high gloss.	More than 85 units	-

1.6 REGULATORY REQUIREMENTS

- A. Conform to 2022 California Building Code for flame spread and smoke density requirements for finishes.
- B. Furnish certification that all paint coatings furnished for the location of the project comply with the EPA clean air act for permissible levels of volatile organic content for architectural coatings applied in California as designated by California Air Resources Board (CARB).

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to site in manufacturer's original unopened, labeled containers; inspect to verify acceptance.
- B. Store and protect products from abuse and contamination.
- C. Container labeling is to include manufacturer's name, type of paint, brand name, brand code, coverage, surface preparation, drying time, cleanup, color designation and instructions for mixing and reducing.
- D. Store paint materials at minimum ambient temperature of 50 degrees F and a maximum of 90 degrees F, in well-ventilated area, unless required otherwise by manufacturer's instructions.
- E. Take precautionary measures to prevent fire hazards and spontaneous combustion.

1.8 ENVIRONMENTAL REQUIREMENTS

- A. Provide continuous ventilation and heating facilities to maintain surface and ambient temperatures above 50 degrees F for 24 hours before, during and 48 hours after application of finishes, unless required otherwise by manufacturer's instructions.
- B. Do not apply exterior coatings during rain or snow, or when relative humidity is above fifty percent, unless required otherwise by manufacturer's instructions.
- C. Minimum Application Temperatures for Paints: 50 degrees F for interior work and exterior work, unless required otherwise by manufacturer's instructions.
- D. Provide lighting level of 80 foot candles measured mid-height at substrate surface.

1.9 EXTRA STOCK

- A. Provide a new and unopened one-gallon container of each type, color, and sheen to Owner.
- B. Label each container with color, in addition to the manufacturer's label.

PART 2 PRODUCTS

2.1 PAINT SYSTEMS, GENERAL

- A. Material Compatibility:
 - 1. Provide materials for use within each paint system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
 - 2. For each coat in a paint system, provide products recommended in writing by manufacturers of topcoat for use in paint system and on substrate indicated.

2.2 SUSTAINABLE DESIGN REQUIREMENTS

- A. VOC Content of Field-Applied Paints and Coatings: Provide products that comply with the SCAQMD rule 1113 limits for VOC content.

2.3 ACCEPTABLE MANUFACTURERS – PAINT

- A. Refer to Table at the end of this Section.
- B. Substitutions: Under provisions of Division 01.

2.4 ACCEPTABLE MANUFACTURERS – PRIMER SEALERS

- A. Refer to Table at the end of this Section.
- B. Substitutions: Under provisions of Division 01.

2.5 ACCEPTABLE MANUFACTURERS – STAIN AND CLEAR FINISHES

- A. Refer to Table at the end of this Section.
- B. Substitutions: Under provisions of Division 01.

2.6 MATERIALS

- A. All paint materials shall be provided from a single manufacturer unless noted otherwise in this Section.
- B. Coatings:
 - 1. Ready mixed. Process pigments to a soft paste consistency capable of being readily and uniformly dispersed to a homogeneous coating.
 - 2. Good flow and brushing properties; capable of drying or curing free of streaks or sags.
- C. All field-applied interior paints shall use zero VOC colorants.
- D. Accessory Materials: All other materials not specifically indicated but required to achieve the finishes specified, of commercial quality.

2.7 FINISHES

- A. Refer to schedule at end of Section for surface finish schedule. Refer to Drawings for color schedule.

PART 3 EXECUTION

3.1 INSPECTION

- A. Verify that surfaces are ready to receive work as instructed by the product manufacturer.
- B. Examine surfaces scheduled to be finished prior to commencement of work. Report any condition that may potentially affect proper application.
- C. Measure moisture content of surfaces using an electronic moisture meter. Do not apply finishes unless moisture content of surfaces are below the following maximums:
 - 1. Plaster and Gypsum Wallboard: 18 percent.
 - 2. Interior Located Wood: 15 percent.
- D. Beginning of application constitutes acceptance of existing surfaces.

3.2 PREPARATION

- A. Remove electrical plates, hardware, light fixture trim, and fittings prior to preparing surfaces for painting.
- B. Correct minor defects and clean surfaces that affect work of this Section.
- C. Seal marks that may bleed through surface finishes.
- D. Impervious Surfaces: Remove mildew by scrubbing with solution of tri-sodium phosphate and bleach. Rinse with clean water and allow surface to dry.
- E. Gypsum Board Surfaces: Latex fill minor defects. Spot-prime defects after repair.
- F. Galvanized Surfaces: Remove passivators, oil, grease, acid residue, and surface contamination; wash with solvent. Apply coat of etching primer, unless otherwise recommended by finish coating system manufacturer.

- G. Shop-Primed Steel Surfaces: Sand and scrape to remove loose primer and rust. Feather edges to make touch-up patches inconspicuous. Clean surfaces as recommended by primer manufacturer. Prime shop-primed steel items with steel primers specified in this Section.
- H. Interior Wood Items Scheduled to Receive Finish: Hand sandpaper and wipe off dust and grit prior to priming. Seal knots, pitch streaks and sappy sections with sealer. Fill nail holes and cracks after primer has dried; sand between coats.
 - 1. At woodwork with transparent finish, nail holes, cracks or defects shall be filled with wood filler tinted to match color of stain.

3.3 PROTECTION

- A. Protect elements surrounding the work of this Section from damage or disfiguration.
- B. Repair damage to other surfaces caused by work of this Section.
- C. Furnish drop cloths, shields and protective methods to prevent spray or droppings from disfiguring other surfaces.
- D. Remove empty paint containers from site.

3.4 APPLICATION

- A. Apply products in accordance with manufacturer's instructions.
 - 1. Paint mil thicknesses shall not be less than the minimums recommended by the paint manufacturers.
- B. Do not apply finishes to surfaces that are not dry.
- C. Apply each coat to uniform finish.
- D. Apply each coat of paint slightly darker than preceding coat unless otherwise approved.
- E. Sand lightly between coats to achieve required finish.
- F. Allow applied coat to dry before next coat is applied.
- G. All shop-primed items shall be fully re-primed in the field.
- H. Prime back surfaces of interior woodwork with primer paint.
- I. Where clear finishes are required, tint fillers to match wood. Work fillers into the grain before set. Wipe excess from surface.
- J. Prime back surfaces of interior woodwork scheduled to receive stain or varnish finish with gloss varnish.

3.5 FINISHING MECHANICAL AND ELECTRICAL EQUIPMENT

- A. See Divisions 21 – 23 and 26 – 28 for other items requiring painting.
- B. Paint interior surfaces of air ducts and convactor heating cabinets that are visible through grilles and louvers with one) coat of flat black paint, to limit of sight line. Paint dampers exposed behind grilles to match face panels. Paint all interior and exterior exposed ductwork and ductwork supports. Paint all conduit, pipes, and conduit/pipe supports in exposed interior and exterior locations.

- C. Reinstall electrical plates, hardware, light fixture trim, and fittings removed for surface preparation or painting.
- D. Do not paint factory-finished mechanical and electrical equipment.

3.6 CLEANING

- A. As Work proceeds, promptly remove paint where spilled, splashed, or spattered.
- B. During progress of Work, maintain premises free of unnecessary accumulation of tools, equipment, surplus materials and debris.
- C. Collect cotton waste, cloths, and material which may constitute a fire hazard, place in closed metal containers and remove from site daily.

3.7 PAINTING SCHEDULE – EXTERIOR SURFACES

- A. Ferrous Metal:
 - 1. 1st coat – Acrylic Flat Primer
 - 2. 2nd and 3rd coats – 100 percent Acrylic Low Sheen
- B. Ferrous Metal:
 - 1. 1st coat – Acrylic Flat Primer
 - 2. 2nd and 3rd coats – 100 percent Acrylic Semi-Gloss
- C. Ferrous and Galvanized Metal (Industrial) – For use at exterior metal architectural features/exposed structure:
 - 1. 1st coat – Epoxy Flat Primer
 - 2. 2nd and 3rd coats – Aliphatic Urethane Gloss Enamel
- D. Galvanized Metal and Aluminum:
 - 1. 1st coat – Etch Prep
 - 2. 2nd coat – Acrylic Flat Primer
 - 3. 3rd and 4th coats – 100 percent Acrylic Low Sheen
- E. Galvanized Metal and Aluminum:
 - 1. 1st coat – Etch Prep
 - 2. 2nd coat – Acrylic Flat Primer
 - 3. 3rd and 4th coats – 100 percent Acrylic Semi-Gloss
- F. Cement Plaster with Acrylic Finish Coat:
 - 1. 1st coat – Acrylic Flat Primer
 - 2. 2nd and 3rd coats – 100 percent Acrylic Elastomeric Flat
- G. Mineral-Fiber Cement Siding, Paneling, and Trim:
 - 1. 1st coat – Acrylic Flat Primer
 - 2. 2nd and 3rd coats – 100 percent Acrylic Satin

3.8 PAINTING SCHEDULE – INTERIOR SURFACES

A. Gypsum Board Gypsum Board Scheduled to Receive Texture:

1. 1st coat – PVA Flat Primer Sealer
2. Texture per Section 09 29 00
3. 2nd coat – PVA Flat Primer Sealer
4. 3rd and 4th coats – Acrylic Semi-Gloss Enamel

B. Gypsum Board Without Texture:

1. 1st coat – PVA Flat Primer Sealer
2. 2nd and 3rd coats – Acrylic Semi-Gloss Enamel

C. Gypsum Board Scheduled to Receive Texture:

1. 1st coat – PVA Flat Primer Sealer
2. Texture per Section 09 29 00
3. 2nd coat – PVA Flat Primer Sealer
4. 3rd and 4th coats – Acrylic Eggshell Enamel

D. Gypsum Board Without Texture:

1. 1st coat – PVA Flat Primer Sealer
2. 2nd and 3rd coats – Acrylic Eggshell Enamel

E. Wood (Opaque finish):

1. 1st coat – Acrylic Flat Primer
2. 2nd and 3rd coats – Acrylic Semi-Gloss Enamel

F. Wood (Transparent Finish):

1. 1st coat – Low VOC Alkyd Flat Stain
2. 2nd coat – Low VOC Alkyd Semi-Gloss Sanding Sealer
3. 3rd and 4th coats – Acrylic Satin Polyurethane Varnish or Acrylic Gloss Polyurethane Varnish

G. Ferrous Metal:

1. 1st coat – Acrylic Flat Primer
2. 2nd and 3rd coats – Acrylic Eggshell Enamel

H. Ferrous Metal:

1. 1st coat – Acrylic Flat Primer
2. 2nd and 3rd coats – Acrylic Semi-Gloss Enamel

I. Galvanized Metal, Zinc Alloy Metal, and Aluminum:

1. 1st coat – Etch Prep
2. 2nd coat – Acrylic Flat Primer
3. 3rd and 4th coats – Acrylic Eggshell Enamel

J. Galvanized Metal, Zinc Alloy Metal, and Aluminum:

1. 1st coat – Etch Prep
2. 2nd coat – Acrylic Flat Primer
3. 3rd and 4th coats – Acrylic Semi-Gloss Enamel

			MANUFACTURERS				
APPLICATION	TYPE	MPI Gloss Level	Dunn Edwards/US Coatings	PPG Paints	Sherwin Williams	Kelly Moore/Devoe	Benjamin Moore
PRIMERS							
Exterior Ferrous Metal	Acrylic	G1	BRPR00-1 or ENPR00	4020	B66W01310	6646	HP04
Exterior Ferrous and Galvanized Metal (Industrial)	Epoxy	G1	EG2300 EG2000 at ferrous.	Amerlock 2 VOC	B58W00620	Amerlock 2 VOC	Corotech V155
Exterior Galvanized Metal and Aluminum	Acrylic	G1	ULGM00	4020	B66W01310	6646	HP04
Exterior Cement Plaster System with Acrylic Finish Coat	Acrylic	G1	ESPR00	17-921XI	LX02WU050	250	608
Exterior Fiber-Reinforced Cement Siding, Panels, and Trim	Acrylic	G1	ESPR00	17-921XI	LX02WU050	247	608
Zero VOC Interior Gypsum Board and Wood	Acrylic	G1	VNSL00	9-900	B28 2600	971/973	N534
Interior Gypsum Board	PVA	G1	VNSL00	6-2	B28 2600	971	N534
Interior Wood	Acrylic	G1	DCPR00	17-921XI	B28W8111	973	027
Interior Ferrous Metal	Acrylic	G1	BRPR00	4020	B66W01251	6646	HP04
Interior Galvanized Metal and Aluminum	Acrylic	G1	UGPR00 or ULGM00	4020	B66W01251	6646	HP04
FINISHES							
Exterior Ferrous Metal and Galvanized Metal, Aluminum	100 percent Acrylic	G2	SSHL20	76-110XI	A75W51 Solo	1245	447
Exterior Ferrous Metal and Galvanized Metal, Aluminum	100 percent Acrylic	G5	SSHL50	78-811XI	A76W51 Solo	1250	448
Exterior Ferrous and Galvanized Metal (Industrial)	Aliphatic Urethane Enamel	G6	UG3010 VOC	Amershield VOC	Acrolon 100	Amershield VOC	Corotech V500
Exterior Cement Plaster with Acrylic Finish Coat	Acrylic Elastomeric	G1	EDLX10	4-110XI	A5W451	1122	359
Exterior Fiber-Reinforced Cement Siding, Panels, and Trim	100 percent Acrylic	G4	SSHL40	76-110XI	A-89-1100	1247	455
Zero VOC Interior Gypsum Board and Wood	100 percent Acrylic	G1	SZRO10	9-110XI	Solo A74	1600	536
Zero VOC Interior Gypsum Board and Wood	100 percent Acrylic	G3	SWLL30	9-310XI	Solo A75	1610	537
Zero VOC Interior Gypsum Board, Wood	100 percent Acrylic	G5	SWLL50	9-510XI	Solo A76	1650	539
Interior Gypsum Board, Wood	100 percent Acrylic	G3	SWLL30	589-10	Solo A75	1610	537
Interior Gypsum Board, Wood	100 percent Acrylic	G5	SWLL50	9-510XI	Solo A76	1650	539
Interior Ferrous Metal, Galvanized Metal, and Aluminum	100 percent High Performance Acrylic	G3	Sierra Performance MetalMax DTM Acrylic Enamel	90-474	B66W01251	2887	V342
Interior Ferrous Metal, Galvanized Metal, and Aluminum	100 percent High Performance Acrylic	G5	Sierra Performance MetalMax DTM Acrylic Enamel	4216	B66W01151	2888	V341
MISCELLANEOUS							

Interior Wood Stain	Low VOC Alkyd	G1	Old Masters W-B Stain	DEFT DFT300 Wood Stain	MinWax 250 Stain	Old Masters Water Based Stain	Lenmar WB Stain
Interior Wood Sanding Sealer	Low VOC Alkyd	G5	Old Masters W-B Sanding Sealer	DEFT DFT61 Sanding Sealer	Gemini Gem Coat 210-0022 Sanding Sealer	Old Masters Water-Based Sanding Sealer	Lenmar WB Stain
Interior Wood Varnish	Acrylic Urethane	G4	Old Masters W-B Poly	DEFT DFT159 Satin	A68F00090	Old Master Water-Based Polyurethane	W423
Interior Wood Varnish	Acrylic Urethane	G5	Old Masters W-B Poly	DEFT DFT158 Semi-Gloss	A68V00091	Old Master Water-Based Polyurethane	W423
Exterior Heavy Duty Cleaner	Water-Based	N/A	Krud Kutter Gloss-Off	Dura-Prep 88		Devprep 88	Corotech V600
Exterior and Interior Galvanized Metal Etch Prep.	N/A	N/A	Krud Kutter Metal Clean and Etch, Dissco Eco-Prime 100, or Jasco Prep & Prime				

END OF SECTION

SECTION 09 96 23
ANTI-GRAFFITI COATING

PART 1 GENERAL

1.1 SCOPE

- A. Work shall include furnishing and installing multi-coat anti-graffiti coating system on all manufactured stone masonry surfaces.

1.2 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 04 73 00 – Manufactured Stone Masonry.
- B. Section 07 19 19 – Water Repellents.

1.3 SUBMITTAL

- A. Contractor shall submit to Architect for his approval, manufacturer's data sheets for installation requirements, application procedures and coverage rates. Upon approval of the Architect, manufacturer's specifications do thereby become a part of this specification and shall be used as the basis for approval or rejection of work carried out in this Section.
- B. Prior to commencement of work, applicator shall provide to Contractor estimated quantities of each product required to perform the work outlined herein.
- C. Contractor shall provide documentation of quantities of each product obtained for the work performed. Such information shall be required prior to job acceptance and final payment.

1.4 QUALITY ASSURANCE

- A. Application shall be performed by an experienced and manufacturer-approved applicator in strict accordance with manufacturer's recommendations. At no time shall the number of coats and coverage rates be less than recommended in manufacturer's technical data sheets.
- B. Manufacturer shall be available to make recommendations specific to project, substrate coating appearance and cleaning options.

1.5 PRODUCT DELIVERY AND STORAGE

- A. Deliver to job site in manufacturer's container, with seals unbroken. Containers shall be properly labeled including the batch number and date of manufacture.
- B. Keep material protected from the elements and in original unopened containers to prevent contamination by foreign materials.

PART 2 PRODUCTS

2.1 MANUFACTURER

- A. Basis of Design: Rainguard. Product: Vandl-Guard System.
- B. Substitutions: Under provisions of Division 01.

2.2 MATERIALS

- A. This system requires the prior use of clear water repellent; see Section 07 19 19 for specified water repellent.
- B. Graffiti resistant coating: Rainguard Vandl-Guard System, including Vandl-Guard, a chemically resistant one part, water-based, cross linked co-polymer emulsion that dries to a clear, colorless film, and Vandl-Top, a sacrificial top coat, that will not increase flammability of the substrate or support the growth of mildew, bacteria or fungus.
- C. Rates of coverage and number of coats: Based on manufacturer's minimum coverage rates based on permeability and surface area as indicated on Drawings. For information contact manufacturer:

PART 3 EXECUTION

3.1 SURFACE PREPARATION

- A. Manufactured stone masonry shall be cured for a minimum of thirty (30) days. Moisture content shall be no higher than 15 percent as registered on an electronic moisture meter. Do not apply to surface below 45 degrees F or above 90 degrees F. Do not apply in the direct sun.
- B. Surfaces shall be structurally sound, dry, clean, and free of dust, dirt, grime, soils, scale, rust, silicones, curing compounds, alkali, acid residue, etc.

3.2 APPLICATION

- A. Follow manufacturer's current application instructions at all times. Allow coating to dry and become clear before applying subsequent coats. Achieve a uniform pinhole free, continuous film.

3.3 CLEANUP AND PROTECTION

- A. During process of work, remove discarded coating materials, rubbish, cans, and rags at end of each work day.
- B. Protect work of other trades, whether to be coated or not, against damage by coating and finish work. Correct any damage by cleaning, repairing or replacing, and recoating, as acceptable to Architect.

END OF SECTION

SECTION 10 14 00

SIGNAGE

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Exterior Signages:
 - 1. Accessibility Signage.
 - 2. Metal Dimensional Characters.
 - 3. Site Monument Sign.
 - 4. Project Identification Signs.
- B. Interior Signages:
 - 1. Accessibility Signage.
- C. Life Safety Signages.

1.2 RELATED SECTIONS

- A. Section 03 30 00 – Cast-In-Place Concrete.
- B. Section 08 14 00 – Wood Doors.
- C. Section 09 29 00 – Gypsum Board.

1.3 REFERENCES

- A. The publications listed below form a part of this Section to the extent referenced. The publications are referred to in the text by the basic designation only. Refer to Division 01 for definitions, acronyms, and abbreviations.
- B. Standards, manuals, and codes refer to the latest edition of such standards, manuals, and codes in effect as of the date of issue of this Project Manual, unless indicated otherwise in CBC Chapter 35 and CFC Chapter 80.
- C. Referenced Standards:
 - 1. ADA – Americans with Disabilities Act - 2010 Standards for Accessible Design.
 - 2. ASTM A53/A53M – Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
 - 3. ASTM A123/A123M – Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
 - 4. ASTM A283/A283M – Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates.
 - 5. ASTM A500/A500M – Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
 - 6. ASTM B26/B26M – Standard Specification for Aluminum-Alloy Sand Castings.

7. ASTM B209 – Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
8. ASTM E84 – Standard Test Method for Surface Burning Characteristics of Building Materials.
9. ASTM F593 – Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
10. AWS D1.1 – Structural Welding Code – Steel.
11. AWS D1.2 – Structural Welding Code – Aluminum.
12. 2022 California Building Code (CBC).
13. NFPA 80, 4.1.4 – Signage on Fire Doors.
14. NFPA 101 – Life Safety Code.
15. UL 924 – Emergency Lighting and Power Equipment.
16. UL Building Materials Directory.

1.4 SUBMITTALS

- A. General: Submit in accordance with Division 01.
- B. Shop Drawings: Submit shop drawing for each sign and plaque to show construction, sections, text, character spacing, fonts, colors, and mounting details.
- C. Product Data: Submit product data for each product specified in this Section with the product and selected attributes clearly identified.
- D. Samples: Submit one full-size physical sample of each of the following sign types:
 1. Acrylic functional room sign demonstrating font, color, symbols, and braille characters.
 2. Acrylic restroom sign demonstrating font, color, symbols, and braille characters.
 3. Dimensional metal character demonstrating material, font, size, and finish.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Firm specializing in manufacturing products specified in this Section with a minimum five years' experience.
- B. Regulatory Requirements:
 1. Accessibility Signage, General: Provide signage in accordance with California Code of Regulations, Title 24, Part 2, Chapter 11B, Sections 11B-216 and 11B-703, 2022 California Building Code.
 - a. Finish, Color, and Contrast: Characters, pictograms, symbols and their backgrounds shall have a non-glare finish. Characters shall contrast with their background with either light characters on a dark background or dark characters on a light background.
 - b. Depth: Raised characters shall be 1/32 inch minimum above their background.
 - c. Case:
 - 1) Raised Characters: Characters shall be uppercase.
 - 2) Visual Characters: Characters shall be uppercase or lowercase or a combination of both.

- d. Style: Characters shall be conventional in form. Characters shall not be italic, oblique, script, highly decorative, or of other unusual forms. Raised characters shall be sans serif.
- e. Proportions: Visual characters on signs shall be selected from fonts where the width of the uppercase letter "O" is 60 percent minimum and 110 percent maximum of the height of the uppercase letter "I". Stroke thickness of the uppercase letter "I" shall be 15 percent maximum of the height of the character.
- f. Character Height:
 - 1) Raised Characters: Character height measured vertically from the baseline of the character shall be 5/8 inch minimum and 2 inches maximum based on the height of the uppercase letter "I". Stroke thickness of tactile characters shall be 15 percent maximum of the height of the character.
 - 2) Visual Characters: Minimum character height shall comply with CBC Table 11B-703.5.5. Viewing distance shall be measured as the horizontal distance between the character and an obstruction preventing further approach towards the sign. Character height shall be based on the uppercase letter "I".
- g. Character Spacing:
 - 1) Raised Characters: Character spacing shall be measured between the two closest points of adjacent raised characters within a message, excluding word spaces. Where characters have rectangular cross sections, spacing between individual raised characters shall be 1/8 inch minimum and four times the raised character stroke width maximum, Where characters have other cross sections, spacing between individual raised characters shall be 1/16 inch minimum and four times the raised character stroke width maximum at the base of the cross sections, and 1/8 inch minimum and four times the raised character stroke width maximum at the top of the cross sections. Characters shall be separated from raised borders and decorative elements 3/8 inch minimum. Spacing between individual tactile characters shall comply with CBC Section 11B-703.2.7 and Section 11B-703.2.8.
 - 2) Visual Characters: Character spacing shall be measured between the two closest points of adjacent characters, excluding word spaces. Spacing between individual characters shall be 10 percent minimum and 35 percent maximum of character height.
- h. Line Spacing: Spacing between the baselines of separate lines of characters within a message shall be 135 percent minimum and 170 percent maximum of the character height.
- i. Format: Text shall be in horizontal format.
- j. Braille: Comply with CBC Section 11B-703.3, contracted Grade 2 Braille.
 - 1) Dimensions and Capitalization: Braille dots shall have a domed or rounded shape and shall comply with CBC Table 11B-703.3.1. The indication of an uppercase letter or letters shall only be used before the first word of sentences, proper nouns and names, individual letters of the alphabet, initials, and acronyms.

- 2) Position: Braille shall be positioned below the corresponding text in a horizontal format, centered under text. If text is multi-lined, Braille shall be placed below the entire text. Braille shall be separated 3/8 inch minimum and 1/2 inch maximum from any other tactile characters and 3/8 inch minimum from raised borders and decorative elements.
 - k. Pictograms: Comply with CBC Section 11B-703.6.
 - 1) Pictogram Field: Pictograms shall have a field height of six inches minimum. Characters and Braille shall not be located in the pictogram field.
 - 2) Text Descriptors; Pictograms shall have text descriptors located directly below the pictogram field. Text descriptors shall comply with CBC Sections 11B-703.2, 11B-703.3, and 11B-703.4.
 - l. Symbols of Accessibility: Symbols of accessibility shall comply with CBC Section 11B-703.7.
 - m. Edges and verticals on geometric symbols shall comply with CBC Section 11B-703.7.2.6.4.
2. Accessibility Signage:
- a. Tactile Exit Signage: CBC Chapter 10 "Means of Egress," Section 1013 "Exit Signs," Section 1013.1 "Where Required," and Section 1013.4 "Raised Character and Braille Exit Signs".
 - 1) Tactile signs required by CBC Section 1013.4 need not be provided with illumination per Section 1013.3.
 - b. Other Accessible Signage: CBC Chapter 11B, "Accessibility to Public Buildings, Public Accommodations, Commercial Buildings and Public Housing."
 - 1) Toilet Room and Bathing Room Signage: CBC Section 11B-216.8, "Toilet Rooms and Bathing Rooms" and CBC Section 11B-703.7.2.6, "Toilet and Bathing Facilities Geometric Symbols".
 - 2) Detailed Requirements for Accessible Signage: CBC Chapter 11B, Division 7, Section 11B-703, "Signs".
 - a) Sign Mounting Heights and Locations: CBC Sections 11B-703.4, 11B-703.5.6, and 11B-703.7.2.6.
 - b) Symbols of Accessibility: CBC Section 11B-703.7, "Symbols of Accessibility".
 - c) International Symbol of Accessibility: CBC Section 11B-703.7.2.1, "International Symbol of Accessibility".
 - 3) Site Accessibility Signage: CBC Sections 11B-216, "Signs", 11B-502.6, "Identification", 11B-502.8, "Additional Signs", and 11B-703, "Signs".
 - 4) Accessible Parking Signage: CBC Section 11B-502.6 "Identification".
 - 5) Post or Pylon Mounted Signs: CBC Section 11B-307.3 "Post-Mounted Objects".
 - c. Field Inspection: Signs and identification shall be field inspected after installation and approved by the enforcing agency, in accordance with CBC Section 11B-703.1.1, "Plan Review and Inspection".

3. Exit Signage: Provide signage in accordance with California Code of Regulations, Title 24, Part 2, 2022 California Building Code, Chapter 10 "Means of Egress", Section 1013 "Exit Signs", as applicable to Occupancy Group.
 - a. Illuminated Exit Signs: CBC Section 1013.1 "Where Required", Section 1013.3 "Illumination", Section 1013.5 "Internally Illuminated Exit Signs", and Section 1013.6 "Externally Illuminated Exit Signs".
 - b. Floor Exit Signs (SFM Requirement): CBC Section 1013.7 "Floor-Level Exit Signs".
4. Wind Load Requirements: Exterior signages shall be designed to resist wind loads in accordance with CBC.

C. Pre-Installation Meetings:

1. Conduct pre-installation meeting in accordance with provisions of Division 01.
2. Convene pre-installation meeting one week prior to commencing work of this Section.
3. Coordinate work in this Section with work in related Sections.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Comply with requirements of Division 01.
- B. Deliver products in manufacturer's original containers, dry and undamaged, with seals and labels intact.
- C. Storage and Protection: Store materials in a dry secure place. Protect from weather, surface contaminants, corrosion, construction traffic, and other potential damage.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers:

1. WeidnerCA, Sacramento, CA; 916-452-8000, URL: www.weidnerca.com.
2. ASI-Modulux, Dallas, TX; 800-274-7732, URL: www.asisignage.com.
3. In Pro Corporation, Muskego, WI; 800-222-5556, URL: www.inprocorp.com.
4. Mohawk Sign Systems, Inc., Schenectady, NY; 518-842-5303, URL: www.mohawksign.com.
5. APCO, Atlanta, GA; 404-688-9000, URL: www.apcosigns.com.
6. Diverse ID, Tampa, FL; 877-446-2374, URL: www.diverseid.com.

B. Substitutions: Under provisions of Division 01.

2.2 MATERIALS

- A. Acrylic Plastic: Non-glare finish acrylic with integral color as manufactured by Romark, Rohm and Haas, CYRO Industries Acrylite FF, or accepted equal. Thickness shall be 1/4 inch at door mounted geometric symbols and 1/8 inch minimum at all other locations, unless noted otherwise. Colors as selected by Architect from manufacturer's full range of colors.

- B. Aluminum: ASTM B209 for sheet or plate and ASTM B26/B26M for castings. Aluminum extrusions shall be 1/8 inch thick minimum. Wall and post mounted panels shall be 0.080 inch thick minimum. Aluminum panels shall have a non-glare acrylic polyurethane paint finish.
- C. Steel Posts: ASTM A53/A53M, Type E or S, Grade B; galvanized 1-1/2 inch nominal pipe size (NPS), Schedule 40. Provide 1/8 inch thick steel cap (ASTM A283/A283M) welded to top of post. Galvanize post and cap to minimum G50 in accordance with ASTM A123/A123M.
- D. Vinyl Sheet for Graphics: Precision cut; five year to seven year premium type; shall be in accordance with flammability requirements of ASTM E84; minimum 0.003 inch film thickness. Film shall include a precoated pressure sensitive adhesive backing or positionable pressure sensitive backing. Film shall be 3M Scotchcal, Orafol Oracal 651 Intermediate Calendered Film, or accepted equal. Vinyl graphics shall be acceptable for use in exterior locations. Colors as selected by Architect.
- E. Anchors and Fasteners: Stainless steel conforming to ASTM F593.

2.3 EXTERIOR SIGNAGE

- A. Accessible Signage: Provide the following signages in accordance with 2010 ADA Standards for Accessible Design and 2022 CBC where indicated on the Drawings.
 - 1. Entrance to Parking Lot Sign: 17 inches wide by 22 inches high (minimum) metal panel, reflectorized sign mounted on a single post with text "UNAUTHORIZED VEHICLES PARKED IN DESIGNATED ACCESSIBLE SPACES NOT DISPLAYING DISTINGUISHING PLACARDS OR SPECIAL LICENSE PLATES ISSUED FOR PERSONS WITH DISABILITIES WILL BE TOWED AWAY AT OWNERS EXPENSE. TOWED VEHICLES MAY BE RECLAIMED AT _____ OR BY TELEPHONING _____."
 - a. Blank Space Text: Coordinate text requirement for blank spaces with Owner.
 - 2. Accessible Parking Stall Sign: Provide a 12 inch wide by 18 inch high metal panel, reflectorized International Symbol of Accessibility sign, mounted on a single post, at every accessible parking stall indicated on the Drawings. Text shall occur below the symbol and read "PARKING ONLY".
 - 3. Van Accessible Parking Stall Sign: Provide a 12 inches wide by 18 inches high metal panel, reflectorized International Symbol of Accessibility sign, mounted on a single post for each van accessible parking stall as indicated on the Drawings. Text shall occur below the symbol and read "PARKING ONLY". Mounted on the same post, below this sign, a sign of the same width and required height shall display the text "VAN ACCESSIBLE". Refer to Drawings for additional sign information.
 - 4. Sign for Parking Violation Fine: An additional sign or additional language below the symbol of accessibility shall state "Minimum Fine \$250".
- B. Exterior Metal Dimensional Characters:
 - 1. Manufacturers:
 - a. Vomar.
 - b. Gemini Sign Letters.
 - c. Or accepted equal.

2. Material: ASTM B26/B26M #514 alloy cast aluminum.
3. Size: As indicated on Drawings.
4. Font: Helvetica Medium, all capital letters, 1-1/2 inches thick, 5/8 inch thick strokes.
5. Characters Required: Refer to Drawings. Where indicated on Drawings, characters shall be backlit.
6. Finish: Class I clear, anodized finish or factory paint finish in color selected by Architect.

C. Site Monument Sign:

1. Refer to Drawings for materials, size, configuration, and finishes.
 - a. Refer to Section 03 30 00 for cast-in-place concrete work.
 - b. Refer to Section 04 22 00 for concrete unit masonry work.
 - c. Refer to Section 04 73 00 for manufactured stone masonry work.
 - d. Refer to Division 26 for electrical work.

D. Project Identification Signs:

1. One painted sign, 32 square foot area, bottom six feet above ground.
2. Content:
 - a. Project title and name of Owner as indicated on Contract Documents.
 - b. Names and titles of authorities.
 - c. Names and titles of Architect and Consultants.
 - d. Name of Prime Contractor and major Subcontractors.
3. Graphic Design, Colors, Style of Lettering: Designated by Architect.
4. Design sign and structure to withstand sixty miles per hour wind velocity.
5. Finishes, Painting: Adequate to withstand weathering, fading, and chipping for duration of construction.
6. Show content, layout, lettering, color, structure, sizes, and grades of members.
7. Sign Materials:
 - a. Structure and Framing: Wood or metal, structurally adequate.
 - b. Sign Surfaces: Exterior grade plywood with medium density overlay, minimum 3/4 inch thick, standard large sizes to minimize joints.
 - c. Rough Hardware: Galvanized.
 - d. Paint and Primers: Exterior quality, one prime coat and two finish coats; sign background color as selected by Architect.
 - e. Lettering: Exterior quality paint or pre-cut vinyl self-adhesive products, colors as selected by Architect.

2.4 INTERIOR SIGNAGE

- A. Accessible Signage: Provide the following signages in accordance with 2010 ADA Standards for Accessible Design and 2022 CBC where indicated on Drawings:
1. Material: Acrylic plastic, edges rounded, chamfered, or eased. Corners shall have minimum radius of 1/8 inch.

2. Color: Characters, symbols, and pictograms on contrasting background per CBC Section 11B-703. Colors as selected by Architect from manufacturer's full range of colors.
3. Restroom Signage:
 - a. Unisex Restroom Symbol (door mounted): Provide for each unisex restroom door a circle, 1/4 inch thick and 12 inches in diameter with a 1/4 inch thick equilateral triangle with a vertex pointing upward superimposed on the circle and within the 12 inch diameter. The triangle symbol shall contrast with the circle, either light on a dark background or dark on a light background. The circle symbol shall contrast with the door color, either light on a dark background or dark on a light background.
 - b. Unisex Restroom Sign (wall mounted): Provide for each unisex restroom a 6 inch wide by 10 inch high acrylic plaque, with an international symbol of accessibility centered at the top of the sign; 1 inch high by 1/32 inch raised text below to read "RESTROOM"; with corresponding contracted Grade 2 Braille 3/8 inch minimum to 1/2 inch maximum below text.
4. Functional Room Signage: Provide room signage with inlaid characters raised 1/32-inch, upper case, sans serif type with corresponding contracted Grade 2 Braille. Raised characters shall be at least 5/8 inch high, but no higher than 2 inches. Characters and symbols shall contrast with their background per CBC Section 11B-703.
5. Tactile Exit Signage:
 - a. Provide tactile exit signs at doors in rooms or areas that require more than one exit or exit access per CBC Sections 1013.1 and 1013.4.
 - b. Acrylic plaque tactile exit signs shall have text at least 5/8 inch high, but no higher than 2 inch high, and corresponding contracted Grade 2 Braille shall be placed a minimum of 3/8 inch and a maximum of 1/2 inch directly below the text as follows:
 - 1) Each grade-level exterior exit door that is required to comply with CBC Section 1013.1 shall be identified by a tactile exit sign with the word "EXIT".
 - 2) Each exit door that is required to comply with CBC Section 1013.1, and that leads directly to a grade-level exterior exit by means of a stairway or ramp shall be identified by a tactile exit sign with the following words as appropriate: "EXIT STAIR DOWN", "EXIT RAMP DOWN," "EXIT STAIR UP," or "EXIT RAMP UP." At exit discharge level, door sign shall include a raised five-pointed star located to the left of the identifying floor level.
 - 3) Each exit door that is required to comply with CBC Section 1013.1, and that leads directly to a grade-level exterior exit by means of an exit enclosure or an exit passageway shall be identified by a tactile exit sign with the words "EXIT ROUTE".
 - 4) Each exit access door from an interior room or area to a corridor or hallway that is required to comply with CBC Section 1013.1 shall be identified by a tactile exit sign with the words "EXIT ROUTE".
 - 5) Each exit door through a horizontal exit that is required to comply with CBC Section 1013.1 shall be identified by a tactile exit sign with the words "TO EXIT".

2.5 LIFE SAFETY SIGNAGE

- A. Exit Signs: Internally illuminated exit signs conforming to NFPA 101, Section 7.10.7; UL listed in accordance with UL 924, with wording in legible characters not less than 4 inch high and text "EXIT".

2.6 FABRICATION

- A. Work shall be assembled in the shop, as far as practical, ready for installation at the site. Work that cannot be shop assembled be trial fit in the shop to ensure proper field assembly.
- B. Drill or punch holes for bolts and screws; produce clean, true lines and surfaces.
- C. Acrylic signs shall have inlaid acrylic copy/characters and Braille symbols as described in this Section.
- D. Aluminum welding shall be in accordance with AWS D1.2. Steel welding shall be in accordance with AWS D1.1. Welding shall be continuous along the entire area of contact. Grind smooth exposed welds.
- E. Galvanized items shall be hot-dip process after fabrication if practical in accordance with ASTM A123/A123M.
- F. Exposed work surfaces shall have a smooth finish and exposed riveting shall be flush. Fastenings shall be concealed where practical.
- G. Joints exposed to the weather shall be formed to exclude water. Provide drainage and weep holes to prevent condensation buildup.

2.7 SHOP FINISHING

- A. Surfaces of miscellaneous metal work, except nonferrous metal, corrosion resisting steel, and zinc-coated work, shall be given one coat of zinc-molybdate primer or an accepted rust-resisting treatment and metallic primer in accordance with manufacturer's standard practice.
- B. Surfaces to be embedded in concrete shall not be painted.
- C. Upon completion of work, damaged surfaces shall be recoated.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install signs and plaques level and plumb.
- B. Mount sign posts directly into concrete foundation. Mount sign to post using tamper resistant mechanical fasteners as recommended by manufacturer and accepted by the Architect.
- C. Accessible Sign Mounting Heights and Locations:
 - 1. Site Signage:
 - a. Parking Signage: Per CBC Section 11B-502.6, signs not located within a circulation path shall be 60 inches minimum above the finish floor or ground surface measured to the bottom of the sign.
 - 2. Mounting Height With Tactile Characters: Per CBC Section 11B-703.4.1, tactile characters on signs shall be located 48 inches minimum above the finished floor or ground surface, measured from the baseline of the lowest Braille cells and 60 inches maximum above the finished floor or ground surface, measured from the baseline of the highest line of raised characters.

3. Mounting Location with Tactile Characters: Per CBC Section 11B-703.4.2 as follows:
 - a. Where a tactile sign is provided at a door, the sign shall be located alongside the door at the latch side.
 - b. Where a tactile sign is provided at double doors with one active leaf, the sign shall be located on the inactive leaf.
 - c. Where a tactile sign is provided at double doors with two active leafs, the sign shall be located to the right of the right hand door.
 - d. Where there is no space at the latch side of a single door or at the right side of double doors, signs shall be located on the nearest adjacent wall.
 - e. Signs containing tactile characters shall be located so that a clear floor space of 18 inches minimum by 18 inches minimum, centered on the tactile characters, is provided beyond the arc of any door swing between the closed position and 45 degree open position.
 - f. Where permanent identification signage is provided for rooms and spaces, they shall be located on the approach side of the door as one enters the room or space. Signs that identify exits shall be located on the approach side of the door as one exits the room or space.
 4. Mounting Height With Visual Characters: Per CBC Section 11B-703.5.6, visual characters shall be 40 inches minimum above the finished floor or ground.
 5. Toilet and Bathing Facility Signage: Per CBC Section 11B-703.7.2.6, the geometric door symbol shall be mounted at 58 inches minimum and 60 inches maximum above the finished floor or ground surface measured from the centerline of the symbol. The symbol shall be mounted within 1 inch of the vertical centerline of the door.
- D. Metal Dimensional Characters: Mount to substrate with metal studs threaded into sign and silicone adhesive into metal wall receivers.
- E. Project Identification Signs:
1. Install project identification sign within fifteen days after date fixed by Notice to Proceed.
 2. Erect at designated location.
 3. Erect supports and framing on secure foundation, rigidly braced and framed to resist wind loadings.
 4. Install sign surface plumb and level, with butt joints. Anchor securely.
 5. Paint exposed surfaces of sign, supports, and framing.
 6. Maintenance: Maintain signs and supports clean, repair deterioration and damage.
 7. Removal: Remove signs, framing, supports, and foundations at completion of Project and restore area.
- F. Site Monument Sign: Construct sign as indicated on Drawings. Make electrical connections to internal lighting fixtures.
- G. Exterior Signs: Mount to exterior door and wall surfaces using tamper proof stainless steel mechanical fasteners suitable for the mounting substrate as recommended by the manufacturer and accepted by the Architect.
1. Glass Mounted Signs: Apply acrylic sign to exterior glass surfaces using double faced adhesive foam tape strips. Install same size, thickness, and color acrylic blank backer or sign of equal size on opposite side of exterior sign using double faced adhesive foam

tape strips.

- H. Interior Restroom Signs, Functional Room Signs, and Tactile Exit Signs: Mount to door and wall surfaces with double faced adhesive foam tape strips and silicone adhesive.
 - 1. Glass Mounted Signs: Apply acrylic sign to glass surfaces using double faced adhesive foam tape strips. Install same size, thickness, and color acrylic blank backer or sign of equal size on opposite side of exterior sign using double faced adhesive foam tape strips.
- I. Vinyl Door Graphics: Install on exterior Fire Riser Room and Electrical Room doors per manufacturer's recommendations.

3.2 ADJUST AND CLEAN

- A. Clean and Touch-up: Remove all packing and protection blemishes and thoroughly clean and polish all finish surfaces. Restore any marred or abraded surfaces to their original condition by touching up in accordance with the manufacturer's recommendations. Touch-up shall not be obvious.
- B. Defective Work: Remove and replace all defective work that cannot be properly repaired, cleaned or touched-up, as directed by the Architect, with no additional cost to the Owner.
- C. Protect installed work during the construction period to prevent abuse and damage.

3.3 CLEAN-UP

- A. Upon completion of the work of this Section, remove all surplus materials, rubbish and debris from the premises.

END OF SECTION

SECTION 10 28 13
TOILET ACCESSORIES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Toilet accessories.
- B. Attachment hardware.

1.2 RELATED SECTIONS

- A. Section 06 10 00 – Rough Carpentry.
- B. Section 09 29 00 – Gypsum Board.
- C. Section 09 30 00 – Tiling.
- D. Section 09 77 10 – Sanitary Wall and Ceiling Finishes.

1.3 REFERENCES

- A. The publications listed below form a part of this Section to the extent referenced. The publications are referred to in the text by the basic designation only. Refer to Division 01 for definitions, acronyms, and abbreviations.
- B. Standards, manuals, and codes refer to the latest edition of such standards, manuals, and codes in effect as of the date of issue of this Project Manual, unless indicated otherwise in CBC Chapter 35 and CFC Chapter 80.
- C. Referenced Standards:
 - 1. ASTM A167 – Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet and Strip.
 - 2. ASTM A269 – Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service.

1.4 SUBMITTALS

- A. Submit under provisions of Division 01.
- B. Product Data: Submit data on accessories describing size, finish, details of function, attachment methods.
- C. Manufacturer's Installation Instructions: Submit installation instructions, special procedures, and conditions requiring special attention.

1.5 KEYING

- A. Master key all accessories.

1.6 REGULATORY REQUIREMENTS

- A. Conform to applicable code for installing work in conformance with Title 24 Accessibility Requirements.
 - 1. Toilet accessories required to be accessible shall be mounted at heights according to CBC Section 11B-603.5.
 - 2. Toilet accessories shall not be located closer than 1-1/2 inches clear of the bottom and ends of the grab bar and 12 inches clear of the top of the grab bar per CBC Section 11B-609.3.
 - 3. Toilet tissue dispensers shall be continuous flow type per CBC Section 11B-604.7.

1.7 SEQUENCING AND SCHEDULING

- A. Coordinate the work of this Section with the placement of internal wall reinforcement and reinforcement of toilet partitions to receive anchor attachments.

1.8 WARRANTY

- A. Manufacturer's standard one year warranty for materials and workmanship.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Bobrick.
- B. American Specialties, Inc.
- C. Bradley.
- D. Substitutions: Under provisions of Division 01.

2.2 MATERIALS

- A. Stainless Steel Sheet: ASTM A167, Type 304.
- B. Tubing: ASTM A269, stainless steel.
- C. Fasteners, Screws, and Bolts: Hot dip galvanized, tamperproof.
- D. Expansion Shields: Fiber, lead, or rubber as recommended by accessory manufacturer for component and substrate.

2.3 FABRICATION

- A. Weld and grind smooth joints of fabricated components.
- B. Form exposed surfaces from single sheet of stock, free of joints.
- C. Form surfaces flat without distortion. Maintain flat surfaces without scratches or dents.
- D. Back paint components where contact is made with building finishes to prevent electrolysis.
- E. Shop assemble components and package complete with anchors and fittings.

F. Provide steel anchor plates, adapters, and anchor components for installation.

G. Hot dip galvanize exposed and painted ferrous metal and fastening devices.

2.4 FACTORY FINISHING

A. Stainless Steel: No. 4 satin luster finish.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that site conditions are ready to receive work and dimensions are as instructed by the manufacturer.

B. Beginning of installation means acceptance of existing conditions.

3.2 PREPARATION

A. Deliver inserts and rough-in frames to site at appropriate time for building-in.

B. Provide templates and rough-in measurements as required.

C. Verify exact location of accessories for installation.

3.3 INSTALLATION

A. Install fixtures, accessories and items in accordance with manufacturers' instructions.

B. Install all items plumb and level.

C. Secure all items rigidly in place. Anchor to structure with anchors appropriate for use with type of adjacent construction. Fasteners shall securely fasten items to wall construction involved. Fasteners shall provide stiffness and rigidity to keep items square, in accurate position without twisting, buckling or warping. Fasteners to framing substrate shall be the following minimums; greater as required by the toilet accessory manufacturer or as conditions warrant:

1. Wood Framing: #12 corrosion resistant pan head wood screws with 1-1/2 inches minimum embed into backing.

3.4 SCHEDULE

A. Bobrick Washroom Equipment model numbers indicated below are listed to establish a quality standard.

<u>Item</u>	<u>Bobrick #</u>	<u>Mounting</u>	<u>Symbol</u>
Toilet Tissue Dispenser	B-667	Recessed	TTD
Grab Bars	B-6206 Series	Surface	GB
Soap Dispenser, Wall Mounted	B-150	Wall	SD
Paper Towel Dispenser and Receptacle	B-38034	Recessed	PTD
Toilet Seat Cover Dispenser	B-221	Surface	TSCD

Mop and Broom Holder 36 inches long, 6 holders	B-224	Surface	-----
Coat Hook	B-982	Surface	-----
Shelf	B-676	Surface	-----
Towel Bar, 24 inch	B-673	Surface	-----
Shower Curtain Rod	B-207	Surface	-----

END OF SECTION

SECTION 10 44 00
FIRE PROTECTION SPECIALTIES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Fire extinguishers.
- B. Cabinets.
- C. Accessories.

1.2 RELATED SECTIONS

- A. Section 06 10 00 – Rough Carpentry: Blocking/backing for attachment.
- B. Section 09 29 00 – Gypsum Board.

1.3 REFERENCES

- A. The publications listed below form a part of this Section to the extent referenced. The publications are referred to in the text by the basic designation only. Refer to Division 01 for definitions, acronyms, and abbreviations.
- B. Standards, manuals, and codes refer to the latest edition of such standards, manuals, and codes in effect as of the date of issue of this Project Manual, unless indicated otherwise in CBC Chapter 35 and CFC Chapter 80.
- C. Referenced Standards:
 - 1. California Fire Code (CFC) – Section 906, Portable Fire Extinguishers.
 - 2. California Code of Regulations (CCR), Title 19, Division 1, Chapter 3, Fire Extinguishers.
 - 3. UL 299 – Dry Chemical Fire Extinguishers.

1.4 SUBMITTALS

- A. Submit under provisions of Division 01.
- B. Shop Drawings: Indicate cabinet physical dimensions, rough-in measurements for recessed cabinets, and locations.
- C. Product Data: Provide extinguisher operational features, color and finish, and anchorage details.
- D. Manufacturer's Installation Instructions: Indicate special criteria and wall opening coordination requirements.
- E. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

1.5 OPERATION AND MAINTENANCE DATA

- A. Maintenance Data: Include test, refill or recharge schedules and re-certification requirements.

1.6 REGULATORY REQUIREMENTS

- A. Conform to CFC Section 906 and CCR Title 19 for requirements for extinguishers.
- B. Location and Operation: Fire extinguishers and fire extinguisher cabinets shall conform to CBC Sections 11B-307, 11B-308, 11B-309, and 11B-403.

1.7 WARRANTIES

- A. Fire Extinguishers: Fire extinguishers shall be free from defects in material and workmanship under conditions of normal use for a period of six years from date of shipment.
 - 1. Carbon dioxide and water/water-based fire extinguishers shall be free from defects in material and workmanship under conditions of normal use for a period of five years from date of shipment.
- B. Fire Extinguisher Cabinets: Fire extinguisher cabinets shall be free from defects in material and workmanship under conditions of normal use for a period of one year from date of shipment.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Acceptable Manufacturers and Products:
 - 1. J.L. Industries, Inc., Bloomington, MN; 800.554.6077; www.activarcpg.com/jl-industries. Products:
 - a. Fire Extinguishers:
 - 1) Cosmic Series, Model No. 5E.
 - b. Cabinets:
 - 1) Non-Rated: Ambassador Series, Model No. 1817W10.
 - 2) Fire-Rated: Ambassador Series, Model No. 1817W10FX2.
 - c. Fire Extinguisher Wall Brackets: Model No. MB818C.
 - 2. Larsen's Manufacturing Co., Minneapolis, MN; 763.571.1181; www.larsensmfg.com .
 - 3. Potter-Roemer, Santa Ana, CA; 800.366.3473; www.potterroemer.com .
- B. Substitutions: Under provisions of Division 01.

2.2 EXTINGUISHERS

- A. Dry Chemical Type, UL 299, five pound capacity, enameled steel tank, with pressure gauge; minimum 3A-40B:C Rating.

2.3 CABINETS

- A. Door and Trim Construction: 18 gauge cold rolled steel. Cabinet doors shall be flush and have a 5/8 inch door stop. Frame trim shall be 1-3/4 inches wide and door trim shall be 1-1/4 inches wide on doors with glazing.
- B. Trim Style and Depth: Semi-recessed with 3 inch rolled edge.
- C. Tub: 18 gauge cold rolled steel.

- D. Door Glazing: 1/8 inch thick clear acrylic.
- E. Hardware: Continuous hinge, zinc-plated handle above Saf-T-Lok, and roller catch. Handle shall be in compliance with CBC Section 11B-309.4 and shall not require more than five pounds force to operate.
- F. Mounting Fasteners: Appropriate to cabinet and mounting substrate material.

2.4 FABRICATION

- A. Form cabinet enclosure with right angle inside corners and seams. Form perimeter trim and door stiles.
- B. Pre-drill for anchors.
- C. Weld, fill and grind components smooth.

2.5 FINISHES

- A. Extinguisher: Manufacturer's standard finish.
- B. Steel Cabinets:
 - 1. Cabinet Exterior Trim and Door: White powder coat paint finish.
 - a. Provide vertical black lettering on door stating FIRE EXTINGUISHER.
 - 2. Cabinet Interior: White powder coat paint finish.
- C. Wall Brackets: Red baked enamel paint finish.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify rough openings for cabinets are correctly sized and located.
- B. Verify blocking/backing for wall brackets are correctly sized and located.

3.2 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Mount cabinets and wall brackets such that the fire extinguisher handle is at 48 inches maximum above the finished floor.
- C. Install cabinets and wall brackets plumb and level.
- D. Secure cabinets and wall brackets rigidly in place. Anchor to structure with anchors appropriate for use with type of adjacent construction. Anchorage shall securely fasten items to wall construction involved. Fasteners shall provide stiffness and rigidity to keep items square, in accurate position without twisting, buckling or warping. Fasteners to framing substrate shall be the following minimums; greater as required by the cabinet/bracket manufacturer or as conditions warrant:
 - 1. Wood Framing:

- a. Cabinets: Three-#10 wood screws each side of cabinet with 1-1/2 inch minimum penetration into the framing or backing member.
 - b. Wall Brackets: Three-#10 wood screws each bracket with 1-1/2 inch minimum penetration into the framing or backing member.
- E. Place extinguishers in cabinets and on wall brackets.

END OF SECTION

SECTION 10 51 30
TURNOUT GEAR LOCKERS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Design, fabrication and installation of wall-mounted turnout gear lockers as specified herein.

1.2 REFERENCES

- A. The publications listed below form a part of this Section to the extent referenced. The publications are referred to in the text by the basic designation only. Refer to Division 01 for definitions, acronyms, and abbreviations.
- B. Standards, manuals, and codes refer to the latest edition of such standards, manuals, and codes in effect as of the date of issue of this Project Manual, unless indicated otherwise in CBC Chapter 35 and CFC Chapter 80.
- C. Referenced Standards:
 - 1. ASTM A510 – Standard Specification for General Requirements for Wire Rods and Coarse Round Wire, Carbon Steel, and Alloy Steel.
 - 2. ASTM A513 – Standard Specification for Electric-Resistance-Welded Carbon and Alloy Steel Mechanical Tubing.

1.3 SUBMITTALS

- A. Product Data: Submit manufacturer's product data and installations.
- B. Shop Drawings: Submit manufacturer's shop drawings for each individual free-standing unit of lockers.
- C. Samples: Submit manufacturer's standard color samples.
- D. Warranty: Submit manufacturer's standard warranty.

1.4 QUALITY ASSURANCE

- A. Manufacturer shall have a minimum of ten years' experience in the direct manufacture of lockers.
- B. Installer shall have experience in locker assembly and installation according to manufacturer instructions.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Delivery: Deliver materials to site in manufacturer's original, unopen containers with labels identifying product and manufacturer's name.
- B. Storage: Store materials in a clean dry area.

- C. Handling: Protect materials and finish during installation and handling to prevent damage.

PART 2 PRODUCTS

2.1 MANUFACTURER

- A. Basis of Design: GearGrid, LLC, Forest Lake, MN; 888-643-6694, www.geargrid.com.
- B. Or accepted equal.
- C. Substitutions: Under provisions of Division 01.

2.2 TURN-OUT GEAR LOCKERS

- A. Model: GearGrid Wall Mounted Storage System
- B. Locker Size:
 - 1. Width: 24 inches.
 - 2. Depth: 20 inches.
 - 3. Height: 74.5 inches.
- C. Construction: Units shall be welded at all applicable joints. Forming of metal shall be completed by standard cold-forming operations. Use of fasteners will only be required to allow for knock-down shipping, securing units to mounting surface and on applicable accessories.
- D. Vertical Dividers:
 - 1. Outer Frames: 1.25 inch O.D. x 16-gauge wall thickness ASTM A513 steel tubing.
 - 2. Inner Grid: 0.25 inch diameter ASTM 510 cold drawn steel wire resistance welded to a 3 inch square pattern. Inner grid wires shall be full length and width of inside vertical divider frame. Wires shall run horizontally and vertically creating a square or rectangular grid pattern. Weld at all wire intersections.
- E. Back Panel:
 - 1. Required on each locker. Grid: 0.25 inch diameter ASTM A510 cold drawn steel wire resistance welded to a 3 inch square pattern.
- F. Top Cover: 0.25 inch diameter ASTM A510 cold drawn steel wire resistance welded to a 3 inch square pattern, to securely enclose top of locker.
- G. Shelves: (1) Top, (1) Bottom, 0.25 inch diameter ASTM A510 cold drawn steel wire resistance welded and cold formed.
- H. Apparel Hooks: (3) per locker opening. 0.192 inch diameter ASTM A510 cold drawn steel wire resistance welded, cold formed and powder coated. Hooks shall securely engage and snap onto side or back grid.
- I. Base Assembly: Base frame shall be manufactured from 1.25 inch x 11-gauge wall thickness ASTM A513 square steel tubing. Each unit shall be supplied with four bolt-down pads per unit.

2.3 ACCESSORIES

A. Door (provide at all lockers):

1. Frame: 1.25 inch O.D. x 16-gauge wall thickness ASTM A513 steel tubing.
2. Inner Grid: 0.25 inch diameter ASTM A510 cold drawn steel wire resistance welded to a 3 inch square pattern.
3. Hinge: Single pin welded style with brass pivot bushing. Hinge shall be welded, not mechanically fastened.
4. Placard Channel: 20-gauge steel to accept a 2 inch x 12 inch name placard, securely welded to inner grid panel.
5. Latch/Hasp: Self-latching with padlock hasp, minimum 0.125 inch sheet steel welded to vertical divider frame. Lock by Owner.

B. Gear Drying Hanger (provide at all lockers):

1. 0.25 inch diameter type 304 stainless steel wire cold formed and resistance welded.
2. Provide black vinyl coating on hook end.

2.4 FINISH

A. General: All system components excluding assembly and mounting hardware and stainless-steel components are to receive manufacturer's standard finish as follows:

1. Components shall be cleaned using a phosphatized bath, clear water rinse and electro-statically coated with a durable TGIC powder coating.
2. Color: To be selected by Owner.

PART 3 EXECUTION

3.1 EXAMINATION

- #### A. Examine areas to receive lockers. Notify Architect if areas are not acceptable. Do not begin installation until unacceptable conditions have been corrected.

3.2 INSTALLATION

- #### A. Assemble wall-mounted lockers in accordance with manufacturer's written instructions.
- #### B. Use manufacturer-provided hardware for assembly.
- #### C. Anchor to mounting surface with proper hardware.

END OF SECTION

SECTION 10 75 00

FLAGPOLES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Aluminum flagpoles, ground-mounted.
- B. Halyards and accessories.
- C. Flags.
- D. Concrete foundation.

1.1 PRODUCTS FURNISHED BUT INSTALLED UNDER OTHER SECTIONS

- E. Furnish anchor devices and foundation tube sleeve to Section 03 11 00, Concrete Forming, for placement.

1.2 RELATED SECTIONS

- A. Section 03 30 00 – Cast-In-Place Concrete; for concrete foundation.
- B. Division 26 Sections for grounding, site lighting fixtures, and related work.

1.3 REFERENCES

- A. The publications listed below form a part of this Section to the extent referenced. The publications are referred to in the text by the basic designation only. Refer to Division 01 for definitions, acronyms, and abbreviations.
- B. Standards, manuals, and codes refer to the latest edition of such standards, manuals, and codes in effect as of the date of issue of this Project Manual, unless indicated otherwise in CBC Chapter 35 and CFC Chapter 80.
- C. Referenced Standards:
 - 1. American Architectural Manufacturers Association; AAMA 611 - Voluntary Specification for Anodized Architectural Aluminum.
 - 2. American Association of State Highway and Transportation Officials; AASHTO M-36 – Standard Specification for Corrugated Steel Pipe, Metallic-Coated, for Sewer and Drains.
 - 3. ASTM B241/B241M – Standard Specification for Aluminum and Aluminum-Alloy Seamless Pipe and Seamless Extruded Tube.
 - 4. ASTM C33 - Standard Specification for Concrete Aggregates.
 - 5. ASTM C1107/C1107M - Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink).
 - 6. ASTM D1187 - Standard Specification for Asphalt-Base Emulsions for Use as Protective Coatings for Metal.
 - 7. National Association of Architectural Metal Manufacturers (NAAMM) - Metal Finishes Manual for Architectural and Metal Products.
 - 8. NAAMM FP 1001 - Guide Specifications for Design of Metal Flagpoles.

1.4 SUBMITTALS

- A. Submit under provisions of Division 01.
- B. Submit shop drawings indicating detail dimensions, base attachment details, anchor requirements and imposed loads.
- C. Provide product data on pole, accessories and configurations.
- D. Submit manufacturer's installation instructions under provisions of Division 01.

1.5 SYSTEM DESCRIPTION

- A. Pole with Flag(s): Designed for 100 mph wind speed, without permanent deformation, non-resonant, design safety factor of 2.5, equipped with two four-foot by six-foot flags; meeting applicable requirements of NAAMM FP 1001.
- B. Type: One piece, ground set; fixed type.
- C. Pole Design: Tapered top end.
- D. Nominal Height: 30 feet, measured from ground.
- E. Halyard: Internal type.
- F. Foundation: Cast-in-place concrete, as indicated on Drawings; and in accordance with manufacturer's recommendations.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to site under provisions of Division 01.
- B. Store and protect products under provisions of Division 01.
- C. Spiral wrap flagpole with protective covering and pack in protective shipping tubes or containers.
- D. Protect flagpole and accessories on site from damage or moisture.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Flagpoles:
 - 1. L.Ph. Bolander & Sons, San Francisco, CA; 800-434-5611, www.bolanderflagpole.com. Product: Catalog #HTJ30, one-piece, 30-foot exposed height flagpole.
 - 2. Baartol Company, Kenton, OH; 800-558-6044, www.baartol.com.
- B. Flags:
 - 1. The Flag Company, Inc., Acworth, GA; 800-962-0956, www.flagco.com.
 - 2. Annin Flagmakers, Roseland, NJ; 973-228-9400, www.annin.com.
 - 3. The Flag Zone, Gilbertsville, PA; 800-976-4201, www.theflagzone.com.
- C. Substitutions: Under provisions of Division 01.

2.2 POLE MATERIALS

- A. Aluminum Tube: ASTM B241; 6063 alloy, T6 tempered.

2.3 POLE FABRICATION

- A. All flagpoles shall be of one-piece construction.
- B. Outside Butt Diameter: 6 inches.
- C. Outside Top Diameter: 3-1/2 inches.
- D. Nominal Wall Thickness: 0.188 inch.

2.4 FLAGPOLE COMPONENTS

- A. Internal Halyard and Truck Assembly: Provide pole with an internal halyard system including a manually operated cam cleat, a halyard of 5/16-inch diameter, braided, UV-resistant polypropylene rope, and a concealed revolving truck assembly. Halyard and cam cleat shall be serviced through a flush hinged access door with a continuously reinforced periphery.
 - 1. Provide a hinged access door assembly. Door shall hinge on a heavy-duty piano hinge and shall be secured with a cylinder lock.
 - 2. Interior Platform: Provide 24-inch or longer round, solid piece of flexible plastic foam to serve as a platform inside the flagpole tube. Foam shall be adhesively attached to tube wall at two feet below the door opening.
 - 3. The halyard device shall permit a flag to be raised, lowered and flown from any position on the pole without entanglement or slippage.
 - 4. The flag attachment arrangement shall consist of a beaded cable sling encircling the pole and a counterweight to assure descent of flags in all weather conditions. Provide with stainless steel snap hooks.
 - a. Provide additional stainless steel snap hooks as required for attachment of second flag.
- B. Flags:
 - 1. Material: Polyester, 100 percent, two-ply, spun, woven fabric.
 - a. Flag of the United States of America: Embroidered stars, sewn stripes, double-stitched; heavy-duty, non-shrink canvas header; and brass grommets.
 - b. Flag of the State of California: Printed graphics; heavy-duty, non-shrink canvas header; and brass grommets.
 - 2. Quantity and Size: Provide two flags as follows, unless otherwise indicated on Drawings.
 - a. One four-foot by six-foot flag of the United States of America, and one four-foot by six-foot flag of the State of California.
- C. Finial Ball: Flush-seam ball, spun aluminum, 0.0641-inch wall thickness, minimum; 6 inches diameter.

2.5 MOUNTING COMPONENTS

- A. Foundation Tube: AASHTO M-36, corrugated tube, 16 gauge (uncoated metal thickness 0.060-inch, minimum) steel, galvanized, with 3/8-inch thick welded plates for setting; tube depth as indicated.

- B. Lightning Protection: Grounding rod (spike), 3/4-inch diameter, welded to foundation tube assembly.
- C. Pole Base Attachment: Flush; aluminum base with cover.

2.6 ACCESSORIES

- A. Non-shrink, Non-metallic Grout: Factory-packaged, non-staining, noncorrosive, nongaseous grout complying with ASTM C1107.
- B. Sand: ASTM C33, fine aggregate.
- C. Elastomeric Joint Sealant: Single-component non-sag urethane or single-component neutral-curing silicone joint sealant complying with requirements in Section 07 92 00 for "Use NT (non-traffic)" and for "Use M, G, A," and, as applicable to joint substrates indicated, for "Use O."
- D. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187.

2.7 ALUMINUM FINISHES

- A. General: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
 - 1. Protection of Dissimilar Surfaces: Coat dissimilar metals and metal surfaces in contact with concrete with bituminous paint.
- B. Aluminum Surfaces Except Finial: Architectural Class I finish per Aluminum Association Standard AA-M10C22 A41, clear anodized (0.018 mm or thicker coating); complying with AAMA 611.
- C. Finial Ball: Gold anodized finish; AAMA 611, AA-M32C22A43 (Class I, 0.018 mm or thicker); gold color.

PART 3 EXECUTION

3.1 INSPECTION

- A. Verify that concrete foundation is ready to receive work and dimensions are as indicated on shop drawings.
- B. Beginning of installation means acceptance of existing conditions.

3.2 PREPARATION

- A. Coat metal sleeve surfaces below grade and surfaces in contact with dissimilar materials with a heavy coat of bituminous paint.
- B. Foundation Excavation: Excavate to neat clean lines in undisturbed soil. Remove loose soil and foreign matter from excavation and moisten earth before placing concrete. Place and compact drainage material at excavation bottom.
- C. Provide forms where required due to unstable soil conditions and for perimeter of flagpole base at grade. Secure and brace forms to prevent displacement during concreting.

- D. Place concrete, as specified in Section 03 30 00. Compact concrete in place by using vibrators. Moist-cure exposed concrete for not less than seven days. Non-staining curing compound may be used for curing.

3.3 INSTALLATION

- A. Install flagpole, base assembly and fittings in accordance with manufacturer's printed instructions.
 - 1. Verify and ensure that plastic foam platform inside the flagpole tube is firmly attached to tube wall.
- B. Install welded base assembly for flagpoles in concrete and fasten in place.
- C. Ground Setting:
 - 1. Place foundation tube, center, and brace to prevent displacement during concreting. Place concrete. Plumb and level foundation tube and allow concrete to cure. Install flagpole, plumb, in foundation tube.
 - 2. Place flagpole on bottom plate between steel centering wedges and install hardwood wedges to secure flagpole in place. Place and compact sand in foundation tube and remove hardwood wedges. Seal top of foundation tube with a 2-inch layer of non-shrink grout, and joint sealant, and cover with flashing collar. Seal space between flagpole and collar with joint sealant.
- D. Electrically ground flagpole installation.
- E. Install flags and check flagpole assembly for smooth operation in presence of Owner's Representative.

3.4 TOLERANCES

- A. Maximum Variation from Plumb: 1 inch.

3.5 ADJUSTING AND CLEANING

- A. Clean surfaces as recommended by flagpole manufacturer.
- B. Adjust operating devices so that halyard functions smoothly.

END OF SECTION

SECTION 10 90 00
MISCELLANEOUS SPECIALTIES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Miscellaneous specialty items.
- B. Accessory anchors, bolts, screws, and braces.

1.2 REFERENCES

- A. The publications listed below form a part of this Section to the extent referenced. The publications are referred to in the text by the basic designation only. Refer to Division 01 for definitions, acronyms, and abbreviations.
- B. Standards, manuals, and codes refer to the latest edition of such standards, manuals, and codes in effect as of the date of issue of this Project Manual, unless indicated otherwise in CBC Chapter 35 and CFC Chapter 80.
- C. Referenced Standards:
 - 1. ASTM E84 – Standard Test Method for Surface Burning Characteristics of Building Materials.

1.3 SUBMITTALS

- A. Submit under provisions of Division 01.
- B. Shop Drawings:
 - 1. Indicate fabrication, materials, installation details, finishes, and any other required anchoring, fastenings, and hardware.
 - 2. Submit drawing layout for product configuration, support attachment, and anchorage details.
- C. Product Data: Submit product data for each product specified in this Section with the product and selected attributes clearly identified.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to site under provisions of Division 01.
- B. Store in manufacturer's original unopened containers and packaging. Protect and handle products to prevent damage to products or finishes.

PART 2 PRODUCTS

2.1 WALL PANELING

- A. Manufacturer and Product:
 - 1. Basis of Design: Ezoboard, 416-665-3571, ezoboard.com. Product: Ezoboard.
 - 2. Or accepted equal.

3. Substitutions: Under provisions of Division 01.

B. Wall Paneling:

1. Material: 100 percent polyester.
2. Size: 24 inches x 48 inches.
3. Thickness: 9mm.
4. Edge condition: Beveled.
5. Weight: 0.266 lbs. sq. ft.
6. Fire performance: Class A per ASTM E84:
 - a. Flame Spread: 25.
 - b. Smoke Developed: 450 maximum.
7. NRC: 0.30 to 0.75.
8. Color: As indicated on Drawings.

PART 3 EXECUTION

3.1 INSTALLATION

- A. All products in this Section shall be installed according to manufacturer's written installation instructions and as detailed on Drawings.

3.2 ADJUST AND CLEAN

- A. Clean and Touch-Up: Remove all packing and protection blemishes and thoroughly clean and polish all finish surfaces. Restore any marred or abraded surfaces to their original condition by touching-up in accordance with the manufacturer's recommendations. Touch-up shall not be obvious.
- B. Defective Work: Remove and replace all defective work which cannot be properly repaired, cleaned or touched-up, as directed by Architect, with no additional cost to the Owner.
- C. Protect installed work during the construction period to prevent abuse and damage.

END OF SECTION

SECTION 12 24 13
ROLLER WINDOW SHADES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Manually operated Roller window shades including the following:
 - 1. Single roller shades.
 - 2. Double roller shades.
 - 3. Shade accessories.
 - 4. Shade fabric.
 - 5. Blackout fabric.

1.2 RELATED SECTIONS

- A. Section 06 10 00 – Rough Carpentry.
- B. Section 09 29 00 – Gypsum Board.

1.3 REFERENCES

- A. The publications listed below form a part of this Section to the extent referenced. The publications are referred to in the text by the basic designation only. Refer to Division 01 for definitions, acronyms, and abbreviations.
- B. Standards, manuals, and codes refer to the latest edition of such standards, manuals, and codes in effect as of the date of issue of this Project Manual, unless indicated otherwise in CBC Chapter 35 and CFC Chapter 80.
- C. Referenced Standards:
 - 1. ASTM E2180 – Standard Test Method for Determining the Activity of Incorporated Antimicrobial Agent(s) In Polymeric or Hydrophobic Materials.
 - 2. ASTM G21 – Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.
 - 3. NFPA 701 – Standard Methods of Fire Tests for Flame Propagation of Textiles and Films.

1.4 SUBMITTALS

- A. Submit in accordance with Division 01.
- B. Shop Drawings:
 - 1. Provide plans, elevations, sections, product details, installation details, operational clearances, and relationship to adjacent work.
 - 2. Provide window treatment schedule for all roller shades. Use same room designations as indicated on Drawings and include opening sizes and key to typical mounting details.
- C. Product Data: Submit product data for each product specified in this Section with the product and selected attributes clearly identified.

- D. Samples: Provide 2 samples each of the following:
 - 1. Selection of metal component finishes.
 - 2. Selection of shade and blackout fabric colors, weaves, and types.
- E. Storage and handling requirements and recommendations.
- F. Manufacturer's written installation instructions.
- G. Manufacturer's Written Operation and Maintenance Instructions: Methods for maintaining roller shades, precautions regarding cleaning materials and methods, and written installation instructions for operating hardware and controls.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Minimum 10 years' of experience manufacturing similar products.
- B. Installer Qualifications: Minimum 5 years' of experience installing similar products.
- C. Child Safety Standards: Shades and installation shall be in compliance with ANSI/WCMA child safety standards.

1.6 PRE-INSTALLATION MEETINGS

- A. Conduct on-site meetings prior to starting work of this Section to review project requirements.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Comply with requirements of Division 01.
- B. Deliver products when all concrete, masonry, plaster, painting, and other wet work has been completed and dried.
- C. Deliver products in manufacturer's original containers, dry and undamaged, with seals and labels intact.
- D. Deliver shades in factory-labeled packages, marked with manufacturer and product name, fire test response characteristics, and location of installation using same room designations indicated on Drawings and in the Window Treatment Schedule.
- E. Store materials in a dry secure place. Protect from weather, surface contaminants, corrosion, construction traffic, and other potential damage.

1.8 PROJECT CONDITIONS

- A. Maintain environmental conditions between 32 and 104 degrees Fahrenheit and humidity below 90 percent. Do not install products under environmental conditions outside manufacturer's recommended limits.

1.9 SEQUENCING

- A. Ensure that products of this Section are supplied to affected trades in time to prevent interruption of construction progress.

1.10 WARRANTY

- A. Comply with provisions of Division 01.
- B. Warrant installed units to be free from defects in material and workmanship as follows:
 - 1. Manual Roller Shade Hardware at Window Shades, Channels, Chain, Fabric, and Blackout Fabric: Manufacturer's standard non-depreciating 25-year limited warranty.
 - 2. Roller Shade Installation: 1-year.
- C. In the event a warranted product or component fails, facilitate materials replacement at no cost to the Owner under the provisions of Division 01.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Basis of Design Manufacturer: Inpro Corporation, Muskego, WI; 800-222-5556, www.inprocorp.com.
- B. The following manufacturers shall be acceptable if products submitted are equal or greater in quality to the Basis of Design products specified in this Section:
 - 1. MechoShade Systems, LLC, Long Island City, NY; 718-729-2020, www.mechoshade.com.
 - 2. Lutron, Coopersburg, PA; 844-588-7661, www.lutron.com.
 - 3. Hunter Douglas, New York, NY; 800-789-0331, www.hunterdouglas.com.
 - 4. Draper, Inc., Spiceland, IN; 800-238-7999, www.draperinc.com.
- C. Substitutions: Under provisions of Division 01.

2.2 MANUAL ROLLER SHADES

- A. SoloMount Manual Clutch Roller Shade, Model: H100 SoloMount as manufactured by Inpro Corporation with the following properties:
 - 1. Clutch shall have metal hook attachment to bracket for maximum stability and safety.
 - 2. Clutch shall have integrated safety hold-down screw physically locking the clutch to the mounting bracket.
 - 3. Reinforced chain skirt shall have combined stainless steel plate for increased strength.
 - 4. Universal Mounting Bracket shall be ceiling, wall, or jamb mount capable. Refer to Drawings for mounting conditions.
 - 5. Roll: Regular or Reverse Roll, as indicated on Drawings. If not indicated, as selected by Architect.
 - 6. Maximum Roll Diameter: Model H100 = 2-1/4-inches. Model H200= 2-3/4-inches. Model H300= 3-3/4-inches.
 - 7. Drive Chain: #10 Stainless Steel chain, nickel plated steel chain shall not be accepted.
 - 8. Child Safety Devices, factory attached to chain:
 - a. Tension Device: Meets ANSI/WCMA child safety standards.

- b. Chain Guard: Meets ANSI/WCMA child safety standards. Provide at locations determined by Architect.
- 9. Hembar: Aluminum slat heat sealed inside 1-3/4-inch hem pocket, including sealed side pockets.
- 10. Clutch Mechanism:
 - a. Clutch mechanism shall have an interchangeable drum to accommodate multiple tube sizes.
 - b. Clutch mechanism shall have a metal attachment point for strength and safety. Clutch mechanisms with plastic attachment points shall not be accepted.
 - c. Composition: 30 percent glass filled nylon.
 - d. Finish Color: As selected by Architect to coordinate with shade fabric color.
- 11. SoloMount Bracket Finish: As selected by Architect to coordinate with shade fabric color.
- 12. Idler mechanism shall be spring loaded with interchangeable housing to allow for multiple tube sizes. Spring loaded idler shall have a metal axle.
 - a. Composition: 10 percent glass filled nylon.
 - b. Idler Finish: As selected by Architect to coordinate with shade fabric color.
- 13. Provide 6061-T6 Aluminum Notchless Front and/or Rear Fascia.
 - a. Size: 2-7/8-inch.
 - b. Finish: As selected by Architect to coordinate with shade fabric color.
- 14. Aluminum End Caps shall not exceed 1/32-inch thick and shall be press fit onto SoloMount brackets. End Cap finish to match Front and/or Rear Fascia.

2.3 SHADE ACCESSORIES

- A. Light Blocking: Provide Extruded 6061-T6 aluminum side channels, center channels, sill channel and light stop angles as indicated on Drawings.
 - 1. Channel Color: As selected by Architect to coordinate with shade assembly.
 - 2. Side channels have 1/4-inch non-adhesive brush insert. Color: Grey.
 - 3. Light Stop Angle Color: As selected by Architect to coordinate with shade assembly.
 - 4. Provide channel top caps and hole plugs with channels.

2.4 FABRICS

- A. Shade Fabric: Inpro Corporation Solar Protective Screen Fabrics.
 - 1. Screen Fabric: 3 percent Openness Factor.
 - 2. UV Blockage: 99 percent – 95 percent.
 - 3. Inpro Corporation 24X Series:
 - a. 243 Fabric (Openness Factor: 3 percent), Basketweave.
 - 1) Meet or exceed requirements of NFPA 701 and Title 19 CCR Division 1, Chapter 8.
 - 2) Composition: 22 percent Polyester/78 percent PVC.
 - 3) Fabric Thickness: 0.024-inch.
 - 4) Fabric Weight: 13.71 oz./sq. yd.

- 5) GreenGuard Gold Certified.
 - 6) Fungal resistance in accordance with ASTM G21.
 - 7) Microbial resistance in accordance with ASTM E2180.
 - 8) Color: As selected by Architect.
- B. Blackout Fabric: Inpro Corporation Solar Protective Light Blocking Fabrics.
1. Blackout Fabric: 0 percent Openness Factor.
 2. UV Blockage: 100 percent.
 3. Inpro Corporation 245B Fabric: (Openness Factor: 0 percent).
 - a. Composition: 78 percent PVC/22 percent Polyester with White acrylic backing.
 - b. Fabric Thickness: 0.027-inch, Fabric Weight: 18.27 oz./sq. yd.
 - c. GreenGuard Gold Certified; ASTM G21; ASTM E2180.
 - d. Select color from manufacturers standard colors.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine substrate conditions and dimensions. Verify if substrate is ready and acceptable to receive window shade system.
- B. Confirm that blocking for roller shades is installed plumb, level, and fitted to window mullion as indicated on Drawings and in accordance with industry standard tolerances.
- C. Report unacceptable conditions to the Architect. Begin installation only when unacceptable conditions have been corrected.

3.2 INSTALLATION

- A. Install in accordance with manufacturer's written installation instructions and accepted shop drawings.
- B. Install roller shades level, plumb, square, and true according to manufacturer's written installation instructions, and located so shade band is not closer than 2-inches to interior face of glass. Allow proper clearances for window operation hardware.
- C. Adjust, align, and balance roller shades to operate smoothly, easily, safely, and free from binding or malfunction throughout entire operational range.
- D. Verify child safety hold-down is installed correctly.

3.3 ADJUSTING

- A. Adjust parts for smooth, uniform operation.
- B. Adjust shade assembly and fabric to hang flat without buckling and distortion.
- C. Replace any units or components, which do not hang properly, or operate smoothly at no additional cost to Owner.

3.4 CLEANING

- A. Clean exposed surfaces, including metal and fabric, using non-abrasive materials and methods as recommended by manufacturer.
- B. Do not use materials or methods, which may damage finish or surrounding construction.
- C. Remove and replace work which cannot be satisfactorily cleaned at no additional cost to Owner.

3.5 PROTECTION

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

END OF SECTION

SECTION 21 00 50

BASIC FIRE SPRINKLER MATERIALS AND METHODS

PART 1 - GENERAL

1.01 RELATED REQUIREMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. This Section is part of each Division 21 Section.

1.02 ADDITIONAL REQUIREMENTS

- A. Furnish and install incidental work not shown or specified necessary to provide a complete and workable system.
- B. Make temporary connections required to maintain services during the course of the Contract without additional cost to Owner. Notify Owner seven days in advance before interrupting services.

1.03 REFERENCES AND STANDARDS

- A. Where material or equipment is specified to conform to referenced standards, it shall be assumed that the most recent edition of the standard in effect at time of bid shall be used.
 - 1. ANSI - American National Standards Institute.
 - 2. ASTM - American Society for Testing and Materials.
 - 3. CCR - California Code of Regulations.
 - a. Title 8 - Division of Industrial Safety, Subchapter 7; General Industry Safety Orders, Articles 31 through 36.
 - 4. NCPWB - National Certified Pipe Welding Bureau.
 - 5. CEC - California Electrical Code.
 - 6. NEMA - National Electrical Manufacturers' Association.
 - 7. NFPA - National Fire Protection Association, as amended by the CBC.
 - 8. OSHA - Occupational Safety and Health Act.
 - 9. UL - Underwriters' Laboratories, Inc.
- B. Requirements of Regulatory Agencies:
 - 1. The publications listed below form part of this Specification. Comply with provisions of these publications except as otherwise shown or specified.
 - a. California Building Code, 2022.
 - b. California Electrical Code, 2022.
 - c. California Energy Code, 2022.
 - d. California Fire Code, 2022.
 - e. California Green Building Standards Code, 2022.
 - f. California Mechanical Code, 2022.

- g. California Plumbing Code, 2022.
 - h. California Code of Regulations, Title 24.
 - i. California Health and Safety Code.
 - j. CAL-OSHA.
 - k. California State Fire Marshal, Title 19 CCR.
 - l. DSA - Division of the State Architect. Interpretive Regulations (IR's).
 - m. National Fire Protection Association, as amended by the CBC.
 - n. Occupational Safety and Health Administration.
 - o. Other applicable state laws.
2. Nothing in Drawings or Specifications shall be construed to permit work not conforming to these codes, or to requirements of authorities having jurisdiction. It is not the intent of Drawings or Specifications to repeat requirements of codes except where necessary for clarity.

1.04 DRAWINGS

- A. Examine Contract Documents prior to bidding of Work and report discrepancies in writing to Architect.
- B. Drawings showing location of equipment and materials are diagrammatic and job conditions will not always permit installation in location shown. The fire protection Drawings show general arrangement of equipment and materials, etc., and shall be followed as closely as existing conditions, actual building construction, and work of other trades permit.
 - 1. Architectural and structural Drawings are part of the Work. These Drawings furnish Contractor with information relating to design and construction of the Project. Architectural Drawings take precedence over fire protection Drawings.
 - 2. Because of the small scale of fire protection Drawings, not all offsets, fittings, and accessories required are shown. Investigate structural and finish conditions affecting the Work and arrange Work accordingly. Provide offsets, fittings, and accessories required to meet conditions. Inform Architect immediately when job conditions do not permit installation of equipment and materials in locations shown. Obtain Architects' approval prior to relocation of equipment and materials.
 - 3. Relocate equipment and materials installed without prior approval of Architect. Remove and relocate equipment and materials at Contractors' expense upon Architects' direction.
 - 4. Minor changes in locations of equipment, piping, ducts, etc., from locations shown shall be made when directed by the Architect at no additional cost to the Owner providing such change is ordered before such items of work, or work directly connected to same are installed and providing no additional material is required.
- C. Execute work mentioned in Specifications and not shown on Drawings, or vice versa, the same as if specifically mentioned or shown in both.

1.05 FEES AND PERMITS

- A. Obtain and pay for permits and service required in installation of the Work. Arrange for required inspections and secure approvals from authorities having jurisdiction. Comply with the requirements of Division 1.

- B. Arrange for utility connections and pay charges incurred, including excess service charges.
 - 1. Bear the cost of construction related to utility services, from point of connection to utility services shown on Contract Documents. This includes piping, excavation, backfill, meters, boxes, check valves, backflow prevention devices, general service valves, concrete work, and the like, whether or not Work is performed by Contractor, local water/sanitation district, public utility, other governmental agencies or agencies' assigns.

1.06 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. General:

- a. Coordinate Work in this Section with trades covered in other Specification Sections to provide a complete and operable installation of highest quality workmanship.

2. Electrical Coordination:

- a. Refer to the Electrical Drawings and Specifications, Division 26, for service voltage and power feed wiring for equipment specified in this Section. Contractor has full responsibility for the following items of work:
 - 1) Review the Electrical Drawings and Division 26 Specifications to verify that electrical services provided are adequate and compatible with equipment requirements.
 - 2) If additional electrical services are required above that indicated on Electrical Drawings and in Division 26, such as more control interlock conductors, larger feeder, or separate 120 volt control power source, include cost to furnish and install additional electrical services as part of bid.
 - 3) Prior to proceeding with installation of additional electrical work, submit detailed drawings indicating exact scope of additional electrical work.

3. Mechanical Coordination:

- a. Arrange for pipe spaces, chases, slots and openings in building structure during progress of construction, to accommodate mechanical system installation.
- b. Coordinate installation of supporting devices. Set sleeves in poured-in-place concrete and other structural components during progress of construction.
- c. Coordinate requirements for access panels and doors for mechanical items requiring access where concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section "Access Doors and Frames."

1.07 SUBMITTALS

A. Refer to Division 01 Submittals Section(s) for additional requirements.

- B. Provide submittal of materials proposed for use as part of this Project. Product names in Specifications and on Drawings are used as standards of quality. Furnish standard items on specified equipment at no extra cost to the Contract regardless of disposition of submittal data. Other materials or methods shall not be used unless approved in writing by Architect. Architect's review will be required even though "or equal" or synonymous terms are used.

- 1. Partial or incomplete submittals will not be reviewed.

2. Quantities are Contractor's responsibility and will not be reviewed.
 3. Provide materials of same brand or manufacturer for each class of equipment or material.
 4. Identify each item by manufacturer, brand, trade name, number, size, rating, or other data necessary to properly identify and review materials and equipment. Words "as specified" are not sufficient identification.
 5. Identify each submittal item by reference to items' Specification Section number and paragraph, by Drawing and detail number, and by unit tag number.
 6. Organize submittals in same sequence as in Specification Sections.
 7. Show physical arrangement, construction details, finishes, materials used in fabrications, provisions for piping entrance, access requirements for installation and maintenance, physical size, mechanical characteristics, foundation and support details, and weight.
 - a. Submit shop drawings, performance curves, and other pertinent data, showing size and capacity of proposed materials.
 - b. Specifically indicate, by drawn detail or note, that equipment complies with each specifically stated requirement of Contract Documents.
 - c. Drawings shall be drawn to scale and dimensioned (except schematic diagrams). Drawings may be prepared by vendor but must be submitted as instruments of Contractor, thoroughly checked and signed by Contractor before submission to Architect for review.
 - d. Catalog cuts and published material may be included with supplemental scaled drawings.
- C. Review of submittals will be only for general conformance with design concept and general compliance with information given in Contract Documents. Review will not include quantities, dimensions, weights or gauges, fabrication processes, construction methods, coordination with work of other trades, or construction safety precautions, which are sole responsibility of Contractor. Review of a component of an assembly does not indicate acceptance of an assembly. Deviations from Contract Documents not clearly identified by Contractor are Contractor's responsibility and will not be reviewed by Architect.
- D. Within reasonable time after award of contract and in ample time to avoid delay of construction, submit to Architect shop drawings or submittals on all items of equipment and materials provided. Provide submittal in at least seven copies and in complete package.
1. Shop drawings and submittals shall include Specification Section, Paragraph number, and Contract Drawing unit symbol or detail number for reference. Organize submittals into booklets for each Specification section and submit in loose-leaf binders with index. Deviations from Contract Documents shall be clearly identified and appear at the beginning of submittal package, and shall be referenced to applicable Contract Documents requirements.
- E. Provide layouts for fire protection systems, for inclusion in coordinated layout specified in Section 23 80 00. Comply with requirements for layouts specified in Section 23 80 00.

1.08 ACTION SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data and installation instructions for fire protection systems materials and products.

- B. Shop Drawings.
- C. Provide product data for insulation products, including insulation, insulation facings, jackets, adhesives, sealants, and coatings, indicating compliance with requirement that these products contain less than 0.1 percent (by mass) polybrominated diphenyl ethers (PBDEs) in penta, octa, or deca formulations.
- D. Product Data for California Green Building Standards Code Compliance: For adhesives and sealants, including primers, documentation of compliance including printed statement of VOC content and chemical components.
- E. Delegated-Design Submittal: For seismic supports, anchorages, and restraints indicated to comply with performance requirements and design criteria.
 - 1. Calculations performed for use in selection of seismic supports, anchorages, and seismic restraints shall utilize criteria indicated in Structural Contract Documents.
 - 2. Supports, anchorage and restraints for piping and equipment shall be an HCAI pre-approved system such as Tolco, ISAT, Mason, or equal. Pipes and equipment shall be seismically restrained in accordance with requirements of current edition of California Building Code and NFPA 13. System shall have current OPA number and shall meet additional requirements of authority having jurisdiction. Provide supporting documentation required by the reviewing authority and the Architect and Engineer. Provide layout drawings showing piping, ductwork and restraint locations.
 - a. Bracing of Piping and Equipment: Specifically state how bracing attachment to structure is accomplished. Provide shop drawings indicating seismic restraints, including details of anchorage to building. In-line equipment must be braced independently of piping, and in conformance with applicable building codes. Provide calculations to show that pre-approval numbers have been correctly applied in accordance with general information notes of pre-approval documentation.
 - 3. In lieu of the above or for non-standard installations not covered in the above pre-approved systems, Contractor shall provide layout drawings showing piping, equipment, and restraint locations, and detailing supports, attachments and restraints, and furnish supporting calculations and legible details sealed by a California registered structural engineer, in accordance with 2022 California Building Code and NFPA 13.
 - 4. Additional Requirements: In addition to the above, conform to State and local requirements.

1.09 INFORMATIONAL SUBMITTALS

- A. Provide coordination drawings for fire protection systems in accordance with the requirements of Specification Section 21 10 00.
- B. Furnish to Project Inspector complete installation instructions on material and equipment before starting installation.

1.10 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data:
 - 1. Refer to Division 01 for complete instructions.
 - 2. Furnish three complete sets of Operating and Maintenance Manual bound in hardboard binder, and one compact disc containing complete Operating and Maintenance Manual

in searchable PDF format. Provide Table of Contents. Provide index tabs for each piece of equipment in binder and disc. Start compiling data upon approval of submittals.

a. Sets shall incorporate the following:

- 1) Product Data.
 - 2) Shop Drawings.
 - 3) Record Drawings.
 - 4) Service telephone number, address and contact person for each category of equipment or system.
 - 5) Complete operating instructions for each item of fire sprinkler system.
 - a) Original manual of NFPA-25 for fire sprinkler system.
 - 6) Copies of guarantees/warranties for each item of equipment or systems.
 - 7) Test data as specified.
 - 8) Typewritten maintenance instructions for each item of equipment listing lubricants to be used, frequency of lubrication, inspections required, adjustment, etc.
 - 9) Manufacturers' bulletins with parts numbers, instructions, etc., for each item of equipment.
 - 10) A complete list or schedule of scheduled valves giving the number of the valve, location and the rooms or area controlled by the valve. Identify each valve with a permanently attached metal tag stamped with number to match schedule. Post list in frame under plastic on wall in mechanical room or where directed by Architect.
 - 11) Check test and start reports for each piece of fire protection equipment provided as part of the Work.
 - 12) Commissioning and Preliminary Operation Tests required as part of the Work.
- b. Post service telephone numbers and addresses in an appropriate place designated by Architect.

B. Record Drawings:

1. Refer to Division 01, Record Documents, for requirements governing Work specified herein.
2. Upon completion of the work, deliver to Architect the following:
 - a. Originals of drawings showing the Work exactly as installed.
 - b. One complete set of reproducible drawings showing the Work exactly as installed.
 - c. One compact disc with complete set of drawings in PDF format showing the Work exactly as installed.
 - d. Provide Contractor's signature, verifying accuracy of record drawings.
 - e. Obtain the signature of the Project Inspector for all record drawings.

1.11 SUBSTITUTIONS

A. Refer to Division 01 for complete instructions. Requirements given below are in addition to or are intended to amplify Division 01 requirements. In case of conflict between

requirements given in this Section and those of Division 01, Division 01 requirements shall apply.

- B. It is the responsibility of Contractor to assume costs incurred because of additional work and or changes required to incorporate proposed substitute into the Project. Refer to Division 01 for complete instructions.
- C. Substitutions will be interpreted to be manufacturers other than those specifically listed in Contract Documents by brand name, model, or catalog number.
- D. Only one request for substitution will be considered for each item of equipment or material.
- E. Substitution requests shall include the following:
 - 1. Reason for substitution request.
 - 2. Complete submittal information as described herein; see "Submittals."
 - 3. Coordinated scale layout drawings depicting position of substituted equipment in relation to other work, with required clearances for operation, maintenance and replacement.
 - 4. List optional features required for substituted equipment to meet functional requirements of the system as indicated in Contract Documents.
 - 5. Explanation of impact on connected utilities.
 - 6. Explanation of impact on structural supports.
- F. Installation of reviewed substitution is Contractors' responsibility. Any mechanical, electrical, structural, or other changes required for installation of substituted equipment or material must be made by Contractor without additional cost to Owner. Review by Architect of substituted equipment or material will not waive these requirements.
- G. Contractor may be required to compensate Architect for costs related to substituted equipment or material.

1.12 DELIVERY, STORAGE AND HANDLING

- A. Protect equipment and materials delivered to Project site from weather, humidity and temperature variations, dirt, dust and other contaminants.

1.13 FIELD CONDITIONS

- A. Information on Drawings relative to existing conditions is approximate. Deviations from Drawings necessary during progress of construction to conform to actual conditions shall be approved by Architect and shall be made without additional cost to Owner. The Contractor shall be held responsible for damage caused to existing services. Promptly notify Architect if services are found which are not shown on Drawings.

1.14 WARRANTY

- A. Refer to Division 01 for warranty requirements, and duration and effective date of Contractor's Standard Guarantee.
- B. Repair or replace defective work, material, or part that appears within warranty period, including damage caused by leaks.

- C. On failure to comply with warranty requirements within a reasonable length of time after notification is given, Architect/Owner shall have repairs made at Contractor's expense.

PART 2 - PRODUCTS

2.01 GENERAL

- A. Materials or equipment of the same type shall be of the same brand wherever possible. All materials shall be new and in first class condition.
- B. All sizes, capacities, and efficiency ratings shown are minimum.
- C. Refer to Section 21 10 00 for specific system piping materials.

2.02 MATERIALS

- A. No material installed as part of this Work shall contain asbestos.
- B. California Green Building Code Compliance:
 - 1. Fire protection equipment shall not contain CFCs.
 - 2. Fire protection equipment shall not contain Halons.

2.03 PIPE IDENTIFICATION

- A. Identify each piping system and indicate the direction of flow by means of Seton, Inc., Marking Services Inc., Reef Industries, Inc., or equal, pre-tensioned, coiled semi-rigid plastic pipe labels formed to circumference of pipe, requiring no fasteners or adhesive for attachment to pipe.
- B. The legends and flow arrows shall conform to ASME A13.1.

PART 3 - EXECUTION

3.01 FRAMING, CUTTING AND PATCHING

- A. Special framing, recesses, chases and backing for Work of this Section, unless otherwise specified, are covered under other Specification Sections.
- B. Contractor is responsible for placement of pipe sleeves, hangers, inserts, supports, and location of openings for the Work.
- C. Cut existing concrete construction with a concrete saw. Do not utilize pneumatic devices.
- D. Core openings through existing construction for passage of new piping and conduits. Cut holes of minimum diameter to suit size of pipe and associated insulation installed. Coordinate with building structure, and obtain Structural Engineer's approval prior to coring through existing construction.

3.02 ELECTRICAL REQUIREMENTS

- A. Provide adequate working space around electrical equipment in compliance with the California Electrical Code. Coordinate the fire protection Work with the electrical Work to comply.

- B. Furnish necessary control diagrams and instructions for controls. Before permitting operation of equipment which is furnished, installed, or modified under this Section, Contractor shall review associated electrical work, including overload protection devices, and assume complete responsibility for correctness of electrical connections and protective devices. Motors and control equipment shall conform to the Standards of the National Electrical Manufacturers' Association. Equipment and connections exposed to weather shall be installed in NEMA IIIIR enclosures with factory wired strip heaters in each starter enclosure and temperature control panel where required to inhibit condensation.
- C. All line voltage and low voltage wiring and conduit associated with fire protection system are included in this Section. Wiring and conduit shall comply with Division 26.

3.03 PIPING SYSTEM REQUIREMENTS

- A. Drawing plans, schematic and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.

3.04 PRIMING AND PAINTING

- A. Perform priming and painting on the equipment and materials as specified herein.
- B. See Division 09 Painting Section(s) for detailed requirements.
- C. Priming and Painting:
 - 1. Exposed ferrous metals, including piping, which are not galvanized or factory-finished shall be primed and painted.
 - a. Black Steel Piping:
 - 1) Primer: One coat gray Sherwin-Williams Pro Industrial Pro-Cryl Universal Primer, comparable products by Rust-Oleum, Kelly Moore, or equal.
 - 2) Topcoat: Two coats gray Sherwin-Williams Pro Industrial Waterbased Alkyd Urethane Enamel, comparable products by Rust-Oleum, Kelly Moore, or equal.
 - 2. Metal surfaces of items to be jacketed or insulated except piping shall be given two coats of primer unless furnished with equivalent factory finish. Items to be primed shall be properly cleaned by effective means free of rust, dirt, scale, grease and other deleterious matter and then primed with the highest grade zinc rich primer. After erection or installation, primed surfaces shall be properly cleaned of foreign or deleterious matter that might impair proper bonding of subsequent paint coatings. Abrasion or other damage to shop or field prime coat shall be properly repaired and touched up with same material used for original priming.
 - 3. Where equipment is provided with nameplate data, the nameplate shall be masked off prior to painting. When painting is completed, remove masking material.

3.05 EXCAVATING

- A. Perform excavating required for Work of this Section. Provide the services of a pipe/cable locating service prior to excavating activities to determine location of existing utilities.
- B. Unless shown otherwise, provide 3 foot minimum cover for fire piping, or 1 foot below frost line, whichever results in deepest installation. Trim trench bottom by hand or provide a 4 inch deep minimum bed of sand to provide a uniform grade and firm support throughout

entire length of pipe. For PVC pipe, bed pipe in 4 inch deep minimum sand bed. Pipe bedding materials should be clean crushed rock, gravel or sand of which 100 percent will pass a 1 inch sieve. For pipes that are larger than 10 inches in diameter, at least 95 percent should pass a 3/4 inch sieve, and for pipes 10 inches in diameter or smaller, 100 percent should pass a 1/2 inch sieve. Other materials should have minimum sand equivalent of 50. Only a small proportion of native soils will meet these requirements without extensive processing; therefore, importation of pipe bedding materials should be anticipated. Pipe bedding materials shall be compacted in lifts not exceeding 6 inches in compacted thickness. Each lift shall be compacted to not less than 90 percent relative compaction at or above the optimum moisture content, in accordance with ASTM Specification D2940, except that bedding materials graded such that less than 100 percent will pass a No. 200 sieve shall be compacted in 6 inch lifts using a single pass of a flat-plate, vibratory compactor or vibratory drum. Pipe bedding materials should extend at least to the spring line.

- C. Maintain warning signs, barricades, flares, and red lanterns as required.
- D. For trenches 5 feet or more in depth, submit copy of permit, and detailed drawings showing shoring, bracing, sloping, or other provisions to be made for worker protection from hazard of caving ground during excavation of such trenches. Obtain a permit from Division of Industrial Safety prior to beginning excavations. A copy of permit shall be available at the Project site.

3.06 BACKFILLING

- A. Backfill shall comply with applicable provisions of Division 31 of these Specifications.
- B. Except under existing or proposed paved areas, walks, roads, or similar surfaces, backfill for other types of pipe shall be made using suitable excavated material or other approved material. Place backfill in 8 inch layers, measured before compaction, and compact with impact hammer to at least 90 percent relative compaction per ASTM D2940.
 - 1. Backfill plastic pipe and insulated pipe with sand for minimum distance of 12 inches above the top of pipe. Compact using mechanical tamping equipment.
- C. Entire backfill for excavations under existing or proposed pavements, walks, roads, or similar surfaces, under new slabs on grade, shall be made with clean sand compacted with mechanical tamping equipment vibrator to at least 90 percent relative compaction per ASTM D2940. Remove excess earth. Increase minimum compaction within uppermost two feet of backfill to 95 percent.
- D. Replace or repair to its original condition sod, concrete, asphalt paving, or other materials disturbed by trenching operation. Repair within warranty period.
- E. Thrust Blocks:
 - 1. Provide concrete anchors or thrust blocks on PVC and cast iron water lines installed underground. Install thrust blocks at changes in direction and at connections to mains 1-1/2 inches and larger. Form thrust blocks by pouring concrete between pipes and trench wall. Thrust blocks shall be adequate in size and placed to take thrusts created by the maximum internal water pressure; sizing and placement shall be per manufacturer's recommendations and in accordance with requirements of NFPA 24.
 - 2. Anchor piping to building construction.

3.07 PIPING SYSTEMS INSTALLATION

- A. At time of final connection, and prior to opening valve to allow pressurization of water piping from existing systems, on site or off site, perform a pressure test to indicate static pressure of existing systems. If pressure on fire protection piping is greater than 175 psi, inform Architect immediately. Do not allow piping systems to be pressurized without written consent of the Architect.
- B. General:
1. Piping shall be concealed unless shown or otherwise directed. Allow sufficient space for ceiling panel removal.
 2. Installation of piping shall be made with appropriate fittings. Bending of piping will not be accepted.
 3. Install piping to permit application of insulation where required and to allow valve servicing.
 4. Where piping or conduit is left exposed within a room, the piping or conduit shall be run true to vertical, horizontal, or intended planes. Where possible, uniform margins are to be maintained between parallel lines and/or adjacent wall, floor, or ceiling surfaces.
 5. Horizontal runs of pipes and/or electrical conduit suspended from ceilings shall provide for maximum headroom clearance. The clearance shall not be less than 6'-6" without written approval from Architect.
 6. Close ends of pipe immediately after installation. Leave closure in place until removal is necessary for completion of installation.
 7. Each piping system shall be thoroughly flushed and proved clean before connection to equipment.
 8. Install exposed polished or enameled connections with special care showing no tool marks or threads at fittings.
 9. Install horizontal valves with valve stem above horizontal.
 10. Use reducing fittings; bushings shall not be allowed. Use eccentric reducing fittings wherever necessary to provide free drainage of lines and passage of air.
 11. Verify final equipment locations for roughing-in.
 12. Service Markers: Mark location of each plugged or capped pipe with 4 inch round by 30 inch long concrete marker, set flush with finished grade. Provide 2-1/2 inch diameter engraved brass plate as part of service marker.
 13. Where piping is installed in walls within one inch of face of stud, provide 16 gauge sheet metal shield plate on face of stud. The shield plate shall extend minimum 1-1/2 inches beyond outside diameter of pipe.
- C. Sleeves:
1. Install Adjus-to-Crete, Pipeline Seal and Insulator, or equal, pipe sleeves of sufficient size to allow for free motion of pipe, 24 gauge galvanized steel. The space between pipe and sleeves through floor slabs on ground, through outside walls above or below grade, through roof, and other locations, as directed, shall be caulked with oakum and mastic and made watertight. The space between pipe and sleeve and between sleeve and slab or wall shall be sealed watertight.
 2. At Contractor's option, Link-Seal, Metraflex Metraseal, or equal, casing seals may be used in lieu of caulking. Wrap pipes through slabs on grade with 1 inch thick fiberglass insulation to completely isolate pipe from concrete.

D. Floor, Wall, and Ceiling Plates:

1. Fit pipes, with or without insulation, passing through walls, floors, or ceilings, and hanger rods penetrating finished ceilings with chrome-plated or stainless escutcheon plates.

E. Firestopping:

1. Pack annular space between pipe sleeves and pipe through floors and walls with UL listed fire stop, and seal at ends. Pipe penetrations shall be UL listed, Hilti, 3M Pro-Set, or equal.
 - a. Install fire caulking behind fire protection services installed within fire rated walls, to maintain continuous rating of wall construction.
2. Provide SpecSeal Systems UL fire rated sleeve/coupling penetrators, or equal, for each pipe penetration or fixture opening passing through floors, walls, partitions or floor/ceiling assemblies. Penetrators shall comply with UL Fire Resistance Directory (Latest Edition), and with Chapter 7, CBC requirements.
3. Sleeve penetrators shall have built in anchor ring for waterproofing and anchoring into concrete pours or use special fit cored hole penetrator for cored holes.
4. Copper and steel piping shall have SpecSeal plugs, or equal on both sides of penetrator to reduce noise and to provide waterproofing.
5. All above systems to be installed in strict accordance with manufacturer's instructions.
6. Alternate firestopping systems are acceptable if approved as equal. Contractor is responsible for determining suitability of alternate products for their intended use, and shall assume all risks and liabilities in connection with the use of alternate products.

F. Flashing:

1. Flashing for penetrations of metal or membrane roof for fire protection items shall be coordinated with roofing manufacturer and roofing installer for specific roofing type utilized. The work of this section shall include furnishing, layout, sizing, and coordination of penetrations required for fire protection work.
 - a. Furnish and install flashing and counterflashing in strict conformance with requirements of the roofing manufacturer. Submit shop drawing details for review prior to installation.
 - b. Furnish and install counterflashing above each flashing required. Elmdor/Stoneman Model 1540, or equal.
2. For other types of roofing systems, furnish and install around each pipe, where pipe passes through roof, a flashing and counterflashing. Flashing shall be made of four pound seamless sheet lead with 6 inch minimum skirt and steel reinforced boot. Counterflashing shall be cast iron. Elmdor/Stoneman Model 1100-4, or equal.

G. Hangers and Supports:

1. General: Support equipment and piping so that it is firmly held in place by approved iron hangers and supports and special hangers as required. Hangers and supports shall be UL listed for fire protection service. Components shall support weight of equipment, pipe, fluid, and pipe insulation based on spacing between supports with minimum factor of safety of five based on ultimate strength of material used. Do not exceed manufacturer's load rating. Pipe attachments or hangers, shall be of same size as pipe or tubing on which used, or nearest size available. Architect shall approve

hanger material before installation. Do not support piping with plumbers' tape, wire rope, wood, or other makeshift devices. Where building structural members do not match piping support spacing, provide "trapeze" (bridging) support members attached to building structural members by methods approved by structural Engineer.

- a. Materials, design, and type numbers per Manufacturers' Standardization Society (MSS), Standard Practice (SP)-58.
2. Hanger components shall be provided by one manufacturer. B-Line, Grinnell, Tolco, Afcon, Loos & Co., Uni-Strut, or equal.
3. Hanger and Supports:
 - a. Vertical Piping: Tolco Fig. 6, or equal, clamps attached to pipe above each floor to rest on floor. Provide intermediate support for vertical piping greater than 25 feet in length.
 - b. Individually Suspended Piping: Tolco Fig. 200 or Fig. 1 Clevis, complete with threaded rod, or equal.

<u>Pipe Size</u>	<u>Rod Size</u>
4" and Smaller	3/8"
5" to 6"	5/8"

- c. Trapeze Suspension: Sch-10 or Sch-40 steel pipe trapeze member in accordance with NFPA 13- published load ratings.
- d. Pipe Clamps and Straps: B-Line B2000 or B2400, Tolco, Fig. 200 or Fig. 1, or equal. Where used for seismic support systems, provide B-line B2400, Tolco fig. 69 series retainer pipe straps, or equal.
- e. Steel Connectors: Tolco Fig. 65 beam clamps with Fig. 69 retainer straps, or equal.
- f. Deck Connectors: Afcon Fig. 610 steel ceiling plate, or equal, where approved by structural Engineer.
4. Support to Structure:
 - a. Steel Structure: Provide and install additional steel bracing as required to suit structure. Provide through bolts with length to suit requirements of structural components. Burning or welding on structural member may only be done if approved by Architect.
5. Pipe hanger and support spacing: Locate hangers and supports at each change of direction, within one foot of elbow, and spaced per NFPA 13, and per pipe manufacturer's listing, except as noted below.
6. Provide support for piping through roof, arranged to anchor piping solidly in place at the roof penetration.
7. Provide rigid insulation and a 12 inch long, 18 gauge galvanized sheet iron shield between the covering and the hanger whenever hangers are installed on the outside of the pipe covering.
8. Insulate copper piping from ferrous materials and hangers with two layers of 3 inch wide, 10 mil polyvinyl tape wrapped around pipe.

9. Provide a support or hanger close to each change of direction of pipe either horizontal or vertical and as near as possible to concentrated loads.
10. Suspend rods from concrete inserts with removable nuts where suspended from concrete decks. Power actuated inserts will not be allowed.

3.08 UNIONS AND FLANGE INSTALLATION

- A. Install Watts, Epco, Nibco, or equal, dielectric unions or flanges at points of connection between copper or brass piping or material and steel pipe or material. Bushings or couplings shall not be used.
- B. Install unions in piping NPS 2" and smaller and flanges in piping NPS 2-1/2" and larger whether shown or not at each connection to equipment and tanks, and at connections to automatic valves.
- C. Locate unions for easy removal of equipment, tanks, or valves.

3.09 PIPE IDENTIFICATION

- A. Provide temporary identification of each pipe installed, at time of installation. Temporary identification shall be removed and replaced with permanent identification as part of the Work.
- B. Apply legend and flow arrow at valve locations; at points where piping enters or leaves a wall, partition, cluster of piping or similar obstruction, at each change of direction, and at approximately 20'-0" intervals on pipe runs. Variations or changes in locations and spacing may be made with approval of Architect. There shall be at least one marking in each room. Markings shall be located for maximum visibility from expected personnel approach.
- C. Wherever two or more pipes run parallel, markings shall be supplied in the same relative location on each.
- D. Apply markings after painting and cleaning of piping and insulation is completed.

3.10 TESTS AND ADJUSTMENTS

- A. Test installations in accordance with the following requirements and all applicable codes:
 1. Project Inspector should witness tests of piping systems.
 2. Notify Architect at least seven days in advance of tests.
 3. Notify local fire department of time and date of fire systems testing.
 4. Piping shall be tested at completion of roughing-in, or at other times as directed by Architect.
 5. Furnish necessary materials, test pumps, gases, instruments and labor required for testing.
 6. Isolate from system equipment that may be damaged by test pressure.
- B. Test Schedule: No loss in pressure or visible leaks shall show after four hours at pressures indicated:

<u>System Tested</u>	<u>Test Pressure PSI</u>	<u>Test With</u>
Fire Sprinkler Piping	200	Water

1. Piping, including underground piping, connected to fire sprinkler system shall be tested and certified in accordance with NFPA requirements, except where requirements listed in this Section exceed requirements of NFPA.
 2. Non-corrosive leak test fluid shall be suitable for use with piping material specified, and with type of gas conveyed by piping system.
- C. Should material or work fail in any of these tests, it shall be immediately removed and replaced with new material, and portion of work replaced shall again be tested by Contractor at his own expense.
- D. Lubricate each item of equipment, including motors, before operation.

3.11 CHECK, TEST AND START REQUIREMENTS

- A. An authorized representative of the equipment manufacturer shall perform check, test and start of each piece of fire protection equipment. The representative may be an employee of the equipment manufacturer, or a manufacturer-certified contractor. Submit written certification from the manufacturer stating that the representative is qualified to perform the check test and start of the equipment.
1. As part of the submittal process, provide a copy of each manufacturer's printed startup form to be used.
 2. Some items of specified equipment may require that check, test and start of equipment must be performed by the manufacturer, using manufacturer's employees. See specific equipment Articles in these Specifications for this requirement.
 3. Provide all personnel, test instruments, and equipment to properly perform the check, test and start work.
 4. When work has been completed, provide copies of reports for review, prior to final observation of work.
- B. Provide copies of the completed check, test and start report of each item of equipment, bound with the Operation and Maintenance Manual.
- C. Upon completion of the work, provide a schedule of planned maintenance for each piece of equipment. Indicate frequency of service, recommended spare parts and methods for adjustment and alignment of all equipment components. Provide a copy of the schedule with each operating and maintenance manual. Provide a copy of certification from the Owner's representative indicating that they have been properly instructed in maintenance requirements for the equipment installed.

END OF SECTION

SECTION 21 10 00
FIRE SPRINKLER SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Sprinkler heads.
2. Pipe and Fittings.
3. Valves.
4. Water flow alarm switch.

1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Section 21 00 50 Basic Fire Sprinkler Materials and Methods.

1.3 REFERENCES

- A. It is the intent of these Specifications to provide for complete and operating fire protection automatic sprinkler system in full compliance with the following standards:
1. National Fire Protection Association (NFPA) Standard No. 13, 2016, as amended by the CBC.
 2. CBC Chapter 9.
 3. NFPA No. 24, 2016 (as amended).
 4. NFPA No. 25, 2013 (California Edition).
- B. The work shall also be in accordance with all local or state requirements that apply.

1.4 DESCRIPTION OF WORK

- A. Work of this section includes, but is not limited to, the following:
- B. Furnish all coordination, labor, design drawings, calculations, materials, tools, and equipment to install the wet pipe automatic fire sprinkler system as described in this Specification Section. System shall be hydraulically calculated and designed for the building occupancy classification as determined by NFPA 13.
1. The Work includes, but is not limited to the following:
 - a. Complete automatic fire risers, including valves, fire department connections, flow switches, pressure switch and service mains as indicated.
 - b. Complete interior wet type automatic fire protection spray type sprinkler distribution system, including overhead service and branch mains, lateral supply piping, supports, hangers, seismic bracing, and heads
 - c. Required tests and inspections.

- d. Provide electrical work required to complete the system. Contractor shall be responsible for providing complete and operable systems, including electrical wiring. Install wiring in conduit, in accordance with Division 26.
 - e. Protected areas shall include areas above and below the finished ceilings, exterior exposure, canopies, stairways, rooms, areaways, entry, etc, and other areas requiring sprinklers. Thoroughly examine architectural and other drawings as required to satisfy this requirement.
 - f. Tags, identification labels and instruction manuals for proper operation and maintenance.
- C. Provide fire sprinklers to protect combustible building overhangs greater than 4 feet wide, as required by local authority.
- D. Determine the static and residual pressure for the site as required for accurate determination of system requirements. Base system calculations on the lowest expected static and residual pressure for the area.
- 1. Test data for static and residual pressure shall be obtained from water district or local fire department; test shall be made within the last six months prior to start of work.
 - 2. Provide calculations based on 10 percent minimum safety factor. For hydraulically calculated fire sprinkler systems the maximum velocity in the building and the fire main piping shall not exceed 15 feet per second.

1.5 DRAWINGS

- A. Contractor shall thoroughly examine architectural, structural, and other Drawings provided as part of this Contract.
- B. Number of sprinkler heads indicated on Contract Drawings shall not be reduced. Provide additional heads required for coordination and to obtain approvals. Coordinate suitable head locations and spacing with Architect.

1.6 QUALITY ASSURANCE

- A. Manufacturers: Firms regularly engaged in manufacture of fire protection products, of types, materials, and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.
- B. Installer Qualifications: A firm with at least five years of successful installation experience on projects with fire sprinkler piping systems similar to that required for this Project.
 - 1. A State of California Fire Protection Contractor's license (C-16) is required.
- C. Fire Sprinkler Fitter Certification:
 - 1. Automatic fire extinguishing systems sprinkler pipefitters shall be certified by Office of the State Fire Marshall (OSFM).
- D. Design Criteria: Provide complete fire protection systems as indicated and as required by authority having jurisdiction.
 - 1. When there is conflict between requirements of authority having jurisdiction or requirements of other agencies and these Drawings and Specifications, requirements of authority having jurisdiction and recommendations of standards agencies shall govern.

2. Design and install entire system in accord with applicable codes, standards, and regulations.
3. The automatic sprinkler system shall conform to requirements of the National Fire Protection Association, Standard No. 13, as amended by the CBC. Contractor shall hydraulically calculate sprinkler system in accordance with NFPA 13.
4. Drawings are diagrammatic only to indicate rooms/areas of sprinkler protection and piping clearances when appropriate. Rerouting of pipe and addition, deletion or relocation of heads may be necessary. Submit proposed layout for approval prior to start of installation.
5. FM Compliance: Comply with Factory Mutual "Approval Guide."
6. Supply equipment and accessories in accordance with requirements of all applicable national, state and local codes.
7. Items of a given type shall be the products of the same manufacturer.
8. Scheduled equipment performance is minimum capacity required.
9. Scheduled electrical capacity shall be considered as maximum available.

1.7 COORDINATION

- A. Coordinate Work in this Section with trades covered in other Sections of Specifications to provide a complete and operable installation of highest quality workmanship.
- B. Coordinate location of fire protection piping, mains and branches, to avoid interference with work by other trades. Plumbing drainage piping and ductwork shall have right-of-way over fire protection piping. Wherever conflicts exist, fire protection piping shall be offset or rerouted at no additional cost to Owner. Provide locations of piping for use in Coordinated Layout called for in Specification Section 23 80 00.
- C. Piping shall be concealed, except where so indicated or where absolutely necessary to be exposed. Exposed piping shall be placed as approved by Architect prior to installation. Heads shall be fully coordinated with architectural reflected ceiling plan and placed in center of ceiling tiles.
- D. On-site measurement of pipe will be required. Offsets, pipe, fittings, drains, etc., required to meet job conditions shall be furnished and installed at no extra cost to Owner.
- E. Additional heads required by NFPA 13 regulations shall be provided at no extra cost, if required as a result of Contractors' coordination. Location of heads and mains shall not be changed unless approved by Architect.
- F. Coordinate layout and installation of sprinklers with other construction penetrating ceilings, including light fixtures, HVAC equipment, and partition assemblies.
- G. The Architect shall decide any differences or disputes concerning coordination, interference or extent of work, and his decision shall be final.

1.8 SUBMITTALS

- A. Samples: Provide one sample of each sprinkler head type.
- B. Shop Drawings: Submit in accordance with Division 01, and as follows:

1. Prepare Drawings, calculations, and product data of fire protection systems indicating pipe sized, pipe locations, fittings, shutoffs, equipment, etc. Note, in bold type, any piping which will project beyond finished surfaces of normally occupied rooms, exterior of the building or other locations which will expose the system to view.
 2. Layout drawings and flow calculations approved by agencies having jurisdiction.
 3. Drawings and calculations shall be stamped and signed by a State of California licensed professional engineer prior to submission to the Architect. Engineer shall be qualified for this work.
- C. Manufacturer's data for each item of material or equipment used.
- D. Welding operator qualification certificates.
- E. Office of the State Fire Marshall (OSFM) certification cards for automatic fire extinguishing systems sprinkler pipefitters.
- F. Test Reports: As indicated in paragraph "Tests".
1. Sprinkler pressure test.
 2. Alarm system test.
 3. Underground piping test.
- G. Operation and Maintenance Manual:
1. Operation and Maintenance Manual in accordance with Section 21 00 50. Include an original copy of NFPA 25, California edition, in Operation and Maintenance Manual for fire sprinkler system.
 2. Guarantees in accordance with Division 01.
- H. Deferred Approval Documents: Do not proceed with fabrication or installation of fire sprinkler system until deferred approval documents have been approved by regulatory agencies.
1. General: Provide detailed drawings, specifications, and calculations prepared by a State of California licensed professional engineer.
 - a. Documents produced by the Contractor shall be stamped and signed by the licensed mechanical engineer responsible for their preparation.
 2. Architect Review: Make additions, changes and corrections as directed by Architect and resubmit.
 3. Agency Review: Architect will submit documents to Agency or Authority Having Jurisdiction. Make additions, changes and corrections required by Agency / Authority at no cost to Owner and resubmit to Architect.
 4. Agency Approval: Architect will submit documents to Agency / Authority for final approval.

1.9 APPLICABLE PUBLICATIONS

- A. The following publications form a part of this specification:
1. ANSI - American National Standards Institute.
 2. ASME - American Society of Mechanical Engineers.
 3. UL - Underwriters' Laboratories, Inc. Fire Resistance Directory.

4. CBC – 2022 California Building Code.
5. NFPA National Fire Protection Standards as amended by the CBC.
6. CFC – 2022 California Fire Code.
7. CPC – 2022 California Plumbing Code.

1.10 SUPERVISION

- A. Keep a competent superintendent on the job that shall coordinate the activities of the crafts and maintain the progress of the work to the satisfaction of the Architect.

1.11 SITE CONDITIONS

- A. Verify all dimensions at the building site and check existing conditions before beginning work. Make changes that are necessary to coordinate the work with other trades, after review by the Architect.

1.12 REGULATIONS

- A. All work shall be installed in strict conformity with California Building Code (CBC), California Plumbing Code (CPC), and California Electric Codes (CEC), Industrial Safety Orders, California Mechanical Code (CMC), California Fire Code (CFC), and other laws and regulations of authorities having jurisdiction.

1.13 FEES AND PERMITS

- A. Take out permits and pay fees and charges required in connection with the Work.

1.14 TEMPORARY CONNECTIONS

- A. Temporary connections required to maintain services during the course of the Contract shall be made without additional cost to Owner. The normal function of the building must not be interrupted; notify Owner minimum seven days in advance before interrupting any service.

PART 2 - PRODUCTS

2.1 GENERAL

- A. The equipment to be furnished under this Specification shall be standard product of manufacturer. Where two or more units of the same class of equipment are required, these units shall be products of a single manufacturer; however, component parts of system need not be products of the same manufacturer.

2.2 MATERIALS AND EQUIPMENT

- A. Unless otherwise shown on Drawings, specified, or directed by Architect, materials and equipment used in installation of sprinkler systems shall be listed as approved by FM or UL for fire protection systems, and shall be the latest design of the manufacturer.

2.3 SPRINKLER HEADS

- A. Provide spray pattern type sprinkler heads, of ordinary degree temperature rating, except that sprinkler heads for installation in vicinity of heating equipment, and in other areas

noted on Drawings, shall have temperature ratings required for such locations by NFPA 13.

- B. Sprinkler heads shall be upright, pendent, or sidewall, as required.
 - 1. Heads in ceilings of occupied spaces with recessed lights shall be chrome plated, semi-recessed pendent type, with white escutcheon.
 - 2. Sprinkler heads in rooms with surface mounted lights shall be chrome plated pendant style, with two-piece white escutcheon.
 - 3. Provide head guards in equipment rooms and storage rooms and all other locations where subject to damage.
 - 4. Upright heads in areas with no ceilings shall be rough bronze finish.
 - 5. Provide quick response type heads in light and ordinary hazard occupancies.
 - 6. Side wall heads may be used (except in extended coverage type) to cover special areas where overhead piping and heads are impractical or a considered visual problem by the Architect or Owner. Side wall heads shall be chrome finish.
 - 7. Outdoor heads, if required shall be dry or freeze resistant.
 - 8. Adjustable drop nipples are not acceptable.
- C. Recessed sprinkler heads shall have chrome finish and adjustable chrome finish escutcheons; exposed pendent heads in finished ceilings shall have chrome finish and white ceiling escutcheons. Concealed (flush) heads shall be all brass, with white cover plate.
 - 1. Provide oversized escutcheons where required to meet the requirements of ASCE 7.
- D. Spare Heads: Furnish spare heads equal to one percent of total number of heads installed under Contract, but not less than twelve. Spare head types furnished shall be representative of types and temperature ratings of heads installed, and in proportion to number of each type and temperature rating of heads installed. Furnish not less than two sprinkler head wrenches, with at least one wrench for each type of sprinkler head installed. Place spare heads and wrenches in wall mounted box manufactured for this purpose.

2.4 PIPE AND FITTINGS

- A. For Installation Aboveground: 150 PSI, Schedule 40 black steel pipe, ASTM A-53 with ductile or cast iron screwed fittings.
 - 1. Schedule 10 black steel pipe, ASTM A 135 or ASTM A 795, with grooved fittings and associated couplings may be used for pipe sizes 2 inches through 5 inches. Provide NFPA 13-specified wall thickness for pipe sizes 6 inches through 10 inches. Threading of piping will not be accepted.
- B. For Installation Underground to 12 inches Above Ground:
 - 1. Pipe and fittings shall be approved for fire protection use.
 - 2. Underground Piping Outside Building: PVC Pipe: AWWA C900 or UL 1285, Class 200, with bell end with gasket, and with spigot end. PVC Fittings: AWWA C900 or UL 1285, Class 200, with bell-and-spigot or double-bell ends. Include elastomeric gasket in each bell.

- a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:
 - 1) Diamond Plastics Corporation.
 - 2) J.M. Eagle, Inc.
- 3. Underground Piping Below Building Footing and Slab: One-piece, 304 stainless steel 90-degree fitting, with AWWA C900 bell-and-spigot gasketed inlet connection with lugs on inlet end, and AWWA C606 groove on outlet end, for connection to in-building riser using AWWA C606 grooved couplers and gaskets.
 - a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:
 - 1) Ames Fire and Waterworks, a Watts Water Technologies Company.
 - 2) Wilkins, a Zurn Company.
- C. Mechanical tees, saddle fittings, bushings and mechanical sprinkler head fittings shall not be used.

2.5 ENCASEMENT FOR PIPING

- A. Standard: ASTM A 674 or AWWA C105.
- B. Material: Linear low-density PE film of 0.008-inch minimum thickness.
- C. Form: Tube.
- D. Color: Natural.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:
 - a. Northtown Pipe Protection Products; Polywrap.

2.6 VALVES

- A. Angle, Check, and Globe Valves: Fed. Spec WW-V-51; Class A, type as suitable for application.
 - 1. Select check valves for installation in vertical lines recommended by manufacturer as suitable for vertical installation. Install in vertical lines only where flow is upward.
- B. Gate Valves:
 - 1. Sizes 1-1/2 inches or less: Fed. Spec WW-V-54, Class A.
 - 2. Sizes above 1-1/2 inches: Fed. Spec WW-V-58, Class A, designation OS or OF, as required. Provide OS&Y type, 175 pound rated working pressure.
 - 3. Furnish and deliver to Owner one wrench of each size required for operating underground valves.
- C. Drain Valves: angle, or globe. Fed. Spec WW-V-51; Class A, type as suitable for application.
 - 1. UL listed and FM approved combination test and drain fittings may be used.

- D. Zone Control Valves: UL listed, outside screw and yoke or butterfly. Valves shall be sealed open with approved seal. Provide weatherproof actuator housing, with two single pole, double throw switches.
 - 1. Supervisory Switch: Fit the control valves on the fire sprinkler risers with supervisory switch, with single pole double throw switch actuator installed to change switch position when valve is being closed.
- E. Sprinkler Inspector's Test Fittings:
 - 1. Standard: UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."
 - 2. Pressure Rating: 175-psig minimum.
 - 3. Body Material: Cast- or ductile-iron housing with sight glass.
 - 4. Integral factory or field-installed pressure relief valve.
 - 5. Size: Same as connected piping.
 - 6. Inlet and Outlet: Threaded.

2.7 WATER FLOW ALARM SWITCH

- A. UL listed water flow alarm switch suitable for variable pressure, complete with instantaneous recycling retard and two single pole double throw electrical contacts. Provide continuously monitored water flow alarm switch and trouble sensor, automatically transmitted to an approved control alarm station.

2.8 UNION AND FLANGES

- A. Size and Type:
 - 1. Steel 2 inches and smaller: 150 pound screwed black or galvanized malleable iron, match pipe, ground joint, brass to iron seat.
 - 2. Steel 2-1/ inches and larger: 150 pound black flange union, flat faced, full gasket.
- B. Gaskets: 1/16 inch thick rubber Garlock #122, Johns-Manville, or equal.
- C. Flange Bolts: Open hearth bolt steel, square heads, with cold pressed hexagonal nuts, cadmium plated when installed below ground. Provide copper plated steel bolts and nuts or brass bolts and nuts for brass flanges.

2.9 GAUGES

- A. Marsh "Quality Gage", U.S. Gage, Danton 800, or equal, U.L. listed, with bronze bushed movement and front recalibration. Dials shall be white with black numerals, 3-1/2 inch dial face. Normal reading shall be at midscale. Provide a three-way valve on each gauge connection.

PART 3 - EXECUTION

3.1 GENERAL

- A. Installation of the sprinkler system shall not be started until complete plans and specifications (including water supply information and type of existing sprinkler system, if any) have been approved by the State Fire Marshal.
 - 1. Piping shall be concealed unless shown or otherwise directed.

2. Where piping is left exposed within a room, it shall be run true to vertical, horizontal or intended planes. Where possible, uniform margins shall be maintained between parallel lines and/or adjacent wall, floor or ceiling surfaces.
3. Horizontal runs of pipes and/or electrical conduit suspended from ceilings shall provide for maximum headroom clearance. This clearance shall not be less than 6'-6" without written approval from Architect.
4. Minor changes in locations of equipment, piping, etc., from locations shown shall be made when directed by Architect at no additional cost to Owner, providing such change is ordered before such items of work, or work directly connected to same, are installed and providing no additional material is required.
5. Grade all piping as required by NFPA 13.
6. Close ends of pipe immediately after installation; leave closure in place until removal is necessary for completion of installation.
7. Piping systems shall be thoroughly flushed and proved clean before connection to equipment.
8. Pipe discharge of each drain valve to floor sink or drain.

3.2 HANGER AND SUPPORT INSTALLATION

- A. General: Support piping so that it is firmly held in place by approved iron hangers and supports and by special hangers as required in accordance with NFPA 13. Hangers shall support loads specified in NFPA 13, and, in addition, shall support weight of pipe, fluid and pipe insulation, based on spacing between supports with minimum factor of safety of five based on ultimate strength of material used. Do not exceed manufacturer's load rating. Pipe attachments, or hangers, shall be of same size as pipe or tubing on which used, or nearest larger size available. Materials, design, and type numbers per Manufacturers' Standardization Society (MSS) Standard Practice SP-58, provide branch line restraints where hangers exceed 6 inches long, in accordance with NFPA 13. Install concrete anchors required. Hanger material shall be approved by Architect before installation. Do not support piping by plumbers' tape, wire, rope, wood or other makeshift devices.
- B. Suspend rods from angle clips, in accordance with Section 21 00 50.

3.3 SEISMIC REQUIREMENTS

- A. Comply with CBC, Volume 2, Chapter 16A and CBC Chapter 9 and NFPA 13.
- B. Seismic bracing system shall be a complete pre-engineered bracing system. Pre-engineered bracing system shall include plan layout, brace selection, specification, and calculations. Complete system shall be submitted to Architect for review. See Delegated Design Submittal paragraph in article, Submittals, in Section 21 00 50.
- C. Anchorage for various manufactured and fabricated items is detailed and scheduled on the drawings or specified.
 1. For proposed changes to anchorage shown, or specified, submit proposed methods of anchorage with calculations prepared by a California Registered Structural Engineer. Design of anchorage shall comply with the above regulations using minimum coefficients, CP, listed CBC Chapter 16A.
- D. It is not intended that prototype or non-standard equipment or equipment frames be provided. However, items of equipment shown or specified to be anchored shall maintain

integrity at point of anchor after being subjected to accelerations equivalent to those established herein.

- E. Anchors: Piping shall be provided with anchors for protection of piping against damage due to earthquakes, as required by CBC Chapter 16A, NFPA 13, and other sections of this Specification.

3.4 TESTS

- A. At various stages and upon completion, the system must be tested in the presence of the enforcing agency.
- B. Upon completion and prior to acceptance of the installation, subject entire new system to tests required in NFPA 13, and furnish Owner with certificates as appropriate.

3.5 IDENTIFICATION

- A. Coordinate requirements with the authority having jurisdiction.
- B. Provide brass valve tags at each system valve, indicating valve service.
- C. Provide signage at each sprinkler valve, with sign indicating specific portion of system controlled by valve.
- D. Provide signage at each outdoor alarm device, with sign indicating which authority to call if device is activated.
- E. Prior to final acceptance, Contractor shall provide accurate color-coded Building Plan at riser location, clearly depicting fire protection system area of coverage, location of inspectors' test/drain connection and auxiliary drain connections. Provide this information at each system or building at riser location for building. Plan(s) shall be one-half size and plastic laminated.
- F. Provide hydraulic data signage permanently attached to risers, indicating location, basis of design, water supply and pressure requirements of system.

3.6 ELECTRICAL WIRING

- A. Coordination of wiring systems is part of this work. Contractor shall ensure that the following is completed.
 - 1. Work provided in other Specification Sections:
 - a. Supervised wiring to fire alarm control panel.
 - b. Supervised wiring from main waterflow indicator to fire alarm panel.
 - c. Supervised wiring from sprinkler flow switches to fire alarm panel.
 - d. Supervised wiring from valve water flow alarm switches to fire alarm panel.
 - 2. Work provided in this Specification Section:
 - a. Wiring diagrams for devices.
 - b. Other wiring not specified to provide an operating system.

3.7 SPRINKLER HEAD INSTALLATION

- A. Heads shall be placed upright where on exposed piping, unless otherwise noted, and in pendant position on concealed piping, unless noted otherwise, with deflectors parallel to the ceiling or roof slope. Clearance between deflectors and ceilings, electric, or heating equipment, or other obstruction shall be in accordance with the requirements of NFPA 13. Provide sprinkler head guards where heads are subject to mechanical damage, for example, at mechanical rooms, and storage rooms and gymnasiums.
- B. Mount box containing spare sprinkler heads and wrenches on wall in location selected by Owner.
- C. Do not install pendent sprinkler heads until flushing of piping has been completed.
- D. Provide return bend as illustrated in NFPA 13 (NFPA exceptions do not apply) for each sprinkler head installed in finished ceiling.

3.8 PIPING INSTALLATION

- A. Pipe shall be assembled in accordance with the applicable requirements of NFPA 13 and NFPA 24.
- B. Install pipe encasement on underground and under-slab metal piping.
- C. Provide concrete thrust blocks for underground and underslab piping in accordance with NFPA 24 and CBC.

3.9 VALVE IDENTIFICATION

- A. All valves shall be identified by permanent metal tags or other approved means.

3.10 DRAIN INSTALLATION

- A. Auxiliary drains shall be installed on low points in each system.
 - 1. Five or fewer trapped gallons will not require a drain valve but may be drained through a plugged fitting. Drain valves shall be in accordance with the requirements of NFPA 13.
- B. Install one inspector's test drain on sprinkler system. Extend drain to outside in location approved by Architect. Water discharge shall be positioned such that landscaping will not be damaged.
- C. Drain valves shall be piped to a safe place of discharge and discharge shall be visible either by open-end drainpipe or sight drain fitting.
- D. Provide flushing connections at ends of cross-mains.

3.11 SLEEVE INSTALLATION

- A. Install AMI Products, Adjus-to-Crete, or equal, pipe sleeves of sufficient size to allow for free motion of pipe, 24 gauge galvanized steel. The space between pipe and sleeves through floor slabs on ground, through outside walls above or below grade, through roof, and other locations as directed shall be caulked with oakum and mastic and made watertight. The space between pipe and sleeve and between sleeve and slab or wall shall be sealed watertight.

- B. At walls below grade Link-Seal casing seals, or equal, may be used in lieu of caulking. Pipes penetrating walls below grade shall be anchored at wall.

3.12 FLOOR, WALL, AND CEILING PLATE INSTALLATION

- A. Fit pipes with or without insulation passing through walls, floors, or ceilings and hanger rods penetrating finished ceilings with chrome plated or stainless steel plates.

3.13 FIRESTOPPING

- A. The annular space between pipe sleeves and pipe passing through all floors and walls shall be packed with incombustible mastic or other suitable material, in accordance with U.L. Fire Resistance Directory.
- B. Penetrations in fire rated assemblies shall also be protected in accordance with CBC Chapter 7, Section 712, and UL Fire Resistance Directory.

3.14 UNION AND FLANGE INSTALLATION

- A. Install unions whether shown or not at each connection to equipment and at one connection to each valve or cock.
- B. Locate the unions for easy removal of the equipment or valve.

3.15 CLEANING

- A. Upon completion of tests, clean equipment, piping, etc., installed under this Section of the Specifications.

3.16 PIPING SYSTEM FLUSHING

- A. Entire system shall be flushed out and cleaned after completion of piping, and prior to installation of sprinkler heads. Flush shall be continued until water runs clear at drain connections.

END OF SECTION

SECTION 22 00 50

BASIC PLUMBING MATERIALS AND METHODS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Electric motors.
2. Motor starters.
3. Strainers.
4. Valve boxes.
5. Gauges.
6. Thermometers.
7. Access Doors.
8. Expansion loops.
9. Flexible joints.
10. Insulation.

1.2 RELATED REQUIREMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. This Section is a part of each Division 22 Section.

1.3 ADDITIONAL REQUIREMENTS

- A. Furnish and install any incidental work not shown or specified which is necessary to provide a complete and workable system.
- B. Make all temporary connections required to maintain services during the course of this Contract without additional cost to the Owner. Notify the Owner seven days in advance before disturbing any service.
- C. Plumbing work done under this contract shall not adversely affect the operation of the existing plumbing systems.

1.4 REFERENCES AND STANDARDS

- A. Where material or equipment is specified to conform to referenced standards, it shall be assumed that the most recent edition of the standard in effect at the time of bid shall be used.
1. CSA – Canadian Standards Association International.
 2. ANSI - American National Standards Institute.
 3. ASTM - American Society for Testing and Materials.
 4. CCR - California Code of Regulations.

- a. Title 8 - Division of Industrial Safety, Subchapter 7; General Industry Safety Orders, Articles 31 through 36.
5. NCPWB - National Certified Pipe Welding Bureau.
6. CEC - California Electrical Code.
7. NEMA - National Electrical Manufacturers' Association.
8. NFPA - National Fire Protection Association.
9. OSHA - Occupational Safety and Health Act.
10. UL - Underwriters' Laboratories, Inc.
- B. Requirements of Regulatory Agencies:
 1. The publications listed below form part of this specification; comply with provisions of these publications except as otherwise shown or specified.
 - a. California Building Code, 2022.
 - b. California Electrical Code, 2022.
 - c. California Energy Code, 2022.
 - d. California Fire Code, 2022.
 - e. California Green Building Standards Code, 2022.
 - f. California Mechanical Code, 2022.
 - g. California Plumbing Code, 2022.
 - h. California Code of Regulations, Title 24.
 - i. California Health and Safety Code.
 - j. CAL-OSHA.
 - k. California State Fire Marshal, Title 19 CCR.
 - l. National Fire Protection Association.
 - m. Occupational Safety and Health Administration.
 - n. Other applicable state laws.
 2. Nothing in Drawings or specifications shall be construed to permit work not conforming to these codes, or to requirements of authorities having jurisdiction. It is not the intent of Drawings or specifications to repeat requirements of codes except where necessary for clarity.

1.5 DRAWINGS

- A. Examine Contract Documents prior to bidding of work and report discrepancies in writing to Architect.
- B. Drawings showing location of equipment and materials are diagrammatic and job conditions will not always permit installation in location shown. The Plumbing Drawings show general arrangement of equipment and materials, etc., and shall be followed as closely as existing conditions, actual building construction, and work of other trades permit.
 1. Architectural and Structural Drawings shall be considered part of the Work. These Drawings furnish Contractor with information relating to design and construction of the Project. Architectural Drawings take precedence over Plumbing Drawings.

2. Because of the small scale of Plumbing Drawings, not all offsets, fittings, and accessories required are shown. Investigate structural and finish conditions affecting the Work and arrange Work accordingly. Provide offsets, fittings, and accessories required to meet conditions. Inform Architect immediately when job conditions do not permit installation of equipment and materials in the locations shown. Obtain the Architects approval prior to relocation of equipment and materials.
 3. Relocate equipment and materials installed without prior approval of the Architect. Remove and relocate equipment and materials at Contractors' expense upon Architects' direction.
 4. Minor changes in locations of equipment, piping, etc., from locations shown shall be made when directed by the Architect at no additional cost to the Owner providing such change is ordered before such items of work, or work directly connected to same are installed and providing no additional material is required.
- C. Execute work mentioned in Specifications and not shown on Drawings, or vice versa, the same as if specifically mentioned or shown in both.

1.6 FEES AND PERMITS

- A. Obtain and pay for all permits and service required in installation of this work; arrange for required inspections and secure approvals from authorities having jurisdiction. Comply with requirements of Division 01.
- B. Arrange for utility connections and pay charges incurred, including excess service charges.
1. Bear the cost of construction related to utility services, from point of connection to utility services shown on Contract Documents. This includes piping, excavation, backfill, meters, boxes, check valves, backflow prevention devices, general service valves, concrete work, and the like, whether or not Work is performed by Contractor, local water/sanitation district, public utility, other governmental agencies or agencies' assigns.
- C. Prior to the start of construction, contact local gas company representative and coordinate location of gas meter and piping. In addition, coordinate time required for installation, in order to avoid delay to the Project.
- D. Obtain permits to operate compressed air tanks required to be furnished under this Work. Pay costs, and perform tests required to obtain permits. Post permits under glass in a conspicuous place on or near tanks, or as required by authorities having jurisdiction.
- E. Coordination:
1. General:
 - a. Coordinate plumbing Work with trades covered in other Specifications Sections to provide a complete, operable and sanitary installation of the highest quality workmanship.
 2. Electrical Coordination:
 - a. Refer to the Electrical Drawings and Specifications, Division 26, for service voltage and power feed wiring for equipment specified under this section. Contractor has full responsibility for the following items of work:

- 1) Review the Electrical Drawings and Division 26 Specifications to verify that electrical services provided are adequate and compatible with equipment requirements.
 - 2) If additional electrical services are required above that indicated on Electrical Drawings and in Division 26, such as more control interlock conductors, larger feeder, or separate 120 volt control power source, include cost to furnish and install additional electrical services as part of the bid.
 - 3) Prior to proceeding with installation of additional electrical work, submit detailed drawings indicating exact scope of additional electrical work.
3. Mechanical Coordination:
- a. Arrange for pipe spaces, chases, slots and openings in building structure during progress of construction, to accommodate mechanical system installation.
 - b. Coordinate installation of supporting devices. Set sleeves in poured-in-place concrete and other structural components during progress of construction.
 - c. Coordinate requirements for access panels and doors for mechanical items requiring access where concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section "Access Doors and Frames."
 - d. Coordinate with other trades equipment locations, pipe, duct and conduit runs, electrical outlets and fixtures, air inlets and outlets, and structural and architectural features. Provide information on location of piping and seismic bracing to other trades as required for a completely coordinated project.

1.7 SUBMITTALS - GENERAL

- A. Refer to Division 01 Submittals Section(s) for additional requirements.
- B. Submittal packages may be submitted via email as PDF electronic files, or as printed packages. PDFs shall be legible at actual size (100 percent). Provide seven copies of printed submittal packages.
- C. Provide submittal of materials proposed for use as part of this Project. Product names in Specifications and on Drawings are used as standards of quality. Furnish standard items on specified equipment at no extra cost to the Contract regardless of disposition of submittal data. Other materials or methods shall not be used unless approved in writing by Architect. Architect's review will be required even though "or equal" or synonymous terms are used.
1. Partial or incomplete submittals will not be considered.
 2. Quantities are Contractor's responsibility and will not be reviewed.
 3. Provide materials of the same brand or manufacturer for each class of equipment or material.
 4. Identify each item by manufacturer, brand, trade name, number, size, rating, or other data necessary to properly identify and review materials and equipment. Words "as specified" are not sufficient identification.
 5. Identify each submittal item by reference to items' Specification Section number and paragraph, by Drawing and detail number, and by unit tag number.
 6. Organize submittals in same sequence as in Specification Sections.

7. Show physical arrangement, construction details, finishes, materials used in fabrications, provisions for piping entrance, access requirements for installation and maintenance, physical size, mechanical characteristics, foundation and support details, and weight.
 - a. Submit Shop Drawings, performance curves, and other pertinent data, showing size and capacity of proposed materials.
 - b. Specifically indicate, by drawn detail or note, that equipment complies with each specifically stated requirement of Contract Documents.
 - c. Drawings shall be drawn to scale and dimensioned (except schematic diagrams). Drawings may be prepared by vendor but must be submitted as instruments of Contractor, thoroughly checked and signed by Contractor before submission to Architect for review.
 - d. Catalog cuts and published material may be included with supplemental scaled drawings.
- D. Review of submittals will be only for general conformance with design concept and general compliance with information given in Contract Documents. Review will not include quantities, dimensions, weights or gauges, fabrication processes, construction methods, coordination with work of other trades, or construction safety precautions, which are sole responsibility of Contractor. Review of a component of an assembly does not indicate acceptance of an assembly. Deviations from Contract Documents not clearly identified by Contractor are Contractor's responsibility and will not be reviewed by Architect.
- E. Within reasonable time after award of contract and in ample time to avoid delay of construction, submit to Architect Shop Drawings or submittals on all items of equipment and materials provided. Provide submittal in at least seven copies and in complete package.
 1. Shop Drawings and submittals shall include Specification Section, Paragraph number, and Drawing unit symbol or detail number for reference. Organize submittals into booklets for each Specification section and submit in loose-leaf binders with index. Deviations from the Contract Documents shall be prominently displayed in the front of the submittal package and referenced to the applicable Contract requirement.
- F. Furnish to the Project Inspector complete installation instructions on material and equipment before starting installation.

1.8 ACTION SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data and installation instructions for plumbing systems materials and products.
- B. Shop Drawings.
- C. Pipe, pipe or plumbing fittings, fixtures, solder and flux installed in a system providing water for human consumption shall comply with lead free requirements of the California Health and Safety Code Section 11 68 75. Provide submittal information for products third-party certified by an approved laboratory as complying with California Health and Safety Code Section 11 68 75.
- D. Delegated-Design Submittals: For seismic supports, anchorages, restraints, and vibration isolators indicated to comply with performance requirements and design criteria.

1. Calculations performed for use in selection of seismic supports, anchorages, and restraints shall utilize criteria indicated in Structural Contract Documents.
2. Include design calculations and details for selecting vibration isolators and vibration isolation bases complying with performance requirements, design criteria, and analysis data signed and sealed by the California registered structural engineer responsible for their preparation.
3. Supports, anchorages and restraints for piping, ductwork, and equipment shall be an HCAI pre-approved system such as TOLCO, ISAT, Mason, or equal. Pipes, ducts and equipment shall be seismically restrained in accordance with requirements of current edition of California Building Code. System shall have current OPM number and shall meet additional requirements of authority having jurisdiction. Provide supporting documentation required by the reviewing authority and the Architect and Engineer. Provide layout drawings showing piping, ductwork and restraint locations.
 - a. Bracing of Piping and Equipment: Specifically state how bracing attachment to structure is accomplished. Provide shop drawings indicating seismic restraints, including details of anchorage to building. In-line equipment must be braced independently of piping, and in conformance with applicable building codes. Provide calculations to show that pre-approval numbers have been correctly applied in accordance with general information notes of pre-approval documentation.
 - b. In lieu of the above or for non-standard installations not covered in the above pre-approved systems, Contractor shall provide layout drawings showing piping, ductwork, and restraint locations, and detail supports, attachments and restraints, and furnish supporting calculations and legible details sealed by a California registered structural engineer, in accordance with the 2022 California Building Code
4. Additional Requirements: In addition to the above, conform to all state and local requirements.

1.9 INFORMATIONAL SUBMITTALS

- A. Provide layouts for plumbing systems, for inclusion in coordinated layout specified in Section 23 80 00. Comply with requirements for layouts specified in Section 23 80 00.

1.10 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data:

1. Refer to Division 01 for complete instructions.
2. Furnish three complete sets of Operation and Maintenance Manual bound in hardboard binder, and one compact disc containing complete Operation and Maintenance Manual in searchable PDF format. Provide Table of Contents. Provide index tabs for each piece of equipment in binder and disc. Begin compiling data upon approval of submittals.
 - a. Sets shall incorporate the following:
 - 1) Product Data.
 - 2) Shop Drawings.
 - 3) Record Drawings.

- 4) Service telephone number, address and contact person for each category of equipment or system.
 - 5) Complete operating and maintenance instructions for each item of plumbing equipment and systems.
 - 6) Copies of guarantees/warranties for each item of equipment and systems.
 - 7) Test data and system balancing reports.
 - 8) Typewritten maintenance instructions for each item of equipment listing lubricants to be used, frequency of lubrication, inspections required, adjustment, etc.
 - 9) Manufacturers' bulletins with parts numbers, instructions, etc., for each item of equipment.
 - 10) Control diagrams and literature.
 - 11) A complete list or schedule of all scheduled valves giving the number of the valve, location and the rooms or area controlled by the valve. Identify each valve with a permanently attached metal tag stamped with number to match schedule. Post list in frame under plastic on wall in mechanical room or where directed by Architect.
 - 12) Check test and start reports for each piece of plumbing equipment provided as part of the Work.
 - 13) Commissioning and Preliminary Operation Tests required as part of the Work.
- b. Post service telephone numbers and/or addresses in an appropriate place as designated by the Architect.

B. Record Drawings:

1. Refer to Division 01, Record Documents, for requirements governing Work specified herein.
2. Upon completion of the work, deliver to Architect the following:
 - a. Originals of drawings showing the Work exactly as installed.
 - b. One complete set of reproducible drawings showing the Work exactly as installed.
 - c. One compact disc with complete set of drawings in PDF format showing the Work exactly as installed.
 - d. Provide Contractor's signature, verifying accuracy of record drawings.
 - e. Obtain the signature of the Project Inspector for all record drawings.

1.11 SUBSTITUTIONS

- A. Refer to Division 01 for complete instructions. Requirements given below are in addition to or are intended to amplify Division 01 requirements. In the case of conflict between requirements given herein and those of Division 01, Division 01 requirements shall apply.
- B. It is the responsibility of Contractor to assume costs incurred because of additional work and or changes required to incorporate proposed substitute into the Project. Refer to Division 01 for complete instructions.
- C. Substitutions will be interpreted to be all manufacturers other than those specifically listed in the Contract Documents by brand name, model or catalog number.

- D. Only one request for substitution will be considered for each item of equipment or material.
- E. Substitution requests shall include the following:
 - 1. Reason for substitution request.
 - 2. Complete submittal information as described herein; see "Submittals."
 - 3. Coordinated scale layout drawings depicting position of substituted equipment in relation to other work, with required clearances for operation, maintenance and replacement.
 - 4. List optional features required for substituted equipment to meet functional requirements of the system as indicated in Contract Documents.
 - 5. Explanation of impact on connected utilities.
 - 6. Explanation of impact on structural supports.
- F. Installation of reviewed substitution is the Contractors' responsibility. Any mechanical, electrical, structural, or other changes required for installation of reviewed substituted equipment or material must be made by the Contractor without additional cost to the Owner. Review by the Architect of the substituted equipment or material, including dimensioned Drawings will not waive these requirements.
- G. Contractor may be required to compensate the Architect for costs related to substituted equipment or material.

1.12 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of plumbing systems products, of types, materials, and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.
- B. Contractor's Qualifications: Firm with at least 5 years of successful installation experience on projects with plumbing systems work similar to that required for this Project.
- C. California Health and Safety Code Compliance: For products covered under the scope of HSC 116875 for potable water service. Products for potable water service shall be third-party certified by an approved laboratory as complying with California Health and Safety Code Section 11 68 75.
- D. Comply with applicable portions of California Plumbing Code pertaining to selection and installation of plumbing materials and products.
- E. All materials and products shall be new and shall match existing.

1.13 DELIVERY, STORAGE, AND HANDLING

- A. Protect equipment and piping delivered to Project site from weather, humidity and temperature variations, dirt, dust and other contaminants.

1.14 FIELD CONDITIONS

- A. Contractor shall visit Project site and examine existing conditions in order to become familiar with Project scope. Verify dimensions shown on Drawings at Project site. Bring discrepancies to the attention of Architect. Failure to examine Project site shall not

constitute basis for claims for additional work because of lack of knowledge or location of hidden conditions that affect Project scope.

- B. Information on Drawings relative to existing conditions is approximate. Deviations from Drawings necessary during progress of construction to conform to actual conditions shall be approved by the Architect and shall be made without additional cost to the Owner. The Contractor shall be held responsible for damage caused to existing services. Promptly notify the Architect if services are found which are not shown on Drawings.

1.15 WARRANTY

- A. Refer to Division 01 for warranty requirements, and duration and effective date of Contractor's Standard Guarantee.
- B. Repair or replace defective work, material, or part that appears within the warranty period, including damage caused by leaks.
- C. On failure to comply with the warranty requirements within a reasonable length of time after notification is given, the Architect/Owner shall have the repairs made at the Contractor's expense.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Materials or equipment of the same type shall be of the same brand wherever possible. All materials shall be new and in first class condition.
- B. All sizes, capacities, and efficiency ratings shown are minimum, except that gas capacity is maximum available.
- C. Refer to Sections 22 10 00 and 23 80 00 for specific system piping materials.

2.2 MATERIALS AND PRODUCTS

- A. No material installed as part of this Work shall contain asbestos.
- B. Insulation products, including insulation, insulation facings, jackets, adhesives, sealants and coatings shall not contain polybrominated diphenyl ethers (PBDEs) in penta, octa, or deca formulations in amounts greater than 0.1 percent (by mass).

2.3 ELECTRIC MOTORS

- A. General Motor Requirements: Comply with NEMA MG 1 unless otherwise indicated. Comply with IEEE 841 for severe-duty motors.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:
 - a. U.S. Motors.
 - b. Century Electric.
 - c. General Electric.
 - d. Lincoln.

- e. Gould.
- B. Motor Characteristics: Designed for continuous duty at ambient temperature of 40 deg. C and at altitude of 3300 feet above sea level. Capacity and torque shall be sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.
 - 1. Motors exceeding the nameplate amperage shall be promptly replaced at no cost to the Owner. Horsepower shown is minimum and shall be increased as necessary to comply with above requirements. Furnish motors with splash-proof or weatherproof housings, where required or recommended by the manufacturer. Match the nameplate voltage rating with the electrical service supplied. Check Electrical Drawings. Provide a transformer for each motor not wound specifically for system voltage.
- C. Polyphase Motors: NEMA MG 1, Design B, medium induction motor, premium efficiency as defined in NEMA MG 1. Select motors with service factor of 1.15. Provide motor with random-wound, squirrel cage rotor, and permanently lubricated or regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading. Temperature rise shall match insulation rating. Provide Class F insulation.
 - 1. Multispeed motors shall have separate windings for each speed.
- D. Polyphase Motors with Additional Requirements:
 - 1. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.
 - 2. Motors Used with Variable Frequency Controllers:
 - a. Separately Connected Motors: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.
 - b. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
 - c. Energy- and Premium-Efficient Motors: Class B temperature rise; Class F insulation.
 - d. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
 - e. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.
 - f. Each motor shall be provided with a shaft grounding device for stray current protection.
 - 3. Severe-Duty Motors: Comply with IEEE 841, with 1.15 minimum service factor.
- E. Single-Phase Motors:
 - 1. Select motors with service factor of 1.15.
 - 2. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:
 - a. Permanent-split capacitor.
 - b. Split phase.

- c. Capacitor start, inductor run.
 - d. Capacitor start, capacitor run.
 - 3. Multispeed Motors: Variable-torque, permanent-split-capacitor type.
 - 4. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.
 - 5. Motors 1/20 HP and Smaller: Shaded-pole type.
- F. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

2.4 MOTOR STARTERS

- A. Square D, Allen Bradley, or equal, in NEMA Type 1 enclosure, unless otherwise specified or required. Minimum starter size shall be Size 1. Provide NEMA 3R enclosure where exposed to outdoors.
- B. Provide magnetic motor starters for equipment provided under the Mechanical Work. Starters shall be non-combination type. Provide part winding or reduced voltage start motors where shown or as hereinafter specified. Minimum size starter shall be Size 1.
 - 1. All starters shall have the following:
 - a. Cover mounted hand-off-automatic switch. Starters installed exposed in occupied spaces shall have key operated HOA switch.
 - b. Ambient compensated thermal overload.
 - c. Fused control transformer (for 120 or 24 volt service).
 - d. Pilot lights, integral with the starters. Starters located outdoors shall be in NEMA IIIR enclosures.
 - 2. Where three phase motors are provided for two-speed operation, provide two speed motor starters.
 - 3. Starters for single-phase motors shall have thermal overloads. NEMA I enclosure for starters located indoors, NEMA IIIR enclosure for starters located outdoors.
 - 4. Provide OSHA label indicating the device starts automatically.

2.5 STRAINERS FOR POTABLE WATER SYSTEMS

- A. Strainers: Full line size, conforming to lead-free requirements of California Health and safety Code Section 11 68 75. "Y" pattern, 125 psi SWP minimum, with 304 stainless steel screens. Install all strainers with a blow-off hose valve with hose adapter. Strainer shall have gasketed cover with straight thread.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:
 - a. 3 inches and smaller: bronze or brass body, threaded ends, with 20 mesh screen. Watts LF777SI, Wilkins SXL.
 - b. 4 inches and larger: Cast iron body, flanged ends, 1/16 inch or 1/8 inch screen as normally supplied for each size. Watts 77F-DI-125, Mueller 758.

2.6 VALVE BOXES

A. General:

1. Where several valves or other equipment are grouped together, provide larger boxes of rectangular "vault" type adequately sized for condition and similar in construction to those specified above.
2. Provide valve box extensions as required to set bottom of valve box tight up to top of piping in which valve is installed.
3. Provide a tee handle wrench for each size, Alhambra Foundry Co. #A-3008, or equal.

B. Valve Boxes in Traffic Areas: Provide Christy No. G5 traffic valve box, Brooks, or equal, 10-3/8 inches inside diameter with extensions to suit conditions, with cast iron or steel locking cover. Provide Owner with set of special wrenches or tools as required for operation of valves.

C. Valve Boxes in Non-Traffic Areas: Provide Christy No. F22, Brooks, or equal, 8 inches inside diameter by 30 inches long, with cast iron or steel locking cover. Provide Owner with set of special wrenches or tools as required for operation of valves. Cut bottom of plastic body for operation of valves.

D. Valve Box (Rectangular Vault Type): Precast concrete or cast iron with cast iron or steel locking type covers lettered to suit service – Brooks No. 3-TL, Christy No. B3, Fraser No. 3, Alhambra A-3004 or A-3005, Alhambra E-2202, or E-2702, or equal, with extension to suit conditions.

2.7 GAUGES

A. Marsh "Series J", U.S. Gage, Danton 800, or equal, with bronze bushed movement and front recalibration. Dials shall be white with black numerals, 3-1/2 inch dial face. Normal reading shall be at mid-scale. Provide a needle valve on each gauge connection. Supply a gauge piped with branch isolation valves across the inlet and outlet of each pump and where shown on the Drawings.

B. Provide Pete's Plug II, Sisco P/T, or equal, test plug with Nordel core {and gasketed cap}, on inlet and outlet of each coil, boiler, condenser, chiller and heat exchanger and where shown on Drawings.

2.8 THERMOMETERS

A. Marsh, Taylor, Palmer, or equal, 5 inch diameter bimetal dial, adjustable from face, with adjustable positioner, located to be easily read from normal personnel approach. Normal reading shall be at mid-scale.

1. Provide extension for insulation.
2. Provide thermometers with steel bulb chambers and brass separable sockets.

B. Provide Pete's Plug II, Sisco P/T, or equal, test plug with Nordel core, on inlet and outlet of each coil, boiler, and heat exchanger and provide two digital electronic test thermometers for each range of fluid temperature and where shown on Drawings.

2.9 ACCESS DOORS

- A. Where floors, walls, or ceilings must be penetrated for access to mechanical equipment, provide access doors, 14 inch by 14 inch minimum size in usable opening. Where entrance of a serviceman may be required, provide 20 inch by 30 inch minimum usable opening. Locate access doors/panels for non-obstructed and easy reach.
 - 1. All access doors less than 7'-0" above floors and exposed to public access shall have keyed locks.
- B. Access doors shall match those supplied in Division 08 in all respects, except as noted herein.
- C. Provide stainless steel access doors for use in toilet rooms, shower rooms, kitchens and other damp areas. Provide steel access doors with prime coat of baked-on paint for all other areas.
- D. Do not locate access doors in highly visible public areas such as lobbies, waiting areas, and primary entrance areas. Coordinate with the Architect when access is required in these areas.
- E. Where specific information or details relating to access panels different from the above is shown or given on the Drawings or other Divisions of work, then that information shall supersede this specification.
- F. Manufacturers: Subject to compliance with requirements, available manufacturers offering products which may be incorporated into the Work include Milcor, Karp, Nystrom, or Cesco, equal to the following:
 - 1. Milcor
 - a. Style K (plaster).
 - b. Style DW (gypsum board).
 - c. Style M (Masonry).
 - d. Style "Fire Rated" where required.

2.10 THERMAL AND SEISMIC EXPANSION LOOPS

- A. Manufactured assembly consisting of inlet and outlet elbow fittings, two sections of flexible metal hose and braid, and 180-degree return bend. Return bend section shall have support lug and plugged FPT drain. Flexible hose shall consist of corrugated metal inner hose and braided metal outer sheath. Assemblies shall be constructed from materials compatible with the fluid or gas being conveyed and shall be suitable for the system operating pressure and temperature. Provide assembly selected for 4 inches of movement.
- B. Provide CSA certified expansion loops for use in natural or propane gas piping systems.
- C. Where used in potable water systems, provide expansion loops of certified lead-free construction.
- D. Basis-of-Design Product: Subject to compliance with requirements, provide Metraflex Inc., Metraloop series, or comparable product by one of the following, or equal:
 - 1. Flexicraft Industries.

2.11 FLEXIBLE JOINTS

- A. Where indicated on Drawings, provide Metraflex Metrasphere, Style R, Mason Industries, or equal, Spherical Expansion Joints. Provide control units at each expansion joint, arranged to limit both expansion and compression.
- B. Flexible joints at entry points to building shall be Barco Ductile iron, Advanced Thermal Systems, or equal, threaded style with stainless ball and mineral filled seal.

2.12 PIPE GUIDES

- A. Where flexible connections are indicated on Drawings, provide Metraflex style IV, B-Line, or equal, pipe guides in locations recommended by manufacturer. Maximum spacing from flexible connection to first pipe guide is 4 pipe diameters, and maximum spacing from second pipe guide is 14 pipe diameters.

2.13 EQUIPMENT IDENTIFICATION

- A. Identify each piece of equipment with a permanently attached engraved bakelite plate, 1/2 inch high white letters on black background.

2.14 PIPE IDENTIFICATION

- A. Identify each piping system and indicate the direction of flow by means of Seton, Inc., Marking Services Inc., Reef Industries, Inc., or equal, pre-tensioned, coiled semi-rigid plastic pipe labels formed to circumference of pipe, requiring no fasteners or adhesive for attachment to pipe.
- B. The legends and flow arrows shall conform to ASME A13.1.

2.15 INSULATION WORK

- A. General:
 - 1. Insulation products, including insulation, insulation facings, jackets, adhesives, sealants and coatings shall not contain polybrominated diphenyl ethers (PBDEs) in penta, octa, or deca formulations in amounts greater than 0.1 percent (by mass).
 - 2. Adhesives and sealants shall comply with testing and product requirements of South Coast Air Quality Management District, Rule 1168.
 - 3. The term "piping" used herein includes pipe, valves, strainers and fittings.
 - 4. Apply insulating cement to fittings, valves and strainers and trowel smooth to the thickness of adjacent covering. Cover with jacket to match piping. Extend covering on valves up to the bonnet. Leave strainer cleanout plugs accessible.
 - 5. Provide pre-formed PVC valve and fitting covers.
 - 6. Provide Calcium Silicate rigid insulation and sheet metal sleeve, 18 inch minimum length at each pipe hanger. Seal ends of insulation to make vapor tight with jacket.
 - 7. Test insulation, jackets and lap-seal adhesives as a composite product and confirm flame spread of not more than 25 and a smoke developed rating of not more than 50 when tested in accordance with UL723 or ASTM E84.
 - 8. Clean thoroughly, test and have approved, all piping and equipment before installing insulation and/or covering.

9. Repair all damage to existing pipe and equipment insulation whether or not caused during the work of this contract, to match existing adjacent insulation for thickness and finish, but conforming to flame spread and smoke ratings specified above.

B. Insulation of Piping:

1. Insulate domestic hot and tempered water with minimum 3-1/2 pounds per cubic foot density fiberglass with ASJ-SSL jacket. Insulation thickness shall be the following:
 - a. Pipe 3/4 inches and smaller: 1 inch thick.
 - b. Pipe 1 inch through 1-1/2 inches: 1-1/2 inches thick.
 - c. Pipe 2 inches and larger: 2 inches thick.
2. Insulate domestic hot water piping under slab on grade and cold water piping exposed to the weather with 3/4 inch thick Therma-Cel, Armaflex, or equal; seal water tight per manufacturer's directions.
3. Insulate roof drain and overflow drain bodies, horizontal sections of rainwater leader piping and overflow piping, and condensate drains within the building envelope with 1 inch thick fiberglass, minimum 3-1/2 pound per cubic foot density, with ASJ-SSL jacket.
4. Insulate domestic cold water piping outside of insulation envelope in outside walls, vented attic spaces, and unheated spaces, including equipment rooms and below raised floor with 1 inch thick molded fiberglass, minimum 3-1/2 pound per cubic foot density, with ASJ-SSL jacket.
5. Exposed insulated piping within the building shall have a Zeston 2000 25/50, Proto Lo-Smoke, or equal, PVC jacket and fitting cover installed over the insulation, applied per manufacturer's instructions. Insulation shall be vapor tight before applying PVC jacket and fitting covers. Verify suitability with manufacturer of insulation. Insulation with pre-applied polymer jacket may be substituted at Contractor's option.
6. Insulate condensate drain piping in freezer with 3/4 inch thick Therma-Cel, Armaflex, or equal. Seal water tight per manufacturer's directions. Install heat tape prior to insulation of piping, in accordance with manufacturer's directions.
7. Where insulated piping is exposed to the weather apply aluminum jacket secured with 1/2 inch stainless-steel bands on 12 inch centers. Insulation shall be vapor tight before applying metal jacket, and aluminum fitting covers. Install jacketing with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Cover fittings with glass cloth, two coats of Foster Sealfas 30-36, and factory-fabricated aluminum fitting covers, of same material, finish, and thickness as jacket. Insulation shall be vapor tight before applying metal jacket and fitting covers.
 - a. Fitting covers:
 - 1) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
 - 2) Tee covers.
 - 3) Flange and union covers.
 - 4) End caps.
 - 5) Beveled collars.
 - 6) Valve covers.
 - 7) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

b. Jacket thickness:

- 1) Pipes 10 inches diameter and smaller: Minimum .016 inch thick jacket with smooth finish.
- 2) Pipes 12 inches diameter and larger: Minimum .020 inch thick jacket with smooth finish.

PART 3 - EXECUTION

3.1 EXISTING MATERIALS

- A. Remove existing equipment, piping, wiring, construction, etc., which interferes with Work of this Contract. Promptly return to service upon completion of work in the area. Replace items damaged by Contractor with new material to match existing.
- B. Removed materials which will not be re-installed and which are not claimed by Owner shall become property of Contractor and shall be removed from Project site. Consult Owner before removing any material from Project site. Carefully remove materials claimed by Owner to prevent damage and deliver to Owner-designated storage location.
- C. Existing piping and wiring not reused and are concealed in building construction may be abandoned in place and all ends shall be capped or plugged. Remove unused piping and wiring exposed in Equipment Rooms or occupied spaces. Material shall be removed from Project premises. Disconnect power, water, gas, pump or any other active energy source from piping or electrical service prior to abandoning in place.
- D. Existing piping, ductwork, and equipment modified or altered as part of this Work shall comply with the most recent applicable code requirements.

3.2 FRAMING, CUTTING AND PATCHING

- A. Special framing, recesses, chases and backing for Work of this Section, unless otherwise specified, are covered under other Specification Sections.
- B. Contractor is responsible for placement of pipe sleeves, hangers, inserts, supports, and location of openings for the Work.
- C. Cutting, patching, and repairing of existing construction to permit installation of equipment, and materials is the responsibility of Contractor. Repair or replace damage to existing work with skilled mechanics for each trade.
- D. Cut existing concrete construction with a concrete saw. Do not utilize pneumatic devices.
- E. Core openings through existing construction for passage of new piping and conduits. Cut holes of minimum diameter to suit size of pipe and associated insulation installed. Coordinate with building structure, and obtain Structural Engineer's approval prior to coring through existing construction.

3.3 ELECTRICAL REQUIREMENTS

- A. Provide adequate working space around electrical equipment in compliance with the California Electrical Code. Coordinate the Mechanical Work with the Electrical Work to comply.

- B. Furnish necessary control diagrams and instructions for the controls. Before permitting operation of any equipment which is furnished, installed, or modified under this Section, review all associated electrical work, including overload protection devices, and assume complete responsibility for the correctness of the electrical connections and protective devices. Motors and control equipment shall conform to the Standards of the National Electrical Manufacturers' Association. All equipment and connections exposed to the weather shall be NEMA IIIIR with factory-wired strip heaters in each starter enclosure and temperature control panel where required to inhibit condensation.
- C. All line voltage and low voltage wiring and conduit associated with the Temperature Control System are included in this Section. Wiring and conduit shall comply with Division 26.

3.4 PIPING SYSTEM REQUIREMENTS

- A. Drawing plans, schematic and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.

3.5 PRIMING AND PAINTING

- A. Perform priming and painting on the equipment and materials as specified herein.
- B. See Division 09 Painting Section(s) for detailed requirements.
- C. Priming and Painting:
 - 1. Exposed ferrous metals, including piping, which are not galvanized or factory-finished shall be primed and painted.
 - a. Black Steel Piping:
 - 1) Primer: One coat gray Sherwin-Williams Pro Industrial Pro-Cryl Universal Primer, comparable products by Rust-Oleum, Kelly Moore, or equal.
 - 2) Topcoat: Two coats gray Sherwin-Williams Pro Industrial Waterbased Alkyd Urethane Enamel, comparable products by Rust-Oleum, Kelly Moore, or equal.
 - 2. Metal surfaces of items to be jacketed or insulated except piping shall be given two coats of primer unless furnished with equivalent factory finish. Items to be primed shall be properly cleaned by effective means free of rust, dirt, scale, grease and other deleterious matter and then primed with the best available grade of zinc rich primer. After erection or installation, all primed surfaces shall be properly cleaned of any foreign or deleterious matter that might impair proper bonding of subsequent paint coatings. Any abrasion or other damage to the shop or field prime coat shall be properly repaired and touched up with the same material used for the original priming.
 - 3. Where equipment is provided with nameplate data, the nameplate shall be masked off prior to painting. When painting is completed, remove masking material.

3.6 EXCAVATING

- A. Perform all excavating required for work of this Section. Provide the services of a pipe/cable locating service prior to excavating activities to determine location of existing utilities.

- B. Unless shown otherwise, provide a minimum of 2'-6" cover above top of pipe to finished grade for all service piping, unless otherwise noted. Trim trench bottom by hand or provide a 4 inch deep minimum bed of sand to provide a uniform grade and firm support throughout entire length of pipe. For all PVC pipe and for PE gas pipe, bed the pipe in 4 inch sand bed. Pipe bedding materials should be clean crushed rock, gravel or sand of which 100 percent will pass a 1 inch sieve. For pipes that are larger than 10 inches in diameter, at least 95 percent should pass a 3/4 inch sieve, and for pipes 10 inches in diameter or smaller, 100 percent should pass a 1/2 inch sieve. All other materials should have a minimum sand equivalent of 50. Only a small proportion of the native soils will meet these requirements without extensive processing; therefore, importation of pipe bedding materials should be anticipated. Pipe bedding materials shall be compacted in lifts not exceeding 6 inches in compacted thickness. Each lift shall be compacted to not less than 90 percent relative compaction at or above the optimum moisture content, in accordance with ASTM Specification D2940, except that bedding materials graded such that 100 percent of the material will pass a No. 200 sieve shall be compacted in 6 inch lifts using a single pass of a flat-plate, vibratory compactor or vibratory drum. Pipe bedding materials should extend at least to the spring line.
- C. Maintain all warning signs, barricades, flares, and red lanterns as required.
- D. For all trenches 5 feet or more in depth, submit copy of permit detailed drawings showing shoring, bracing, sloping, or other provisions to be made for worker protection from the hazard of caving ground during the excavation of such trenches. Obtain a permit from the Division of Industrial Safety prior to beginning excavations. A copy of the permit shall be available at the site at all times.

3.7 BACKFILLING

- A. Backfill shall comply with applicable provisions of Division 31 of these Specifications.
- B. Except under existing or proposed paved areas, walks, roads, or similar surfaces, backfill for other types of pipe shall be made using suitable excavated material or other approved material. Place backfill in 8 inch layers, measured before compaction, and compact with impact hammer to at least 90 percent relative compaction per ASTM D2940.
 - 1. Backfill plastic pipe and insulated pipe with sand for a minimum distance of 12 inches above the top of the pipe. Compact using mechanical tamping equipment.
- C. Entire backfill for excavations under existing or proposed pavements, walks, roads, or similar surfaces, under new slabs on grade, shall be made with clean sand compacted with mechanical tamping equipment vibrator to at least 90 percent relative compaction per ASTM D2940. Remove excess earth. Increase the minimum compaction within the uppermost two feet of backfill to 95 percent.
- D. Replace or repair to its original condition all sod, concrete, asphalt paving, or other materials disturbed by the trenching operation. Repair within the guarantee period as required.

3.8 PIPING SYSTEMS INSTALLATION

- A. At time of final connection, and prior to opening valve to allow pressurization of water and gas piping from existing systems, on site or off site, perform a pressure test to indicate static pressure of existing systems. If pressure on water piping is greater than 80 psi, or

gas pressure is not as indicated on Contract Documents, inform Architect immediately. Do not allow piping systems to be pressurized without written consent of the Architect.

B. General:

1. All piping shall be concealed unless shown or otherwise directed. Allow sufficient space for ceiling panel removal.
2. Installation of piping shall be made with appropriate fittings. Bending of piping will not be accepted.
3. Install piping to permit application of insulation and to allow valve servicing.
4. Where piping or conduit is left exposed within a room, the same shall be run true to plumb, horizontal, or intended planes. Where possible, uniform margins are to be maintained between parallel lines and/or adjacent wall, floor, or ceiling surfaces.
5. Horizontal runs of pipes and/or electrical conduit suspended from ceilings shall provide for a maximum headroom clearance. The clearance shall not be less than 6'-6" without written approval from the Architect.
6. Close ends of pipe immediately after installation. Leave closure in place until removal is necessary for completion of installation.
7. Each piping system shall be thoroughly flushed and proved clean before connection to equipment.
8. Pipe the discharge of each relief valve, air vent, backflow preventer, and similar device to floor sink or drain.
9. Install exposed polished or enameled connections with special care showing no tool marks or threads at fittings.
10. Install horizontal valves with valve stem above horizontal.
11. Use reducing fittings; bushings shall not be allowed. Use eccentric reducing fittings wherever necessary to provide free drainage of lines and passage of air.
12. Verify final equipment locations for roughing-in.
13. Service Markers: Mark the location of each plugged or capped pipe with a 4 inch round by 30 inch long concrete marker, set flush with finish grade. Provide 2-1/2 inch diameter engraved brass plate as part of monument marker.
14. Furnish and install anchors or thrust blocks on PVC water lines in the ground, at all changes in direction of piping, and at all connections or branches from mains 1-1/2 inch and larger. Form anchors or thrust blocks by pouring concrete between pipe and trench wall. Thrust blocks shall be of adequate size and so placed as to take thrusts created by maximum internal water pressure. Sizing and placement shall be per manufacturer's recommendations, CPC, and IAPMO installation standards. Anchor piping to building construction.
15. Sanitary Sewer and Storm Drain: Grade piping inside building uniformly 1/4 inch per foot if possible but not less than 1/8 inch per foot. Run piping as straight as possible. Make piping connections between building piping and outside service pipe with cast iron reducers or increasers. Slope sewers uniformly between given elevations where invert elevations are shown.
16. Where piping is installed in walls within one inch of the face of stud, provide a 16 gauge sheet metal shield plate on the face of the stud. The shield plate shall extend a minimum of 1-1/2 inches beyond the outside diameter of the pipe.

C. Expansion Loops:

1. Install expansion loops where piping crosses building expansion or seismic joints, between buildings, between buildings and canopies, and as indicated on Drawings.
2. Install expansion loops of sizes matching sizes of connected piping.
3. Install grooved-joint expansion joints to grooved-end steel piping.
4. Materials of construction and end fitting type shall be consistent with pipe material and type of gas or liquid conveyed by the piping system in which expansion loop is installed.

D. Sleeves:

1. Install Adjus-to-Crete, Pipeline Seal and Insulator, or equal, pipe sleeves of sufficient size to allow for free motion of pipe, 24 gauge galvanized steel. The space between pipe and sleeves through floor slabs on ground, through outside walls above or below grade, through roof, and other locations as directed shall be caulked with oakum and mastic and made watertight. The space between pipe and sleeve and between sleeve and slab or wall shall be sealed watertight.
2. At Contractor's option, Link-Seal, Metraflex Metraseal, or equal, casing seals may be used in lieu of caulking. Wrap pipes through slabs on grade with 1 inch thick fiberglass insulation to completely isolate the pipe from the concrete.

E. Floor, Wall, and Ceiling Plates:

1. Fit all pipes with or without insulation passing through walls, floors, or ceilings, and all hanger rods penetrating finished ceilings with chrome-plated or stainless escutcheon plates.

F. Firestopping:

1. Pack the annular space between the pipe sleeves and the pipe through all floors and walls with UL listed fire stop, and sealed at the ends. All pipe penetrations shall be UL listed, Hilti, 3M Pro-Set, or equal.
 - a. Install fire caulking behind mechanical services installed within fire rated walls, to maintain continuous rating of wall construction.
2. Provide SpecSeal Systems UL fire rated sleeve/coupling penetrators for each pipe penetration or fixture opening passing through floors, walls, partitions or floor/ceiling assemblies. All Penetrators shall comply with UL Fire Resistance Directory (Latest Edition), and in accordance with Chapter 7, CBC requirements.
3. Sleeve penetrators shall have a built in anchor ring for waterproofing and anchoring into concrete pours or use the special fit cored hole penetrator for cored holes.
4. Copper and steel piping shall have SpecSeal plugs on both sides of the penetrator to reduce noise and to provide waterproofing.
5. All above Systems to be installed in strict accordance with manufacturer's instructions.
6. Alternate firestopping systems are acceptable if approved equal. However, any deviation from the above specification requires the Contractor to be responsible for determining the suitability of the proposed products and their intended use, and the Contractor shall assume all risks and liabilities whatsoever in connection therewith.

G. Flashing:

1. Flashing for penetrations of metal or membrane roof for mechanical items such as flues and pipes shall be coordinated with the roofing manufacturer and roofing installer for the specific roofing type. The work of this section shall include furnishing, layout, sizing, and coordination of penetrations required for the mechanical work.
 - a. Furnish and install flashing and counterflashing in strict conformance with the requirements of the roofing manufacturer. Submit shop drawing details for review prior to installation.
 - b. Furnish and install counterflashing above each flashing required. Provide Stoneman, or equal, vandalproof top and flashing combination. Provide vandalproof top for each plumbing vent through roof. Elmdor/Stoneman Model 1540, 1550, 1570, or equal.
2. For all other types of roofing system, furnish and install around each pipe, where it passes through roof, a flashing and counterflashing. All flashing shall be made of four pound seamless sheet lead with 6 inch minimum skirt and steel reinforced boot. Counterflashing shall be cast iron. For vents, provide vandalproof top and flashing combination. Elmdor/Stoneman Model 1100-4, 1100-5, 1100-7, or equal.

H. Hangers and Supports:

1. General: Support equipment and piping so that it is firmly held in place by approved iron hangers and supports and special hangers. Hanger and support components shall support weight of equipment and pipe, fluid, and pipe insulation based on spacing between supports with minimum factor of safety of five based on ultimate strength of material used. Do not exceed manufacturer's load rating. Pipe attachments or hangers, of same size as pipe or tubing on which used, or nearest available. Rigidly fasten hose faucets, fixture stops, compressed air outlets, and similar items to the building construction. The Architect shall approve hanger material before installation. Do not support piping with plumbers' tape, wire rope, wood, or other makeshift devices. Where building structural members do not match piping support spacing, provide "bridging" support members firmly attached to building structural members in a fashion approved by the structural engineer.
 - a. Materials, design, and type numbers per Manufacturers' Standardization Society (MSS), Standard Practice (SP)-58.
 - 1) Provide copper-plated or felt-lined hangers for use on copper tubing.
2. Hanger components shall be provided by one manufacturer: B-Line, Grinnell, Unistrut, Badger, or equal.
3. Riser clamps: B-line model B3373, or equal.
4. Pipe Hanger and Support Placement and Spacing:
 - a. Vertical piping support spacing: Provide riser clamps for piping, above each floor, in contact with the floor. Provide support at joints, branches, and horizontal offsets. Provide additional support for vertical piping, spaced at or within the following maximum limits:

<u>Pipe Diameter</u>	<u>Steel Threaded or Welded (Note 3)</u>	<u>Steel Gas</u>	<u>Copper Brazed or Soldered (Note 3)</u>	<u>CPVC & PVC (Note 2)</u>
1/2 - 1"	12 ft.	6 ft.	Each Floor, Not to Exceed 10 ft.	Base and Each Floor (Note 1)
1-1/4 - 2"	12 ft.	Each Floor, Not to Exceed 10 ft.	Each Floor, Not to Exceed 10 ft..	Base and Each Floor (Note 1)
2-1/2 - 3"	12 ft.	Each Floor, Not to Exceed 10 ft.	Each Floor, Not to Exceed 10 ft.	Base and Each Floor (Note 1)
Over 4"	12 ft.	Each Floor, Not to Exceed 10 ft.	Each Floor, Not to Exceed 10 ft.	Base and Each Floor (Note 1)

- 1) Note 1: Provide mid-story guides.
 - 2) Note 2: For PVC piping, provide for expansion every 30 feet per IAPMO installation standard. For CPVC piping, provide for expansion per IAPMO installation standard.
 - 3) Note 3: Spacing of hangers and supports for piping assembled with mechanical joints shall be in accordance with standards acceptable to authorities having jurisdiction.
- b. Vertical cast iron piping support spacing: Base and each floor not to exceed 15 feet.
- c. Horizontal piping, hanger and support spacing: Locate hangers and supports at each change of direction, within one foot of elbow, and spaced at or within following maximum limits:

<u>Pipe Diameter</u>	<u>Steel Threaded or Welded (Note 2)</u>	<u>Steel Gas</u>	<u>Copper Brazed or Soldered (Notes 2, 3)</u>	<u>CPVC & PVC (Note 1)</u>
1/2 - 1"	6 ft.	6 ft.	5 ft.	3 ft.
1-1/4 - 2"	7 ft.	10 ft.	6 ft.	4 ft.
2-1/2 - 3"	10 ft.	10 ft.	10 ft.	4 ft.
Over 4"	10 ft.	10 ft.	10 ft.	4 ft.

- 1) Note 1: For PVC piping, provide for expansion every 30 feet per IAPMO installation standard. For CPVC piping, provide for expansion per IAPMO installation standard.
- 2) Note 2: Spacing of hangers and supports for piping assembled with mechanical joints shall be in accordance with standards acceptable to authorities having jurisdiction.
- 3) Note 3: Includes all refrigerant piping, including vapor and hot gas pipes.
- d. Horizontal cast iron piping support spacing:
 - 1) Support piping at every other joint for piping length of less than 4 feet.
 - 2) For piping longer than 4 feet, provide support on each side of the coupling, within 18 inches of each joint.
 - 3) Hanger shall not be installed on the coupling.
 - 4) Provide support at each horizontal branch connection.
 - 5) Provide sway brace at 40 foot maximum spacing for suspended pipe with no-hub joints, except where a lesser spacing is required by the seismic design criteria used in delegated design for seismic systems. Refer to Article, Submittals.
 - 6) Provide a brace on each side of a change in direction of 90 degrees or more.
5. Suspended Piping:
 - a. Individually suspended piping: B-Line B3690 J-Hanger or B3100 Clevis, complete with threaded rod, or equal. All hangers on supply and return piping handling heating hot water or steam shall have a swing connector at point of support.

<u>Pipe Size</u>	<u>Rod Size Diameter</u>
2" and Smaller	3/8"
2-1/2" to 3-1/2"	1/2"
4" to 5"	5/8"
6"	3/4"

- b. Trapeze Suspension: B-Line 1-5/8 inch width channel in accordance with manufacturer's published load ratings. No deflection to exceed 1/180 of a span.
- c. Trapeze Supporting Rods: Shall have a safety factor of five; securely anchor to building structure.
- d. Pipe Clamps and Straps: B-Line B2000, B2400; isolate copper pipe with two thicknesses of 2 inches wide 10-mil polyvinyl tape. Where used for seismic support systems, provide B-Line B2400 series pipe straps.
- e. Steel Connectors: Beam clamps with retainers.
6. Support to Structure:
 - a. Wood Structure: Provide and install wood blocking as required to suit structure. Provide lag screws or through bolts with length to suit requirements, and with size (diameter) to match the size of hanger rods required.

- 1) Do not install Lag screws in tension without written review and acceptance by Structural Engineer.

Side Beam Angle Clip	B-Line B3062 MSS Type 34
Side Beam Angle Clip	B-Line B3060
Ceiling Flange	B-Line B3199

- 2) Blocking for support of piping shall be not less than 2 inch thick for piping up to 2 inch size. Provide 3 inch blocking for piping up through 5 inch size, and 4 inch blocking for larger piping. Provide support for blocking in accordance with Structural Engineers requirements.
- 3) Where lag screws are used, length of screw shall be 1/2 inch less than the wood blocking. Pre-drill starter holes for each lag screw.
- b. Steel Structure: Provide and install additional steel bracing as required to suit structure. Provide through bolts with length to suit requirements of the structural components. Burning or welding on any structural member may only be done if approved by the Architect.
7. Rubber Neoprene Pipe Isolators:
 - a. Pipe isolators shall comprise an internal rubber or neoprene material that isolates pipe from hanger and structure. Install at all piping located in acoustical walls. Refer to Architectural Drawings for location of acoustical walls.
 - b. Isolation material shall be either a rubber or neoprene material that prevents contact between the pipe and the structure. The rubber shall have between a 45 to 55 durometer rating and a minimum thickness of 1/2 inch.
 - c. Acceptable Suppliers:
 - 1) Vertical runs: Acousto-Plumb or equal.
 - 2) Horizontal runs: B-Line, Vibraclamp; Acousto-Plumb or equal.
8. Provide support for piping through roof, arranged to anchor piping solidly in place at the roof penetration.
9. Provide rigid insulation and a 12 inch long, 18 gauge galvanized sheet iron shield between the covering and the hanger whenever hangers are installed on the outside of the pipe covering.
10. Insulate copper tubing from ferrous materials and hangers with two thicknesses of 3 inch wide, 10 mil polyvinyl tape wrapped around pipe.
11. Provide a support or hanger close to each change of direction of pipe either horizontal or vertical and as near as possible to concentrated loads.
12. Suspend rods from concrete inserts with removable nuts where suspended from concrete decks. Power actuated inserts will not be allowed.

3.9 UNION AND FLANGE INSTALLATION

- A. Install Watts, Epco, Nibco, or equal, dielectric unions or flanges at points of connection between copper or brass piping or material and steel or cast iron pipe or material except in drain, waste, vent, or rainwater piping. Bushings or couplings shall not be used. Dielectric

unions installed in potable water systems shall conform to the lead-free requirements of the California Health and Safety Code Section 11 68 75.

- B. Install unions in piping NPS 2" and smaller, and flanges in piping NPS 2-1/2" and larger whether shown or not at each connection to all equipment and tanks, and at all connections to all automatic valves, such as temperature control valves. Unions installed in potable water systems shall conform to the lead-free requirements of the California Health and Safety Code Section 11 68 75.
- C. Locate the unions for easy removal of the equipment, tank, or valve.

3.10 ACCESS DOOR INSTALLATION

- A. Furnish and install access doors wherever required whether shown or not for easy maintenance of mechanical systems; for example, at concealed valves, strainers, traps, cleanouts, dampers, motors, controls, operating equipment, etc. Access doors shall provide for complete removal and replacement of equipment.

3.11 CONCRETE WORK

- A. Concrete work required for work of this Section shall be included under another section of the Specification, unless otherwise noted, including poured-in-place concrete work for installing precast manholes, catch basins, etc., and shall include reinforced concrete bases for pumps, tanks, compressors, fan units, boilers, unless the work is specifically indicated on the Drawings to be furnished under this Section.
- B. Thrust blocks, underground anchors, and pads for cleanouts, valve access boxes and washer boxes are included under this Section of the Specification. Concrete shall be 3000 psi test minimum. Refer to Division 03 for concrete types.

3.12 PIPE PROTECTION

- A. Wrap bare galvanized and black steel pipe buried in the ground and to 6" above grade, including piping in conduit, with one of the following, or equal:
 - 1. Polyethylene Coating: Pressure sensitive polyethylene coating, "X-Tru-Coat" as manufactured by Pipe Line Service Corporation or "Green Line" wrap as manufactured by Royston Products, or equal.
 - a. Field Joints and Fittings: Protecto Wrap #1170 tape as manufactured by Pipe Line Service Corporation, or Primer #200 tape by Royston Products, or equal. Installation shall be as per manufacturer's recommendation and instructions.
 - 2. Tape Wrap: Pressure-sensitive polyvinyl chloride tape, "Transtex #V-10 or V-20", "Scotchwrap 50", Slipknot 100, PASCO Specialty & Mfg., Inc., or equal, with continuous identification. Tape shall be a minimum of 20 mils thick for fittings and irregular surfaces, two wraps, 50 percent overlap, 40 mils total thickness. Tape shall be laminated with a suitable adhesive; widths as recommended by the manufacturer for the pipe size. Wrap straight lengths of piping with an approved wrapping machine.
- B. Field Joints: Valves and Fittings: double wrap polyvinyl chloride tape as above. Provide at least two thicknesses of tape over the joint and extend a minimum of 4 inches over adjacent pipe covering. Build up with primer to match adjacent covering thickness. Width of tape of fittings shall not exceed 3 inches. Tape shall adhere tightly to all surfaces of the fittings without air pockets.

- C. Testing: Test completed wrap of piping, including all epoxy painted piping with Tinker and Razor Co. test machine (San Gabriel, CA - 818-287-5259), Pipeline Inspection Company (Houston, TX - 713-681-5837), or equal.
- D. Cleaning: Clean all piping thoroughly before wrapping.
 - 1. Inspection: Damaged or defective wraps shall be repaired as directed. No wrapped pipe shall be covered until approved by Architect.
- E. Sleeve copper piping/tubing installed below slab with "Polywrap-C" polyethylene sleeve, as manufactured by Northtown Pipe Protection Products, or equal. Sleeve shall be a minimum of 6 mils thick, colored blue for domestic water piping and orange for other piping. Install sleeve per manufacturer's recommendations and instructions.
- F. Sleeve copper piping/tubing installed outside building below grade with "Polywrap-C" polyethylene sleeve, as manufactured by Northtown Pipe Protection Products, or equal. Sleeve shall be a minimum of 6 mils thick, colored blue for domestic water piping. Install sleeve per manufacturer's recommendations and instructions.
- G. Sleeve cast iron and ductile iron pipe below grade and below slab with "Polywrap" polyethylene sleeve, as manufactured by Northtown Pipe Protection Products, or equal. Sleeve shall be a minimum of 8 mils thick, colored natural. Install sleeve per manufacturer's recommendations and instructions.
- H. Covering: No rocks or sharp edges shall be backfilled against the wrap or sleeve. When backfilling with other than sand, protect wrap with an outer wrapping of Kraft paper; leave in place during backfill.

3.13 PIPE IDENTIFICATION

- A. Provide temporary identification of each pipe installed, at the time of installation. Temporary identification shall be removed and replaced with permanent identification as part of the work.
- B. Apply the legend and flow arrow at all valve locations; at all points where the piping enters or leaves a wall, partition, cluster of piping or similar obstruction, at each change of direction and at approximately 20'-0" intervals on pipe runs. Variations or changes in locations and spacing may be made with the approval of the Architect. There shall be at least one marking in each room. Markings shall be located for maximum visibility from expected personnel approach.
- C. Wherever two or more pipes run parallel, the markings shall be supplied in the same relative location on each.
- D. Each valve on non-potable water piping shall be labeled with a metal tag stamped "DANGER -- NON-POTABLE WATER" in 1/4 inch high letters.
- E. Apply markings after painting and cleaning of piping and insulation is completed.

3.14 PIPING SYSTEM PRESSURE TESTING

- A. General:
 - 1. Perform operational tests under simulated or actual service conditions, including one test of complete plumbing installation with fixtures and other appliances connected.

2. Repair leaks and defects with new materials, and retest piping or portion thereof until satisfactory results are obtained.
- B. Piping Systems: Test piping systems in accordance with the following requirements and applicable codes:
1. Authority having jurisdiction shall witness tests of piping systems.
 2. Notify Architect at least seven days in advance of testing.
 3. All piping shall be tested at completion of roughing-in, or at other times as directed by Architect.
 4. Furnish necessary materials, test pumps, gases, instruments and labor required for testing.
 5. Isolate from system equipment that may be damaged by test pressure.
 6. Make connections to existing systems with flanged connection. During testing of new work, provide a slip-in plate to restrict test pressure to new systems. Remove plate and make final connection to existing system at completion of testing.
 - a. Authority having jurisdiction shall witness final connection to system.
- C. Test Schedule: No loss in pressure or visible leaks shall show after four hours at the pressures indicated.
- D. Testing of Sanitary Sewer, Drain, Vent, and Storm Drain may be done in segments in order to limit pressure to within manufacturer's recommendations. Test to 10 feet above highest point in the system.

<u>System Tested</u>	<u>Test Pressure PSI</u>	<u>Test With</u>
Sanitary Sewer, Drain, Vent	10 Ft. Hd.	Water
Storm Drain, Condensate Drains	10 Ft. Hd.	Water
Domestic Water	125	Water
Natural Gas (PE)	60	Air & Non-corrosive Leak Test Fluid
Natural Gas (Steel)	100	Air & Non-corrosive Leak Test Fluid
Compressed Air	200 lb.	Air & Non-corrosive Leak Test Fluid

1. Non-corrosive leak test fluid shall be suitable for use with piping material specified, and with the type of gas conveyed by the piping system.

3.15 TRACER WIRES

- A. Provide tracer wire for non-metallic gas and water pipe in ground outside of buildings. Use AWG #14 tracer wire with low density high molecular weight polyethylene insulation, and lay continuously on pipe so that it is not broken or stressed by backfilling operations.

Secure wire to the piping with tape at 18 inch intervals. Solder all joints. Tracer wire insulation shall be colored yellow for gas piping, blue for water piping.

- B. Terminals: Precast concrete box and cast iron locking traffic cover, Brooks 3TL, or equal; cover marked with name of service; 6 inches of loose gravel below box. Plastic terminal board with brass bolts; identify line direction with plastic tags. Test for continuity between terminals, after backfilling, in presence of Inspector.
- C. Alternate: Use electronically detectable plastic tape with metallic core, Terra Tape D, manufactured by Reef Industries, Inc., Seton, Inc., Marking Services, Inc., or equal; tape 2 inches wide, continuously imprinted "CAUTION WATER (GAS, etc.) LINE BELOW". Install, with printed side up, directly over pipe, 18 inches below finish grade. Backfill material shall be as specified for the particular condition where pipe is installed, but avoid use of crushed rock or of earth with particles larger than 1/2 inch within the top 12 inches of backfill. Take precautions to insure that tape is not damaged or misplaced during backfill operations. Terminal boxes not required.

3.16 OPERATION OF SYSTEMS

- A. Do not operate any plumbing equipment for any purpose, temporary or permanent, until all of the following has been completed:
 - 1. Complete all requirements listed under "Check, Test and Start Requirements."
 - 2. Piping has been properly cleaned. Piping systems shall be flushed and treated prior to operation.
 - 3. Filters, strainers etc. are in place.
 - 4. Bearings have been lubricated, and alignment of rotating equipment has been checked.
 - 5. Equipment has been run under observation, and is operating in a satisfactory manner.
- B. Provide test and balance agency with one set of Contract Drawings, Specifications, Addenda, Change orders issued, applicable shop drawings and submittals and temperature control drawings.

3.17 CHECK, TEST AND START REQUIREMENTS

- A. An authorized representative of the equipment manufacturer shall perform check, test and start of each piece of plumbing equipment. The representative may be an employee of the equipment manufacturer, or a manufacturer-certified contractor. Submit written certification from the manufacturer stating that the representative is qualified to perform the check test and start of the equipment.
 - 1. As part of the submittal process, provide a copy of each manufacturer's printed startup form to be used.
 - 2. Some items of specified equipment may require that check, test and start of equipment must be performed by the manufacturer, using manufacturer's employees. See specific equipment Articles in these Specifications for this requirement.
 - 3. Provide all personnel, test instruments, and equipment to properly perform the check, test and start work.
 - 4. When work has been completed, provide copies of reports for review, prior to final observation of work.

- B. Provide copies of the completed check, test and start report of each item of equipment, bound with the Operation and Maintenance Manual.
- C. Upon completion of the work, provide a schedule of planned maintenance for each piece of equipment. Indicate frequency of service, recommended spare parts (including filters and lubricants), and methods for adjustment and alignment of all equipment components. Provide a copy of the schedule with each operating and maintenance manual. Provide a copy of certification from the Owner's representative indicating that they have been properly instructed in maintenance requirements for the equipment installed.

3.18 PRELIMINARY OPERATIONAL REQUIREMENTS AND TESTS

- A. Prior to observation to determine final acceptance, put all mechanical systems into service and check that work required for that purpose has been done, including but not limited to the following condensed check list. Provide indexed report to tabulating the results of all work.
 - 1. All equipment has been started, checked, lubricated and adjusted in accordance with the manufacturer's recommendations.
 - 2. Correct rotation of motors and ratings of overload heaters are verified.
 - 3. Specified filters are installed and spare filters have been turned over to Owner.
 - 4. All manufacturers' certificates of start-up specified have been delivered to the Owner.
 - 5. All equipment has been cleaned, and damaged painted finishes touched up.
 - 6. Missing or damaged parts have been replaced.
 - 7. Flushing and chemical treatment of piping systems has been completed and water treatment equipment, where specified, is in operation.
 - 8. Equipment labels, pipe marker labels, ceiling markers and valve tags are installed.
 - 9. Valve tag schedules, corrected control diagrams, sequence of operation lists and start-stop instructions have been posted.
 - 10. Preliminary test and balance work is complete, and reports have been forwarded for review.
 - 11. Automatic control set points are as designated and performance of controls checks out to agree with the sequence of operation.
 - 12. Operation and Maintenance Manuals have been delivered and instructions to the operating personnel have been made.
- B. Prior to the observation to determine final acceptance, operate all mechanical systems as required to demonstrate that the installation and performance of these systems conform to the requirements of these specifications.
 - 1. Operate and test all mechanical equipment and systems for a period of at least five consecutive 8 hour days to demonstrate the satisfactory overall operation of the project as a complete unit.
 - 2. Commence tests after preliminary balancing and adjustments to equipment have been checked. Immediately before starting tests, install air filters and lubricate all running equipment. Notify the Architect at least seven calendar days in advance of starting the above tests.
 - 3. During the test period, make final adjustments and balancing of equipment, systems controls, and circuits so that all are placed in first class operating condition.

4. Where Utility District rebates are applicable, demonstrate that the systems meet the rebate program requirements.

C. Review of Contractor's Tests:

1. All tests made by the Contractor or manufacturers' representatives are subject to observation and review by the Owner. Provide timely notice prior to start of each test, in order to allow for observation of testing. Upon the completion of all tests, provide a letter to confirm that all testing has been successful.

D. Test Logs:

1. Maintain test logs listing the tests on all mechanical systems showing dates, items tested, inspectors' names, remarks on success or failure of the tests.

E. Preliminary Operation:

1. The Owner reserves the right to operate portions of the plumbing system on a preliminary basis without voiding the guarantee.

3.19 CERTIFICATES OF INSTALLATION

- A. Contractor shall complete applicable "Certificates of Installation" forms contained in the California Building Energy Efficiency Standards and submit to the authorities having jurisdiction for approval and issuance of final occupancy permit, as described in the California Energy Code.

3.20 DEMONSTRATION AND TRAINING

- A. An authorized representative of the equipment manufacturer shall train Owner-designated personnel in maintenance and adjustment of equipment. The representative may be an employee of the equipment manufacturer, or a manufacturer-certified contractor. Submit written certification from the manufacturer stating that the representative is qualified to perform the Owner training for the equipment installed.
 1. As part of the submittal process, provide a training agenda outlining major topics and time allowed for each topic.
 2. Some items of specified equipment require that training must be performed by the manufacturer, using manufacturer's employees. See specific equipment Articles in these Specifications for this requirement.
 3. Contractor shall provide three copies of certification by Contractor that training has been completed, signed by Owner's representative, for inclusion in Operation and Maintenance Manual. Certificates shall include:
 - a. Listing of Owner-designated personnel completing training, by name and title.
 - b. Name and title of training instructor.
 - c. Date(s) of training.
 - d. List of topics covered in training sessions.
 4. Refer to specific equipment Articles for minimum training period duration for each piece of equipment.

END OF SECTION

SECTION 22 10 00
PLUMBING PIPING SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Pipe and fittings.
2. Valves.
3. Domestic water piping specialties.
4. Gas piping specialties.
5. Drain and waste piping specialties.
6. Heat tracing.

1.02 RELATED REQUIREMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Section 22 00 50 Basic Plumbing Materials and Methods.

1.03 ACTION SUBMITTALS

- A. For additional requirements, refer to Section 22 00 50, Basic Plumbing Materials and Methods.
- B. Product Data: Submit manufacturer's technical product data and installation instructions for plumbing piping systems materials and products.

1.04 INFORMATIONAL SUBMITTALS

- A. For additional requirements, refer to Section 22 00 50, Basic Plumbing Materials and Methods.
- B. Provide welding certificate for all gas pipe welders.
- C. Gas Pipe Installer Qualifications: Provide evidence of current qualifications for individuals performing work requiring qualifications.

1.05 CLOSEOUT SUBMITTALS

- A. For additional requirements, refer to Section 22 00 50, Basic Plumbing Materials and Methods.
- B. Maintenance Data: Submit maintenance data and parts lists for plumbing piping systems materials and products. Include this data in Operation and Maintenance Manual.

1.06 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish to Owner, with receipt, one valve key for each key operated hydrant, bibb, or faucet installed.

1.07 QUALITY ASSURANCE

- A. For additional requirements, refer to Section 22 00 50, Basic Plumbing Materials and Methods.
- B. Gas Pipe Installer Qualifications: Individuals performing tasks requiring qualifications under Federal and State regulations shall be qualified by the gas utility supplying Project site. The qualifications shall be current at the time of performing the Work.
- C. NFPA/ANSI Compliance: Fabricate and install natural gas systems in accordance with latest edition of NFPA 54/ANSI Z223.1 "National Fuel Gas Code."
- D. Pipe Welding: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.
- E. Fabricate and install natural gas systems in accordance with California Plumbing Code.
- F. Utility Compliance: Fabricate and install natural gas systems in accordance with local gas utility company requirements.

PART 2 - PRODUCTS

2.01 MATERIALS AND PRODUCTS

- A. Provide piping materials and factory-fabricated piping products of sizes, types, pressure ratings, temperature ratings, and capacities as indicated. Provide materials and products complying with California Plumbing Code. Where more than one type of material or product is indicated, selection from materials or products specified is Contractor's option.
- B. Potable-water piping and components shall comply with NSF 14, NSF 61, and NSF 372. Plastic piping components shall be marked with "NSF-pw."

2.02 PIPE AND FITTINGS ATTACHED TO AND BELOW BUILDINGS INCLUDING 5 FEET FROM BUILDINGS

- A. Piping and fittings attached to covered walkways and corridors shall comply with the requirements of this article.
- B. Drain and Waste Pipe Above Grade: Cast iron soil pipe and fittings, asphaltic coated, conforming to ASTM A888 and Cast Iron Soil Pipe Institute Standard (CISPI) 301 and so marked. Pipe and fittings shall be as manufactured by AB&I, Charlotte, Tyler Pipe, or equal. Pipe and fittings shall be the products of a single manufacturer. At Contractor's option, vertical piping above floor from lavatories, sinks, and drinking fountains may be Schedule 40 galvanized steel pipe with black cast iron drainage fittings, or DWV weld pipe and fittings.
 - 1. Joints above grade: No-Hub pipe conforming to ASTM A888 and CISPI 301. Couplings conforming to ASTM 1277 and CISPI 310, with stainless steel bands. Provide products by ANACO-Husky, Tyler, Ideal or equal. Provide sway brace at 20'-0" maximum spacing for suspended pipe with No-Hub joints. Provide a brace on each side of a change in direction of 90 degrees or more. Brace riser joints at each floor and at 15 foot maximum intervals (also see Specification Section 22 00 50).
 - a. Provide sway brace at each joint per 2022 CBC.

- b. Joints located over critical areas including food preparation, food storage, food serving, and eating areas shall be ANACO-Husky SD 4000, Clamp-All 125, or equal, meeting the requirements of FM 1680, SD Class I and ASTM C1540.
- C. Drain and Waste Pipe Below Grade: Cast iron soil pipe and fittings, asphaltic coated, conforming to ASTM A888 and CISPI 301 and so marked. Pipe and fittings shall be as manufactured by AB&I, Charlotte, Tyler Pipe, or equal. Pipe and fittings shall be the products of a single manufacturer. At Contractor's option, hub and spigot cast iron soil pipe and fittings, asphaltic coated, conforming to ASTM A-74 and so marked, may be used.
 - 1. Joints below grade: ANACO-Husky SD 4000, Clamp-All 125, or equal couplings and No-Hub fittings, meeting the requirements of FM 1680, SD Class I and ASTM C1540.
 - 2. Joints below grade (hub and spigot option): Neoprene gaskets conforming to ASTM C564, as manufactured by Ty-Seal, Dual-Tite, or equal.
- D. Vent Pipe:
 - 1. 3 inch and larger: Cast iron soil pipe and fittings conforming to ASTM A888 and Cast Iron Soil Pipe Institute Standard 301 and so marked. Joints in cast iron vent pipe shall be the same as specified for cast iron waste pipe above grade.
 - 2. 2-1/2 inch and smaller: Schedule 40 galvanized steel pipe with black cast iron drainage fittings, or DWV copper pipe and fittings.
 - 3. Vent pipe buried in ground and to 6 inches above ground: Cast iron soil pipe and fittings conforming to ASTM A888 and Cast Iron Soil Pipe Institute Standard 301 and so marked. Joints in cast iron vent pipe shall be the same as specified for cast iron waste pipe below ground.
- E. Type DWV copper tubing or No-Hub cast iron pipe and fittings may be used for concealed rainwater leaders. Where no-hub piping is used, the fittings and couplings shall match those used for waste piping.
- F. Water Pipe (Tempered Water, Tempered Water Return, Hot Water, Hot Water Return and Cold Water): ASTM B88, Type L copper tubing, hard-temper, with wrought copper fittings. Provide full solder cup for all fittings. Capped or plugged outlets shall be Schedule 40 screwed brass. Water piping below slab: ASTM B88, Type K copper tubing, hard temper, with wrought copper fittings. At Contractor's option, pipe runs below slab having no branches may be ASTM B88, Type K annealed copper tubing without joints. See Section 22 00 50 for pipe protection requirements for below slab copper piping.
- G. Temperature and Pressure Relief Valve Piping: ASTM B88, Type L copper tubing, hard-temper, with wrought copper fittings. Provide full solder cup for all fittings. Capped or plugged outlets shall be Schedule 40 screwed brass.
- H. Gas Pipe: Schedule 40 black steel conforming to ASTM A53, with malleable iron threaded fittings above grade for piping 2 inch and smaller; welded piping below grade and for above grade piping larger than 2 inches, with Class 150 welding fittings.
 - 1. Appliance Flexible Connectors for Indoor Equipment Without External Spring Isolation:
 - a. Contractor may choose one of the following:
 - 1) Direct gas pipe connection.
 - 2) Appliance flexible connector:

- a) Comply with ANSI Z21.24.
 - b) Polymer or hot-dipped PVC coated corrugated 304 stainless steel.
 - c) Operating-Pressure Rating: 0.5 psig.
 - d) End Fittings: Zinc-coated steel.
 - e) Maximum Length: 30 inches.
 - f) Manufacturers: Dormont, Series 30C, 31, 40C, 41, and 51, Brasscraft model ProCoat, or equal.
- b. Provide with end connections compatible with equipment and piping system.
- c. Equipment located in spaces normally accessible to building occupants, other than maintenance personnel, shall utilize direct gas pipe connection.
- d. Provide anti-microbial PVC coating for use with appliances located in kitchen areas.
- 2. Flexible Gas Connector for Outdoor Equipment Without External Spring Isolation:
 - a. Contractor may choose one of the following:
 - 1) Direct gas pipe connection.
 - 2) Corrugated stainless steel hose with 304 stainless steel braid covering, CSA certified. Metraflex model GASCT, Unisource Manufacturing series 400, or equal. Provide with end connections compatible with equipment and piping system.
- I. Compressed Air Pipe: Type K copper tubing, hard temper, with wrought copper fittings. Capped or plugged outlets shall be screwed brass.
- J. Condensate Drain Piping:
 - 1. Inside buildings provide ASTM B88, Type L copper tubing and fittings. Provide Wye fittings with capped cleanout plug for tubing up to 1 inch size. Provide wrought or cast DWV fittings for sizes 1-1/4 inch and larger.
 - 2. Outside buildings provide ASTM B88, Type L copper pipe and fittings, cast iron drain pipe and fittings or Schedule 40 galvanized steel pipe and cast iron drain or vent fittings.
 - 3. Connect condensate drains to mechanical equipment per equipment manufacturer's recommendations; provide P-trap where required. Slope piping to drain, with 1 inch in 10 foot minimum pitch. Provide di-electric couplings or unions at connections to dissimilar materials.
 - 4. Where Drawings indicate installation of mechanical equipment on spring isolation rails spring mounted curbs, or spring hangers, provide threaded metal connector at mechanical equipment, Metraflex Model SST, or equal by Unisource Mfg. Co., or Flexicraft Industries. Arrange flexible connection to ensure drainage of condensate, and support flexible connection at each end of connector, to ensure proper alignment.
 - 5. Where condensate drain P-traps are required, install trap using Wye fitting on inlet and outlet of trap. Provide cap on top of each Wye, made removable for cleaning and inspection. Drill 1/8 inch diameter hole in cap at outlet of the trap to allow venting of the system. Minimum depth of trap should be 4 inches, or as recommended by the manufacturer in printed literature.
 - 6. Provide cleanout tees or "Y" at each change in direction.

2.03 SITE PIPING AND FITTINGS TO 5 FEET FROM BUILDINGS

A. Buried Drain, Waste, and Vent Piping:

1. Install piping from street connection to the property line in accordance with local requirements.
2. 4 inches and larger: PVC, ASTM D3034 - SDR 35; use matching Ring Tite fittings.
3. 3 inches and smaller: Cast iron soil pipe and fittings, asphaltic coated, conforming to ASTM A888 and Cast Iron Soil Pipe Institute Standard 301 and so marked. Pipe and fittings shall be as manufactured by AB&I, Charlotte, Tyler pipe, or equal. Provide ANACO-Husky SD 4000, Clamp-All 125, or equal couplings and No-Hub fittings, meeting the requirements of FM 1680, SD Class I and ASTM C1540. Pipe and fittings shall be the product of a single manufacturer.

B. Water Service Piping:

1. Sizes 2 inches and larger (not under building): Gasket style PVC conforming to ASTM D2241-SDR21, Class 200 with gasket type fittings or ductile iron mechanical joint couplings. Gasket fittings shall be one piece injection molded PVC fittings, equal to Flo-Seal water main fittings for PVC pressure pipe, 200 psi, ASTM D-3139.
2. Sizes less than 2 inches: Type K copper tubing, hard temper, with wrought copper fittings. See Section 22 00 50 for pipe protection requirements for below grade copper piping.
3. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:
 - a. J.M. Eagle.
 - b. P.W. Pipe.
 - c. Ipex Series Pipe.

C. Water Service Piping Above Grade:

1. Sizes 2 inches and larger: Class 150 flanged ductile cast iron water pipe conforming to AWWA/ANSI C150/A21.50 and manufactured in accordance with AWWA/ANSI C151/A21.51. Fittings shall conform to AWWA/ANSI C110/A21.10, Class 250 pattern. Pipe and fittings shall have factory applied cement-mortar lining in accordance with AWWA/ANSI C104/A21.4. Flanges shall conform to ASME/ANSI B16.1.
2. Piping 1-1/2 inches and smaller: Type L copper tubing, hard temper, with brazed wrought copper fittings.

D. Gas Piping Underground: Performance Pipe, "DriscoPlex" 6500 PE 2708 (yellow), Polypipe, Inc., "Polypipe", or equal, polyethylene gas distribution pipe, ASTM D2513, ASTM D3261, and ASTM D2683 fittings with fusion welded joints. Provide piping labeled for natural gas in accordance with CPC.

1. Electrically isolate underground ferrous gas piping from the rest of the gas system with listed or approved isolation fittings installed a minimum of six inches above grade.
2. Provide Central Plastics Corp., Perfection, or equal, anodeless, single seal riser for transition from below grade polyethylene to schedule 40 steel piping above grade. Minimum horizontal length shall be 30 inches. Minimum vertical length shall be 30 inches, or greater as required. Provide fusion connection to polyethylene pipe below grade, and screwed connection to steel pipe above grade.

- E. Gas Piping Aboveground to 30 inches Belowground: Schedule 40 black steel with beveled ends for welding, with Class 150 welding fittings. Mitering to form elbows or tees will not be permitted; where branch tee connections of welded piping are required, Bonney "Weldolet" Allied Pipe Fittings, or equal fittings may be used if the branch is one-half of the diameter of the main or less.

2.04 FIRE PROTECTION PIPING

- A. Refer to specification Section 21 10 00 "Fire Protection."

2.05 PIPE JOINING MATERIALS

- A. Refer to piping Articles in this Section for special joining materials not listed below.
- B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
 - 1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch (3.2-mm) maximum thickness unless thickness or specific material is indicated
 - a. Full-Face Type: For flat-face, Class 125, cast iron and cast bronze flanges.
 - b. Narrow-Face Type: For raised-face, Class 250, cast iron and steel flanges.
 - 2. AWWA C111, rubber, flat face, 1/8-inch (3.2mm) thick, unless otherwise indicated; and full-face or ring type, unless other indicated.
 - 3. Flange Bolts and Nuts: AWWA C111, carbon steel, unless otherwise indicated.
 - 4. Plastic, Pipe-Flange Gasket, Bolts and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.
- C. Solder Filler Metals: ASTM B 32, 100 percent lead free alloys. Include water-flushable flux according to ASTM B813.
- D. Brazing Filler Metals: AWS A5.8, BCup-5 Series, copper-phosphorus unless otherwise indicated. Sil-Fos 15, or equal.
- E. Welding Filler Metals: Comply with ASME B31.1 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2.06 VALVES AND FITTINGS FOR POTABLE WATER SYSTEMS

- A. General:
 - 1. Provide valves and fittings conforming to lead-free requirements of California Health and Safety Code Section 11 68 75.
 - a. Provide valves listed to NSF/ANSI 61-G or NSF/ANSI 372 for valve materials for potable-water service.
 - 1) Exception: Main distribution gate valves above 1-1/2 inches located underground outside building are not required to conform lead-free requirements of California Health and Safety Code Section 11 68 75.
- B. Gate Valves:
 - 1. General: Furnish valves in copper lines with adapters to suit valve/line requirements.

2. 1-1/2 inches and smaller: Minimum 200 psi CWP, bronze body, threaded bonnet, rising or non-rising stem, solid wedge, threaded or solder ends, conforming to MSS SP-80. Milwaukee UP148, UP149, Nibco T-113-LF, S-113-LF, or equal.
 3. 2 inches through 3 inches: Minimum 200 psi CWP, bronze body, threaded bonnet, non-rising stem, solid wedge, threaded or solder ends, conforming to MSS SP-80. Nibco T-113-LF, S-113-LF, or equal.
 4. Main distribution gate valves underground outside building above 1-1/2 inches:
 - a. Underground valves 2 inches thru 12 inches: 250 psi, iron body, Non-rising stem, bolted bonnet, resilient wedge valves, conforming to AWWA C509, equipped with operating nuts, Mueller Series 2360, Nibco F-619-RW-SON, or equal.
 - 1) Underground valves 3 inches and smaller may be furnished with operating nuts or hand-wheels, and with Ring-Tite joint ends.
 - 2) Furnish and deliver to Owner one wrench of each size required for operating underground valves.
- C. Ball Valves:
1. 2 inches and smaller: 600 psi CWP, cast bronze or brass body, full port, two piece, threaded ends, and reinforced PTFE seal, conforming to MSS SP-110. Nibco T-685-80-LF, Milwaukee UPBA400, Apollo 77C-LF10, Kitz 868, or equal.
 2. 2-1/2 inches: Apollo 77C-LF10, or equal.
- D. Swing Check Valves:
1. Minimum 200 psi CWP, bronze or brass body, suitable for regrinding, threaded ends, conforming to MSS SP-80. Milwaukee UP509, Nibco T-413LF, Kitz 822T, or equal.
- E. Silent Check Valves (for use on pump discharge):
1. General: Provide spring loaded check valves at pump discharge of all pumps.
 - a. 2 inches and smaller: Minimum 300 psi CWP, bronze body, Apollo 61LF, Milwaukee UP548-T, or equal.
 - b. 2-1/2 inches and larger: Class 250, cast iron body, suitable for regrinding, Mueller 103MAP, or equal.
- F. Calibrated Balancing Valves:
1. General: Calibrated orifice ball type rated for 400 psig maximum operating pressure and 250 degrees F. maximum operating pressure.
 - a. Body: Brass.
 - b. Ball: 304 Stainless Steel.
 - c. Seat: Glass and Carbon filled TFE.
 - d. End Connections: Threaded.
 - e. Pressure Gage connections: Integral capped readout valves with internal check valves and drain port, for use with portable pressure differential meter.
 - f. Handle Style: Dial, with memory stops to retain set position.
 2. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:

- a. 1 inch and smaller: Bell & Gossett model CB, "LF" series.

2.07 VALVES AND FITTINGS FOR NON-POTABLE WATER, COMPRESSED AIR, AND GAS SYSTEMS

A. Gate Valves:

1. 2-1/2 inches and smaller: Class 150, bronze body, union bonnet, rising stem, solid wedge, threaded or solder ends, conforming to MSS SP-80. Hammond IB641, IB648, Nibco T-134, S-134, Milwaukee 1151, 1169, or equal.
2. 3 inches and larger: Class 125, iron body, bronze mounted, bolted bonnet, non-rising stem, solid wedge, flanged ends, conforming to MSS SP-70. Hammond IR-1138, Nibco F619, Milwaukee F2882A, Stockham G-612, or equal.
3. Underground valves 2 inches thru 12 inches: 250 psi, iron body, Non-rising stem, bolted bonnet, resilient wedge valves, conforming to AWWA C509, equipped with operating nuts, Mueller Series 2360, Nibco F-619-RW-SON, or equal.
 - a. Underground valves 3 inches and smaller may be furnished with operating nuts or hand-wheels, and with Ring-Tite joint ends.
 - b. Furnish and deliver to Owner one wrench of each size required for operating underground valves.

B. Ball Valves:

1. 2 inches and smaller: 600 psi CWP, 150 psi SWP, cast bronze body, full port, two piece, threaded ends, and reinforced PTFE seal, conforming to MSS SP-110. Nibco T585-70, Milwaukee BA-400, Stockham T-285, or equal.
2. 2-1/2 inches and larger: Class 150, carbon steel body, full port, two piece, stainless steel vented ball, flanged ends, and reinforced PTFE seal, conforming to MSS SP-72. Nibco F-515-CS-F-66-FS, Milwaukee F20-CS-15-F-02-GO-VB, or equal.
3. Compressed Air Services: 600 psi CWP, 150 psi SWP, bronze body, full port, three piece, threaded ends, and reinforced PTFE seal, conforming to MSS SP-110. Nibco Model T-595-Y, Milwaukee BA-300, or equal.

- C. Swing Check Valves: Class 125 or 150, bronze body, suitable for regrinding, threaded ends, conforming to MSS SP-80. Stockham B-321, Milwaukee 509, Nibco T-433, or equal.

D. Silent Check Valves (for use on pump discharge):

1. General: Provide spring loaded check valves at pump discharge of all pumps.
2. 2 inches and smaller: 250 psi CWP, bronze body, Nibco Model T-480, Milwaukee 548-T, or equal.
3. 2-1/2 inches and larger: Class 250, cast iron body, wafer style, suitable for regrinding. Nibco Model F960, Milwaukee 1400, Mueller 103MAP, or equal.

- E. Calibrated Balance Valves (Symbol CBV): Provide globe style valves for precision regulation and control rated 175 psi for sizes 2-1/2 inches through 12 inches and rated 240 psi for bronze sizes 2 inches and below. Each valve shall have two metering/test ports with internal check valves and protective caps. All valves must be equipped with visual position readout and concealed memory stops for repeatable regulation and control.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:
 - a. Bell & Gossett Circuit Setter Plus.
 - b. Armstrong CBV.
 - c. Flow Design Inc. Accusetter.
 - d. Tour & Andersson.
 - e. Circuit Sensor with butterfly valve above 3 inches.
 - f. Illinois Series 5000 through 2 inches.
- F. Flow Control Valves: Automatic pressure compensating flow control valves shall be Griswold, Flow Design, Inc., or equal.
- G. Building Gas Shut-Off Valves:
 1. 2 inches and smaller: Provide 175 psi SWP ball valve, CSA listed, full port, lockwing type, with AGA painted grey finish. Jomar 175-LWN, or equal.
 2. Above 2 inches: Provide ReSun D-126, Key Port, or equal, lubricated plug cock, CSA listed, rectangular port, full pipe area, 125 psi SWP, flanged ends. Provide T-Handle socket wrench and adapter fittings as required for operation of valves. Provide one package of spare lubricant sticks, sizes as required for valve sizes. Lubricant shall be the product recommended by valve manufacturer for use with type of gas conveyed by the piping system.
 3. Provide valves same size as upstream piping. Make any reduction in size of gas piping downstream of shutoff valves.
- H. Gas Shut-off Valve Above Grade:
 1. 2 inches and smaller: Provide Milwaukee BB2-100, Jomar T-100NE, or equal, ball valve, CSA listed, full port.
 2. Above 2 inches: Provide ReSun D-126, Key Port, or equal, CSA listed, rectangular port, full pipe area, 125 psi SWP, flanged ends. Provide T-Handle socket wrench and adapter fittings as required for operation of valves. Provide one package of spare lubricant sticks, sizes as required for valve sizes. Lubricant shall be the product recommended by valve manufacturer for use with type of gas conveyed by the piping system.
 3. Provide valves same size as upstream piping. Make any reduction in size of gas piping downstream of shutoff valves.
- I. For Gas Service Below Grade:
 1. Lubricated plug cocks: ReSun Model D-126, Key Port, or equal, lubricated plug cock, CSA listed, rectangular port, full pipe area, 125 psi SWP, flanged ends. Provide extended lubrication stem, arranged to allow for lubrication of the valve from grade. The extension must be constructed to allow for lubrication of the valve and for operation of the valve from grade. Provide T-Handle socket wrench and adapter fittings as required for operation of valves. Provide one package of spare lubricant sticks, sizes as required for valve sizes. Lubricant shall be the product recommended by valve manufacturer for use with type of gas conveyed by the piping system.

- a. Provide flanged ends on valves installed below grade. Connect to polyethylene piping with flanges and stainless steel bolts.
 - b. Anchor each valve flange to valve box with welded angle iron, or provide vertical stiff leg, minimum 18 inches into earth.
 - c. Provide Central Double O Seal Transition Fittings, or equal, flanged style for connection between valve and piping system.
 - d. Wrap valve, flanges and exposed pipe with PASCO Specialty & Mfg., Inc., or equal tape wrap, installed in accordance with requirements listed under "Pipe Protection".
- J. Seismic Gas Shut-Off Valves: Certified by State of California and compliant with ASCE 25. Provide standard or high pressure model as required to match site gas pressure. Provide unit arrangement per Drawings schedule and details.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Little Firefighter Corporation, models NAGV, VAGV, and AGV.
 - b. Seismic Safety Products, LLC, Northridge series.

2.08 DOMESTIC WATER PIPING SPECIALTIES

A. Hose Bibbs:

1. Manufacturers: Drawing schedules indicate Basis of Design products. Subject to compliance with requirements, provide product indicated on Drawings, or comparable product by one of the following, or equal:
 - a. Acorn Engineering Co.
 - b. Woodford Manufacturing Co.
2. Hose Station: Leonard THS-25-VB-CW, Symmons, or equal.

B. Wall Hydrants:

1. Manufacturers: Drawing schedules indicate Basis of Design products. Subject to compliance with requirements, provide product indicated on Drawings, or comparable product by one of the following, or equal:
 - a. Acorn Engineering Co.
 - b. Woodford Manufacturing Co.
 - c. Mifab, Inc.

C. Water Hammer Arrestors:

1. Provide water hammer arrestors conforming to lead-free requirements of California Health and Safety Code Section 11 68 75, with nesting type bellows contained within a casing having sufficient displacement volume to dissipate the calculated kinetic energy generated in the piping system. Water hammer arrestors shall be sized for type and number of fixtures served. Provide all stainless steel shell construction with stainless steel bellows and threaded connection to water system.
2. Water hammer arrestors shall be certified under P.D.I. Standard WH201 and by ASSE Standard 1010.
3. Select units in accordance with the requirements of Plumbing and Drainage Institute Standard P.D.I. WH201. Install above ceilings or behind wall access door at each

plumbing fixture, or where plumbing fixtures are installed in groups, at each group of fixtures.

4. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:
 - a. Josam Company, series 75000.
 - b. Smith (Jay R.) Mfg. Co., Hydrotrol 5005-5050.
 - c. Mifab, series WHB.

D. Water Filters:

1. Provide Cuno Incorporated, Aqua Pure model AP510, or equal, point of use water filters, conforming to lead-free requirements of California Health and Safety Code Section 11 68 75, in locations indicated on Drawings.
 - a. Provide model AP517 filter cartridge at each location, with 5 micron rating and 2,000 gallon rating, to remove sediment, rust, scale and chlorine taste and odor from incoming water. 2 gallon per minute capacity.
 - b. Provide one spare cartridge for each unit provided.

E. Potable Water Pressure-Regulating Valve:

1. Provide pressure-regulating valves, single-seated, direct-operated type, bronze body, integral strainer, complying with requirements of ASSE Standard 1003, and the lead-free requirements of California Health and Safety Code Section 11 68 75. Size for maximum flow rate and inlet and outlet pressure indicated on Drawings.
2. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:
 - a. Cla-Val Company.
 - b. Watts Regulator Company.

F. Thermostatic Water Temperature Control Valve:

1. Provide thermostatic water temperature control valve conforming to lead free requirements of California Health and Safety Code Section 11 68 75, with size as noted on Drawings, complete with union angle strainer checkstops. Valves shall be thermostatic type, with a maximum temperature setting as follows:
2. Provide surface recessed semi-recessed mounted, white enameled or stainless steel cabinet with locking door for control valves. Including:
 - a. Control valve cabinet and valve shall be provided as a package, and include thermostatic water mixing valve, thermometer, safety checkstops, volume control valve and internal piping.
3. Where indicated on drawings, provide a temperature alarm system, utilizing a micro-processor based controller and solid state temperature controller. Provide audible and visual indication of high and low temperature set points. Provide required hardware and wiring for a complete operating system.
 - a. Provide isolation transformer for control of the alarm system.
 - b. Provide solenoid valve and shock absorber, installed and wired to the alarm module.

4. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:
 - a. Leonard Valve Company.
 - b. Lawler Manufacturing Co., Inc.
 - c. Powers.

G. Relief Valves:

1. Provide relief valves as indicated, of size and capacity as selected by Contractor for proper relieving capacity, in accordance with ASME Boiler and Pressure Vessel Code.
2. Combined Pressure-Temperature Relief Valves: Bronze body, test lever, thermostat, complying with ANSI A21.22 listing requirements for temperature discharge capacity. Provide temperature relief at 210 degrees F, and pressure relief at 150 psi.
3. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:
 - a. Watts Regulator Company.
 - b. Cash (A.W.) Valve Manufacturing Corporation.
 - c. Zurn Industries, Inc.; Wilkins-Regulator Division.

H. Trap Primers:

1. Manufacturers: Drawing schedules indicate Basis of Design products. Subject to compliance with requirements, provide product indicated on Drawings, or comparable product by one of the following, or equal:
 - a. MiFab, Inc.
 - b. Precision Plumbing Products.
 - c. Sioux Chief Manufacturing Company.

2.09 GAS PIPING SPECIALTIES

A. Gas Pressure Regulating Valves:

1. Provide single-stage, spring-loaded, corrosion-resistant gas pressure regulators, with die-cast aluminum or cast iron body, complying with ANSI Z21.80. Unit shall be with atmospheric vent, internal relief overpressure protection, threaded ends for 2 inches and smaller, flanged ends for 2-1/2 inches and larger. For inlet and outlet gas pressures, specific gravity, and volume flow refer to Drawings schedule.
2. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:

<u>Size</u>	<u>Manufacturer/Model</u>
1/2 inch	Elster (American, Singer) model 1213B Itron (Actaris, Slumberger, Sprague) model B42R.
3/4 thru 1-1/4inches	Elster (American, Singer) model 1813C Sensus (Ivensys, Equimeter, Rockwell) model 143-80-12 Itron (Actaris, Slumberger, Sprague) models B42R, B57R, B58R
1-1/2 thru 2 inches	Elster (American, Singer) models 1813, 1813B Sensus (Ivensys, Equimeter, Rockwell) model 243 Itron (Actaris, Slumberger, Sprague) models B43SR, B34R, B38R

B. Gas and Air Outlets:

1. Air Outlets: Panel mounted Chicago 986-937CH; deck-mounted Chicago 980-937CH, T&S Brass, or equal. Provide integral check valve, and single lever handle in compliance with ADA requirements.
2. Air Hose Valve: Lincoln 815 coupler and 11659 nipple, Grover, or equal, with ball valve on inlet. Refer to drawing details for additional requirements. Provide Wilkerson Model CB6-04-000 air pressure regulator, or equal.
3. Hose Reels: Lincoln Model 85062, Grover or equal. Provide heavy-duty type with delivery hose, universal swivel, ball stop, shut-off valve, control valve and filter as required. Connect services to reels with ball valve.

2.10 DRAIN AND WASTE PIPING SPECIALTIES

A. Cleanouts:

1. General: Install cleanouts of same diameter as pipe (4 inch maximum) in all horizontal soil and waste lines where indicated and at all points of change in direction. Cleanouts shall be located not less than 18 inches from building construction so as to provide sufficient space for rodding. No horizontal run over 50 feet inside buildings or 100 feet outside buildings shall be without cleanout, whether shown on Drawings or not. Provide two-way cleanouts where indicated on drawings, and where required for satisfactory use.
 - a. Provide cleanouts in waste drop from each sink and urinal.
 - b. Provide one wrench for each size and type of cleanout used. Turn over to Owner at completion of the project, and obtain receipt. Place receipt in Operation and Maintenance Manuals.
2. Cleanouts in floor and in concrete sidewalks: Ducco Cast Iron with nickel bronze top, clamping collar and ABS plastic plug: Zurn ZN-1400-KC, or equal, with square or round top to suit floor construction.
3. Cleanouts in composition floors: Zurn ZN-1400-X-DX, or equal (nickel bronze top).

4. Cleanouts in concealed, aboveground cast-iron soil or waste lines: Zurn Z-1440A, or equal, with ABS plastic plug.
5. Cleanouts in walls: Zurn Z-1441 or Z-1443, or equal, with stainless steel cover. Provide long sweep elbow or combination wye at connection to riser and install with surface of cleanout within ½ inch of front face of finished wall.
 - a. Where space does not permit the above installation, provide Zurn Z-1446, or equal, with stainless steel access cover, and vandal resistant screw.
 - b. Install face of cleanout plug within 1/2 inch of front face of finished wall.
6. Cleanouts exterior to building in landscaped areas: Zurn Z-1449-BP, or equal, cleanout ferrule with tapered bronze plug. Where located at grade, provide 18 by 18 by 6 inch concrete pad; Trowel concrete smooth and edge; set flush with finished grade.
7. Cleanouts in drive areas: Zurn -1400-HD-KC, or equal, with heavy-duty top and ABS plastic plug.

B. Floor Drains:

1. Manufacturers: Drawing schedules indicate Basis of Design products. Subject to compliance with requirements, provide product indicated on Drawings, or comparable product by one of the following, or equal:
 - a. J.R. Smith.
 - b. MIFAB.
 - c. Watts.
 - d. Zurn.

C. Floor Sinks:

1. Floor Sinks: Provide anchoring flange (seepage pan) at all floor sinks, and provide flashing clamp in locations where floor membrane is used. Provide cast iron "P" trap and trap primer connection at P-Trap.
2. Manufacturers: Drawing schedules indicate Basis of Design products. Subject to compliance with requirements, provide product indicated on Drawings, or comparable product by one of the following, or equal:
 - a. J.R. Smith.
 - b. MIFAB.
 - c. Watts.
 - d. Zurn.

D. Area Drain:

1. Manufacturers: Drawing schedules indicate Basis of Design products. Subject to compliance with requirements, provide product indicated on Drawings, or comparable product by one of the following, or equal:
 - a. Brooks.
 - b. J.R. Smith.
 - c. Old Castle Precast.
 - d. Watts.
 - e. Zurn.

E. Roof Drains and Overflow Drains:

1. See Architectural Drawings for drain style to be used.
2. Provide offset downspout boots where required for connection of exposed sheet metal downspouts to underground cast iron or PVC piping.
3. Provide rainwater leader nozzles on overflow piping. Nozzle body shall be bronze with threaded inlet and bronze wall flange with mounting holes. Size nozzle to match connected rainwater leader.
4. Manufacturers: Drawing schedules indicate Basis of Design products. Subject to compliance with requirements, provide product indicated on Drawings, or comparable product by one of the following, or equal:
 - a. J.R. Smith.
 - b. Mifab.
 - c. Zurn.

2.11 HEAT TRACING

- A. Label all heat traced piping every 10 feet with "ELECTRIC TRACED" label.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine areas and conditions under which plumbing piping systems are to be installed. Do not proceed with Work until unsatisfactory conditions have been corrected in manner acceptable to Contractor.
- B. Make all arrangements for the utilities required. Pay all costs involved in obtaining the services including gas service and meter, water meter, pressure reducing valve, access boxes, street work. Connect to site utilities. Verify the location of all services. No extra cost will be allowed if services are not as shown.
- C. Determine sanitary sewer and storm drain location and elevation at all points of connection before installing any piping. Notify Architect immediately if indicated grades cannot be maintained.
- D. At time of final connection, and prior to opening valve to allow pressurization of water and gas piping from existing systems, on site or off site, perform a pressure test to indicate static pressure of existing systems. If pressure on water piping is greater than 80 psi, or gas pressure is not as indicated on Contract Documents, inform Architect immediately. Do not allow piping systems to be pressurized without written consent of the Architect.

3.02 INSTALLATION OF WATER PIPING

- A. Run all water piping generally level, free of traps or unnecessary bends, arranged to conform to the building requirements, and to suit clearance for other mechanical work such as ducts, flues, conduits, and other work. No piping shall be installed so as to cause unusual noise from the flow of water therein under normal conditions.
- B. Provide manufactured water hammer arrestors, sized and installed in accordance with Plumbing and Drainage Institute Standard PDI WH201.

1. Locate water hammer arrestors at every plumbing fixture, or, where fixtures are located in groups, at every group of fixtures, and as indicated on Drawings.
 2. Install water hammer arrestors above accessible ceilings, or install access doors for service.
- C. In freezing locations arrange water piping to drain as shown.
- D. Install piping on room side of building insulation.
- E. Check final location of rubber rings within couplings on PVC water piping with gauge or as recommended by manufacturer. Make connection to valves with cast iron adapters connected to water pipe with cast iron couplings. Furnish and install anchors or thrust blocks.
- F. For all faucets, hose bibbs, or other water outlets delivering industrial hot and/or cold water, provide a sign, permanently mounted, indicating "CAUTION: NON-POTABLE WATER, DO NOT DRINK". Each sign shall be permanently engraved with black uppercase letters on a yellow background. Letters shall be minimum 1-1/4 inch high.

3.03 INSTALLATION OF SANITARY AND STORM DRAINAGE SYSTEMS

- A. Sewer Piping: Run all horizontal sanitary drain piping inside of building on a uniform grade of not less than 1/4 inch per foot unless otherwise noted or later approved. Unless otherwise noted on the plans, piping shall have invert elevations as shown and slope uniformly between given elevations.
- B. Storm Drain Piping: Run all horizontal storm drain piping inside of building on a uniform grade of not less than 1/4 inch per foot. Unless otherwise noted on the plans, piping shall have invert elevations as shown and slope uniformly between given elevations.
- C. Install rainwater leader nozzles at exposed bottom of leaders where they spill onto grade.
- D. Run all drainage piping as straight as possible and provide easy bends with long turns; make all offsets at an angle of 45 degrees or less.
- E. Grade all vent piping so as to free itself quickly of any water condensation.
- F. Where possible, join groups of vent risers together with one enlarged outlet through roof. Maintain minimum of 10 foot horizontal or 3 foot vertical clearance from air intakes.
- G. Install drip pan under storm drain piping, sanitary drain piping, and vent piping that must be run over kitchen areas.
- H. Hubless Cast Iron Joints: Comply with coupling manufacturer's installation instructions.

3.04 INSTALLATION OF NATURAL GAS PIPING

- A. Install natural gas piping in accordance with Division 22 Basic Plumbing Materials and Methods sections.
- B. Use sealants on metal gas piping threads that are chemically resistant to natural gas. Use sealants sparingly, and apply to only male threads of metal joints.
- C. Remove cutting and threading burrs before assembling piping.

- D. Do not install defective piping or fittings. Do not use pipe with threads that are chipped, stripped, or damaged.
- E. Plug each gas outlet, including valves, with threaded plug or cap immediately after installation and retain until continuing piping or equipment connections are completed.
- F. Ground gas piping electrically and continuously within project, and bond tightly to grounding connection.
- G. Install drip-legs in gas piping where indicated and where required by code or regulation.
 - 1. Install "Tee" fitting with bottom outlet plugged or capped at bottom of pipe risers.
 - 2. Where gas supply is connected to equipment with flexible connectors, install drip-leg in piping on downstream side of flexible connector, and install shut off valve on piping on upstream side of flexible connector.
- H. Install piping with 1/64 inch per foot (1/8 percent) downward slope in direction of flow.
- I. Install piping parallel to other piping.
- J. Paint all gas piping installed in exposed exterior locations. For additional requirements, refer to Section 22 00 50, Basic Plumbing Materials and Methods, article, Painting.
- K. Provide shutoff valve downstream of meter.
- L. Provide exterior shutoff valve at each building. Provide sign affixed to wall at valve location reading: "Gas Shut-Off." Size and location of the sign shall be as required by the Authority Having Jurisdiction. Where gas piping enters a building in more than one location, exterior shutoff valves shall have a permanently attached metal tag identifying the area served by that valve, in addition to sign on wall.
- M. Provide watertight Schedule 40 PVC conduit to protect gas piping installed below covered walk, covered driveways, and where noted on Drawings. Extend sleeve at least 12 inches beyond any area where it is required to be installed, and terminate with valve box extended to grade, and marked "GAS".
- N. Maintain minimum of 12 inch clearance between gas piping and steam piping above 200 degrees F.

3.05 PIPE JOINTS AND CONNECTIONS

- A. General:
 - 1. Cutting: Cut pipe and tubing square, remove rough edges or burrs. Bevel plain ends of steel pipe.
 - 2. Remove scale, slag, dirt and debris from inside and outside of pipe before assembly.
 - 3. Boss or saddle type fittings or mechanically extracted tube joints will not be allowed.
- B. Threaded Pipe: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply thread compound to external pipe threads: Rectorseal No. 5, Permatex No. 1, or equal.

2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
- C. Flanged Joints: Select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for domestic water service. Join flanges with gasket and bolts according to ASME B31.9.
- D. Joint Construction for Solvent-Cemented Plastic Piping: Clean and dry joining surfaces. Join pipe and fittings according to the following:
 1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements. Apply primer.
 2. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
- E. Copper Pipe and Tubing (Except pneumatic control piping): All joints shall be brazed according to ASME Section IX, Welding and Brazing Qualifications, except domestic water piping 1-1/4 inches and smaller when not buried in the ground or concrete and type DWV plumbing piping may be soldered.
 1. Soldered joints: Apply water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B 828.
- F. Cast Iron Soil Pipe:
 1. No-Hub fittings shall be made with a torque wrench.
 2. Hub joints shall be with Ty-Seal couplings.
 3. Wrought iron, steel, or copper pipe shall have a ring or part of a coupling screwed on to form a spigot end if caulked into a joint.
 4. Connect cast iron sewer piping to outside service pipe with cast iron or vitrified LOP reducers or increasers as required. Caulking of smaller pipe into the larger without a reducer or increaser will not be permitted.
- G. Welded Pipe:
 1. Make up with oxyacetylene or electric arc process.
 2. All line welds shall be of the single "V" butt type. Welds for flanges shall be of the fillet type.
 3. Where the branch is two pipe sizes smaller than the main or smaller, Bonney Weldolets, Threadolets, Nibco, or equal, may be used in lieu of welding tees.
- H. Polyethylene and Polypropylene Pipe: Assemble with fusion joints in strict accordance with manufacturer's instructions.
- I. Flexible Connections:
 1. Furnish and install Thermo Tech., Inc. F/J/R, Metraflex, or equal, flexible couplings with limiter bolts on piping connections to all equipment mounted on anti-vibration bases, on each connection to each base mounted pump and where shown. Couplings shall be suitable for pressure and type of service.
 2. Anchor piping securely on the system side of each flexible connection.

3.06 INSTALLATION OF VALVES

- A. Install valves as indicated on Drawings and in the following locations:

1. Shutoff Valves: Install on inlet of each plumbing equipment item, and on inlet of each plumbing fixture, and elsewhere as indicated.
2. Drain Valves: Install on each plumbing equipment item located to completely drain equipment for service or repair. Install at base of each riser, at base of each rise or drop in piping system, and elsewhere indicated or required to completely drain potable water system.
3. Provide gate or globe valves on inlet and outlet of each water heater or pump.

B. General:

1. Valves shall be full line size unless indicated otherwise on Drawings.
2. Install horizontal valves with valve stem above horizontal, except butterfly valves.
3. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
4. Locate valves for easy access and provide separate support where necessary.
5. Install valves in position to allow full stem movement.
6. Install exposed polished or enameled connections with special care showing no tool marks or exposed threads.
7. Butterfly valves conforming to the paragraph "Butterfly Valves" may be used in lieu of gate or globe valves for locations above grade.
8. Ball valves conforming to the paragraph "Ball Valves" may be used in lieu of gate valves for locations above grade for services 2-1/2 inches and smaller.
9. Valves 2-1/2 inches and smaller (except ball valves) in nonferrous water piping systems may be solder joint type with bronze body and trim.
10. Rigidly fasten hose bibbs, hydrants, fixture stops, compressed air outlets, and similar items to the building construction.

C. Gate Valves:

1. Furnish valves in copper lines with adapters to suit valve / line requirements.
2. Underground gate valves:
 - a. Underground valves 3 inches and smaller may be furnished with operating nuts or hand-wheels, and with Ring-Tite joint ends.
 - b. Furnish and deliver to Owner one wrench of each size required for operating underground valves.

D. Swing Check Valves: Install in horizontal position with hinge pin level.

E. Silent Check Valves: Install in horizontal or vertical position between flanges.

F. Calibrated Balancing Valves: Install calibrated balancing valves per manufacturers' recommendations, including requirements for straight pipe lengths at valve inlet and outlet.

G. Gas Shut-Off Valves:

1. Provide line size ball valve in gas line to each appliance.
2. Provide line size electric solenoid gas valve in gas line to kitchen equipment (if not supplied with appliance) under Type 1 hood. Interlock with hood fire alarm system.

- H. Valve Adjustment: Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.07 INSTALLATION OF CLEANOUTS

- A. Cleanouts: Install in piping as indicated, as required by California Plumbing Code, at each change in direction of piping greater than 45 degrees. Install at maximum intervals of 50 feet for piping 4 inches and smaller and 100 feet for larger piping inside buildings, and at base of each conductor.
- B. Flashing Flanges: Install flashing flange and clamping device with each cleanout passing through water resistant membrane.

3.08 INSTALLATION OF FLOOR DRAINS AND FLOOR SINKS

- A. Install drains in accordance with manufacturer's written instructions and in locations indicated. Install floor drains with lip of drain slightly below finished floor to ensure drainage. Install floor sinks flush with finished floor. Coordinate with other trades to ensure that floor slopes to drain. Provide flashing flange and clamping device with each drain passing through water resistant membrane.
- B. Install vented P-trap below each drain. Where trap primers are indicated, install trap primer connection in the P-trap.

3.09 INSTALLATION OF ROOF DRAINS AND OVERFLOW DRAINS

- A. Install roof drains and overflow roof drains in accordance with manufacturer's written instructions and in locations indicated.
- B. Coordinate with roofing as necessary to interface roof drains with roofing work.

3.10 TRAP PRIMER INSTALLATION

- A. Install as indicated in manufacturers printed literature, with 1/2 inch, Type L, hard copper piping to trap primer connection on floor drains and floor sinks where indicated on Drawings. At Contractor's option, Type K annealed copper tubing without joints may be used below slab only. See Section 22 00 50 for pipe protection requirements for below slab copper piping/tubing.
- B. Install trap primer piping with 1/4 inch per foot slope, to insure that the line will drain fully to the floor drain or floor sink.
 - 1. Provide ball valve to the inlet at each trap primer location.
- C. Install trap primer and distribution unit exactly as called for in manufacturers printed installation instructions. Connect to domestic water piping from the top of the water line, in order to prevent foreign material from entering directly into primer assembly.
- D. Mount trap primer in wall, in sheet metal box, with Karp or equal access door. Size access door and box to suit valve operation, and solder all seams of box. Seal all penetrations to box with non-hardening waterproof sealant. Provide locking door where installed in occupied spaces.
- E. Where one trap primer will be used for more than one trap, provide a distribution unit with feeder piping for a maximum of four traps sized for equal pressure drop to each trap.

3.11 INSTALLATION OF GAS PRESSURE REGULATING VALVES

- A. Install as indicated; comply with utility requirements. In locations where regulators are installed in confined spaces, pipe atmospheric vent to outdoors, full size of outlet. Install gas shutoff valve upstream and downstream of each pressure-regulating valve.

3.12 GAS PIPING EQUIPMENT CONNECTIONS

- A. Connect gas piping to each gas-fired equipment item, with union, drip leg and shutoff gas cock full size of supply line shown. Reduce only at connection to equipment. Comply with equipment manufacturer's instructions.
 - 1. Route gas vent and gas relief to outside.
 - 2. Gas shutoff valve shall be placed as close as possible to equipment in a location where it can be serviced. Distance from equipment to valve shall not exceed 6 feet.

3.13 EQUIPMENT CONNECTIONS

- A. Piping Runouts to Fixtures: Provide hot and cold water piping runouts to fixtures of sizes indicated.
- B. Mechanical Equipment Connections: Connect hot and cold water piping system and gas piping system to mechanical equipment as indicated, and provide with shutoff valve and union for each connection.

3.14 HEAT TRACING INSTALLATION

- A. Provide heat cable on all domestic hot water piping.
- B. Manufacturer's installation recommendation shall be considered as part of this specification.
- C. Field testing of insulation resistance and continuity of the units shall be carried out with a 500 volt meter and recorded by the contractor. Testing shall be done when received on the job site, after installation on the pipe, and after the heat insulation has been installed. Insulation resistance shall be consistently not less than 50 megohms with no decline in reading.
- D. Where source of supply does not coincide with location of thermostat, cable shall be run along the pipe under the insulation to the thermostat.
- E. All junction boxes shall be located above grade level. Covers shall be kept on boxes at all times when not working therein. Where allowable, a hole shall be provided in bottom of junction boxes to permit moisture to escape.
- F. All terminations shall be protected from the water and from physical damage.
- G. Any field alterations or deviations shall proceed only after authority via signed change order has been issued by Architect. All changes shall be accurately recorded by the Contractor and shall be turned over to the Engineer upon completion of that phase of the work.
- H. All lines shall be insulated within 24 hours upon cable installation and acceptance.

- I. Junction boxes, thermostats, transformers and the like shall not be attached to the insulation, but shall be mounted on brackets fabricated of galvanized angle, channel or other material of sufficient strength to support equipment mounted on them. Brackets shall not be mounted on pipe, but rather on separate supports.
- J. Heating cables to be laid out along sections of piping to be heat traced to ensure uniform distribution of heat. It is recommended that the cable first be "roughed-in" using tape or rubber bands which are to be removed after permanent bending. The cable shall not be pulled taut, but allowed reasonable waving along axis of pipe.
- K. Cable sheaths shall not cross or touch one another nor shall cables be installed directly on top of pipe.
- L. Heating cable shall be strapped to two-inch and larger pipe using one-half inch wide stainless steel banding at intervals not exceeding one foot per CEC. Stainless steel tie wire #18 AWG, or larger, shall be used to hold the cable to irregular surfaces such as valves. Tie wire and strapping shall be snug but not so tight as to indent cable sheath. On small diameter and low temperature pipe, nylon ties or glass tape may be used.
- M. Extra cable to be provided at areas of increased heat loss such as valves and flanges to allow dismantling and removal of equipment.
- N. Thermostat bulb to be located as far away from heating cable as possible. Thermostat capillary and control wire shall have mechanical protection between the equipment rack and the pipelines.
- O. Apply "ELECTRICALLY HEATED" signs to the outside of the thermal insulation.

3.15 KITCHEN EQUIPMENT INSTALLATION

- A. Coordinate all work with Specification Section for Kitchen Equipment.
- B. All equipment shall be fully connected.
- C. Furnish and install all required "P" traps.
- D. Provide stops on all hot and cold water lines at equipment, in an accessible position. Include lines to kettle and range swing faucets.
- E. Water pressure for dishwasher and glass-washer to be 25 pound maximum. Provide pressure reducing valves on water line to washers.
- F. All floor openings are to be sealed watertight.
- G. Indirect waste lines required for standard or fabricated items of kitchen equipment, except sinks, shall be furnished and installed by the Kitchen Equipment Contractor.
- H. Provide all sink drains. All indirect drains shall terminate above floor sinks at least 1-1/2 times ID of drain line and shall be so set that flare will not spill on floor area.
- I. Provide approved vacuum breaker or anti siphon device on water lines to equipment wherever required.

- J. Provide gas pressure regulators for modular front manifold cooking equipment assemblies. Pressure regulators shall be adjustable from 2 inch to 7 inch water column and shall be set for approximately 6 inches W.C. at manifold connection.
- K. All gas pressure regulators shipped loose with gas fired equipment shall be installed by Plumbing Contractor.
- L. The Kitchen Equipment Contractor will provide all equipment trim including faucets and sink wastes and swing faucets at kettles all to be installed by Plumbing Contractor.
- M. All horizontal piping lines connected to equipment shall be run at the highest possible elevation not less than 6 inches above floor. Piping rough-in shall be stubbed in walls wherever possible.
- N. Vent piping for waste lines shall be concealed wherever possible and vertical vents for island or free-standing equipment shall be avoided. Any required exposed vents shall be submitted to the Architect for approval.
- O. Kitchen Equipment Contractor to furnish coffee maker. Plumbing Contractor shall provide a cold water connection terminating in a 3'-0" length of 1/4 inch OD soft copper tubing with a 1/4 inch female flare fitting on the end.
- P. Fire protection systems for ventilators and cooking equipment are furnished and installed by Kitchen Equipment Contractor unless shown otherwise on the drawings. Gas valves which are a part of the fire protection systems are furnished only. Plumbing Contractor shall install gas valves.

3.16 DOMESTIC WATER SYSTEM STERILIZATION

- A. Clean and disinfect new or altered hot and cold water piping connected to domestic water systems using methods prescribed by the Health Authority. If the Health Authority does not prescribe methods, clean and disinfect new or altered hot and cold water piping using methods given in the California Plumbing Code.
 - 1. A water treatment company that has a current state EPA license to apply disinfectant chlorine in potable water shall perform the procedure.

3.17 CARE AND CLEANING

- A. Repair or replace broken, damaged, or otherwise defective parts, materials, and work. Leave entire work in condition satisfactory to Architect. At completion, carefully clean and adjust equipment, fixtures, and trim that are installed as part of this work. Remove labels from stainless steel sinks, except 316 stainless steel sink labels should be retained to confirm that the correct material has been provided. Leave systems and equipment in satisfactory operating condition.

3.18 OPERATIONAL TESTS

- A. Test each piece of equipment to show that it will operate in accordance with indicated requirements.

3.19 TESTING AND BALANCING

- A. See Section 23 05 93 of Specifications for testing and balancing requirements.

3.20 CLEANING UP

- A. Upon completion of Work remove materials, equipment, apparatus, tools, and the like, and leave premises clean, neat, and orderly.

END OF SECTION

SECTION 22 40 00
PLUMBING FIXTURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Water supplies and stops.
2. Plumbing fixture hangers and supports.
3. Refrigerator ice maker outlet boxes.
4. Dishwasher air gap fittings.
5. Washing machine hose/supply boxes.

1.2 RELATED REQUIREMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Section 22 00 50 Basic Plumbing Materials and Methods.

1.3 ACTION SUBMITTALS

- A. For additional requirements, refer to Section 22 00 50, Basic Plumbing Materials and Methods.
- B. Product Data: Submit manufacturer's specifications for plumbing fixtures and trim, including catalog cut of each fixture type and trim item furnished.

1.4 INFORMATIONAL SUBMITTALS

- A. Refer to Section 22 00 50, Basic Plumbing Materials and Methods.

1.5 CLOSEOUT SUBMITTALS

- A. For additional requirements, refer to Section 22 00 50, Basic Plumbing Materials and Methods.
- B. Maintenance Data: Submit maintenance data and parts lists for each fixture type and trim item, including instructions for care of finishes. Include this data in Operation and Maintenance Manual.

1.6 QUALITY ASSURANCE

- A. For additional requirements, refer to Section 22 00 50, Basic Plumbing Materials and Methods.
- B. Plumbing Fixture Standards: Comply with applicable portions of the latest edition of the following codes and requirements for all work in this Section:
1. California Building Code – CBC
 2. California Plumbing Code – CPC

3. California Health and Safety Code
 4. American National Standards Institute - ANSI
 5. Federal Standards - F.S.
 6. National Sanitary Foundation – NSF International
- C. ANSI Standards: Comply with ANSI/NSF 61, "Drinking Water System Components – Health Effects."
- D. PDI Compliance: Comply with standards established by Plumbing and Drainage Institute pertaining to plumbing fixture supports.
- E. UL Labels: Provide water coolers that have been listed and labeled by Underwriters' Laboratories.
- F. ARI Labels: Provide water coolers that are rated and certified in accordance with applicable Air-Conditioning and Refrigeration Institute Standards.
- G. Americans with Disabilities Act (ADA).
- H. California Green Building Standards Code Requirements:
1. Tank-type water closets shall be certified to the performance criteria of the U.S. EPA WaterSense Specification for Tank-Type Toilets.
 2. Single Showerheads shall be certified to the performance criteria of the U.S. EPA WaterSense Specification for Showerheads.

PART 2 - PRODUCTS

2.1 PLUMBING FIXTURES

- A. General: Provide factory fabricated fixtures of type, style and material indicated. For each type fixture, provide fixture manufacturer's standard trim, carrier, seats, and valves as indicated by their published product information; either as designed and constructed, or as recommended by the manufacturer, and as required for a complete, installation. Where more than one type is dedicated, selection is Contractor's option; but, all fixtures of same type must be furnished by single manufacturer.
1. Take special care with the roughing-in and finished plumbing where batteries of fixtures occur.
 2. Take location and mounting heights for roughing-in from Architectural Drawings.
 3. Follow schedule on Plumbing Drawings for roughing-in connections. Set roughing-in for all fixtures exactly as per measurements furnished by the manufacturers of the fixtures used.
 4. Roughing-in for lavatories and sinks shall be brought in through the wall under the centerline of the drain from the fixture wherever possible and as close to the fixture as possible.

2.2 MATERIALS

- A. Provide materials that have been selected for their surface flatness and smoothness. Exposed surfaces that exhibit pitting, seam marks, roller marks, foundry sand holes, stains, discoloration, or other surface imperfections on finished units are not acceptable.

- B. Where fittings, trim and accessories are exposed or semi-exposed, provide, chromium plated 17 gauge seamless brass and match faucets and fittings. Provide 17 gauge seamless copper or brass where not exposed.
- C. Handles on all faucets and stops shall be all metal chromium plated.
- D. NSF Standard: Comply with NSF 61 and NSF 372 for supply-fitting materials that will be in contact with potable water.

2.3 PLUMBING FITTINGS, TRIM AND ACCESSORIES

- A. Water Outlets: At locations where water is supplied (by manual, automatic or remote control), provide commercial quality faucets, valves, or dispensing devices, of type and size indicated, and as required to operate as indicated.
 - 1. Include manual shutoff valves and connecting stem pipes to permit outlet servicing without shut-down of water supply piping systems.
- B. P-Traps: Include IAPMO approved removable P-traps where drains are indicated for direct connection to drainage system. P-Traps shall be less trap screw cleanout, and incorporate a chrome plated cast brass body, brass connection nuts, 17 gauge seamless brass wall return and chrome plated wall escutcheon to match trap finish.
- C. Carriers: Provide cast iron supports for fixtures of graphitic gray iron, ductile iron, or malleable iron as indicated. Where the carrier for wall mounted water closets are installed more than 6 inches behind the finished wall, provide water closet support for wide pipe chase.
- D. Fixture Bolt Caps: Provide manufacturer's standard exposed fixture bolt caps finished to match fixture finish.
- E. Escutcheons: Where fixture supplies and drains penetrate walls in exposed location, provide chrome-plated cast brass escutcheons with setscrews.
- F. Aerators: Provide aerators of types approved by Health Departments having jurisdiction. Delete aerators where not allowed by CPC for health care occupancies.
- G. Comply with additional fixture requirements contained in Fixture Schedule shown on the drawings.

2.4 MANUFACTURERS

- A. In accordance with California Plumbing Code, provide indelibly marked or embossed manufacturers name or logo, arranged so as to be visible after installation.
- B. Manufacturers: Drawing schedules indicate Basis of Design products. Subject to compliance with requirements, provide product indicated on Drawings, or comparable product by one of the following:
 - 1. Vitrified China Plumbing Fixtures:
 - a. American Standard, U.S. Plumbing Products.
 - b. Eljer Plumbingware Div., Wallace-Murray Corp.
 - c. Kohler Co.
 - d. Vitra.

2. Modular Lavatories:
 - a. Bradley.
 - b. Acorn.
 - c. Willoughby Industries, Inc.
3. Plumbing Trim:
 - a. McGuire Manufacturing Co., Inc.
 - b. Delta Commercial.
 - c. Chicago Faucet Co.
 - d. T&S Brass and Bronze Works, Inc.
4. Flush Valves:
 - a. Sloan Valve Co.
 - b. Zurn Industries, Hydromechanics Div.
 - c. Toto USA, Inc.
5. Faucets:
 - a. Chicago Faucet Co.
 - b. Symmons Scott.
 - c. T&S Brass and Bronze Works, Inc.
 - d. Delta Commercial.
6. Fixture Seats:
 - a. Church Seat Co.
 - b. Bemis Mfg. Co.
 - c. Beneke Corp.
7. Water Coolers and Drinking Fountains:
 - a. Haws Corporation.
 - b. Halsey Taylor Mfg. Co.
 - c. Elkay Mfg. Co.
 - d. Acorn Aqua.
8. Service Sinks:
 - a. American Standard.
 - b. Kohler Co.
 - c. Williams Serviceptor.
 - d. Florestone.
 - e. Acorn.
9. Stainless Steel Sinks:
 - a. Elkay Mfg. Co.
 - b. Just Mfg. Co.
 - c. Haws Corporation.

10. Showers:

- a. Acorn.
- b. Bradley.
- c. Symmons.
- d. Powers.

11. Emergency Equipment:

- a. Haws Corporation.
- b. Gardian.
- c. Symmons.
- d. Bradley.
- e. Encon.

12. Fixture Carriers:

- a. Josam Mfg. Co.
- b. J. R. Smith.
- c. Tyler Pipe; Wade Div.
- d. Zurn Industries; Hydromechanics Div.
- e. Mifab, Inc.

2.5 FLUSH VALVE REQUIREMENTS

- A. Metering flush valves where required and specified shall be non-hold open type with exposed parts chrome plated. Conform to all codes and manufacturers' recommendations. All diaphragms are to have multiple filtered bypass and be chloramine resistant synthetic rubber with internal components suitable for 180 degree hot water to 150 pounds pressure, plastic or leather diaphragm not acceptable.
- B. Electronic flush valves where required and specified shall be non-hold open type with exposed parts chrome plated. Conform to all codes and manufacturers' recommendations. All diaphragms are to have multiple filtered by pass and be chloramine and resistant synthetic rubber with rubber and internal components suitable for 180 degree hot water to 150 pounds pressure, plastic or leather diaphragm not acceptable. All flush valve solenoids and sensors shall be UL listed.

2.6 FIXTURE CONNECTIONS

- A. Make connection between fixtures and flanges on soil pipe absolutely gastight and watertight with neoprene type gaskets (wall hung fixtures) or bowl wax (floor outlet fixtures). Rubber gaskets or putty will not be permitted.
- B. Provide fixtures not having integral traps with P-traps of chromium-plated 17 gauge cast brass, with 17 gauge seamless brass wall return, connected to concealed waste in wall and sanitary fittings. Provide IAPMO approval for trap, and provide less trap screw cleanout.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:

- a. Dearborn Brass, Commercial series with brass nuts.
 - b. Delta Commercial.
 - c. McGuire Manufacturing Co., Inc.
- C. Connections from stacks or horizontal wastes to wall or floor finish for wastes from lavatories, urinals, sinks, and drinking fountains and connection between floor drains and traps shall be IPS 85 percent red brass pipe.
- D. Plumbing fixture traps connected to special waste systems shall be constructed of materials to suit the waste system.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:
 - a. Orion.
 - b. Enfield
- E. Unions on waste pipes on fixture side of traps may be slip or flange joints with soft rubber or lead gaskets. Traps shall rough in full size to waste and vent connection, using deep escutcheon plate to cover wall penetration. Compression adaptor extensions or sweat adaptors are not acceptable.

2.7 WATER SUPPLIES AND STOPS

- A. Provide 85 percent IPS threaded red brass nipple, conforming to the lead-free requirements of California Health and Safety Code Section 11 68 75, securely anchored to building construction, for each connection to stops, hose bibbs, etc. Each fixture, except hose bibbs, shall have stop valves installed on water supply lines.
- B. Provide water supplies to fixtures with compression shut-off stops with threaded inlets and lock shield-loose key handles. Provide combination fixtures with compression stop and threaded inlet on each water supply fitting. Provide lock shield-loose key handle for each stop.
- C. Provide 1/2 inch riser tubes with reducing coupling for fixtures, unless otherwise noted.
- D. Provide cast brass escutcheon.
- E. Furnish shut-off valves on hose bibbs where directly connected to mains with no intervening valves.
- F. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:
 - 1. McGuire Manufacturing Company, Inc., model LFH2167LK.
 - 2. T & S Brass and Bronze Works, Inc., model B-1305.

2.8 PLUMBING FIXTURE HANGERS AND SUPPORTS

- A. Residential type fixture supports are not acceptable.
- B. Install wall mounted water closets with combination support and waste fittings, with feet of support securely anchored to floor.

- C. Install floor mounted water closets with J.R. Smith, Zurn, or equal government pattern cast iron closet flanges with brass bolts, nuts, washers, and porcelain caps secured with Spackle.
- D. Install the following fixtures on concealed support with feet of support securely anchored to floor. Anchor top of support to wall construction in an approved manner.
 - 1. Wall hung lavatories.
 - 2. Wall mounted urinals.
 - 3. Drinking fountains.
 - 4. Electric water coolers.

2.9 PLUMBING FIXTURES

- A. Install all plumbing fixtures at height indicated on Architectural Drawings. Where mounting height is not indicated, install at height required by Code.
- B. Special Requirements For Accessible Fixtures:
 - 1. Operating handle or valve for accessible water closets, urinals, lavatories, and sinks shall operate with less than 5 pounds force. Metering faucets shall be adjusted to operate between 10 and 15 seconds.
 - 2. Insulate exposed waste piping and domestic water supplies below accessible fixtures with CBC access code compliant molded "closed-cell" vinyl covers. Covers shall be installed using vandal resistant fasteners and must be removable. Covers shall meet flame spread rating not to exceed 25 and smoke density not to exceed 50 when tested in accordance with ASTM E-84, and shall comply with the requirements of California Code of Regulations, Title 24. Plumberex – Handy Shield, Johns Manville – Zeston 2000, or equal.
- C. Refrigerator Ice Maker Outlet Boxes:
 - 1. Manufacturers: Drawing schedules indicate Basis of Design products. Subject to compliance with requirements, provide product indicated on Drawings, or comparable product by one of the following, or equal:
 - Guy Gray.
 - Water-Tite.
- D. Dishwasher Air Gap Fittings:
 - 1. Manufacturers: Drawing schedules indicate Basis of Design products. Subject to compliance with requirements, provide product indicated on Drawings, or comparable product by one of the following, or equal:
 - a. Zurn Industries, LLC.
 - b. Dearborn Brass.
- E. Washing Machine Hose/Supply Boxes:
 - 1. Manufacturers: Drawing schedules indicate Basis of Design products. Subject to compliance with requirements, provide product indicated on Drawings, or comparable product by one of the following, or equal:
 - a. Acorn Engineering Co.

PART 3 - EXECUTION

3.1 PRODUCT HANDLING AND PROTECTION

- A. Deliver packaged materials in their original, unopened wrapping with labels intact. Protect materials from water, the elements and other damage during delivery, storage and handling.

3.2 PREPARATORY PROVISIONS

- A. The Contractor is responsible for the examination and acceptance of all conditions affecting the proper construction and/or installation of the Work of this Section. Do not proceed until all unsatisfactory conditions have been corrected. Commencing work will be construed as acceptance of all conditions by the Contractor as satisfactory for the construction and/or installation of the Work.

3.3 INSPECTION AND PREPARATION

- A. Examine roughing-in work of domestic water and waste piping systems to verify actual locations of piping connections prior to installing fixtures. Also examine floors and substrates, and conditions under which fixture work is to be accomplished. Correct any incorrect locations of piping, and other unsatisfactory conditions for installation of plumbing fixtures. Do not proceed with work until unsatisfactory conditions have been corrected.
- B. Install plumbing fixtures of types indicated where shown and at indicated heights; in accordance with fixture manufacturer's written instructions, roughing-in drawings. Ensure that plumbing fixtures comply with requirements and serve intended purposes. Comply with applicable requirements of the National Standard Plumbing Code pertaining to installation of plumbing fixtures.
- C. Fasten plumbing fixtures securely to supports or building structure; and ensure that fixtures are level and plumb. Secure plumbing supplies to blocking behind or within wall construction so as to be rigid, and not subject to pull or push movement.
- D. Install CBC accessible fixtures in accordance with Chapter 4 California Plumbing Code 2022, and Chapters 11A and 11B California Building Code 2022.
- E. Refer to Division 26 for wiring for electronic flush valves.

3.4 FAUCET INSTALLATION

- A. Provide 85 percent IPS red brass pipe, conforming to lead-free requirements of California Health and Safety Code Section 11 68 75, securely anchored to building construction, for each connection to faucets, stops, hose bibbs, etc. Each fixture, except hose bibbs, shall have a stop valve installed on water supply lines to permit repairs without shutting off water mains.
- B. Adjust metering faucets to run for 10 to 15 seconds.

3.5 CLEAN AND PROTECT

- A. Clean plumbing fixtures of dirt and debris upon completion of installation.
- B. Protect installed fixtures from damage during the remainder of the construction period.

- C. Grout voids between all fixtures and adjacent surfaces with white Dow Silicone Sealant, arranged to shed water.

3.6 FIELD QUALITY CONTROL

- A. Upon completion of installation of plumbing fixtures and after units are water pressurized, test fixtures to demonstrate capability and compliance with requirements. When possible, correct malfunctioning units at site, then retest to demonstrate compliance; otherwise, remove and replace with new units and proceed with retesting.

3.7 EXTRA STOCK

- A. General: Furnish special wrenches and other devices necessary for servicing plumbing fixtures and trim to Owner with receipt. Furnish one device for every ten units.

END OF SECTION

SECTION 22 50 00
PLUMBING EQUIPMENT

PART 1 - GENERAL

1.01 SUMMARY

A. SECTION INCLUDES

1. Electric water heaters.
2. Expansion tanks.
3. In-line domestic hot water recirculation pumps.
4. Oil interceptor.
5. Air compressors.
6. Air dryer.

1.02 RELATED REQUIREMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Section 22 00 50 Basic Plumbing Materials and Methods.

1.03 ACTION SUBMITTALS

- A. For additional requirements, refer to Section 22 00 50, Basic Plumbing Materials and Methods.
- B. Product Data: Submit manufacturer's plumbing equipment specifications, installation and start-up instructions, capacity and ratings, with selection points clearly indicated.

1.04 INFORMATIONAL SUBMITTALS

- A. For additional requirements, refer to Section 22 00 50, Basic Plumbing Materials and Methods.

1.05 CLOSEOUT SUBMITTALS

- A. For additional requirements, refer to Section 22 00 50, Basic Plumbing Materials and Methods.
- B. Maintenance Data: Submit maintenance data and parts lists for each item of plumbing equipment. Include "trouble-shooting" maintenance guides. Include this data in Operation and Maintenance Manual.

1.06 QUALITY ASSURANCE

- A. For additional requirements, refer to Section 22 00 50, Basic Plumbing Materials and Methods.
- B. Trade names or catalog numbers stated herein indicates grade or quality of materials desired.

- C. Dimensions, sizes, and capacities shown are minimum and shall not be changed without permission of Architect.
- D. UL and NEMA Compliance: Provide electric motors and electrical components required as part of plumbing equipment, which have been listed and labeled by Underwriters Laboratories and comply with NEMA standards.
- E. CEC Compliance: Comply with California Electrical Code (Title 24, Part 3) as applicable to installation and electrical connections of ancillary electrical components of plumbing equipment.
- F. ANSI Compliance: Comply with ANSI Z223.1 (NFPA 54) "National Fuel Gas Code", as applicable to installation of gas-fired water heaters.
- G. CSA/UL Labels:
 - 1. Provide gas-fired water heaters that have been listed and labeled by CSA International or Underwriters Laboratories, certifying design according to ANSI Z21.10.1-CSA 4.1 standards governing storage-type water heaters with input ratings of 75,000 BTU/hr. or less.
 - 2. Provide gas-fired water heaters that have been listed and labeled by CSA International or Underwriters Laboratories, certifying design according to ANSI Z21.10.3-CSA 4.3 standards governing storage-type water heaters with input ratings of greater than 75,000 BTU/hr.
- H. ASME Relief Valve Stamps: Provide water heaters with safety relief valves bearing ASME valve markings.
- I. ASME Code Symbol Stamps: For the following equipment, comply with ASME Boiler and Pressure Vessel Code for construction, and stamp with ASME Code symbol:
 - 1. Water Heaters 200 MBH and greater.
- J. California Energy Commission Compliance: Provide written confirmation of listing of all water heaters in the "Appliance Efficiency Database."

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Deliver packaged materials in their original, unopened wrapping with labels intact. Protect materials from water, the elements and other damage during delivery, storage and handling.

1.08 WARRANTY

- A. Direct Vented Sealed Combustion Condensing Gas-Fired Water Heater: Three-year minimum limited warranty on tank.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. NSF Compliance: Fabricate and label equipment components that will be in contact with potable water to comply with NSF 61 and NSF 372.

- B. Insulation products, including insulation, insulation facings, jackets, adhesives, sealants and coatings shall not contain polybrominated diphenyl ethers (PBDEs) in penta, octa, or deca formulations in amounts greater than 0.1 percent (by mass).

2.02 COMMERCIAL ELECTRIC WATER HEATERS

- A. General: Provide commercial electric water heaters of size, capacity, and electrical characteristics indicated on Drawings. Comply with ASHRAE 90.1 for energy efficiency. Provide UL listing. Relief valve dip tube shall extend to within 3 inches of tank.
- B. Heater: Working pressure of 150 psi, magnesium anode rod; glass lining on internal surfaces exposed to water.
- C. Heating Elements: Heavy-duty, medium watt density, with incoloy sheath or zinc plated copper, thermostat stepped through magnetic contactor.
- D. Safety Controls: Double-pole, manual-reset, high-limit, probe type electric water low water cutoff; both factory wired.
- E. Jacket: Equip with full size control compartments with front panel opening. Insulate tank with vermin resistant polyurethane or glass fiber insulation. Provide outer steel jacket with bonderized undercoat and baked enamel finish.
- F. Provide the following accessories:
 - 1. Brass drain valve.
 - 2. 3/4 inch temperature and pressure relief valve.
 - 3. Thermometer.
- G. Provide equal flow manifold for piping entering and leaving the water heaters. Manifold shall be provided as a standard option for the heaters proposed.
- H. Controls: Adjustable immersion thermostat or surface mounted therm-o-disc; power circuit fusing.
- I. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:
 - 1. Bradford White Corporation.
 - 2. Lochinvar Corporation.
 - 3. PVI Industries, LLC.
 - 4. Rheem Manufacturing Company.
 - 5. Smith, A.O. Water Products Co.; a division of A.O. Smith Corporation.

2.03 EXPANSION TANKS

- A. Provide thermal expansion tanks of size and number as indicated on Drawings, conforming to lead-free requirements of California Health and Safety Code Section 11 68 75. Construct tank of welded steel for working pressure of 125 psi. Provide specially compounded flexible diaphragm securely sealed into tank to permanently separate air charge from system water, to maintain design expansion capacity.
 - 1. Tanks shall be IAPMO approved and listed for use with domestic water systems.

- B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:
 - 1. Amtrol, Inc.
 - 2. A.O. Smith Water Products Company.
 - 3. Watts Water Technologies, Inc.

2.04 IN-LINE DOMESTIC HOT WATER RECIRCULATION PUMPS

- A. Provide lead-free in-line domestic water recirculation pumps where indicated on Drawings and of capacities as scheduled on Drawings. Pumps shall be third-party certified by an approved laboratory as complying with California Health and Safety Code Section 11 68 75.
- B. Pumps shall be of the centrifugal type with non-overloading characteristics and shall not overload the motor above its nameplate horsepower rating under any operating condition. No allowance for service factor shall be used in pump selection. Motor horsepower shown is minimum; furnish larger motors if necessary to meet the non-overloading requirements.
- C. Type: Horizontal, designed for 125 thru 150 psi maximum working pressure and 225 degrees F continuous water temperature.
- D. Construction: Bronze casing, non-metallic impeller.
- E. Shaft: Ceramic, supported by carbon bearings. Bearings shall be lubricated by the pumped water.
- F. Motors shall have permanently lubricated ball bearings. Motors shall meet NEMA specifications. Motors shall have built-in thermal overload or impedance protection.
- G. Provide control wiring between field-installed controls, indicating devices, and pump control panels as work of this section, complying with requirements of Division 26 sections:
 - 1. Control wiring specified as work of Division 23 for Automatic Temperature Controls is work of that section.
- H. Wire pumps to mechanical control circuits to shut down pump when building is not occupied. Where no control system is installed, furnish pump manufacturers standard timer to automatically turn off circulating pump when hot water is not required.
- I. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:
 - 1. Grundfos Pumps Corporation.
 - 2. Bell & Gossett, ITT Corporation.
 - 3. Taco Incorporated.
 - 4. Armstrong Pumps, Inc.

2.05 CONCRETE INTERCEPTORS

- A. Furnish and install a concrete sand/oil interceptor with minimum capacity as indicated on the drawings, complete as cataloged. Provide manholes to grade for access to each section. Provide cast-iron ring and cover at grade for each manhole.

- B. Provide concrete with an approved coating inside and outside.
- C. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:
 - 1. M.C. Nottingham Company.
 - 2. Jensen Precast.

2.06 AIR COMPRESSORS

- A. Provide single package unit featuring belt driven rotary screw compressor. Compressor shall be driven by TEFC electric motor. Provide enclosed weatherproof casing and include factory wired starter, control panel with stop-start push buttons, indicator lights, gauges, run time meter and reset button.
 - 1. Provide control panel with, discharge air pressure and lubricant discharge temperature, operating hours, start/stop switch, power on light, emergency stop button, and control safety system with compressor ON light.
 - 2. Provide high air pressure shutdown switch, 3-phase motor overload protection, safety valve and oil sight glass. Compressor control shall be by a fully adjustable dual operating control providing idle time and time delay controls. Main air and oil piping shall be rigid steel with flexible connections. The unit shall be delivered with full operating charge of oil and shall be ready for full operation.
- B. Provide ASME stamped receiver, pressure gauge. ASME Code pressure relief valve, tank drain, manual valve on main air line, intake filter and muffler, belt guards, and pressure reducing valve. Provide pipe line filter and refrigerated after-cooler.
- C. Provide soundproof enclosure around compressor unit, complete with filter media on air intake, and locking access doors. Where installed in locations exposed to weather conditions, provide rain hood.
- D. Furnish permit by State Division of Industrial Safety prior to project completion.
- E. Manufacturer shall be Powerex, Kaeser, Quincey, or equal.

2.07 AIR DRYER

- A. Air dryer shall be a single package refrigerated compressed air dryer with built in controls and push button graphic control panel. Unit shall be contained in a weatherproof cabinet.
- B. Manufacturer shall be Kaeser, Quincy, or equal.

2.08 AIR COMPRESSOR CONDENSATE DRAIN SYSTEM

- A. Provide high efficiency condensate drain system to automatically remove oil from compressed air condensate line. Install in accordance with manufacturer's recommendations.
- B. Manufacturer shall be Kaeser, Quincy, or equal.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. The Contractor shall be responsible for the examination and acceptance of all conditions affecting the proper construction and/or installation of the Work of this Section and shall not proceed until all unsatisfactory conditions have been corrected. Commencing work shall be construed as acceptance of all conditions by the Contractor as satisfactory for the construction and/or installation of the Work.

3.02 ELECTRIC WATER HEATER INSTALLATION

- A. Install electric water heaters as indicated, in accordance with manufacturer's installation instructions and in compliance with applicable codes.
- B. Furnish wiring diagram to Electrical Installer. Refer to Division 26 for wiring of units, not work of this section.
- C. Connect to hot and cold water lines with shutoff valve, check valve, and dielectric union in the cold water line, and ASME standard pressure and temperature relief valve and dielectric union in the hot water line. Connect drain and relief piping as noted on Drawings.
- D. Start-up, test, and adjust electric water heaters in accordance with manufacturer's start-up instructions. Check and calibrate controls.
- E. After installation has been completed, seal bottom of heaters without feet to floor with silicone sealer.

3.03 PUMP INSTALLATION

- A. Install pumps where indicated, in accordance with manufacturer's published instructions, complying with recognized industry practices to ensure that pumps comply with requirements and serve intended purposes.
- B. Provide access space around pumps for service as indicated, but in no case less than that recommended by manufacturer.
- C. Install in-line pumps with support from overhead structure on each side of pump, or as indicated on Drawings.
- D. Support piping from the building structure so as to prevent any strain on the pump casings. Provide a final check for perfect alignment of the piping connections after pump has been secured to its base. Provide valves, accessories, gauges, flexible connections, and supports as indicated.
- E. Install electrical devices furnished by manufacturer but not specified to be factory mounted. Furnish copy of manufacturer's wiring diagram submittal to Electrical Installer.
- F. Verify that electrical wiring installation is in accordance with manufacturer's submittal and installation requirements of Division 26 sections. Do not proceed with equipment start-up until wiring installation is complete and correct.
- G. Check alignment, and where necessary, realign shafts of motors and pumps within recommended tolerances by manufacturer.

- H. Lubricate pumps before start-up. Start-up in accordance with manufacturer's instructions.
- I. Increase piping immediately at pump suction and discharge; flexible couplings and all valves shall be full line size.
- J. Trim pump impeller to obtain the desired water flow after installation, without cost to Owner.
- K. Pumps shall not be connected to piping before piping is thoroughly flushed and cleaned of all dirt and grit. After piping connections have been made, systems shall be filled before starting pumps. Pumps shall not be run dry under any circumstances.

3.04 INTERCEPTOR INSTALLATION

- A. Install interceptors as indicated, in accordance with manufacturer's installation instructions and in compliance with applicable codes.
- B. Support: Anchor interceptors securely to substrate. Locate interceptors so that adequate clearance is provided to remove covers and sediment baskets. Set recessed units so top of cover is flush with finished grade.
- C. Piping: Connect inlet and outlet piping to interceptors.
- D. Refer to local standards for special installation requirements.

3.05 AIR COMPRESSOR INSTALLATION

- A. Install air compressors as indicated, in accordance with manufacturer's installation instructions and in compliance with applicable codes.
- B. Prior to initial test run of air compressor, provide lubrication, confirm satisfactory operation of water cooled after cooler, and post operating instructions in a prominent location near the unit.

3.06 DEMONSTRATION AND TRAINING

- A. Provide a minimum of 8 hours of training and orientation of Owners staff in proper care and operation of Plumbing Equipment.

3.07 CARE AND CLEANING

- A. Repair or replace broken, damaged, or otherwise defective parts, materials, and work. Leave entire work in condition satisfactory to Architect. At completion, carefully clean and adjust equipment, fixtures, and trim that are installed as part of this work. Leave systems and equipment in satisfactory operating condition.

3.08 OPERATIONAL TESTS

- A. Test each piece of equipment to show that it will operate in accordance with indicated requirements.

3.09 CLEANING UP

- A. Upon completion of Work remove materials, equipment, apparatus, tools, and the like, and leave premises clean, neat, and orderly.

END OF SECTION

SECTION 23 00 50

BASIC HVAC MATERIALS AND METHODS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Electric motors.
 - 2. Motor starters.
 - 3. Strainers.
 - 4. Access Doors.

1.02 RELATED REQUIREMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. This Section is a part of each Division 23 Section.

1.03 ADDITIONAL REQUIREMENTS

- A. Furnish and install incidental work not shown or specified necessary to provide a complete and workable system.
- B. Make all temporary connections required to maintain services, including adequate heat and cooling, during the course of the Contract without additional cost to Owner. Notify Owner seven days in advance before disrupting services.
- C. Provide for adjustments or modifications to fan and motor sheaves, belts, damper linkages, and other components as required to achieve specified air balance at no additional cost to Owner.

1.04 REFERENCES AND STANDARDS

- A. Where material or equipment is specified to conform to referenced standards, it shall be assumed that the most recent edition of the standard in effect at the time of bid shall be used.
 - 1. AABC - Associated Air Balance Council
 - 2. AFBMA - Anti Friction Bearing Manufacturer's Association
 - 3. AMCA - Air Moving and Control Association Inc.
 - a. Standard 210 - Laboratory Methods of Testing Fans
 - 4. ANSI - American National Standards Institute
 - 5. ARI - Air-Conditioning and 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. CCR - California Code of Regulations
 - a. Title 8 - Division of Industrial Safety, Subchapter 7; General Industry Safety Orders, Articles 31 through 36
10. CSA – Canadian Standards Association International
11. CSFM - California State Fire Marshal
12. NCPWB - National Certified Pipe Welding Bureau
13. NIST - National Institute of Standards and Technology
14. NEMA - National Electrical Manufacturers' Association
15. NFPA - National Fire Protection Association
16. OSHA - Occupational Safety and Health Act
17. SMACNA - Duct Manuals
18. UL - Underwriters' Laboratories, Inc.

B. Requirements of Regulatory Agencies:

1. The publications listed below form part of this specification; comply with provisions of these publications except as otherwise shown or specified.
 - a. California Building Code, 2022.
 - b. California Electrical Code, 2022.
 - c. California Energy Code, 2022.
 - d. California Fire Code, 2022.
 - e. California Green Building Standards Code, 2022.
 - f. California Mechanical Code, 2022.
 - g. California Plumbing Code, 2022.
 - h. California Code of Regulations, Title 24.
 - i. California Health and Safety Code.
 - j. CAL-OSHA.
 - k. California State Fire Marshal, Title 19 CCR.
 - l. National Fire Protection Association.
 - m. Occupational Safety and Health Administration.
 - n. Other applicable state laws.
2. Nothing in Drawings or specifications shall be construed to permit work not conforming to these codes, or to requirements of authorities having jurisdiction. It is not the intent of Drawings or specifications to repeat requirements of codes except where necessary for clarity.

1.05 DRAWINGS

- A. Examine Drawings prior to bidding of work and report discrepancies in writing to Architect.
- B. Drawings showing location of equipment and materials are diagrammatic and job conditions will not always permit installation in location shown. The HVAC Drawings show general

arrangement of equipment and materials, etc., and shall be followed as closely as existing conditions, actual building construction, and work of other trades permit.

1. Architectural and Structural Drawings shall be considered part of the Work. These Drawings furnish Contractor with information relating to design and construction of the Project. Architectural Drawings take precedence over HVAC Drawings.
 2. Because of the small scale of HVAC Drawings, not all offsets, fittings, and accessories required are shown. Investigate structural and finish conditions affecting the Work and arrange Work accordingly. Provide offsets, fittings, and accessories required to meet conditions. Inform Architect immediately when job conditions do not permit installation of equipment and materials in the locations shown. Obtain the Architects approval prior to relocation of equipment and materials.
 3. Relocate equipment and materials installed without prior approval of the Architect. Remove and relocate equipment and materials at Contractors' expense upon Architects' direction.
 4. Minor changes in locations of equipment, piping, ducts, etc., from locations shown shall be made when directed by the Architect at no additional cost to the Owner providing such change is ordered before such items of work, or work directly connected to same are installed and providing no additional material is required.
- C. Execute work mentioned in the Specifications and not shown on the Drawings, or vice versa, the same as if specifically mentioned or shown in both.

1.06 FEES AND PERMITS

- A. Obtain and pay for permits and service required in installation of the Work. Arrange for required inspections and secure approvals from authorities having jurisdiction. Comply with requirements of Division 01.
- B. Arrange for utility connections and pay charges incurred, including excess service charges.
- C. Coordination:
1. General:
 - a. Coordinate HVAC Work with trades covered in other Specifications Sections to provide a complete, operable and sanitary installation of the highest quality workmanship.
 2. Have fire damper and fire smoke damper installation instructions available at Project site during construction for use by Project Inspector.
 3. Electrical Coordination:
 - a. Refer to the Electrical Drawings and Specifications, Division 26, for service voltage and power feed wiring for equipment specified under this section. Contractor has full responsibility for the following items of work:
 - 1) Review the Electrical Drawings and Division 26 Specifications to verify that electrical services provided are adequate and compatible with equipment requirements.
 - 2) If additional electrical services are required above that indicated on Electrical Drawings and in Division 26, such as more control interlock conductors, larger feeder, or separate 120 volt control power source, include cost to furnish and install additional electrical services as part of the bid.

3) Prior to proceeding with installation of additional electrical work, submit detailed drawings indicating exact scope of additional electrical work.

4. Mechanical Coordination:

- a. Arrange for pipe spaces, chases, slots and openings in building structure during progress of construction, to accommodate mechanical system installation.
- b. Coordinate installation of supporting devices. Set sleeves in poured-in-place concrete and other structural components during construction.
- c. Coordinate requirements for access panels and doors for mechanical items requiring access where concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section "Access Doors and Frames."
- d. Coordinate with other trades equipment locations, pipe, duct and conduit runs, electrical outlets and fixtures, air inlets and outlets, and structural and architectural features. Provide information on location of piping and seismic bracing to other trades as required for a completely coordinated project.

1.07 SUBMITTALS - GENERAL

- A. Refer to Division 01 Submittals Section(s) for additional requirements.
- B. Submittal packages may be submitted via email as PDF electronic files, or as printed packages. PDFs shall be legible at actual size (100 percent). Provide seven copies of printed submittal packages.
- C. Provide submittal of materials proposed for use as part of this Project. Product names in Specifications and on Drawings are used as standards of quality. Furnish standard items on specified equipment at no extra cost to the Contract regardless of disposition of submittal data. Other materials or methods shall not be used unless approved in writing by Architect. Architect's review will be required even though "or equal" or synonymous terms are used.
 1. Partial or incomplete submittals will not be considered.
 2. Quantities are Contractor's responsibility and will not be reviewed.
 3. Provide materials of the same brand or manufacturer for each class of equipment or material.
 4. Identify each item by manufacturer, brand, trade name, number, size, rating, or other data necessary to properly identify and review materials and equipment. Words "as specified" are not sufficient identification.
 5. Identify each submittal item by reference to items' Specification Section number and paragraph, by Drawing and detail number, and by unit tag number.
 6. Organize submittals in same sequence as in Specification Sections.
 7. Show physical arrangement, construction details, finishes, materials used in fabrications, provisions for piping entrance, access requirements for installation and maintenance, physical size, mechanical characteristics, foundation and support details, and weight.
 - a. Submit Shop Drawings, performance curves, and other pertinent data, showing size and capacity of proposed materials.
 - b. Specifically indicate, by drawn detail or note, that equipment complies with each specifically stated requirement of Contract Documents.
 - c. Drawings shall be drawn to scale and dimensioned (except schematic diagrams). Drawings may be prepared by vendor but must be submitted as instruments of

Contractor, thoroughly checked and signed by Contractor before submission to Architect for review.

- d. Catalog cuts and published material may be included with supplemental scaled drawings.
- D. Review of submittals will be only for general conformance with design concept and general compliance with information given in Contract Documents. Review will not include quantities, dimensions, weights or gauges, fabrication processes, construction methods, coordination with work of other trades, or construction safety precautions, which are sole responsibility of Contractor. Review of a component of an assembly does not indicate acceptance of an assembly. Deviations from Contract Documents not clearly identified by Contractor are Contractor's responsibility and will not be reviewed by Architect.
- E. Within reasonable time after award of contract and in ample time to avoid delay of construction, submit to Architect shop drawings or submittals on all items of equipment and materials provided. Provide submittal as a complete package.
 - 1. Shop drawings and submittals shall include Specification Section, Paragraph number, and Drawing unit symbol or detail number for reference. Organize submittals into booklets for each Specification section and submit in loose-leaf binders with index. Deviations from the Contract Documents shall be prominently displayed in the front of the submittal package and referenced to the applicable Contract requirement.
- F. Furnish to the Project Inspector complete installation instructions on material and equipment before starting installation.

1.08 ACTION SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data and installation instructions for plumbing systems materials and products.
- B. Shop Drawings.
- C. Sustainable Design Submittals:
 - 1. Product Data: For adhesives and sealants, documentation of compliance including printed statement of VOC content and chemical components.
 - 2. Laboratory Test Reports: For adhesives and sealants, indicating compliance with requirements for low-emitting materials.
- D. Delegated-Design Submittals: For seismic supports, anchorages, restraints, and vibration isolators indicated to comply with performance requirements and design criteria.
 - 1. Calculations performed for use in selection of seismic supports, anchorages, restraints, and vibration isolators shall utilize criteria indicated in Structural Contract Documents.
 - 2. Include design calculations and details for selecting vibration isolators and vibration isolation bases complying with performance requirements, design criteria, and analysis data signed and sealed by the California registered structural engineer responsible for their preparation.
 - 3. Supports, anchorage and restraints for piping, ductwork, and equipment shall be an HCAI pre-approved system such as TOLCO, ISAT, Mason, or equal. Pipes, ducts and equipment shall be seismically restrained in accordance with requirements of current edition of California Building Code. System shall have current OPM number and shall meet additional requirements of authority having jurisdiction. Provide supporting

documentation required by the reviewing authority and the Architect and Engineer. Provide layout drawings showing piping, ductwork and restraint locations.

- a. Bracing of Piping, Ductwork, and Equipment: Specifically state how bracing attachment to structure is accomplished. Provide shop drawings indicating seismic restraints, including details of anchorage to building. In-line equipment must be braced independently of piping and ductwork, and in conformance with applicable building codes. Provide calculations to show that pre-approval numbers have been correctly applied in accordance with general information notes of pre-approval documentation.
 - b. In lieu of the above or for non-standard installations not covered in the above pre-approved systems, Contractor shall provide layout drawings showing piping, ductwork, and restraint locations, and detail supports, attachments and restraints, and furnish supporting calculations and legible details sealed by a California registered structural engineer, in accordance with 2022 California Building Code
4. Additional Requirements: In addition to the above, conform to all state and local requirements.

1.09 INFORMATIONAL SUBMITTALS

- A. Provide coordinated layouts for HVAC Ductwork systems, in accordance with Specification Section 23 80 00.
- B. Provide evidence of equipment certification to California Energy Code Section 110.1 or 110.2, if not providing Electrically Commutated motors for HVAC fans sized below 1 hp and above 1/12 hp. Refer to specific equipment articles requiring electrically commutated motors.
- C. Check, Test, and Start forms, from equipment manufacturers.
- D. Check, Test and Start reports.

1.10 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data:
 1. Furnish three complete sets of Operation and Maintenance Manual bound in hardboard binder, and one compact disc containing complete Operation and Maintenance Manual in searchable PDF format. Provide Table of Contents. Provide index tabs for each piece of equipment in binder and disc. Begin compiling data upon approval of submittals.
 - a. Sets shall incorporate the following:
 - 1) Product Data.
 - 2) Shop Drawings.
 - 3) Record Drawings.
 - 4) Service telephone number, address and contact person for each category of equipment or system.
 - 5) Complete operating instructions for each item of heating, ventilating and air conditioning equipment.
 - 6) Copies of guarantees/warranties for each item of equipment or systems.
 - 7) Test data and system balancing reports.

- 8) Typewritten maintenance instructions for each item of equipment listing lubricants to be used, frequency of lubrication, inspections required, adjustment, etc.
 - 9) Manufacturers' bulletins with parts numbers, instructions, etc., for each item of equipment.
 - 10) Temperature control diagrams and literature.
 - 11) Check test and start reports for each piece of mechanical equipment provided as part of the Work.
 - 12) Commissioning and Preliminary Operation Tests required as part of the Work.
2. Post service telephone numbers and addresses in an appropriate place designated by Architect.

B. Record Drawings:

1. Refer to Division 01 for additional requirements.
2. Upon completion of the Work, deliver to Architect the following:
 - a. Originals of drawings showing the Work exactly as installed.
 - b. One complete set of reproducible drawings showing the Work exactly as installed.
 - c. One compact disc with complete set of drawings in PDF format showing the Work exactly as installed.
 - d. Provide Contractor's signature, verifying accuracy of record drawings.
 - e. Obtain the signature of the Inspector of Record for Record Drawings.

1.11 SUBSTITUTIONS

- A. Refer to Division 01 for complete instructions. Requirements given below are in addition to or are intended to amplify Division 01 requirements. In case of conflict between requirements given herein and those of Division 01, Division 01 requirements shall apply.
- B. It is the responsibility of Contractor to assume costs incurred because of additional work and or changes required to incorporate proposed substitute into the Project. Refer to Division 01 for complete instructions.
- C. Substitutions will be interpreted to be manufacturers other than those specifically listed in the Contract Documents by brand name, model, or catalog number.
- D. Only one request for substitution will be considered for each item of equipment or material.
- E. Substitution requests shall include the following:
 1. Reason for substitution request.
 2. Complete submittal information as described herein; see "Submittals."
 3. Coordinated scale layout drawings depicting position of substituted equipment in relation to other work, with required clearances for operation, maintenance and replacement.
 4. List optional features required for substituted equipment to meet functional requirements of the system as indicated in Contract Documents.
 5. Explanation of impact on connected utilities.
 6. Explanation of impact on structural supports.

- F. Installation of reviewed substitution is Contractors' responsibility. Any mechanical, electrical, structural, or other changes required for installation of substituted equipment or material must be made by Contractor without additional cost to Owner. Review by Architect of substituted equipment or material, will not waive these requirements.
- G. Contractor may be required to compensate Architect for costs related to substituted equipment or material.

1.12 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of HVAC systems products, of types, materials, and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.
- B. Contractor's Qualifications: Firm with at least 5 years of successful installation experience on projects with HVAC systems work similar to that required for this Project.
- C. Comply with applicable portions of California Mechanical Code pertaining to selection and installation of HVAC materials and products.
- D. All materials and products shall be new.

1.13 DELIVERY, STORAGE, AND HANDLING

- A. Protect equipment and materials delivered to Project site from weather, humidity and temperature variations, dirt, dust and other contaminants.

1.14 FIELD CONDITIONS

- A. Information on Drawings relative to existing conditions is approximate. Deviations from Drawings necessary during progress of construction to conform to actual conditions shall be approved by the Architect and shall be made without additional cost to the Owner. The Contractor shall be held responsible for damage caused to existing services. Promptly notify the Architect if services are found which are not shown on Drawings.

1.15 WARRANTY

- A. Refer to Division 01 for warranty requirements, and duration and effective date of Contractor's Standard Guarantee.
- B. Repair or replace defective work, material, or part that appears within the warranty period, including damage caused by leaks.
- C. On failure to comply with warranty requirements within a reasonable length of time after notification is given, Architect/Owner shall have repairs made at Contractor's expense.

PART 2 - PRODUCTS

2.01 GENERAL

- A. Materials or equipment of the same type shall be of the same brand wherever possible. All materials shall be new and in first class condition.
- B. All sizes, capacities, and efficiency ratings shown are minimum, except that gas capacity is maximum available.

C. Refer to Division 22 10 00 and 23 80 00 for specific system piping materials.

2.02 MATERIALS

A. No material installed as part of this Work shall contain asbestos.

B. California Green Building Code Compliance:

1. HVAC and refrigeration equipment shall not contain CFCs.
2. HVAC and refrigeration equipment shall not contain Halons.

2.03 ELECTRIC MOTORS

A. General Motor Requirements: Comply with NEMA MG 1 unless otherwise indicated. Comply with IEEE 841 for severe-duty motors.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:
 - a. U.S. Motors.
 - b. Century Electric.
 - c. General Electric.
 - d. Lincoln.
 - e. Gould.

B. Motor Characteristics: Designed for continuous duty at ambient temperature of 40 deg. C and at altitude of 3300 feet above sea level. Capacity and torque shall be sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

1. Motors exceeding the nameplate amperage shall be promptly replaced at no cost to the Owner. Horsepower shown is minimum and shall be increased as necessary to comply with above requirements. Furnish motors with splash-proof or weatherproof housings, where required or recommended by the manufacturer. Match the nameplate voltage rating with the electrical service supplied. Check Electrical Drawings. Provide a transformer for each motor not wound specifically for system voltage.

C. Polyphase Motors: NEMA MG 1, Design B, medium induction motor, premium efficiency as defined in NEMA MG 1. Select motors with service factor of 1.15. Provide motor with random-wound, squirrel cage rotor, and permanently lubricated or regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading. Temperature rise shall match insulation rating. Provide Class F insulation.

1. Multispeed motors shall have separate windings for each speed.

D. Polyphase Motors with Additional Requirements:

1. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.
2. Motors Used with Variable Frequency Controllers:
 - a. Separately Connected Motors: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.

- b. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
 - c. Premium-Efficient Motors: Class B temperature rise; Class F insulation.
 - d. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
 - e. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.
 - f. Each motor shall be provided with a shaft grounding device for stray current protection.
3. Severe-Duty Motors: Comply with IEEE 841, with 1.15 minimum service factor.

E. Single-Phase Motors:

- 1. Select motors with service factor of 1.15.
- 2. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:
 - a. Permanent-split capacitor.
 - b. Split phase.
 - c. Capacitor start, inductor run.
 - d. Capacitor start, capacitor run.
- 3. Motors for HVAC exhaust, transfer, and supply fans larger than 1/12 hp and smaller than 1 hp shall be the following:
 - a. Electronically Commutated motor (EC type): Motor shall be electronically commutated type specifically designed for applications, with heavy duty ball bearings. The motor shall be speed controllable down to 20% of full speed and 85% efficient at all speeds.
 - 1) Exceptions:
 - a) Motors in fan-coils and terminal units that operate only when providing heating to the space served.
 - b) Motors installed in space conditioning equipment certified under 2022 California Energy Code Section 110.1 or 110.2.
- 4. Contractor's Option: Motors scheduled on Drawings as single-phase, and larger than 1/12 hp and smaller than 1 hp, for applications other than HVAC fans, may be EC type.
- 5. Multispeed Motors: Variable-torque, permanent-split-capacitor type.
- 6. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.
- 7. Motors 1/20 HP and Smaller: Shaded-pole type.
- 8. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

2.04 MOTOR STARTERS

- A. Square D, Allen Bradley, or equal, in NEMA Type 1 enclosure, unless otherwise specified or required. Minimum starter size shall be Size 1. Provide NEMA 3R enclosure where exposed to outdoors.
- B. Provide magnetic motor starters for all equipment provided under the Mechanical Work. Starters shall be non-combination type. Provide part winding or reduced voltage start motors where shown or as hereinafter specified. Minimum size starter shall be Size 1.
 - 1. All starters shall have the following:
 - a. Cover mounted hand-off-automatic switch. Starters installed exposed in occupied spaces shall have key operated HOA switch.
 - b. Ambient compensated thermal overload.
 - c. Fused control transformer (for 120 or 24 volt service).
 - d. Pilot lights, integral with the starters. Starters located outdoors shall be in NEMA IIIIR enclosures.
 - 2. Where three phase motors are provided for two-speed operation, provide two speed motor starters.
 - 3. Starters for single-phase motors shall have thermal overloads. NEMA I enclosure for starters located indoors, NEMA IIIIR enclosure for starters located outdoors.
 - 4. Provide OSHA label indicating the device starts automatically.

2.05 STRAINERS

- A. Charles M. Bailey #100A, Armstrong, Muessco, or equal, Fig. 11 "Y" pattern, 125 psi WP minimum, with monel screens with 20 square mesh for 2 inches and smaller and 3/64 inch perforations for 2-1/2 inches and larger. Install all strainers with a blow-off hose valve with hose adapter. Strainer shall have gasketed cover with straight thread.

2.06 ACCESS DOORS

- A. Where floors, walls, or ceilings must be penetrated for access to mechanical equipment, provide access doors, 14 inch by 14 inch minimum size in usable opening. Where entrance of a serviceman may be required, provide 20 inch by 30 inch minimum usable opening. Locate access doors/panels for non-obstructed and easy reach.
 - 1. All access doors less than 7'-0" above floors and exposed to public access shall have keyed locks.
- B. Access doors shall match those supplied in Division 08 in all respects, except as noted herein.
- C. Provide stainless steel access doors for use in toilet rooms, shower rooms, kitchens and other damp areas. Provide steel access doors with prime coat of baked-on paint for all other areas.
- D. Where panels are located on ducts or plenums, provide neoprene gaskets to prevent air leakage, and use frames to set door out to flush with insulation.
- E. Provide insulated doors where located in internally insulated ducts or casings.

- F. Do not locate access doors in highly visible public areas such as lobbies, waiting areas, and primary entrance areas. Coordinate with the Architect when access is required in these areas.
- G. Where specific information or details relating to access panels different from the above is shown or given on the Drawings or other Divisions of work, then that information shall supersede this specification.
- H. Manufacturers: Subject to compliance with requirements, available manufacturers offering products which may be incorporated into the Work include Milcor, Karp, Nystrom, or Cesco, equal to the following:
 - 1. Milcor
 - a. Style K (plaster).
 - b. Style DW (gypsum board).
 - c. Style M (Masonry).
 - d. Style "Fire Rated" where required.

2.07 EQUIPMENT IDENTIFICATION

- A. Identify each piece of equipment with a permanently attached engraved bakelite plate, 1/2 inch high white letters on black background.

2.08 PIPE IDENTIFICATION

- A. Identify each piping system and indicate the direction of flow by means of Seton, Inc., Marking Services Inc., Reef Industries, Inc., or equal, pre-tensioned, coiled semi-rigid plastic pipe labels formed to circumference of pipe, requiring no fasteners or adhesive for attachment to pipe.
- B. The legend and flow arrow shall conform to ASME A13.1.

PART 3 - EXECUTION

3.01 FRAMING, CUTTING, AND PATCHING

- A. Special framing, recesses, chases and backing for Work of this Section, unless otherwise specified, are covered under other Specification Sections.
- B. Contractor is responsible for placement of pipe sleeves, hangers, inserts, supports, and location of openings for the Work.

3.02 ELECTRICAL REQUIREMENTS

- A. Provide adequate working space around electrical equipment in compliance with the California Electrical Code. Coordinate the Mechanical Work with the Electrical Work to comply.
- B. Furnish necessary control diagrams and instructions for the controls. Before permitting operation of any equipment which is furnished, installed, or modified under this Section, review all associated electrical work, including overload protection devices, and assume complete responsibility for the correctness of the electrical connections and protective devices. Motors and control equipment shall conform to the Standards of the National

Electrical Manufacturers' Association. All equipment and connections exposed to the weather shall be NEMA IIIR with factory-wired strip heaters in each starter enclosure and temperature control panel where required to inhibit condensation.

- C. All line voltage and low voltage wiring and conduit associated with the Temperature Control System are included in this Section. Wiring and conduit shall comply with Division 26.

3.03 PIPING SYSTEM REQUIREMENTS

- A. Drawing plans, schematic and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.

3.04 PRIMING AND PAINTING

- A. Perform priming and painting on the equipment and materials as specified herein.
- B. See Division 09 Painting Section(s) for detailed requirements.
- C. Priming and painting:
 - 1. Exposed ferrous metals, including piping, which are not galvanized or factory-finished shall be primed and painted.
 - a. Black Steel Piping:
 - 1) Primer: One coat gray Sherwin-Williams Pro Industrial Pro-Cryl Universal Primer, comparable products by Rust-Oleum, Kelly Moore, or equal.
 - 2) Topcoat: Two coats gray Sherwin-Williams Pro Industrial Waterbased Alkyd Urethane Enamel, comparable products by Rust-Oleum, Kelly Moore, or equal.
 - b. Interior Ductwork: Refer to Division 09 Painting Section(s). Architect shall select paint color.
 - 2. Metal surfaces of items to be jacketed or insulated except ductwork and piping shall be given two coats of primer unless furnished with equivalent factory finish. Items to be primed shall be properly cleaned by effective means free of rust, dirt, scale, grease and other deleterious matter and then primed with the best available grade of zinc rich primer. After erection or installation, all primed surfaces shall be properly cleaned of any foreign or deleterious matter that might impair proper bonding of subsequent paint coatings. Any abrasion or other damage to the shop or field prime coat shall be properly repaired and touched up with the same material used for the original priming.
 - 3. Where equipment is provided with nameplate data, the nameplate shall be masked off prior to painting. When painting is completed, remove masking material.

3.05 PIPING AND DUCT SYSTEMS INSTALLATION

- A. General:
 - 1. All piping shall be concealed unless shown or otherwise directed. Allow sufficient space for ceiling panel removal.
 - 2. Installation of piping shall be made with appropriate fittings. Bending of piping will not be accepted.
 - 3. Install piping to permit application of insulation and to allow valve servicing.

4. Where piping, conduit, or ductwork is left exposed within a room, the same shall be run true to plumb, horizontal, or intended planes. Where possible, uniform margins are to be maintained between parallel lines and/or adjacent wall, floor, or ceiling surfaces.
5. Horizontal runs of pipes, conduits, or ductwork suspended from ceilings shall provide for a maximum headroom clearance. The clearance shall not be less than 6'-6" without written approval from the Architect.
6. Close ends of pipe immediately after installation. Leave closure in place until removal is necessary for completion of installation.
7. At the time of rough installation, or during storage on the construction site and until final startup of the heating and cooling equipment, all duct and other related air distribution component opening shall be covered with tape, plastic, sheet metal, or other methods acceptable to the enforcing agency.
8. Each piping system shall be thoroughly flushed and proved clean before connection to equipment.
9. Pipe the discharge of each relief valve, air vent, backflow preventer, and similar device to floor sink or drain.
10. Install exposed polished or enameled connections with special care showing no tool marks or threads at fittings.
11. Install horizontal valves with valve stem above horizontal.
12. Use reducing fittings; bushings shall not be allowed. Use eccentric reducing fittings wherever necessary to provide free drainage of lines and passage of air.
13. Verify final equipment locations for roughing-in.
14. Service Markers: Mark the location of each plugged or capped pipe with a 4 inch round by 30 inch long concrete marker, set flush with finish grade. Provide 2-1/2 inch diameter engraved brass plate as part of monument marker.
15. Where piping is installed in walls within one inch of the face of stud, provide a 16 gauge sheet metal shield plate on the face of the stud. The shield plate shall extend a minimum of 1-1/2 inches beyond the outside diameter of the pipe.

B. Sleeves:

1. Install Adjus-to-Crete, Pipeline Seal and Insulator, or equal, pipe sleeves of sufficient size to allow for free motion of pipe, 24 gauge galvanized steel. The space between pipe and sleeves through floor slabs on ground, through outside walls above or below grade, through roof, and other locations as directed shall be caulked with oakum and mastic and made watertight. The space between pipe and sleeve and between sleeve and slab or wall shall be sealed watertight.
2. At Contractor's option, Link-Seal, Metraflex Metraseal, or equal, casing seals may be used in lieu of caulking. Wrap pipes through slabs on grade with 1 inch thick fiberglass insulation to completely isolate the pipe from the concrete.

C. Floor, Wall, and Ceiling Plates:

1. Fit all pipes with or without insulation passing through walls, floors, or ceilings, and all hanger rods penetrating finished ceilings with chrome-plated or stainless escutcheon plates.

D. Firestopping:

1. Pack the annular space between the pipe sleeves and the pipe and between duct openings and ducts through all floors and walls with UL listed fire stop, and sealed at the ends. All pipe penetrations shall be UL listed, Hilti, 3M Pro-Set, or equal.
 - a. Install fire caulking behind mechanical services installed within fire rated walls, to maintain continuous rating of wall construction.
2. Provide SpecSeal Systems UL fire rated sleeve/coupling penetrators for each pipe penetration or fixture opening passing through floors, walls, partitions or floor/ceiling assemblies. All Penetrators shall comply with UL Fire Resistance Directory (Latest Edition), and in accordance with CBC requirements.
3. Sleeve penetrators shall have a built in anchor ring for waterproofing and anchoring into concrete pours or use the special fit cored hole penetrator for cored holes.
4. Copper and steel piping shall have SpecSeal plugs on both sides of the penetrator to reduce noise and to provide waterproofing.
5. All above Firestopping systems to be installed in strict accordance with manufacturer's instructions.
6. Alternate firestopping systems are acceptable if approved equal. However, any deviation from the above specification requires the Contractor to be responsible for determining the suitability of the proposed products and their intended use, and the Contractor shall assume all risks and liabilities whatsoever in connection therewith.

E. Flashing:

1. Flashing for penetrations of metal or membrane roof for mechanical items such as flues, ducts, and pipes shall be coordinated with the roofing manufacturer and roofing installer for the specific roofing type. The work of this section shall include furnishing, layout, sizing, and coordination of penetrations required for the mechanical work.
 - a. Furnish and install flashing and counterflashing in strict conformance with the requirements of the roofing manufacturer. Submit shop drawing details for review prior to installation.
 - b. Furnish and install counterflashing above each flashing required. Provide Stoneman, or equal, vandalproof top and flashing combination. Elmdor/Stoneman Model 1540.
 - c. Flues and ducts shall have 24 gauge galvanized sheet metal storm collar securely clamped to the flue above the flashing.
2. For all other types of roofing system, furnish and install around each pipe, where it passes through roof, a flashing and counterflashing. All flashing shall be made of four pound seamless sheet lead with 6 inch minimum skirt and steel reinforced boot. Counterflashing shall be cast iron. For vents, provide vandalproof top and flashing combination. Elmdor/Stoneman Model 1100-4.

F. Hangers and Supports:

1. General: Support ductwork, equipment and piping so that it is firmly held in place by approved iron hangers and supports, and special hangers. Hanger and support components shall support weight of ductwork, equipment and pipe, fluid, and pipe insulation based on spacing between supports with minimum factor of safety of five based on ultimate strength of material used. Do not exceed manufacturer's load rating. Pipe attachments or hangers, of same size as pipe or tubing on which used, or nearest available. Rigidly fasten hose faucets, fixture stops, compressed air outlets, and similar items to the building construction. The Architect shall approve hanger material before installation. Do not support piping or ductwork with plumbers' tape, wire rope, wood, or

other makeshift devices. Where building structural members do not match piping and ductwork support spacing, provide “bridging” support members firmly attached to building structural members in a fashion approved by the structural engineer.

- a. Materials, design, and type numbers for support of piping per Manufacturers' Standardization Society (MSS), Standard Practice (SP)-58.
 - 1) Provide copper-plated or felt-lined hangers for use on copper tubing.
- b. Materials and design for ductwork support shall be per SMACNA “HVAC Duct Construction Standards, Metal and Flexible.”
2. Hanger components shall be provided by one manufacturer: B-Line, Grinnell, Unistrut, Badger, or equal.
3. Riser clamps: B-line model B3373, or equal.
4. Pipe Hanger and Support Placement and Spacing:
 - a. Vertical piping support spacing: Provide riser clamps for piping, above each floor, in contact with the floor. Provide support at joints, branches, and horizontal offsets. Provide additional support for vertical piping, spaced at or within the following maximum limits:

<u>Pipe Diameter</u>	<u>Steel Threaded or Welded (Note 3)</u>	<u>Copper Brazed or Soldered (Notes 3, 4)</u>	<u>CPVC & PVC (Note 2)</u>
1/2 - 1”	12 ft.	Each Floor, Not to Exceed 10 ft.	Base and Each Floor (Note 1)
1-1/4 - 2”	12 ft.	Each Floor, Not to Exceed 10 ft.	Base and Each Floor (Note 1)
2-1/2 - 3”	12 ft.	Each Floor, Not to Exceed 10 ft.	Base and Each Floor (Note 1)
Over 4”	12 ft.	Each Floor, Not to Exceed 10 ft.	Base and Each Floor (Note 1)

- 1) Note 1: Provide mid-story guides.
- 2) Note 2: For PVC piping, provide for expansion every 30 feet per IAPMO installation standard. For CPVC piping, provide for expansion per IAPMO installation standard.
- 3) Note 3: Spacing of hangers and supports for piping assembled with mechanical joints shall be in accordance with standards acceptable to authorities having jurisdiction.
- 4) Note 4: Includes refrigerant piping, including vapor and hot gas pipes.
- b. Horizontal piping, hanger and support spacing: Locate hangers and supports at each change of direction, within one foot of elbow, and spaced at or within following maximum limits:

<u>Pipe Diameter</u>	<u>Steel Threaded or Welded (Note 2)</u>	<u>Copper Brazed or Soldered (Notes 2, 3)</u>	<u>CPVC & PVC (Note 1)</u>
1/2 - 1"	6 ft.	5 ft.	3 ft.
1-1/4 - 2"	7 ft.	6 ft.	4 ft.
2-1/2 - 3"	10 ft.	10 ft.	4 ft.
Over 4"	10 ft.	10 ft.	4 ft.

- 1) Note 1: For PVC piping, provide for expansion every 30 feet per IAPMO installation standard. For CPVC piping, provide for expansion per IAPMO installation standard.
- 2) Note 2: Spacing of hangers and supports for piping assembled with mechanical joints shall be in accordance with standards acceptable to authorities having jurisdiction.
- 3) Note 3: Includes all refrigerant piping, including vapor and hot gas pipes.

5. Suspended Piping:

- a. Individually suspended piping: B-Line B3690 J-Hanger or B3100 Clevis, complete with threaded rod, or equal. All hangers on supply and return piping handling heating hot water or steam shall have a swing connector at point of support.

<u>Pipe Size</u>	<u>Rod Size Diameter</u>
2" and Smaller	3/8"
2-1/2" to 3-1/2"	1/2"
4" to 5"	5/8"
6"	3/4"

- b. Provide 3/8 inch rod for support of PVC and CPVC and provide continuous support.
- c. Trapeze Suspension: B-Line 1-5/8 inch width channel in accordance with manufacturers' published load ratings. No deflection to exceed 1/180 of a span.
- d. Trapeze Supporting Rods: Shall have a safety factor of five; securely anchor to building structure.
- e. Pipe Clamps and Straps: B-Line B2000, B2400; isolate copper pipe with two thicknesses of 2 inches wide 10-mil polyvinyl tape. Where used for seismic support systems, provide B-Line B2400 series pipe straps.
- f. Above Roof: H frame made from Uni-Strut hot-dipped galvanized 1-5/8 inch single or double channel with P-2072A or P-2073A foot secured to roof and surrounded with waterproof roofed-in sleeper. Secure to sleeper with lag screws, and secure sleeper to blocking under roof.

- g. Steel Connectors: Beam clamps with retainers.
- 6. Duct Hanger and Support Spacing: Conform to Requirements of CMC and SMACNA "HVAC Duct Construction Standards, Metal and Flexible."
- 7. Support to Structure:
 - a. Wood Structure: Provide and install wood blocking as required to suit structure. Provide lag screws or through bolts with length to suit requirements, and with size (diameter) to match the size of hanger rods required.
 - 1) Do not install Lag screws in tension without written review and acceptance by Structural Engineer.

Side Beam Angle Clip	B-Line B3062 MSS Type 34
Side Beam Angle Clip	B-Line B3060
Ceiling Flange	B-Line B3199

- 2) Blocking for support of piping shall be not less than 2 inch thick for piping up to 2 inch size. Provide 3 inch blocking for piping up through 5 inch size, and 4 inch blocking for larger piping. Provide support for blocking in accordance with Structural Engineers requirements.
 - 3) Where lag screws are used, length of screw shall be 1/2 inch less than the wood blocking. Pre-drill starter holes for each lag screw.
 - b. Steel Structure: Provide and install additional steel bracing as required to suit structure. Provide through bolts with length to suit requirements of the structural components. Burning or welding on any structural member may only be done if approved by the Architect.
- 8. Rubber Neoprene Pipe Isolators:
 - a. Pipe isolators shall comprise an internal rubber or neoprene material that isolates pipe from hanger and structure. Install at all piping located in acoustical walls. Refer to Architectural Drawings for location of acoustical walls.
 - b. Isolation material shall be either a rubber or neoprene material that prevents contact between the pipe and the structure. The rubber shall have between a 45 to 55 durometer rating and a minimum thickness of 1/2 inch.
 - c. Acceptable Suppliers:
 - 1) Vertical runs: Acousto-Plumb or equal.
 - 2) Horizontal runs: B-Line, Vibraclamp; Acousto-Plumb or equal.
- 9. Provide support for piping through roof, arranged to anchor piping solidly in place at the roof penetration.
- 10. Provide rigid insulation and a 12 inch long, 18 gauge galvanized sheet iron shield between the covering and the hanger whenever hangers are installed on the outside of the pipe covering.
- 11. Insulate copper tubing from ferrous materials and hangers with two thicknesses of 3 inch wide, 10 mil polyvinyl tape wrapped around pipe.

12. Provide a support or hanger close to each change of direction of pipe either horizontal or vertical and as near as possible to concentrated loads.
13. Suspend rods from concrete inserts with removable nuts where suspended from concrete decks. Power actuated inserts will not be allowed.
14. On chilled or combination hot and chilled water or refrigerant pipes, install the hangers on the outside of the pipe covering and not in contact with the pipe. Provide rigid insulation and a 12 inch long, 18 gauge galvanized sheet iron shield between the covering and the hanger whenever hangers are installed on the outside of the pipe covering.

3.06 UNION AND FLANGE INSTALLATION

- A. Install Epco, Nibco, or equal, dielectric unions or flanges at points of connection between copper or brass piping or material and steel or cast iron pipe or material except in drain piping. Bushings or couplings shall not be used.
- B. Install unions in piping NPS 2" and smaller 3 or flanges in piping NPS 2-1/2" and larger whether shown or not at each connection to all equipment and tanks, and at all connections to all automatic valves, such as temperature control valves.
- C. Locate the unions for easy removal of the equipment, tank, or valve.
- D. Do not install unions or flanges in refrigerant piping systems.

3.07 ACCESS DOOR INSTALLATION

- A. Furnish and install access doors wherever required whether shown or not for easy maintenance of mechanical systems; for example, at concealed valves, strainers, traps, cleanouts, dampers, motors, controls, operating equipment, etc. Access doors shall provide for complete removal and replacement of equipment.

3.08 CONCRETE WORK

- A. Concrete work required for work of this Section shall be included under another section of the Specification, unless otherwise noted, including poured-in-place concrete work for installing precast manholes, catch basins, etc., and shall include reinforced concrete bases for pumps, tanks, compressors, fan units, boilers, unless the work is specifically indicated on the Drawings to be furnished under this Section.
- B. Underground anchors, and pads for valve access boxes are included under this Section of the Specification. Concrete shall be 3000 psi test minimum. Refer to Division 03 for concrete types.

3.09 PIPE PROTECTION

- A. Wrap bare galvanized and black steel pipe buried in the ground and to 6" above grade, including piping in conduit, with one of the following, or equal:
 1. Polyethylene Coating: Pressure sensitive polyethylene coating, "X-Tru-Coat" as manufactured by Pipe Line Service Corporation or "Green Line" wrap as manufactured by Royston Products, or equal.
 - a. Field Joints and Fittings: Protecto Wrap #1170 tape as manufactured by Pipe Line Service Corporation, or Primer #200 tape by Royston Products, or equal. Installation shall be as per manufacturer's recommendation and instructions.

2. Tape Wrap: Pressure-sensitive polyvinyl chloride tape, "Transtex #V-10 or V-20", "Scotchwrap 50", Slipknot 100, PASCO Specialty & Mfg., Inc., or equal, with continuous identification. Tape shall be a minimum of 20 mils thick for fittings and irregular surfaces, two wraps, 50 percent overlap, 40 mils total thickness. Tape shall be laminated with a suitable adhesive; widths as recommended by the manufacturer for the pipe size. Wrap straight lengths of piping with an approved wrapping machine.
- B. Field Joints: Valves and Fittings: double wrap polyvinyl chloride tape as above. Provide at least two thicknesses of tape over the joint and extend a minimum of 4 inches over adjacent pipe covering. Build up with primer to match adjacent covering thickness. Width of tape of fittings shall not exceed 3 inches. Tape shall adhere tightly to all surfaces of the fittings without air pockets.
- C. Testing: Test completed wrap of piping, including all epoxy painted piping with Tinker and Rasor Co. holiday detector, or equal.
- D. Cleaning: Clean all piping thoroughly before wrapping.
 1. Inspection: Damaged or defective wraps shall be repaired as directed. No wrapped pipe shall be covered until approved by Architect.
- E. Covering: No rocks or sharp edges shall be backfilled against the wrap. When backfilling with other than sand, protect wrap with an outer wrapping of Kraft paper; leave in place during backfill.

3.10 PIPE IDENTIFICATION

- A. Provide temporary identification of each pipe installed, at the time of installation. Temporary identification shall be removed and replaced with permanent identification as part of the work.
- B. Apply the legend and flow arrow at all valve locations; at all points where the piping enters or leaves a wall, partition, cluster of piping or similar obstruction, at each change of direction, and at approximately 20'-0" intervals on pipe runs. Variations or changes in locations and spacing may be made with the approval of the Architect. There shall be at least one marking in each room. Markings shall be located for maximum visibility from expected personnel approach.
- C. Wherever two or more pipes run parallel, the markings shall be supplied in the same relative location on each.
- D. Apply the markings after painting and cleaning of piping and insulation is completed.

3.11 PIPING SYSTEM PRESSURE TESTING

- A. General:
 1. Perform operational tests under simulated or actual service conditions.
 2. Repair leaks and defects with new materials, and retest piping or portion thereof until satisfactory results are obtained.
- B. Testing, Evacuating, Charging and Lubrication of Refrigeration Systems:
 1. Pressurize with dry nitrogen and/or refrigerant to 300 psig and test all joints with an electronic detector or halide torch. Release the pressure and attach a high vacuum pump. Evacuate to 4 mm (4000 microns) and hold for 30 minutes. Break to 5 psig with

dry nitrogen and allow to remain in the system for ten minutes. Evacuate to 2 mm (2000 microns) and hold for 30 minutes. Use a mercury manometer or electronic vacuum gauge. Do not start timing until recommended vacuum range is reached.

2. At the end of the evacuation, if the system has been proved leak-free, charge with refrigerant and fill the crankcase to the oil level specified by the manufacturer. All refrigerant oil shall be delivered to the location in sealed containers.
3. Replenish for a period of one year without cost to the Owner all refrigerant and oil required to maintain the proper levels.

3.12 TRACER WIRE INSTALLATION

- A. Provide tracer wire for non-metallic water pipe in ground outside of buildings. Use AWG #14 tracer wire with blue colored low density high molecular weight polyethylene insulation, and lay continuously on pipe so that it is not broken or stressed by backfilling operations. Secure wire to the piping with tape at 18 inch intervals. Solder all joints.
- B. Terminals: Precast concrete box and cast iron locking traffic cover, Brooks 3TL, or equal; cover marked with name of service; 6 inches of loose gravel below box. Plastic terminal board with brass bolts; identify line direction with plastic tags. Test for continuity between terminals, after backfilling, in presence of Inspector.
- C. Alternate: Use electronically detectable plastic tape with metallic core, Terra Tape D, manufactured by Reef Industries, Inc., Seton, Inc., Marking Services, Inc., or equal; tape 2 inches wide, continuously imprinted "CAUTION WATER (GAS, etc.) LINE BELOW". Install, with printed side up, directly over pipe, 18 inches below finish grade. Backfill material shall be as previously specified for the particular condition where pipe is installed, but avoid use of crushed rock or of earth with particles larger than 1/2 inch within the top 12 inches of backfill. Take precautions to insure that tape is not damaged or misplaced during backfill operations. Terminal boxes not required.

3.13 OPERATION OF SYSTEMS

- A. Do not operate any mechanical equipment for any purpose, temporary or permanent, until all of the following has been completed:
 1. Complete all requirements listed under "Check, Test and Start Requirements."
 2. Ductwork and piping has been properly cleaned. Piping systems shall be flushed and treated prior to operation.
 3. Filters, strainers etc. are in place.
 4. Bearings have been lubricated, and alignment of rotating equipment has been checked.
 5. Equipment has been run under observation, and is operating in a satisfactory manner.
- B. Provide test and balance agency with one set of Contract Drawings, Specifications, Addenda, Change orders issued, applicable shop drawings and submittals and temperature control drawings.
- C. Operate every fire damper, smoke damper, combination smoke and fire damper under normal operating conditions. Activate smoke detectors as required to operate the damper, stage fan, etc. Provide written confirmation that all systems operate in a satisfactory manner.

3.14 TEMPORARY HEAT

- A. The General Contractor will provide for all temporary heat at such times as may be required or directed by the Architect and pay all fuel and energy costs incurred.
- B. Temporary heating facilities proposed for use by the Contractor will be subject to review of the Architect. Prior to use of any equipment for temporary heat, install temporary filters on all return air inlets, to preclude dust and construction debris from entering the duct system. In addition, install filters in air handling units, and replace at the completion of temporary operation.
- C. Filters used for temporary operation of systems shall be as specified for permanent filters specified herein.
- D. Comply with Check, Test and Start Requirements for start-up of equipment prior to operation for temporary heat.
- E. Contractor shall complete the permanent heating system as soon as possible, thereby making it available for temporary heat. When available, the system may be used as required at the direction of the Architect after systems are properly prepared for use as specified elsewhere. Contractor shall then be responsible for operating the system during periods required and the General Contractor shall pay the fuel and energy costs incurred. Operation of the heating system prior to the filing of "notice of completion" shall not change the Guarantee provisions in any way.

3.15 CHECK, TEST AND START REQUIREMENTS

- A. An authorized representative of the equipment manufacturer shall perform check, test and start of each piece of mechanical equipment. The representative may be an employee of the equipment manufacturer, or a manufacturer-certified contractor. Submit written certification from the manufacturer stating that the representative is qualified to perform the check test and start of the equipment.
 - 1. As part of the submittal process, provide a copy of each manufacturer's printed startup form to be used.
 - 2. Some items of specified equipment may require that check, test and start of equipment must be performed by the manufacturer, using manufacturer's employees. See specific equipment Articles in these Specifications for this requirement.
 - 3. Provide all personnel, test instruments, and equipment to properly perform the check, test and start work.
 - 4. When work has been completed, provide copies of reports for review, prior to final observation of work.
- B. Provide copies of the completed check, test and start report of each item of equipment, bound with the Operation and Maintenance Manual.
- C. Upon completion of the work, provide a schedule of planned maintenance for each piece of equipment. Indicate frequency of service, recommended spare parts (including filters and lubricants), and methods for adjustment and alignment of all equipment components. Provide a copy of the schedule with each Operation and Maintenance Manual. Provide a copy of certification from the Owner's representative indicating that they have been properly instructed in maintenance requirements for the equipment installed.

3.16 PRELIMINARY OPERATIONAL REQUIREMENTS AND TESTS

- A. Prior to observation to determine final acceptance, put HVAC, plumbing, and fire protection systems into service and check that work required for that purpose has been done, including but not limited to the following condensed check list. Provide indexed report to tabulating the results of all work.
1. All equipment has been started, checked, lubricated and adjusted in accordance with the manufacturer's recommendations, including modulating power exhausts if present.
 2. Correct rotation of motors and ratings of overload heaters are verified.
 3. Specified filters are installed and spare filters have been turned over to Owner.
 4. All manufacturers' certificates of start-up specified have been delivered to the Owner.
 5. All equipment has been cleaned, and damaged painted finishes touched up.
 6. Damaged fins on heat exchangers have been combed out.
 7. Missing or damaged parts have been replaced.
 8. Flushing and chemical treatment of piping systems has been completed and water treatment equipment, where specified, is in operation.
 9. Equipment labels, pipe marker labels, ceiling markers and valve tags are installed.
 10. Valve tag schedules, corrected control diagrams, sequence of operation lists and start-stop instructions have been posted.
 11. Preliminary test and balance work is complete, and reports have been forwarded for review.
 12. Automatic control set points are as designated and performance of controls checks out to agree with the sequence of operation.
 13. Operation and Maintenance Manuals have been delivered and instructions to the operating personnel have been made.
- B. Prior to the observation to determine final acceptance, operate all mechanical systems as required to demonstrate that the installation and performance of these systems conform to the requirements of these specifications.
1. Operate and test all mechanical equipment and systems for a period of at least five consecutive 8 hour days to demonstrate the satisfactory overall operation of the project as a complete unit.
 2. Include operation of heating and air conditioning equipment and systems for a period of not less than two 8 hour days at not less than 90 percent of full specified heating and cooling capacities in tests.
 3. Commence tests after preliminary balancing and adjustments to equipment have been checked. Immediately before starting tests, install air filters and lubricate all running equipment. Notify the Architect at least seven calendar days in advance of starting the above tests.
 4. During the test period, make final adjustments and balancing of equipment, systems controls, and circuits so that all are placed in first class operating condition.
 5. Where Utility District rebates are applicable, demonstrate that the systems meet the rebate program requirements.
- C. Before handing over the system to Owner replace all filters with complete new set of filters.
- D. Review of Contractor's Tests:

1. All tests made by the Contractor or manufacturers' representatives are subject to observation and review by the Owner. Provide timely notice prior to start of each test, in order to allow for observation of testing. Upon the completion of all tests, provide a letter to confirm that all testing has been successful.

E. Test Logs:

1. Maintain test logs listing the tests on all mechanical systems showing dates, items tested, inspectors' names, remarks on success or failure of the tests.

F. Preliminary Operation:

1. The Owner reserves the right to operate portions of the mechanical system on a preliminary basis without voiding the guarantee.

G. Operational Tests:

1. Before operational tests are performed, demonstrate that all systems and components are complete and fully charged with operating fluid and lubricants.
2. Systems shall be operable and capable of maintaining continuous uninterrupted operation during the operating and demonstration period. After all systems have been completely installed, connections made, and tests completed, operate the systems continuously for a period of five working days during the hours of a normal working day.
3. This period of continuous systems operation may be coordinated with the removal of Volatile Organic Compounds (VOCs) from the building prior to occupancy should the Owner decide to implement such a program.
4. Control systems shall be completely operable with settings properly calibrated and adjusted.
5. Rotating equipment shall be in dynamic balance and alignment.
6. If the system fails to operate continuously during the test period, the deficiencies shall be corrected and the entire test repeated.

H. Pre-Occupancy Building Purge:

1. Prior to occupancy, ventilate the building on 100 percent outside air, 100 percent exhaust for a continuous period determined by a qualified industrial hygienist (engaged by the Contractor) to reduce V.O.C's prior to occupancy.
2. Submit report by the industrial hygienist verifying satisfactory completion of the pre-occupancy purge.

3.17 DEMONSTRATION AND TRAINING

- A. An authorized representative of the equipment manufacturer shall train Owner-designated personnel in maintenance and adjustment of equipment. The representative may be an employee of the equipment manufacturer, or a manufacturer-certified contractor. Submit written certification from the manufacturer stating that the representative is qualified to perform the Owner training for the equipment installed.

1. As part of the submittal process, provide a training agenda outlining major topics and time allowed for each topic.
2. Some items of specified equipment require that training must be performed by the manufacturer, using manufacturer's employees. See specific equipment Articles in these Specifications for this requirement.

3. Contractor shall provide three copies of certification by Contractor that training has been completed, signed by Owner's representative, for inclusion in Operation and Maintenance Manual. Certificates shall include:
 - a. Listing of Owner-designated personnel completing training, by name and title.
 - b. Name and title of training instructor.
 - c. Date(s) of training.
 - d. List of topics covered in training sessions.
4. Refer to specific equipment Articles for minimum training period duration for each piece of equipment.

END OF SECTION

SECTION 23 05 93

TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Balancing Air Systems:
 - a. Constant-volume air systems.
 - b. Variable-air-volume systems.
 - 2. Balancing Domestic Water Piping Systems.

1.02 RELATED REQUIREMENTS

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

1.03 REFERENCES AND STANDARDS

- A. Associated Air Balance Council (AABC)
 - 1. National Standards for Total System Balance, latest edition.
- B. National Environmental Balancing Bureau (NEBB)
 - 1. Procedural Standards for Testing and Balancing of Environmental Systems, latest edition.

1.04 DEFINITIONS

- A. The intent of this Section is to use the standards pertaining to the TAB specialist engaged to perform the Work of this Contract, with additional requirements specified in this Section. Contract requirements take precedence over corresponding AABC or NEBB standards requirements. Differences in terminology between the Specifications and the specified TAB organization standards do not relieve the TAB entity engaged to perform the Work of this Contract of responsibility from completing the Work as described in the Specifications.
- B. Similar Terms: The following table is provided for clarification only:

<u>Similar Terms</u>		
Contract Term	AABC Term	NEBB Term
TAB Specialist	TAB Agency	NEBB Certified Firm
TAB Standard	National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems	Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems
TAB Field Supervisor	Test and Balance Engineer	Test and Balance Supervisor

- C. AABC: Associated Air Balance Council.
- D. NEBB: National Environmental Balancing Bureau.
- E. TAB: Testing, adjusting, and balancing.
- F. TAB Organization: Body governing practices of TAB Specialists.
- G. TAB Specialist: An entity engaged to perform TAB Work.

1.05 ACTION SUBMITTALS

- A. For additional requirements, refer to Section 23 00 50, Basic HVAC Materials and Methods.
- B. LEED Submittals:
 1. Air-Balance Report for Prerequisite IEQ 1: Documentation of work performed for ASHRAE 62.1, Section 7.2.2 - "Air Balancing."
 2. TAB Report for Prerequisite EA 2: Documentation of work performed for ASHRAE/IESNA 90.1, Section 6.7.2.3 - "System Balancing."

1.06 INFORMATIONAL SUBMITTALS

- A. For additional requirements, refer to Section 23 00 50, Basic HVAC Materials and Methods.
- B. Qualification Data: Within 30 days of Contractor's Notice to Proceed, submit documentation that the TAB specialist and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.
 1. Provide list of similar projects completed by proposed TAB field supervisor.
 2. Provide copy of completed TAB report, approved by mechanical engineer of record for a completed project with similar system types and of similar complexity.
- C. Contract Documents Examination Report: Within 30 days of Contractor's Notice to Proceed, submit the Contract Documents review report as specified in Part 3.

1. Submit examinations report with qualifications data.
- D. Strategies and Procedures Plan: Within 60 days of Contractor's Notice to Proceed, submit TAB strategies and step-by-step procedures as specified in "Preparation" Article.
- E. Interim Reports. Submit interim reports as specified in Part 3. Include list of system conditions requiring correction and problems not identified in Contract Documents examination report.
- F. Certified TAB reports.
 1. Provide three printed copies of final TAB report. Provide one electronic file copy in PDF format.
- G. Sample report forms.
- H. Instrument calibration reports, to include the following:
 1. Instrument type and make.
 2. Serial number.
 3. Application.
 4. Dates of use.
 5. Dates of calibration.
 - a. Instruments to be used for testing and balancing shall have been calibrated within a period of one year, or less if so recommended by instrument manufacturer and be checked for accuracy prior to start of work.

1.07 CLOSEOUT SUBMITTALS

- A. For additional requirements, refer to Section 23 00 50, Basic HVAC Materials and Methods.
- B. Certified TAB reports, for inclusion in Operation and Maintenance Manual.

1.08 QUALITY ASSURANCE

- A. Independent TAB Specialist Qualifications: Engage a TAB entity certified by AABC or NEBB.
 1. The certification shall be maintained for the entire duration of TAB work for this Project. If TAB specialist loses certification during this period, the Contractor shall immediately notify the Architect and submit another TAB specialist for approval. All work specified in this Section and in other related Sections performed by the TAB specialist shall be invalidated if the TAB specialist loses certification, and shall be performed by an approved successor.
- B. To secure approval for the proposed TAB specialist, submit information certifying that the TAB specialist is either a first tier subcontractor engaged and paid by the Contractor, or is engaged and paid directly by the Owner. TAB specialist shall not be affiliated with any other entity participating in Work of this Contract, including design, furnishing equipment, or construction. In addition, submit evidence of the following:
 1. TAB Field Supervisor: Full-time employee of the TAB specialist and certified by AABC or NEBB.

- a. TAB field supervisor shall have minimum 10 years supervisory experience in TAB work.
2. TAB Technician: Full-time employee of the TAB specialist and who is certified by AABC or NEBB as a TAB technician.
 - a. TAB technician shall have minimum 4 years TAB field experience.
- C. TAB Specialist engaged to perform TAB work in this Project shall be a business limited to and specializing in TAB work, or in TAB work and Commissioning.
- D. TAB specialist engaged to perform TAB work shall not also perform commissioning activities on this Project.
- E. Certified TAB field supervisor or certified TAB technician shall be present at the Project site at all times when TAB work is performed.
 1. TAB specialist shall maintain at the Project site a minimum ratio of one certified field supervisor or technician for each non-certified employee at times when TAB work is being performed.
- F. Contractor shall notify Architect in writing within three days of receiving direction resulting in reduction of test and balance scope or other deviations from Contract Documents. Deviations from the TAB plan shall be approved in writing by the mechanical engineer of record for the Project.
- G. TAB Standard:
 1. Perform TAB work in accordance with the requirements of the standard under which the TAB agencies' qualifications are approved unless Specifications contain different or more stringent requirements:
 - a. AABC National Standards for Total System Balance, or
 - b. NEBB Procedural Standards for Testing, Adjusting, Balancing of Environmental Systems.
 2. All recommendations and suggested practices contained in the TAB standard are mandatory. Use provisions of the TAB standard, including checklists and report forms, to the extent to which they are applicable to this Project.
 3. Testing, adjusting, balancing procedures, and reporting required for this Project, and not covered by the TAB standard applicable to the TAB specialist engaged to perform the Work of this Contract, shall be submitted for approval by the design engineer.
- H. TAB Conference: Meet with Architect and mechanical engineer on approval of the TAB strategies and procedures plan to develop a mutual understanding of the project requirements. Require the participation of the TAB field supervisor. Provide seven days' advance notice of scheduled meeting time and location. TAB conference shall take place at location selected by Architect offices of Capital.
 1. Agenda Items:
 - a. The Contract Documents examination report.
 - b. The TAB plan.
 - c. Coordination and cooperation of trades and subcontractors.
 - d. Coordination of documentation and communication flow, including protocol for resolution tracking and documentation.

2. The requirement for TAB conference may be waived at the discretion of the mechanical engineer of record for the Project.
- I. Certify TAB field data reports and perform the following:
 1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
 2. Certify that the TAB team complied with the approved TAB plan and the procedures specified and referenced in this Specification.
- J. TAB Report Forms: Use standard TAB specialist's forms approved by Architect.
- K. Instrumentation Type, Quantity, Accuracy, and Calibration: As described in ASHRAE 111, Section 5, "Instrumentation."
- L. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 7.2.2 - "Air Balancing."
- M. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.7.2.3 - "System Balancing."

1.09 PROJECT CONDITIONS

1.10 WARRANTY

- A. Provide workmanship and performance warranty applicable to TAB specialist engaged to perform Work of this Contract:
 1. AABC Performance Guarantee.
 2. NEBB Quality Assurance Program.
- B. Refer to Division 01 Specifications for additional requirements.

1.11 COORDINATION

- A. Notice: Provide seven days' advance notice for each test. Include scheduled test dates and times.
- B. Perform TAB after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.
- C. Coordinate TAB work with work of other trades.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Contract Documents Examination Report:
 1. TAB specialist shall review Contract Documents, including plans and specifications. Provide report listing conditions that would prevent the system(s) from operating in accordance with the sequence of operations specified, or would prevent accurate testing and balancing:

- a. Identify each condition requiring correction using equipment designation shown on Drawings. Provide room number, nearest building grid line intersection, or other information necessary to identify location of condition requiring correction.
 - b. Proposed corrective action necessary for proper system operation.
- B. Examine systems for installed balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are accessible.
- C. Examine the approved submittals for HVAC systems and equipment.
- D. Examine design data including HVAC system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about HVAC system and equipment controls.
- E. Examine equipment performance data including fan and pump curves.
 1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
- F. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.
- G. Examine test reports specified in individual system and equipment Sections.
- H. Examine HVAC equipment and filters and verify that bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.
- I. Examine terminal units, such as variable-air-volume boxes, and verify that they are accessible and their controls are connected and functioning.
- J. Examine strainers. Verify that startup screens are replaced by permanent screens with indicated perforations.
- K. Examine heat-transfer coils for correct piping connections and for clean and straight fins.
- L. Examine system pumps to ensure absence of entrained air in the suction piping.
- M. Examine operating safety interlocks and controls on HVAC equipment.
- N. Report conditions requiring correction discovered before and during performance of TAB procedures.
- O. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.02 PREPARATION

- A. Prepare a TAB plan that includes strategies and step-by-step procedures. TAB plan shall be specific to Project and include the following:
 1. General description of each air system and sequence(s) of operation.
 2. Complete list of measurements to be performed.

3. Complete list of measurement procedures. Specify types of instruments to be utilized and method of instrument application.
 4. Qualifications of personnel assigned to Project.
 5. Single-line CAD drawings reflecting all test locations (terminal units, grilles, diffusers, traverse locations, etc).
 6. Table indicating pressure relationships (positive, negative, or neutral) between building spaces.
 7. Air terminal correction factors for the following:
 - a. Air terminal configuration.
 - b. Flow direction (supply or return/exhaust).
 - c. Effective area of each size and type of air terminal.
 - d. Air density.
- B. Complete system-readiness checks and prepare reports. Verify the following:
1. Permanent electrical-power wiring is complete.
 2. Automatic temperature-control systems are operational.
 3. Equipment and duct access doors are securely closed.
 4. Balance, smoke, and fire dampers are open.
 5. Isolating and balancing valves are open and control valves are operational.
 6. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
 7. Windows and doors can be closed so indicated conditions for system operations can be met.

3.03 GENERAL PROCEDURES FOR TESTING AND BALANCING

- A. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Total System Balance" or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" and in this Section.
1. Comply with requirements in ASHRAE 62.1, Section 7.2.2 - "Air Balancing."
- B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.
1. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts.
 2. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Section 23 07 13 "Duct Insulation," Section 23 07 16 "HVAC Equipment Insulation," Section 23 80 00 Heating, Ventilating, and Air Conditioning."
- C. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.
- D. Take and report testing and balancing measurements in inch-pound (IP) units.

3.04 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

- A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.
- B. Test each system to verify building or space operating pressure, including all stages of economizer cycle. Maximum building pressure shall not exceed 0.03 inches of pressure.
- C. Except as specifically indicated in this Specification, Pitot tube traverses shall be made of each duct to measure airflow. Pitot tubes, associated instruments, traverses, and techniques shall conform to ASHRAE Handbook, HVAC Applications, and ASHRAE Handbook, HVAC Systems and Equipment.
 - 1. Use state-of-the-art instrumentation approved by TAB specialists governing agency..
 - 2. Where ducts' design velocity and air quantity are both less than 1000 fpm/CFM, air quantity may be determined by measurements at terminals served.
- D. Test holes shall be placed in straight duct, as far as possible downstream from elbow, bends, take-offs, and other turbulence-generating devices.
- E. For variable-air-volume systems, develop a plan to simulate diversity.
- F. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.
- G. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.
- H. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
- I. Verify that motor starters are equipped with properly sized thermal protection.
- J. Check dampers for proper position to achieve desired airflow path.
- K. Check for airflow blockages.
- L. Check condensate drains for proper connections and functioning.
- M. Check for proper sealing of air-handling-unit components.
- N. Verify that air duct system is sealed as specified in Section 23 31 13 "Metal Ducts." Section 23 80 00 "Heating, Ventilating, and Air Conditioning."
- O. Provide for adjustments or modifications to fan and motor sheaves, belts, damper linkages, and other components as required to achieve specified air balance at no additional cost to Owner.
- P. Automatically operated dampers shall be adjusted to operate as indicated in Contract Documents. Controls shall be checked for proper calibration.

3.05 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

- A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.

1. Measure total airflow.
 - a. Where sufficient space in ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow. Alternative methods shall be examined for determining total CFM, i.e., Pitot-tube traversing of branch ducts, coil or filter velocity profiles, prior to utilizing airflow values at terminal outlets and inlets.
 2. Measure fan static pressures as follows to determine actual static pressure:
 - a. Measure outlet static pressure as far downstream from the fan as practical and upstream from restrictions in ducts such as elbows and transitions.
 - b. Measure static pressure directly at the fan outlet.
 - c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from the flexible connection, and downstream from duct restrictions.
 - d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.
 3. Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and -treating equipment.
 - a. Report the cleanliness status of filters and the time static pressures are measured.
 4. Measure static pressures entering and leaving other devices, such as sound traps, heat-recovery equipment, and air washers, under final balanced conditions.
 5. Review Record Documents to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.
 6. Obtain approval from Architect for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in HVAC Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.
 7. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.
- B. Check operation of relief air dampers. Measure total relief air quantity at each stage of normal, economizer, power exhaust, or power exhaust economizer operation, as applicable to installed equipment. Adjust relief air dampers to provide 100 percent relief in economizer mode. Ensure that relief dampers close completely upon unit shutdown.
- C. Check operation of outside air dampers. Measure total outside air quantity at each stage of normal, economizer, power exhaust, or power exhaust economizer operation, as applicable to installed equipment. Adjust outside air dampers to provide 100 percent outside air in economizer mode. Ensure that outside air dampers close completely upon unit shutdown.
- D. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows within specified tolerances.
1. Measure airflow of submain and branch ducts.

- a. Where sufficient space in submain and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.
 2. Measure static pressure at a point downstream from the balancing damper, and adjust volume dampers until the proper static pressure is achieved.
 3. Remeasure each submain and branch duct after all have been adjusted. Continue to adjust submain and branch ducts to indicated airflows within specified tolerances.
- E. Measure air outlets and inlets without making adjustments.
1. Measure terminal outlets using a direct-reading digital backflow compensating hood. Use outlet manufacturer's written instructions and calculating factors only when direct-reading hood cannot be used due to physical obstruction or other limiting factors. Final report shall indicate where values listed have not been obtained by direct measurement.
- F. Adjust air outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using branch volume dampers rather than extractors and the dampers at air terminals.
1. Adjust each outlet in same room or space to within specified tolerances of indicated quantities without generating noise levels above the limitations prescribed by the Contract Documents, if included.
 2. Adjust patterns of adjustable outlets for proper distribution without drafts. Terminal air velocity at five feet above finished floor shall not exceed 50 feet per minute in occupied air conditioned spaces.
- G. Do not overpressurize ducts.

3.06 PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS

- A. Comply with applicable requirements for constant-volume air systems in addition to those listed below.
- B. Compensating for Diversity: When the total airflow of all terminal units is more than the indicated airflow of the fan, place a selected number of terminal units at a minimum set-point airflow with the remainder at maximum-airflow condition until the total airflow of the terminal units equals the indicated airflow of the fan. Select the reduced-airflow terminal units so they are distributed evenly among the branch ducts.
- C. Pressure-Independent, Variable-Air-Volume Systems: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:
1. Set outdoor-air dampers at minimum, and set return- and exhaust-air dampers at a position that simulates full-cooling load.
 2. Select the terminal unit that is most critical to the supply-fan airflow and static pressure. Measure static pressure. Adjust system static pressure so the entering static pressure for the critical terminal unit is not less than the sum of the terminal-unit manufacturer's recommended minimum inlet static pressure plus the static pressure needed to overcome terminal-unit discharge system losses.
 3. Measure total system airflow. Adjust to within indicated airflow.
 4. Set terminal units at maximum airflow and adjust controller or regulator to deliver the designed maximum airflow. Use terminal-unit manufacturer's written instructions to

make this adjustment. When total airflow is correct, balance the air outlets downstream from terminal units the same as described for constant-volume air systems.

5. Set terminal units at minimum airflow and adjust controller or regulator to deliver the designed minimum airflow. Check air outlets for a proportional reduction in airflow the same as described for constant-volume air systems.
 - a. If air outlets are out of balance at minimum airflow, report the condition but leave outlets balanced for maximum airflow.
6. Remeasure the return airflow to the fan while operating at maximum return airflow and minimum outdoor airflow.
 - a. Adjust the fan and balance the return-air ducts and inlets the same as described for constant-volume air systems.
7. Measure static pressure at the most critical terminal unit and adjust the static-pressure controller at the main supply-air sensing station to ensure that adequate static pressure is maintained at the most critical unit.
8. Record final fan-performance data including optimum operating static control set point.

3.07 PROCEDURES FOR MOTORS

- A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:
 1. Manufacturer's name, model number, and serial number.
 2. Motor horsepower rating.
 3. Motor rpm.
 4. Efficiency rating.
 5. Nameplate and measured voltage, each phase.
 6. Nameplate and measured amperage, each phase.
 7. Starter manufacturer's name, model number, size, type, and thermal-protection-element rating.
 - a. Starter strip heater size, type, and rating.
- B. Motors Driven by Variable-Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum. Test the manual bypass of the controller to prove proper operation. Record observations including name of controller manufacturer, model number, serial number, and nameplate data.

3.08 PROCEDURES FOR CONDENSING UNITS

- A. Verify proper rotation of fans.
- B. Measure entering- and leaving-air temperatures.
- C. Record compressor data.

3.09 PROCEDURES FOR HEAT-TRANSFER COILS

- A. Measure, adjust, and record the following data for each electric heating coil:
 1. Nameplate data.

2. Airflow.
3. Entering- and leaving-air temperature at full load.
4. Voltage and amperage input of each phase at full load and at each incremental stage.
5. Calculated kilowatt at full load.
6. Fuse or circuit-breaker rating for overload protection.

B. Measure, adjust, and record the following data for each refrigerant coil:

1. Dry-bulb temperature of entering and leaving air.
2. Wet-bulb temperature of entering and leaving air.
3. Airflow.
4. Air pressure drop.

3.10 PROCEDURES FOR TESTING, ADJUSTING, AND BALANCING EXISTING SYSTEMS

A. Perform a preconstruction inspection of existing equipment that is to remain and be reused.

1. Measure and record the operating speed, airflow, and static pressure of each fan.
2. Measure motor voltage and amperage. Compare the values to motor nameplate information.
3. Check the condition of filters.
4. Check the condition of coils.
5. Check the operation of the drain pan and condensate-drain trap.
6. Check bearings and other lubricated parts for proper lubrication.
7. Report on the operating condition of the equipment and the results of the measurements taken. Report conditions requiring correction.

B. Before performing testing and balancing of existing systems, inspect existing equipment that is to remain and be reused to verify that existing equipment has been cleaned and refurbished. Verify the following:

1. New filters are installed.
2. Coils are clean and fins combed.
3. Drain pans are clean.
4. Fans are clean.
5. Bearings and other parts are properly lubricated.
6. Conditions requiring correction noted in the preconstruction report are corrected.

C. Perform testing and balancing of existing systems to the extent that existing systems are affected by the renovation work.

1. Compare the indicated airflow of the renovated work to the measured fan airflows, and determine the new fan speed and the face velocity of filters and coils.
2. Verify that the indicated airflows of the renovated work result in filter and coil face velocities and fan speeds that are within the acceptable limits defined by equipment manufacturer.

3. If calculations increase or decrease the air flow rates and water flow rates by more than 5 percent, make equipment adjustments to achieve the calculated rates. If increase or decrease is 5 percent or less, equipment adjustments are not required.
4. Balance each air outlet.

3.11 GENERAL PROCEDURES FOR PLUMBING SYSTEMS

- A. Measure pressure drop across each backflow preventer assembly at design flows.
- B. Measure water flow at pumps. Use the following procedures except for positive-displacement pumps:
 1. Verify impeller size by operating the pump with the discharge valve closed. Read pressure differential across the pump. Convert pressure to head and correct for differences in gage heights. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.
 - a. If impeller sizes must be adjusted to achieve pump performance, obtain approval from Architect Owner Construction Manager Commissioning Authority and comply with requirements in Section 22 50 00 "Plumbing Equipment Section 22 11 23 "Domestic Water Pumps."
 2. Check system resistance. With all valves open, read pressure differential across the pump and mark pump manufacturer's head-capacity curve. Adjust pump discharge valve until indicated water flow is achieved.
 - a. Monitor motor performance during procedures and do not operate motors in overload conditions.
 3. Verify pump-motor brake horsepower. Calculate the intended brake horsepower for the system based on pump manufacturer's performance data. Compare calculated brake horsepower with nameplate data on the pump motor. Report conditions where actual amperage exceeds motor nameplate amperage.
 4. Report flow rates that are not within range given in article, Tolerances.
- C. Set calibrated balancing valves, if installed, at calculated presettings.
- D. Measure flow at all stations and adjust, where necessary, to obtain first balance.
 1. System components that have Cv rating or an accurately cataloged flow-pressure-drop relationship may be used as a flow-indicating device.
- E. Measure flow at main balancing station and set main balancing device to achieve flow that is 5 percent greater than indicated flow.
- F. Adjust balancing stations to within specified tolerances of indicated flow rate as follows:
 1. Determine the balancing station with the highest percentage over indicated flow.
 2. Adjust each station in turn, beginning with the station with the highest percentage over indicated flow and proceeding to the station with the lowest percentage over indicated flow.
 3. Record settings and mark balancing devices.
- G. Measure pump flow rate and make final measurements of pump amperage, voltage, rpm, pump heads, and systems' pressures and temperatures including outdoor-air temperature.

- H. Measure the differential-pressure-control-valve settings existing at the conclusion of balancing.
- I. Check settings and operation of each safety valve. Record settings.

3.12 TOLERANCES

- A. Set HVAC system's air flow rates and water flow rates within the following tolerances:
 - 1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus 10 percent and minus 0 percent .
 - 2. Air Outlets and Inlets: Plus 5 percent and minus 5 percent .
 - 3. Multiple outlets within single room: Plus 5 percent and minus 0 percent for total airflow within room. Tolerance for individual outlets within a single room having multiple outlets shall be as for "Air Outlets and Inlets".
 - a. Room shall be balanced to create pressure relationship (positive, negative, or neutral) with adjacent spaces as indicated on Drawings. Maintain airflow differentials between supply, return, and exhaust indicated on Drawings.
 - 4. Heating-Water Flow Rate: .
 - 5. Cooling-Water Flow Rate: .
- B. Set plumbing systems water flow rates within plus or minus 10 percent.

3.13 REPORTING

- A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for systems' balancing devices. Recommend changes and additions to systems' balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.
- B. Interim Reports: Prepare periodic lists of conditions requiring correction and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

3.14 FINAL REPORT

- A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.
 - 1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing field supervisor. Report shall be co-signed by the Contractor, attesting that he has reviewed the report, and the report has been found to be complete and accurate.
 - 2. The certification sheet shall be followed by sheet(s) listing items for which balancing objectives could not be achieved. Provide explanation for failure to achieve balancing objectives for each item listed.
 - 3. Include a list of instruments used for procedures, along with proof of calibration.
- B. Final Report Contents: In addition to certified field-report data, include the following:
 - 1. Pump curves.

2. Fan curves.
 3. Manufacturers' test data.
 4. Field test reports prepared by system and equipment installers.
 5. Other information relative to equipment performance; do not include Shop Drawings and product data.
- C. General Report Data: In addition to form titles and entries, include the following data:
1. Title page.
 2. Name and address of the TAB specialist.
 3. Project name.
 4. Project location.
 5. Project Performance Guaranty
 6. Architect's name and address.
 7. Engineer's name and address.
 8. Contractor's name and address.
 9. Report date.
 10. Signature of TAB supervisor who certifies the report.
 11. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
 12. Summary of contents including the following:
 - a. Indicated versus final performance.
 - b. Notable characteristics of systems.
 - c. Description of system operation sequence if it varies from the Contract Documents.
 13. Nomenclature sheets for each item of equipment.
 14. Data for terminal units, including manufacturer's name, type, size, and fittings.
 15. Test conditions for fans and pump performance forms including the following:
 - a. Settings for outdoor-, return-, and exhaust-air dampers.
 - b. Conditions of filters.
 - c. Cooling coil, wet- and dry-bulb conditions.
 - d. Face and bypass damper settings at coils.
 - e. Fan drive settings including settings and percentage of maximum pitch diameter.
 - f. Inlet vane settings for variable-air-volume systems.
 - g. Settings for supply-air, static-pressure controller.
 - h. Other system operating conditions that affect performance.
- D. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:
1. Quantities of outdoor, supply, return, and exhaust airflows.
 2. Duct, outlet, and inlet sizes.
 3. Pipe and valve sizes and locations.

4. Terminal units.
 5. Balancing stations.
 6. Position of balancing devices.
- E. Air distribution outlets and inlets shall be shown on keyed plans with designation for each outlet and inlet matching designation used in Contract Documents and TAB test reports. Room numbers shall be included in keyed plans and test reports. Where multiple outlets and inlets are installed within a single room, a designation shall be assigned and listed for each outlet and inlet in addition to room number.
- F. Test Reports – General:
1. All test reports containing air or liquid flow data shall record flow values prior to system adjustment in addition to required data listed for each test report.
- G. Air-Handling-Unit Test Reports: For air-handling units with coils, include the following:
1. Unit Data:
 - a. Unit identification.
 - b. Location.
 - c. Make and type.
 - d. Model number and unit size.
 - e. Manufacturer's serial number.
 - f. Unit arrangement and class.
 - g. Discharge arrangement.
 - h. Sheave make, size in inches, and bore.
 - i. Center-to-center dimensions of sheave, and amount of adjustments in inches.
 - j. Number, make, and size of belts.
 - k. Number, type, and size of filters.
 2. Motor Data:
 - a. Motor make, and frame type and size.
 - b. Horsepower and rpm.
 - c. Volts, phase, and hertz.
 - d. Full-load amperage and service factor.
 - e. Sheave make, size in inches, and bore.
 - f. Center-to-center dimensions of sheave, and amount of adjustments in inches.
 3. Test Data (Indicated and Actual Values):
 - a. Total air flow rate in cfm.
 - b. Total system static pressure in inches wg.
 - c. Fan rpm.
 - d. Discharge static pressure in inches wg.
 - e. Filter static-pressure differential in inches wg.
 - f. Preheat-coil static-pressure differential in inches wg.

- g. Cooling-coil static-pressure differential in inches wg.
- h. Heating-coil static-pressure differential in inches wg.
- i. Outdoor airflow in cfm.
- j. Return airflow in cfm.
- k. Relief airflow in cfm.
- l. Outdoor-air damper position, normal and economizer, power exhaust, or power exhaust economizer modes, as applicable to installed equipment.
- m. Return-air damper position.
- n. Relief-air damper position, normal and economizer, power exhaust, or power exhaust economizer modes, as applicable to installed equipment.
- o. Vortex damper position.

H. Apparatus-Coil Test Reports:

1. Coil Data:

- a. System identification.
- b. Location.
- c. Coil type.
- d. Number of rows.
- e. Fin spacing in fins per inch o.c.
- f. Make and model number.
- g. Face area in sq. ft.
- h. Tube size in NPS.
- i. Tube and fin materials.
- j. Circuiting arrangement.

2. Test Data (Indicated and Actual Values):

- a. Air flow rate in cfm.
- b. Average face velocity in fpm.
- c. Air pressure drop in inches wg.
- d. Outdoor-air, wet- and dry-bulb temperatures in deg F.
- e. Return-air, wet- and dry-bulb temperatures in deg F.
- f. Entering-air, wet- and dry-bulb temperatures in deg F.
- g. Leaving-air, wet- and dry-bulb temperatures in deg F.
- h. Refrigerant expansion valve and refrigerant types.
- i. Inlet steam pressure in psig.

I. Electric-Coil Test Reports: For electric furnaces, duct coils, and electric coils installed in central-station air-handling units, include the following:

1. Unit Data:

- a. System identification.
- b. Location.

- c. Coil identification.
 - d. Capacity in Btu/h.
 - e. Number of stages.
 - f. Connected volts, phase, and hertz.
 - g. Rated amperage.
 - h. Air flow rate in cfm.
 - i. Face area in sq. ft.
 - j. Minimum face velocity in fpm.
2. Test Data (Indicated and Actual Values):
- a. Heat output in Btu/h.
 - b. Air flow rate in cfm.
 - c. Air velocity in fpm.
 - d. Entering-air temperature in deg F.
 - e. Leaving-air temperature in deg F.
 - f. Voltage at each connection.
 - g. Amperage for each phase.
- J. Fan Test Reports: For supply, return, and exhaust fans, include the following:
1. Fan Data:
- a. System identification.
 - b. Location.
 - c. Make and type.
 - d. Model number and size.
 - e. Manufacturer's serial number.
 - f. Arrangement and class.
 - g. Sheave make, size in inches, and bore.
 - h. Center-to-center dimensions of sheave, and amount of adjustments in inches.
2. Motor Data:
- a. Motor make, and frame type and size.
 - b. Horsepower and rpm.
 - c. Volts, phase, and hertz.
 - d. Full-load amperage and service factor.
 - e. Sheave make, size in inches, and bore.
 - f. Center-to-center dimensions of sheave, and amount of adjustments in inches.
 - g. Number, make, and size of belts.
3. Test Data (Indicated and Actual Values):
- a. Total airflow rate in cfm.
 - b. Total system static pressure in inches wg.

- c. Fan rpm.
 - d. Discharge static pressure in inches wg.
 - e. Suction static pressure in inches wg.
- K. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:
 - 1. Report Data:
 - a. System and air-handling-unit number.
 - b. Location and zone.
 - c. Traverse air temperature in deg F.
 - d. Duct static pressure in inches wg.
 - e. Duct size in inches.
 - f. Duct area in sq. ft..
 - g. Indicated air flow rate in cfm.
 - h. Indicated velocity in fpm.
 - i. Actual air flow rate in cfm.
 - j. Actual average velocity in fpm.
 - k. Barometric pressure in psig.
- L. Air-Terminal-Device Reports:
 - 1. Unit Data:
 - a. System and air-handling unit identification.
 - b. Location and zone.
 - c. Apparatus used for test.
 - d. Area served.
 - e. Make.
 - f. Number from system diagram.
 - g. Type and model number.
 - h. Size.
 - i. Effective area in sq. ft.
 - 2. Test Data (Indicated and Actual Values):
 - a. Air flow rate in cfm.
 - b. Air velocity in fpm.
 - c. Preliminary air flow rate as needed in cfm.
 - d. Preliminary velocity as needed in fpm.
 - e. Final air flow rate in cfm.
 - f. Final velocity in fpm.
 - g. Space temperature in deg F.

M. Pump Test Reports: Calculate impeller size by plotting the shutoff head on pump curves and include the following:

1. Unit Data:

- a. Unit identification.
- b. Location.
- c. Service.
- d. Make and size.
- e. Model number and serial number.
- f. Water flow rate in gpm.
- g. Water pressure differential in feet of head or psig.
- h. Required net positive suction head in feet of head or psig.
- i. Pump rpm.
- j. Impeller diameter in inches.
- k. Motor make and frame size.
- l. Motor horsepower and rpm.
- m. Voltage at each connection.
- n. Amperage for each phase.
- o. Full-load amperage and service factor.
- p. Seal type.

2. Test Data (Indicated and Actual Values):

- a. Static head in feet of head or psig.
- b. Pump shutoff pressure in feet of head or psig.
- c. Actual impeller size in inches.
- d. Full-open flow rate in gpm.
- e. Full-open pressure in feet of head or psig.
- f. Final discharge pressure in feet of head or psig.
- g. Final suction pressure in feet of head or psig.
- h. Final total pressure in feet of head or psig.
- i. Final water flow rate in gpm.
- j. Voltage at each connection.
- k. Amperage for each phase.

N. Instrument Calibration Reports:

1. Report Data:

- a. Instrument type and make.
- b. Serial number.
- c. Application.
- d. Dates of use.

- e. Dates of calibration.

3.15 INSPECTIONS

A. Initial Inspection:

1. After testing and balancing are complete, operate each system and randomly check measurements to verify that the system is operating according to the final test and balance readings documented in the final report.
2. Check the following for each system:
 - a. Measure airflow of at least 10 percent of air outlets.
 - b. Measure water flow of at least 5 percent of terminals.
 - c. Measure room temperature at each thermostat/temperature sensor. Compare the reading to the set point.
 - d. Verify that balancing devices are marked with final balance position.
 - e. Note deviations from the Contract Documents in the final report.

B. Final Inspection:

1. After initial inspection is complete and documentation by random checks verifies that testing and balancing are complete and accurately documented in the final report, request that a final inspection be made by Architect.
2. The TAB specialist's test and balance engineer shall conduct the inspection in the presence of Architect.
3. Architect shall randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to either 10 percent of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.
4. If rechecks yield measurements that differ from the measurements documented in the final report by more than 10 percent, the measurements shall be noted as "FAILED."
5. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.

C. TAB Work will be considered defective if it does not pass final inspections. If TAB Work fails, proceed as follows:

1. Recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection.
2. If the second final inspection also fails, Owner may contact the TAB specialists' governing organization for remedial action by the governing organization under the workmanship and performance warranty. See article, Warranty.
3. If remedial action is not provided by the TAB specialists' governing organization in a timely manner, Owner may contract the services of another TAB specialist to complete the TAB Work according to the Contract Documents and deduct the cost of the services from the original TAB specialists' final payment.

D. Prepare test and inspection reports.

3.16 ADDITIONAL TESTS

- A. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional TAB during near-peak summer and winter conditions.

END OF SECTION

SECTION 23 09 00

INSTRUMENTATION AND CONTROLS FOR HVAC

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Furnish all labor, materials, equipment, and service necessary for a complete and operating Native BACnet based Temperature Control System based upon the ANSI/ASHRAE™ Standard 135–2008, BACnet.
- B. Prepare individual hardware layouts, interconnection drawings and control loop configuration data from project design data.
- C. Implement the detailed design for all system input/output points, distributed control and system data bases, graphic displays, logs, and management reports based on control descriptions, logic drawings, configuration data, and bid documents.
- D. Provide and install all controllers, panels, and all interconnecting data communication network cables and all interconnecting cables between the operator terminal and peripheral devices (such as printers, etc.) called for in this section.
- E. Provide as-built documentation, software, and all Direct Digital Control (DDC) control logic and all associated support documentation on approved media which accurately represents the final system.
- F. Supply all equipment and accessories in accordance with the requirements of all applicable national, state and local codes.
- G. Scheduled equipment performance is minimum capacity required.
- H. Scheduled electrical capacity shall be considered as maximum available.
- I. Unless noted otherwise, all conduit and wiring associated with the temperature control system, regardless of voltage, is included as part of this Section. Obtain power for temperature control devices from the nearest available adequate source.
- J. Control system shall incorporate a California Energy Commission listed and approved fault detection and diagnostic (FDD) economizer controls and Title 24 requirements for HVAC operation with space occupancy sensors.

1.02 RELATED DOCUMENTS

- A. MECHANICAL WORK - DIVISION 23 DRAWINGS AND SPECS
- B. ELECTRICAL WORK - DIVISION 26 DRAWINGS AND SPECS

1.03 REFERENCES

- A. CCR - California Code of Regulations, Title 24, Part 3, Basic Electrical Requirements, State Building Standards Electrical Code.
- B. CEC - California Electrical Code

- C. NEMA - National Electrical Manufacturer's Association
- D. NFPA - 70 National Electrical Code (NEC)
- E. UL - Underwriters Laboratories, Inc

1.04 SUBMITTALS

- A. Submit eight copies of shop drawings of the entire control system. Provide point to point wiring diagrams and engineered drawings, complete list of equipment and materials including manufacturer's catalog cuts, and installation instructions. Provide a recommended spare parts list.
- B. Provide complete wiring and schematic diagrams, software descriptions, calculations, and any other details required to demonstrate that the system has been coordinated and will properly function as a system. Indicate terminal identification for all control wiring on the shop drawings.
- C. Provide a complete written Sequence of Operations with the submittal package.
- D. Provide the following minimum system documentation:
 - 1. System configuration diagrams in simplified block format.
 - 2. Input / Output point and alarm point summary listing.
 - 3. Electrical drawings showing all system internal and external connection points, terminal block layouts and terminal identification.
- E. As part of Maintenance and Operating Data, provide manufacturer's instructions and drawings for installation, maintenance and operation of all materials.
- F. Overall system operation and maintenance instructions, including preventive maintenance and troubleshooting instructions.
- G. Upon completion of the work provide a complete set of 'record' drawings including manufacturer's descriptive literature, operating instructions, and maintenance and repair data all in accordance with the requirements of Section 23 05 00.
- H. Provide one CD ROM to the Owner with all Control System As-Built AutoCAD Drawings.

1.05 MANUFACTURER QUALITY ASSURANCE

- A. All BACnet application specific controllers submitted for use on this project must be certified as compliant with BACnet through the BACnet Manufacturers' Association (BMA) BACnet Testing Lab and must have a "BTL Mark". The temperature control system must be developed using existing proven equipment and must be readily available from inventory of the controls manufacturer or vendor at the time of bid.
- B. All controllers used on project must be of regular manufacturer and be readily available from inventory of the BACnet System Manufacturer.
- C. Provide standard components, of regular manufacture for this application for all materials and equipment. All systems and components shall have been thoroughly tested and proven in actual use.
- D. Operator workstation, if specified shall utilize Microsoft Windows XP Professional or newer.

All workstations and controllers shall be native BACnet devices. No 3rd party gateways shall be used for communication to controllers installed under this section.

- E. Provide all necessary BACnet-compliant hardware and software to meet the system's functional specifications. Provide Protocol Implementation Conformance Statement (PICS) for Windows-based control software and every controller in the system.
- F. All BACnet based peer-to-peer controllers, central system controllers and local user displays shall be UL listed under Standard UL 916, category PAZX.
- G. All electronic equipment shall conform to the requirements of FCC Regulation, Part 15, Governing Radio Frequency Electromagnetic Interference and be so labeled.

1.06 EMS SYSTEM CONTRACTOR QUALITY ASSURANCE

- A. Responsibility: All work described in this section shall be engineered, installed, wired, circuit tested calibrated and programmed by regularly employed control system engineers and electricians and technicians of the authorized temperature control system factory representative or branch office of the listed approved manufacturer. System Engineering, Programming and Installation shall not be subcontracted. The supplier of the BACnet Temperature Control and Energy Management System shall be responsible for inspection and Quality Assurance (QA) for all materials and workmanship furnished by him. Contractor must have a valid C-10 and C-20 license to bid this project.
- B. Component Testing and Availability: Maximum reliability shall be achieved through extensive use of high-quality, pre-tested components. The manufacturer prior to shipment shall individually test each and every controller, sensor, and all other DDC components. EMS System Contractor or Manufacturer must certify that any DDC part can be replaced within 5 working days.
- C. Unacceptable Bids: Bids by wholesalers, parts distributors, contractors or franchised dealers or any firm whose principal business is not that of installing automatic temperature control systems shall not be acceptable.
- D. Experience: Energy Management System Contractor (EMSC) shall have been in business and licensed by the State of California for a minimum of five continuous years prior to this project bid. EMSC must have been a factory authorized representative for a minimum of five years of the contractors proposed manufacturer's products and systems.
- E. EMSC must have performed, from an office not more than 100 miles from project site at least 5 projects, each of which included the installation of not less than 100 hardware I/O points, using the contractors proposed manufacturer's products and systems.
- F. EMSC shall have on staff a full time Applications Engineer and Control System Programmer, having not less than three years' experience with the contractors proposed manufacturer's products and systems.
- G. EMSC shall have on staff a minimum of three full time control technicians, Senior control technician shall have not less than three years' experience, junior technicians shall have not less than one years' experience with the contractors proposed manufacturer's products and systems.
- H. EMSC shall have a full time service department with service available 24 hours a day, seven days a week. Service department will have been established for a minimum of five years

and be staffed with factory trained and authorized service technicians capable of servicing all aspects of the control systems depicted on these plans.

- I. EMSC shall assign an in-house project manager to provide a detailed project design and installation schedule with time markings and details for hardware items and software development phases. Schedule shall show all the target dates for transmission of project information and documents and shall indicate timing and dates for system installation, debugging, and commissioning.

PART 2 - PRODUCTS

2.01 CONTROLLER

- A. The Controller shall provide control for all VRV indoor units. The Controller shall be wall mounted and can be adjusted to maintain the optimal operation of the connected indoor unit(s).
- B. Display Features:
 1. Backlit LCD display with contrast adjustment and auto off after 30 seconds.
 2. All displayed items configurable
 3. System Status icons.
 4. The controller shall display temperature setpoint in one degree increments with a range of 60-90oF (16-32oC)
 5. On/Off status shall be displayed with an LED.
 6. Error codes will be displayed with a two digit code in the event of system abnormality/error.
 7. The following system temperatures can be displayed to assist service personnel in troubleshooting:
 - a. Return Air Temperature
 - b. Liquid Line Temperature
 - c. Gas Line Temperature
 - d. Discharge Air Temperature (depending on unit),
 - e. Remote Controller Sensor Temperature
 - f. Temperature used for Indoor Unit Control
- C. Basic Operation:
 1. Capable of controlling a group of up to 16 indoor units.
 2. On/Off, Operation Mode (Cool, Heat, Fan, Dry and Auto* (*with VRV Heat Recovery & Heat Pump Systems))
 3. Independent Cooling and Heating setpoints in the occupied mode
 4. Independent Cooling Setup and Heating Setback setpoints in the unoccupied mode
 5. Fan Speed
 6. Up to 5 speeds (dependent on indoor unit type)
 7. Vane direction and oscillation (dependent on indoor unit type)

8. Provides individual control of up to four (4) louvers on an indoor unit
9. The controller shall be able to limit the user adjustable setpoint ranges individually for cooling and heating in the occupied period
10. Function button lockout (On/Off, Mode, Fan Speed, Up/Down, Left, Right Arrows)
11. Filter service indicator shall be displayed after 100, 1250 or 2500 (default) hours of run time configurable via field setting
12. Clock (12/24 hour) and Day display
13. Automatic adjustment for Daylight Savings Time (DST)
14. Set changeover period (second Sunday in March / first Sunday in November)

D. Programmability:

1. Controller shall support schedule settings with selectable weekly pattern options.
2. The Controller shall support Auto-changeover mode for both Heat Pump and Heat Recovery systems, therefore, allowing the optimal room temperature to be maintained by automatically switching the indoor unit's mode between Cool and Heat according to the room temperature and temperature setpoint.
3. The controller shall support the Auto-setback by sensor function (dependent on indoor unit type)
4. The cooling and heating setpoints shall gradually relax (configurable) internally when the room is determined to be unoccupied
5. The internal setpoint shall return to the original setpoint when room occupancy is detected
6. The controller shall support the Auto-off by sensor function (dependent on indoor unit type)
7. The indoor unit shall turn off when it is determined that the room is unoccupied after a specified time has elapsed
8. The indoor unit shall be turned on manually when occupancy is detected
9. The controller shall support the Filter Auto Clean function to be performed once a day (dependent on indoor unit type)
10. The Controller shall support an Auto Off Timer for temporarily enabling indoor unit operation during the unoccupied period.
11. The controller shall shut off the unit after a set time period
12. The room temperature shall be capable of being sensed at either the NAV Remote Controller, the Indoor Unit return air temperature sensor (default), or Remote Temperature Sensor (KRCS01-1B) configured through the field settings.

2.02 REMOTE TEMPERATURE SENSOR

- A. The Remote Temperature Sensor can provide temperature sensing for all VRV indoor units. The Remote Temperature Sensor is wall mounted and is used to maintain the optimal operation of the connected indoor unit.
- B. The Remote Temperature Sensor can be used in conjunction with the Navigation Remote Controller, Simplified Remote Controller, and the Wireless Remote Controller to sense space temperature outside of the indoor unit. No more than 2 remote controllers can be placed in the same group.

2.03 WIFI ADAPTOR

- A. The Wi-Fi adaptor enables the control of all VRV indoor units through an iOS/Android smartphone app. A remote controller is required to connect to the indoor unit together with the Wi-Fi adaptor. Only one Wi-Fi adaptor can be placed in one remote controller group controlling up to 16 indoor units.
- B. Power supply:
 - 1. The Wi-Fi adaptor shall be supplied with 12-16VDC power, with maximum current of 85mA and max power consumption of 1360mW
 - 2. The Wi-Fi adaptor shall be able to obtain 16VDC power from the indoor unit with a supplied wire of up to 6.5 ft.
- C. Communication:
 - 1. Capable of communicating through WiFi-Certificated network 802.11b/g/n
 - 2. Communication frequency of 2.4GHz
 - 3. Maximum antenna power of 20dBm
 - 4. Sensitivity of -97dBm
 - 5. Static DHCP IP addressing
- D. iOS/Android App Operation:
 - 1. Shall be capable of control a group of up to 16 indoor units
 - 2. Shall display the following:
 - a. On/Off
 - b. Mode – Cool, Heat, Fan, Auto and Dry
 - c. Room temperature
 - d. Sensed by the remote controller or indoor unit return air sensor
 - e. Setpoint
 - f. Fan speed
 - g. Error code
 - h. Next scheduled event
 - 3. Shall be capable of commanding the following:
 - a. On/Off
 - b. Mode – Cool, Heat, Fan, Auto and Dry
 - c. Setpoint
 - d. Fan speed
 - 4. Capable of setting a 7 day schedule for each indoor unit group

PART 3 - EXECUTION

3.01 GENERAL

- A. All electric wiring and all installation work including piping of control systems and internal

wiring of panelboards for temperature control and indicating systems shall be done by an authorized representative of the controls manufacturer whose primary business is the installation and maintenance of temperature control and indicating systems. Wiring shall conform to National Electric Code.

- B. Identify each item of control equipment with stamped tape firmly attached to equipment and each panel with nameplate of 1/16 inch laminated plastic with black background and white letters 1/4 inch high.
- C. All control adjustments shall be accessible without use of ladder.
- D. Thermostats on outside walls shall be mounted on 1 inch rigid fiberglass insulating base.
- E. All thermostat bulbs in water lines shall be installed in separable wells packed with heat-conductive compound.
- F. Drawings:
 - 1. Drawings are diagrammatic only, provide all material and labor required to make the system operate to the complete satisfaction of the Architect at no additional cost to the Owner.
 - 2. Submit to the Architect for approval seven copies of shop drawings of the entire control system before starting work.
 - 3. Upon completion of the work, provide diagrams of the control systems including a detailed description of the operation of the system and each component and post in the mechanical room, or as directed in a permanent frame with 1/8 inch clear plastic cover.
- G. There shall be no power wiring in excess of 40 VAC peak voltages run in conduit with communications trunk wiring. In cases where power or signal wiring is run in conduit with trunk wiring, all communication trunk wiring and power wiring shall be run using separate twisted shielded pairs (24 awg) with the shields grounded in accordance with the manufacturers wiring practices.

3.02 INSTALLATION

- A. All temperature control and control interlock wiring shall be installed in plenum rated cable or EMT conduit per local code unless otherwise noted on the plans.
- B. Wiring shall conform to the California Electrical Code.
- C. The installation and supervision of this project shall be carried out by factory-trained personnel who are employed by the Contractor and licensed for this type of work.
- D. Install in accordance with manufacturer's instructions.
- E. Provide all miscellaneous devices, hardware, software, interconnections installation and programming required to insure a complete operating system in accordance with the sequences of operation and point schedules.
- F. All wiring of any nature in connection with the Direct Digital Control and Temperature Control System, regardless of voltage, including temperature control wiring, interlocking branch circuits from power panels, line voltage to EMS devices and low voltage wiring unless shown or specified in Division 26 documents shall be included in this section.
- G. Division 26 shall provide power wiring to equipment and signal conduit for LAN Wiring

between buildings.

- H. Division 26 shall provide underground race way conduits between buildings with a pull string for the Controls contractor to install direct burial communication cable between buildings.

3.03 OPERATOR INSTRUCTION (Training)

- A. During system commissioning and at such time acceptable performance of the control system hardware and software has been established; provide on-site operator instruction to the Owner's operating personnel. Operator instruction during normal working hours shall be performed by a competent representative familiar with systems hardware, software and accessories.
- B. At a time mutually agreed upon during system commissioning, as stated above, provide 16 hours of instruction to the Owner's designated personnel on the operation of the EMS and Temperature Control Systems and describe its intended use with respect to the programmed functions specified. Training shall be provided at the factory authorized EMS Contractor's training center. Operator orientation of the EMS shall include, but not be limited to, the overall operation of the program, equipment functions (both individually and as part of the total integrated system), commands, systems generation, advisories, and appropriate operator intervention required in responding to the system's operation.

END OF SECTION

SECTION 23 80 00

HEATING, VENTILATING AND AIR CONDITIONING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Split system air conditioning units.
2. Variable Refrigerant Flow - Split system heat pump units.
3. Refrigeration piping and fittings.
4. Fans.
5. Relief and intake vents.
6. Louvers.
7. Air inlets and outlets.
8. Filters.
9. Dampers.
10. Ductwork.
11. Insulation.
12. Electric, Radiant Heaters

1.2 RELATED REQUIREMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Section 23 00 50, Basic HVAC Materials and Methods.
- C. 23 05 93, Testing, Adjusting, and Balancing for HVAC.
- D. Section 23 09 00, Direct Digital Control (DDC) System for HVAC.

1.3 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meetings:

1. Variable Refrigerant Flow System Conference: Installing contractor's foreman shall attend conference at Project site with design Engineer and equipment manufacturer's representative, to comply with requirements of this Section and manufacturer's installation requirements including but not limited to, the following:
 - a. Proposed deviations from system as shown and described in Contract Documents, including location of system components and impacts to refrigerant pipe sizing.
 - 1) Provide Coordinated Layouts as required by this Section for use in discussion.
 - b. Refrigerant piping assembly practices.
 - c. General discussion, question and answer period.

- d. Walk site with equipment manufacturer's representative to identify conditions affecting installation of system as designed.

1.4 ACTION SUBMITTALS

- A. For additional requirements, refer to Section 23 00 50, Basic HVAC Materials and Methods.
- B. Product Data: Submit manufacturer's technical product data, including rated capacities of selected model clearly indicated, dimensions, weight, corner or mounting point weights, furnished specialties and accessories; and installation and start-up instructions. Product data shall include applicable product listings and standards. Refer to Section 23 00 50, Basic HVAC Material and Methods for additional requirements.
 1. Upon approval of submittal, provide manufacturer's installation and operating instructions to the Project inspector for the following:
 - a. Fire dampers, smoke dampers, and combination smoke-fire dampers.
 - b. Type 1 kitchen exhaust field applied grease duct enclosures.
- C. VRF Systems: Submit system documentation for a fully engineered system, including shop drawings, and wiring and control diagrams, showing location of required manufactured system components, component model numbers and capacities, and size and location of all field-installed components, including piping, required seismic and thermal expansion loops, and wiring. Identify proposed deviations from system as shown in Contract Documents.
- D. Engineering Data: Submit fan curves and sound power level data for each fan unit. Data shall be at the scheduled capacity. Data shall include the name of the rating agency or independent laboratory.

1.5 INFORMATIONAL SUBMITTALS

- A. For additional requirements, refer to Section 23 00 50, Basic HVAC Materials and Methods.
- B. Roof Curb Data: For roof mounted equipment where combined weight of equipment unit and roof curb or rail exceeds 400 pounds, submit calculations from manufacturer for roof curbs proving compliance with the seismic requirements of the California Building Code, and ASCE 7-10. Manufacturer shall certify that roof curbs are suitable for use indicated on Drawings and in Specifications for the seismic design category indicated in structural Contract Documents. Calculations shall be stamped and signed by a State of California registered structural engineer.
- C. Economizer Fault Detection and Diagnostics (FDD) System Data: For all air-cooled unitary direct-expansion units equipped with an economizer, provide data for third-party supplied California Energy Commission certified FDD controller, documenting compliance with the requirements of California Building Energy Efficiency Standards. Provide evidence of certification.
- D. Record of pre-installation meeting.
- E. Training Certificates of Completion: Submit certificate from equipment manufacturer, indicating attendance and successful completion of manufacturer's training program for variable refrigerant flow systems installation and service. Training shall include manufacturer's preferred methods for assembling and insulating refrigerant piping and accessories.

- F. Coordinated Layouts: Submit coordinated layouts. For requirements refer to article, Coordinated Layouts, in this Section.

1.6 CLOSEOUT SUBMITTALS

- A. For additional requirements, refer to Section 23 00 50, Basic HVAC Materials and Methods.
- B. Maintenance Data: Submit maintenance data and parts list for each piece of equipment, control, and accessory; including "trouble-shooting guide," in Operation and Maintenance Manual.
- C. Record Drawings: Submit Record Drawings of installed ductwork, duct accessories, and outlets and inlets in accordance with requirements of Division 01.

1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Belts: One set(s) for each belt-driven unit.
 2. Provide one complete set(s) of filters for each filter bank.

1.8 COORDINATED LAYOUT

- A. Coordinated layouts are required to amplify, expand and coordinate the information contained in the Contract Documents.
- B. Provide minimum 1/4 inch equals one foot scaled coordinated layout drawings showing plan and pertinent section or elevation views of piping, ductwork, equipment, accessories, and electrical systems. Drawings shall be reproducible and work of each trade represented shall be fully coordinated with structure, other disciplines, and finished surfaces. Drawings shall be presented on a single size sheet. Coordinated layout drawings shall have title block, key plan, north arrow and sufficient grid lines to provide cross-reference to design Drawings.
1. Provide a stamp or title block on each drawing with locations for signatures from all contractors involved, including but not limited to the General, HVAC, Plumbing, Fire Protection, and Electrical contractors. Include statement for signature that the contractor has reviewed the coordinated layout drawings in detail and has coordinated the work of his trade.
 2. Show on drawings the intended elevation of all ductwork in accordance with the following example:
 - a. B.O.D. = 9'-0"
OFFSET UP 6"
B.O.D. = 9'-6"
 3. Highlight, encircle or otherwise indicate deviations from the Contract Documents on the coordinated layouts. Architect will not be responsible for identifying deviations from the original Contract Documents.
- C. Since scale of contract drawings is small and all offsets and fittings are not shown, Contractor shall make allowances in bid for additional coordination time, detailing, fittings, offsets, hangers and the like to achieve a fully coordinated installation. If changes in duct size are required, equivalent area shall be maintained and the aspect ratio shall not be in excess of 2 to 1 unless approved by the engineer. Drawings shall be submitted for review

prior to fabrication and installation. Drawings may be submitted in packages representing at least one quarter of the building ductwork.

- D. Check routing on all ductwork before fabricating. Report any discrepancies to Architect. No extra cost will be allowed for failure to conform to above.

1.9 QUALITY ASSURANCE

A. Design Criteria:

1. All equipment and accessories to be the product of a manufacturer regularly engaged in its manufacture. All gas-fired equipment shall be UL, ETL or CSA listed.
2. Supply all equipment and accessories in accordance with requirements of applicable national, state and local codes.
3. All items of a given type shall be products of the same manufacturer.
4. Scheduled equipment performance is minimum capacity required.
5. Scheduled electrical capacity shall be considered as maximum available.
6. Scheduled gas BTU input shall be considered as maximum available.

B. Variable Refrigerant Flow Split-System Heat Pump Installer Training: Installing contractor shall have completed training in installation and service of VRF system, by equipment manufacturer.

1. Installing contractor shall obtain, at his own cost, equipment manufacturer's VRF system service tool, unless service tool is normally resident on controller specified for this Project.

1.10 FIELD CONDITIONS

A. Interruption of Existing Services: Do not interrupt services to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary services according to requirements indicated:

1. Notify Architect no fewer than two days in advance of proposed interruption of services.
2. Do not interrupt services without Architect's written permission.

1.11 WARRANTY

A. Air Conditioning Unit, Roof-Mounted:

1. Compressor shall have a five-year warranty.
2. Standard heat exchanger shall have a ten-year warranty.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Insulation products, including insulation, insulation facings, jackets, adhesives, sealants and coatings shall not contain polybrominated diphenyl ethers (PBDEs) in penta, octa, or deca formulations in amounts greater than 0.1 percent (by mass).

2.2 SPLIT SYSTEM AC UNIT

- A. General: Furnish and install split system air conditioner, with R410A refrigerant, and complete with automatic controls. Equipment shall be shipped factory assembled, wired, tested, and ready for field connections.
- B. Quality Assurance:
 - 1. Unit shall be ETL or UL listed and labeled.
 - 2. Unit shall be manufactured in a facility registered to ISO 9001:2000.
 - 3. Unit shall be rated in accordance with ARI standard 210.
- C. Delivery, Storage and Handling: Follow manufacturer's recommendations.
- D. Cooling System: The total certified cooling capacity shall not be less than scheduled. The compressor power input shall not exceed that of the unit specified.
- E. Indoor Section: Wall mounted, ceiling surface mounted, or ceiling recessed mounted, as indicated on Drawings.
 - 1. Cabinet:
 - a. Wall mounted: Molded white high strength plastic.
 - 1) Provide wall mounted unit with factory mounting plate.
 - b. Ceiling surface mounted: Molded white high strength plastic with provision for outside air duct connection.
 - c. Ceiling recessed mounted: galvanized steel with provision for outside air duct connection.
 - 2. Fans: Double inlet, forward curved, statically and dynamically balanced.
 - 3. Fan Motor: Direct drive, permanently lubricated, with two or 4 speed operation for unit size scheduled on Drawings.
 - a. For single-phase fan motors sized larger than 1/12 hp and smaller than 1 hp, refer to Article, Electric Motors, in Section 23 00 50, Basic HVAC Materials and Methods.
 - 4. Air Outlet: With motorized horizontal and vertical vanes.
 - a. Wall and ceiling surface mounted units: Horizontal vane shall close air outlet upon unit shut-down.
 - 5. Evaporator Coil: Aluminum fins mechanically bonded to copper tubes. Coils shall be pressure leak tested.
 - 6. Insulation: Interior surfaces exposed to the airstream shall be fully insulated.
- F. Outdoor Section:
 - 1. Casing: Galvanized steel plate, powder coated with acrylic or polyester.
 - 2. Condenser Fan Grille: ABS plastic.
 - 3. Fan and fan motor: Direct drive, totally enclosed, propeller type, permanently lubricated, horizontal discharge.
 - 4. Compressor: Variable speed rotary type, with crankcase heater and accumulator. Compressor shall be capable of operating at 0 degrees F. Compressor mounted on vibration isolator pads.

5. Coil: Aluminum fins mechanically bonded to copper tubes. Coils shall be pressure leak tested. Provide coil with integral metal guard.
- G. Controls: Hard wired, microprocessor based, wall mounted controller with LCD display shall provide the following functions, as a minimum:
 1. 7-day programmable timer.
 2. Test and check functions.
 3. Diagnostic functions.
 4. Vane position control.
 5. Fan speed adjustment.
 6. Temperature adjustment.
 7. Automatic restart.
 8. Mode selection, including cool/dry/fan.
 - a. Provide lockable enclosure for wall mounted controller.
- H. Safeties: Shall include the following, as a minimum:
 1. Five minute compressor anti-recycle timer.
 2. High pressure protection.
 3. Current and temperature sensing motor overload protection.
- I. Filters: Provide 1 inch thick fiberglass throwaway filters with cardboard holding frames for indoor unit. Provide sufficient filters for four complete changes for each unit.
- J. Service Access: All components, wiring, and inspection areas shall be completely accessible through removable panels.
- K. Refrigerant Piping:
 1. Provide factory pre-charged and sealed line set piping, length to suit the location of equipment. Tubing sizes shall be in accordance with manufacturers written instructions.
 2. Provide refrigeration piping in accordance with Article, Refrigerant Piping, in this Section.
- L. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:
 1. Mitsubishi Electric Corporation.
 2. Carrier Corporation.
 3. Fujitsu.
- M. Owner Training: Manufacturer shall provide one on-site 2-hour training session for Owners' maintenance personnel.

2.3 VARIABLE REFRIGERANT FLOW - SPLIT SYSTEM HEAT PUMPS – HEAT RECOVERY TYPE

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:
 1. Carrier.

2. Daikin.
3. Mitsubishi.
4. Basis of Design: Fujitsu.

B. Indoor Units

1. General:

- a. Galvanized steel casing.
- b. Ducted, ceiling-recessed, or in-room units per Drawings schedule. Available styles shall include:
 - 1) Concealed (ducted) units:
 - a) Ceiling concealed.
 - b) Ceiling concealed, with high-static option.
 - 2) Recessed Units:
 - a) Ceiling-recessed units: One-, two-, and four-way throw configurations.
 - 3) In-room units:
 - a) Ceiling-suspended.
 - b) Wall-mounted.
- c. Factory assembled and tested with factory wiring, piping, expansion valve, control circuit board, and fan motor. Units shall have, as a minimum, the following functions:
 - 1) Self-diagnostic function.
 - 2) Auto restart function.
 - 3) Auto changeover function.
 - 4) Emergency operation function.
 - 5) 3-minute time delay shall provide minimum 3 minute run time for cooling and heating.
- d. Indoor unit and refrigerant pipes shall be charged with dehydrated air prior to shipment from the factory.
- e. The indoor units shall be equipped with a return air thermistor.

2. Unit Cabinet:

- a. The cabinet shall be insulated with foamed polystyrene and polyethylene insulation.

3. Fan:

- a. The fan shall be direct-drive type, statically and dynamically balanced impeller with multiple high and low fan speeds. Auto fan setting shall automatically adjust fan speed.
- b. The fan motor shall be thermally protected.
- c. The fan motor shall be equipped as standard with adjustable external static pressure (ESP) settings.
- d. For single-phase fan motors sized larger than 1/12 hp and smaller than 1 hp, refer to Article, Electric Motors, in Section 23 00 50, Basic HVAC Materials and Methods.

- e. Ceiling recessed and wall-mounted units shall have motorized louvers to direct airflow in up and down directions, and manually adjusted vanes for side-to-side adjustment of airflow direction.
 - f. Ceiling suspended units shall have motorized guide vanes to vary airflow direction.
 - g. All units shall be provided with a condensate drain pan below the coil. Drain pans shall have primary and overflow drains.
 - h. Ceiling recessed units shall have an integral condensate pump. Refer to Drawings schedule for additional condensate pump requirements.
4. Coil:
- a. Coils shall be aluminum fins bonded to internally grooved copper tubes. Fins shall have corrosion-resistant coating.
 - b. The coils shall be pressure tested at the factory.
 - c. Unit shall be provided with ball-type refrigerant service valves at each refrigerant piping connection.
 - d. A condensate pan and drain connections shall be provided under the coil. Provide overflow cutoff switch to disable unit during overflow condition.
5. Filters:
- a. Provide indoor units manufactured to accept washable filter media with two sets for each unit.
 - b. Refer to Drawings schedule, and article, Filters, in this Section for filter requirements for ducted, above-ceiling units incorporating mixing boxes.
6. Controls:
- a. Units shall have controls provided by the manufacturer to perform input functions necessary to operate the system.
 - b. Operating modes shall include Auto Changeover (heat recovery systems only), Heating, Cooling, Dry, and Fan Only.
 - c. Units shall be compatible with a BMS system via optional LonWorks or BACnet gateways.
 - d. Units incorporating mixing boxes for economizer operation shall be furnished with economizer control system certified as meeting the requirements for Fault Detection and Diagnostics (FDD) in the California Building Energy and Efficiency Standards.
- C. Outdoor Condensing Units:
1. General:
- a. Condensing unit shall be factory assembled and pre-wired with all necessary electronic and refrigerant controls. The refrigeration circuit of the condensing unit shall consist of scroll compressors, motors, fans, condenser coil, electronic expansion valves, solenoid valves (when required by manufacturer), 4-way valve, distribution headers, capillaries, filters, shut off valves, oil separators, service ports and refrigerant accumulator and regulator.
 - b. The following safety devices shall be included as part of the condensing unit; high pressure sensor and switch, low pressure sensor, control circuit fuses, over- and under-current protection, phase failure and phase reversal protection, fusible plug or pressure relief valve, and crankcase heater..

- c. All refrigerant lines shall be individually insulated between the condensing units and indoor units. .
 - d. The system will automatically restart operation after a power failure without loss of settings.
 - e. The condensing units shall be modular in design and allow for side-by-side installation with minimum spacing. Provide kit for field piping between connected condensing units. Refer to Drawings schedules and diagrams for connected units.
 - f. To ensure the liquid refrigerant does not flash when supplying to indoor units, the circuit shall be provided with a sub-cooling feature.
 - g. Oil recovery cycle shall be automatic occurring 2 hours after start of operation, and thereafter every 8 hours of operation. Each system shall maintain continuous heating during oil return operation. Reverse cycle (cooling mode) oil return during heating operation shall not be permitted due to the potential reduction in space temperature.
 - h. The condensing unit shall be capable of heating operation at 0°F dry bulb ambient temperature without additional low ambient controls or an auxiliary heat source.
 - 1) Provide condensing unit with low ambient kit when scheduled on Drawings. Low ambient kit components shall be furnished with NEMA 4x rated control box for outdoor installation.
2. Unit Cabinet:
- a. The condensing unit cabinet shall be weatherproof and corrosion resistant. The unit shall be constructed from rust-proofed galvanized steel panels coated with a baked enamel or powder coat finish.
3. Fan:
- a. The condensing unit shall consist of one or more direct-drive, vertical discharge propeller fans with blades constructed of thermoplastic polymer material.
 - b. The condensing unit fan motor shall be variable-speed digitally commutating (DC) type. Fan motor dipswitch shall allow increase of external static pressure setting.
 - c. The fan motor shall have inherent protection and permanently lubricated bearings and be mounted on vibration isolators.
 - d. The fan motor shall be provided with a fan guard to prevent contact with moving parts.
4. Condenser Coil:
- a. Coils shall be aluminum fins bonded to internally grooved copper tubes. Fins shall have corrosion-resistant coating.
 - b. The coils shall be pressure tested at the factory.
 - c. Unit shall be provided with ball-type refrigerant service valves at each refrigerant piping connection.
 - d. Condensing unit cabinet shall be provided with metal coil guard.
5. Compressor:
- a. The scroll compressors shall be variable speed pulse-width inverter (PVM inverter) controlled type, hermetically sealed, which shall vary the compressor speed to follow fluctuations in total cooling and heating load, determined by the suction gas pressure as measured in the condensing unit.

- 1) The inverter driven compressor motor in each condensing unit shall be the reluctance DC (digitally commutating) type.
 - b. Each compressor shall be equipped with a crankcase heater, high pressure safety switch, and internal thermal overload protector.
 - c. Oil separators shall be provided as part of the compressor module together with an intelligent oil management system.
 - d. The compressor shall be isolated to avoid the transmission of vibration.
 - e. In the event of compressor failure the remaining compressors shall continue to operate and provide heating or cooling as required at a proportionally reduced capacity.
 - f. Multiple compressor operation sequencing: When multiple condenser modules are combined, operation hours of each compressor shall be balanced by means of a duty cycling function, enabling sequential starting of each module at each start/stop cycle, completion of oil return, and completion of defrost, or every 8 hours.
 - g. Refrigerant shall be R410a.
- D. Indoor Heat Recovery Controllers: Two- or three-pipe refrigerant control units to match outdoor condensing unit configuration. Heat recovery units shall be installed between outdoor condensing units and indoor zone-conditioning units. Indoor heat recovery unit shall operate to remove heat from zones requiring cooling, and distribute that heat to zones requiring heating. Refer to Drawings for unit locations. Refer to Drawings schedules and details for unit configuration and electrical requirements.
- E. Refrigerant Piping:
1. All refrigerant lines shall be individually insulated between the condensing units and indoor units.
 2. For interconnecting piping between outdoor and indoor equipment, refer to Article, Refrigeration Pipe and Fittings, in this Section.
- F. System Controls:
1. General: The controls network shall be capable of supporting remote controllers, schedule timers, system controllers, centralized controllers, an integrated web based interface, graphical user workstation, and system integration to a Building Management Systems via BACnet® and/or LonWorks®.
 2. Programmable Local Remote Controller: The programmable local remote controller shall be capable of controlling a minimum of 16 indoor units serving a single zone, and of operation with or without a central controller. Controller shall have the following minimum functions:
 - a. On/Off.
 - b. Operating mode (cool, heat, auto, dry, and fan, depending on selected system type).
 - c. Temperature setting.
 - d. Fan speed setting.
 - e. Air swing settings.
 - f. Room temperature and humidity display.
 - g. Occupancy sensor capable.

- h. Schedule operations.
 - i. Allow/Prohibit local remote control functions.
 - j. Unit level error code display.
 - k. Test run.
 - l. Set temperature range limit.
 - m. Override of scheduled functions for indoor unit groups.
 - n. Lock out of On/Off, Mode, Set Temp., Hold-button, and Air Direction.
3. Centralized Controller: The controller shall support system configuration, daily/weekly scheduling, monitoring of operation status, error email notification, online maintenance tool and malfunction monitoring. The controller shall have basic operation controls which can be applied to an individual indoor unit, a group of indoor units, or all indoor units. (cool, heat, auto, dry, and fan)The central controller shall be able to enable or disable operation of local remote controllers via a PC. Controller shall have the following minimum functions:
- a. On/Off.
 - b. Operating mode (cool, heat, auto, dry, and fan, depending on selected system type).
 - c. Temperature setting.
 - d. Fan speed setting.
 - e. Air swing settings.
 - f. Room temperature display.
 - g. Schedule operations.
 - h. Morning warm-up/cool-down.
 - i. Night setback setting.
 - j. Allow/Prohibit local remote control functions.
 - k. Unit level error code display.
 - l. External input/output.
 - m. PC data back-up.
4. BACnet® and/or LonWorks® Gateway: Gateway to allow connection to the central Energy Management System to allow changes to the following, as a minimum:
- a. On/Off.
 - b. Temperature setting.
 - c. Alarm.
 - d. Operating mode.
 - e. Fan speed setting.
 - f. Allow/Prohibit local remote control functions.
 - g. High/Low limit setback temperature (heat recovery systems only).
 - h. Air direction/swing settings.
5. Web browser: The controls network shall allow multiple individual users to monitor and control user defined zones via a network PC web browser.

- G. Owner Training: Manufacturer shall provide one on-site 4 -hour training session for Owners' maintenance personnel.

2.4 REFRIGERATION PIPE AND FITTINGS

- A. Refrigeration gas and liquid piping shall be type ACR hard drawn copper tubing, cleaned and capped in accordance with ASTM B280, with wrought copper fittings. All joints shall be brazed with Sil-fos under nitrogen purge. Relief valve discharge piping shall be full size of relief discharge port.
1. Manufactured, pre-charged and pre-insulated refrigerant line-set refrigerant piping may be utilized at Contractor's discretion.
 - a. VRF Systems: Use of manufactured, pre-charged and pre-insulated refrigerant line-set refrigerant piping between outdoor condensing units and indoor heat recovery controllers, or distribution headers and tees is not allowed. When system manufacturer's installation instructions allow use of refrigerant line-set piping between indoor heat recovery controllers, or distribution headers and tees, and air terminal devices, follow instructions for allowable pipe size range and support to avoid forming traps in the piping.
- B. Variable Refrigerant Flow Heat Pump Systems Fittings:
1. For systems manufacturers requiring engineered, pre-assembled headers and branch fittings, Contractor shall obtain such fittings from system manufacturer. Fittings shall be suitable for system type and configuration.
 2. For systems manufacturers not requiring engineered, pre-assembled headers and branch fittings, Contractor shall furnish fittings complying with manufacturer's requirements.
- C. Refrigeration Piping Specialties: Furnish and install Superior, Sporlan, Alco, Henry, or equal, stop valves, solenoid valves, adjustable thermal expansion valves, sight glass, flexible connection, charging valve, and drier with valve bypass in the liquid lines and Superior DFN shell and cartridge suction line filter sized 2-1/2 times tonnage.
1. Install only those refrigeration piping specialties recommended by manufacturer of specific installed equipment.

2.5 REFRIGERANT ACCESS VALVE LOCKING CAPS

- A. Each refrigerant circuit access valve located outside buildings, including valves located on roofs, shall be provided with a locking cap. Caps shall be of metal construction, with threaded brass inserts. Caps shall be color-coded according to ASHRAE standards for R22 and R410A refrigerant gasses, universal color for other refrigerant gasses. Caps shall be removable only with cap manufacturer's handheld tool.
1. Provide minimum of two (2) cap removal tools for every ten (10) air conditioning units or other systems containing refrigerant installed under this Project.

2.6 FANS

- A. All fans shall be Air Moving and Control Association Inc. (AMCA) labeled.
- B. Provide self-aligning, enclosed ball bearings, accessible for lubrication unless specified otherwise.
- C. Provide variable speed switch for all direct drive fans.

D. Roof Mounted:

1. Direct or V-belt Drive: Provide one-piece heavy-duty ventilator housings, one piece heavy gauge spun aluminum construction, with weatherproof assembly and integral weather shield. Mount ventilators on curbs furnished by the fan manufacturer. Install with fan assembly level.
2. Fan wheels shall be centrifugal design, statically and dynamically balanced. Tip speed, rpm and motor horsepower shall not exceed listing in manufacturer's catalog for unit specified.
3. Fans shall have integral factory formed base and one piece spinning without welding. Housings shall be provided with wiring channel and are to be of the direct discharge design. Motor and fan assembly shall be on vibration isolating mounts. Fans shall have capacity, speeds and motor sizes as shown.
4. Provide the following accessories:
 - a. Gravity backdraft dampers.
 - b. Aluminum bird screen with a minimum of 85 percent free area.
 - c. Adjustable motor pulley.
 - d. Provide grease collection tray for kitchen exhaust fans.
 - e. Provide ventilated roof curb for kitchen exhaust fans where exhaust duct is mounted within rated shaft.
 - f. Provide hinge kit for kitchen hood exhaust fans.

E. In-Line Centrifugal Fans:

1. Centrifugal fan with airfoil blades, aluminum or steel housing, externally mounted belt-drive motor, external lube tubes, integral support brackets.
2. Provide sloped roof or flat roof type roof cap, or wall cap to suit the location indicated on the Drawings.

F. Ceiling Mounted Fans:

1. Acoustic lined cabinet, built-in back draft damper, vibration isolated fan and motor, variable speed switch.
2. Provide sloped roof or flat roof type roof cap, or wall cap to suit the location indicated on the Drawings.

G. Fan Drives:

1. Drive Design: The design horsepower rating of each drive shall be at least 1.5 times, single belt drives 2 times, the nameplate rating of the motor with proper allowances for sheave diameters, speed ratio, arcs of contact and belt length.
2. Provide variable speed drives, Dayco, Browning, Woods, or equal. Allow for replacement of fan and motor drives and belts as required to suit the balance requirements of the project.
3. Select variable speed drives to allow an increase or decrease of minimum of ten percent of design fan speed.

H. Motors:

1. Motors of 25 HP and less shall have adjustable pitch sheaves; sheaves on motors above 25 HP may be non-adjustable. Change, at no extra cost to Owner, the non-adjustable sheaves to obtain desired air quantities.
2. For single-phase fan motors sized larger than 1/12 hp and smaller than 1 hp, refer to Article, Electric Motors, in Section 23 00 50, Basic HVAC Materials and Methods.
- I. Sheaves: Sheaves shall be cast or fabricated, bored to size or bushed with fully split tapered bushings to fit properly on the shafts. All sheaves shall be secured with keys and set screws.
- J. Belts:
 1. All belts shall be furnished in matched sets.
 2. Belts shall be within 1 degree 30 minutes of true alignment in all cases.
- K. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:
 1. Greenheck Fan Corporation.
 2. Loren Cook Company.
 3. PennBarry.
 4. American Coolair Corporation.
- L. Owner Training: Manufacturer shall provide one on-site 1-hour training session for Owners' maintenance personnel.

2.7 RELIEF AND INTAKE VENTS

- A. Galvanized steel housing with 1/2 inch mesh screen, counterbalanced backdraft damper and matching prefabricated curb. Omit backdraft damper on intake vents. Provide pitched roof curb for relief vents, and install with backdraft damper level.
- B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:
 1. Greenheck Fan Corporation.
 2. Lauren Cook Company.
 3. PennBarry.
 4. American Coolair Corporation.

2.8 LOUVERS

- A. Louvers shall be minimum 16 gauge steel with Bonderite and Epon gray primer and 1/2 inch square mesh, 16 gauge galvanized steel screen on the inside. Louvers shall be Airolite #609, Arrow United Industries, or equal, with 4 inch louver depth.

2.9 AIR INLETS AND OUTLETS

- A. Except as otherwise indicated, provide manufacturer's standard inlets and outlets where shown; of size, shape, capacity and type indicated; constructed of materials and components as indicated, and as required for complete installation.
- B. Ceiling, wall or floor Compatibility: Provide inlets and outlets with border styles that are compatible with adjacent ceiling, wall or floor systems, and that are specifically manufactured

to fit into ceiling, wall or floor module with accurate fit and adequate support. Refer to general construction drawings and specifications for types of ceiling systems that will contain each type of air outlet and inlet.

C. Refer to Schedule on Mechanical Drawings for details of inlets and outlets to be used.

2.10 AIR FILTERS

A. Provide MERV 13 disposable pleated media type. Refer to specific equipment Articles for filter depth and for exceptions to this specification. Filters shall conform to the following:

1. Standards:

- a. ASHRAE Standard 52.2-2007.
- b. Underwriters Laboratories: U.L. 900, Class 2.

2. Construction:

- a. Media: Synthetic or cotton-synthetic blend with radial pleats.
- b. Media Frame: High wet-strength beverage board.
- c. Media Support: Welded wire or expanded metal grid bonded to air leaving side of the media.

3. Performance: 2" deep filter shall have a maximum initial air resistance of 0.31 inches w.g.

B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:

1. Camfil Farr, Inc., model 30/30.
2. Flanders Corporation, model 40 LPD.

C. Temporary (Construction Period) Filters:

1. Install new temporary filters in all units that have filter systems installed. Temporary filters shall match the permanent filters that are specified for the units. Replace filters as needed, in accordance with manufacturer's directions, in order to provide protection for the unit prior to occupancy by the Owner.
2. If air handling units are operated during construction of the project, install temporary filters directly over each return air inlet. Filters shall match the permanent filters that are specified for the units. Select size of filter to completely cover the frame of the return air inlet, and tape filters firmly in place to eliminate any construction debris from entering the duct system or unit. Remove the temporary filters upon completion of the work, and repair all damaged paintwork.

D. Spare Filters:

1. Furnish two new, complete sets of filter cartridges for each filter bank on completion and acceptance of the work. Install one set of filters in units (prior to final air balance). Provide units designed to accommodate washable, permanent filters with one washable, permanent filter.

2.11 DAMPERS

A. Backdraft Dampers: Ruskin CBD2, counterbalanced, Nailer Industries, or equal.

B. Manual Air and Balance Dampers: Provide dampers of single blade type or multi-blade type constructed in accordance with SMACNA, "HVAC Duct Construction Standards," except as noted herein.

1. Rectangular Ductwork:

- a. Single damper blades may be used in ducts up to 10 inches in height. Dampers shall be 16 gauge minimum. Provide self-locking regulators, equal to Ventlok 641. Provide end bearings equal to Ventlok 607 at each damper. Provide continuous solid 3/8 inch square shafts.
- b. Multiple blade dampers shall be equal to Ruskin CD35 Standard Control Damper. Maximum width for multiple damper blades for use in rectangular duct shall not exceed 6 inches.
- c. Where duct velocity may be expected to exceed 1500 fpm, provide Ruskin CD-50, or equal, low leakage dampers with airfoil blades.

2. Round Ductwork:

- a. Single damper blades may be used in ducts up to 12 inches in diameter. Provide multiple blade opposed blade dampers, with connected linkage, for ductwork larger than 12 inches in diameter.
 - b. Damper blades for round ductwork shall be 20 gauge steel for ducts up to 12 inches diameter and 16 gauge steel for dampers larger than 12 inches damper. Provide self-locking regulators, equal to Ventlok 641, Durodyne, or equal for operation of dampers. Provide end bearings equal to Ventlok 607 and provide continuous solid 3/8 inch square shafts.
3. Where ductwork is externally insulated, provide self-locking regulators equal to Ventlok 644, Durodyne, or equal for rectangular ductwork, and Ventlok 637, Durodyne, or equal for round ducts.

C. Fire Dampers and Combination Fire/Smoke Dampers:

1. Fire dampers and combination fire/smoke dampers shall be listed and approved by the California State Fire Marshal. Installation shall conform to the manufacturer's UL approved installation instructions.
 - a. Combination fire/smoke dampers. Dampers shall be UL classified and labeled as Leakage Class I Smoke Dampers in accordance with the latest version of UL 555S. Dampers shall be warranted to be free from defects in material and workmanship for a period of 5 years after date of shipment. Damper/actuator assembly shall be tested to full open and full close at minimum 2000 fpm 250° F heated air and 4" w.g. with airflow in both directions. (Specified select: 250° / 350°, 2000 fpm/3000 fpm). Each damper shall be equipped with "controlled closure" quick detect heat actuated release device to prevent duct and HVAC component damage resulting from instantaneous damper closure. Release device shall be EFL type and shall allow reset from outside the sleeve after moderate temperature exposure. (Replacement type fusible links not acceptable.)
 - b. Two position combination fire smoke dampers shall be equipped with one or more factory installed, direct coupled, 120 volt, single phase, electric actuator for energize open – fail close operation. Dampers with multiple actuators shall be factory wired with single point connection at the EFL heat release device for connection to poser. Damper actuator shall include minimum one-year energized hold open (no cycles) and spring return (fail) close reliability. Damper/actuator shall include minimum 20,000 full open-full close cycle performances.

- c. All FSD60 type dampers shall be AMCA licensed and shall bear the AMCA Seal for Air Performance. AMCA certified testing shall verify pressure drop does not exceed .03" w.g. at a face velocity of 1,000 fpm on a 24" x 24" damper.
- d. Wall type fire/smoke damper:
 - 1) Combination fire/smoke dampers for use in the wall of exit corridors shall be classified and labeled as Leakage Class II Smoke Dampers in accordance with the latest version of UL 555S. Dampers shall meet the requirements for combination fire/smoke dampers in paragraph 3 above except AMCA certified testing shall verify pressure drop does not exceed .07" w.g. at a face velocity of 1,000 fpm on a 24" x 24" damper and blades shall be single skin galvanized steel 10 gauge minimum with 3 longitudinal grooves for reinforcement. Dampers shall be Ruskin FSD36, Pottorff, or equal.
 - 2) Front access combination fire/smoke dampers shall meet all the requirements for combination fire/smoke dampers in paragraph 3 above except pressure drop requirement. In addition the dampers shall be constructed so that actuators and all accessories are accessible from the grille side. Actuators and accessories shall be housed within an integral cabinet on the side of the damper frame and shall not be installed in the air stream in front of the damper. The damper sleeve shall be minimum 14" and flanged to accept a steel framed grille. The sleeve shall be covered with fire resistant material. Dampers shall be Ruskin FSD60FA, Pottorff, or equal.
- e. Fusible links shall have temperature rating approximately 50° F above normal maximum operating temperature of the heat producing appliance.
 - 1) If project requires re-openable fire/smoke dampers, provide Ruskin 165 ° F / 350° F TS150, NCA or equal. The TS150 firestat replaces the EFL and allows the damper to be re-opened from remote location up to 350 ° F. TS150 shall include full open and full closed damper position contacts for interface with remote position indication panel.
 - 2) Each fire/smoke damper shall be equipped with "controlled closure" quick detect heat actuated release device to prevent duct and HVAC component damage. Release device shall allow easy reset after moderate temperature rise outside the sleeve. Heat release device shall be the Ruskin EFL, NCA or equal.
 - 3) Unless the system is using a validation control system, each fire/smoke damper shall be equipped with a control panel including blade position indicator lights and a key operated switch. The panel cover shall be oversized for flush mount into the wall or ceiling and shall have a brushed look. Control panel shall be Ruskin MCP2, Pottorff, or equal.
- 2. All actuators used for smoke dampers or combination fire/smoke dampers shall have a cycle time requirement of not more than every twelve months and shall be rated for continuous "On" duty and shall be provided with internal spring return. Actuators shall be equipped with pilot light, remote key test switch, end switch and circuitry to activate pilot light on remote key (test) switch located in corridor ceiling adjacent to damper. Electric motors shall be Invensys MA-250, MA-253, Honeywell H2000, or equal.

2.12 DUCTWORK

- A. Construct and install sheet metal ductwork in accordance with the California Mechanical Code for 2 inches static pressure for supply air, and 2 inches minimum for return and exhaust air unless otherwise noted on Drawings.

1. Where not in conflict with the California Mechanical Code, construct and install all sheet metal ductwork in accordance with SMACNA HVAC Duct Construction Standards (Metal and Flexible). Where applicable for HVAC work, construct and install sheet metal work in accordance with SMACNA Architectural Sheet Metal Manual.
 2. Provide variations in duct size, and additional duct fittings as required to clear obstructions and maintain clearances as approved by the Architect at no extra cost to the Owner.
 3. Gauges, joints and bracing shall be in accordance with the California Mechanical Code.
 4. Provide beading or cross breaking for all ductwork inside building. Provide cross breaking for ductwork exposed to weather.
 5. At the contractor's option, ductwork may be fabricated using the Ductmate, Nexus, Quickduct, Transverse Duct Connection (TDC), Pyramid-Loc duct connection systems, or equal. Fabricate in strict conformance with manufacturer's written installation instructions and in accordance with California Mechanical Code.
 - a. Seal flanged ends with pressure sensitive high density, closed cell neoprene or polyethylene tape gasket, Thermo 440, or equal.
 - b. Provide metal clips for duct connections, except at breakaway connections for fire dampers and fire smoke dampers. Provide corner clips at each corner of duct, through bolted, at all locations except at breakaway connections for fire dampers and fire smoke dampers. Where used on locations exposed to weather, provide continuous metal clip at top and sides of duct, with 1 inch overhang for top side.
- B. Design and installation standards:
1. SMACNA Compliance: Comply with applicable portions of Sheet Metal and Air Conditioning Contractor's National Association (SMACNA) for all work in this section.
 2. NFPA Compliance: Comply with ANSI/NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems," and ANSI/NFPA 90B, "Standard for the Installation of Warm Air Heating and Air Conditioning Systems."
 3. California Mechanical Code.
- C. Duct sizes indicated are external sizes.
- D. Galvanized Sheet Steel: Lock-forming quality, ASTM A924 and ASTM A653, Coating Designation G 90. Provide mill phosphatized finish for exposed surfaces of ducts exposed to view.
1. Provide mill certification for galvanized material at request of the Project Inspector.
- E. Duct Sealants:
1. Sealant shall have a VOC content of 250 g/L or less.
 2. Sealant shall comply with testing and product requirements of South Coast Air Quality Management District, Rule 1168.
 3. Provide one part, non-sag, synthetic latex sealant, formulated with a minimum of 68 percent solids. Sealant shall comply with ASTM E84, Surface Burning Characteristics.
 - a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:
 - 1) Design Polymerics, model DP1010.

- 2) Polymer Adhesive Sealant Systems Inc, model Airseal #11.
- 3) McGill Airseal, LLC.

- F. Provide sheet metal angle frame at all duct penetrations to wall, floor, roof, or ceiling.
- G. Duct Support Materials: Except as otherwise indicated, provide hot-dipped galvanized steel fasteners, anchors, straps, trim, and angles for support of ductwork.
- H. Rectangular Duct Fabrication:
1. Shop fabricate ductwork of gauges and reinforcement complying with the more stringent of the following standards, except as noted herein.
 - a. SMACNA HVAC Duct Construction Standards
 - b. California Mechanical Code
 2. Fabricate ducts for 2 inch pressure class with minimum duct gauges and reinforcement as follows, except as otherwise noted:

<u>Table A</u>		
<u>Duct Dimension</u>	<u>Minimum Gauge</u>	<u>Joint Reinforcement Per CMC</u>
Through 12"	26	Not Required
13" through 18"	24	Not Required
19" through 30"	24	C/4
31" through 42"	22	E/4
43" through 54"	22	F/2
55" through 60"	20	G/4
61" through 84"	20	I/2
85" through 96"	20	J/2
Over 96"	18	K/2

3. Fabricate duct fittings to match adjoining ducts and to comply with duct requirements as applicable to fittings. Except as otherwise indicated, fabricate elbows with center-line radius equal to 1.5 times associated duct width. Fabricate to include single thickness turning vane in elbows where space does not permit the above radius or where square elbows are shown. Limit angular tapers to 30 degrees for contracting tapers and 20 degrees for expanding tapers. Turning vanes shall be E-Z Rail II, Durodyne, or equal.
4. Fabricate round supply connections at rectangular, plenum type fittings using spin-in type fittings, complete with extractor and volume control damper. Refer to Paragraph "DAMPERS" for damper requirements.

5. Provide drive slip or equivalent flat seams for ducts exposed in the conditioned space or where necessary due to space limitations. On ducts with flat seams, provide standard reinforcing on inside of duct. Duct connection to outlet on exposed duct shall be full size of outer perimeter of outlet flange.
 6. Ducts exposed in the conditioned space shall be free of dents and blemishes and be mounted tight against adjacent surface with flat hangers. Remove all fabrication labels from ductwork.
 7. Provide 20 gauge minimum for ductwork exposed within occupied spaces.
- I. Rectangular Internally Insulated Duct Fabrication:
1. Provide internal duct lining where indicated on the Drawings, with a minimum of 10'-0" length in each direction from the fan, fan casing, or unit casing. Line all transfer ducts.
 - a. Where ductwork is exposed to weather or outside the building insulation envelope, provide 2 inch thick, 1-1/2 pound density internal lining with matte facing, with an R-Value of 8.0 minimum.
 - b. Where ductwork is within the building insulation envelope, lining shall be 1" thick, 1-1/2 pound density, with R-value of 4.2 minimum.
 - c. Ducts exposed in the conditioned space shall be free of dents and blemishes and be mounted tight against adjacent surface with flat hangers. Remove all fabrication labels from ductwork.
 - d. Where installed exposed in the conditioned space, duct shall be minimum 20 gauge with 1 inch insulation layer (minimum R-value – R-4.2).
 - e. Cement duct liner in place with nonflammable, non-hardening duct adhesive. Seal all raw edges of insulation inside ductwork with adhesive, including longitudinal liner edges.
 - f. Provide metal nosing at all locations where liner is preceded by unlined metal.
 - g. Provide sheet metal weld pins and washers or clinch pins and washers on all ductwork on 12 inch intervals with the first row within 3 inches of the leading edge of each piece of insulation and within 4 inches of corners. No use of adhesive mounted pins will be considered.
 - 1) Install clinched pin fasteners with properly adjusted automatic fastening equipment. Manual installation will not be considered.
 - 2) Install weld pins with properly adjusted automatic fastening equipment. Installation shall not damage the galvanized coating on the outside of the duct.
 - h. All ductwork, adhesives, lining, sealant, flex duct and the like shall have a flame spread of 25 or less and developed smoke rating of 50 or less when tested in accordance with one of the following test methods: NFPA 255, ASTM E84, or UL 723.
 - i. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:

<u>Manufacturer:</u>	<u>Product:</u>
Johns Manville	Linacoustic RC
CertainTeed Corporation	ToughGard
Fosters Adhesive	85-62
Swifts Adhesive	7336

J. Round and Oval Ductwork Fabrication:

1. Round and oval duct and fittings shall be spiral lockseam or longitudinal seam as indicated in table below. Provide couplings to join each length of duct.
 - a. At contractors' option, round or oval ductwork may be utilized in place of rectangular ductwork shown on Drawings, provided available space allows installation of round or oval ductwork without compromising space required for installation of products and systems of other trades.
 - 1) Round or oval ductwork utilized in place of rectangular ductwork shown on Drawings shall be sized to have a static pressure loss equivalent to rectangular duct shown on Drawings.
 - 2) Unlined round or oval duct shall not be utilized in place of rectangular internally lined ductwork shown on Drawings.
2. Fabricate duct fittings to match adjoining ducts and to comply with duct requirements as applicable to fittings. Except as otherwise indicated, fabricate elbows with center-line radius equal to 1.5 times associated duct width. Provide two-piece, die-stamped, 45-degree to 90-degree elbows for sizes up to 12 inches; five-piece, 90-degree elbows for sizes 12 inches and above; conical tees; and conical laterals. All reducers shall be placed after a tap has been made on the duct main. Reducers shall be long-taper style.
3. Round Ductwork: Construct of galvanized sheet steel complying with ANSI/ASTM A 653 by the following methods and in minimum gauges listed.

<u>Diameter</u>	<u>Minimum Gauge</u>	<u>Method of Manufacture</u>
Up to 14"	26	Spiral Lockseam
15" to 23"	24	Spiral Lockseam
24" to 36"	22	Spiral Lockseam
37" to 50"	20	Spiral Lockseam
51" to 60"	18	Spiral Lockseam
Over 60"	14	Longitudinal Seam

4. Provide locked seams for spiral duct; fusion welded butt seam for longitudinal seam duct.
5. Fittings and Couplings: Construct of minimum gauges listed. Provide continuous welds along seams at exposed ducts. Provide spot weld bonded seams at concealed ducts.

<u>Diameter</u>	<u>Minimum Gauge</u>
3" to 36"	20
38" to 50"	18
Over 50"	16

6. Ducts exposed in the conditioned space shall be free of dents and blemishes and be mounted tight against adjacent surface with flat hangers. Remove all fabrication labels from ductwork.
 7. Provide 20 gauge minimum for ductwork exposed within occupied spaces.
- K. Round Internally Insulated Duct and Fittings: Where ductwork is exposed to weather or outside the building insulation envelope, construct with outer pressure shell, 2 inch thick (Minimum R-value = R-8) insulation layer, and perforated inner liner. Where ductwork is within the building insulation envelope, construct with outer pressure shell, 1 inch thick (minimum R-value = R4.2) insulation layer, and perforated inner liner. Construct shell and liner of galvanized sheet steel complying with ANSI/ASTM A 653, of spiral lockseam construction (use longitudinal seam for over 59 inches), in minimum gauges listed in table below. Where installed exposed in the conditioned space: duct and fitting outer pressure shell shall be minimum 20 gauge with 1 inch insulation layer (minimum R-value = R-4.2), and perforated inner liner.

<u>Nominal Duct Diameter</u>	<u>Outer Shell</u>	<u>Inner Liner</u>
3" TO 12"	26 gauge	24 gauge
13" TO 24"	24 gauge	24 gauge
25" to 34"	22 gauge	24 gauge
35" to 48"	20 gauge	24 gauge
49" to 58"	18 gauge	24 gauge
Over 59"	16 gauge	20 gauge

1. Fittings and Couplings: Construct of minimum gauges listed. Provide continuous weld along seams of outer shell at exposed ducts. Provide spot weld bonded seams at concealed ducts.

<u>Nominal Duct Diameter</u>	<u>Outer Shell</u>	<u>Inner Liner</u>
3" to 34"	20 gauge	24 gauge
36" to 48"	18 gauge	24 gauge
Over 48"	16 gauge	24 gauge

2. Inner Liner: Perforate with 3/32 inch holes for 22 percent open area. Provide metal spacers welded in position to maintain spacing and concentricity.
3. Ducts exposed in the conditioned space shall be free of dents and blemishes and be mounted tight against adjacent surface with flat hangers. Remove all fabrication labels from ductwork.
4. Where installed exposed in the conditioned space, duct shall be minimum 20 gauge with 1 inch insulation layer (minimum R-value – R-4.2).
5. All ductwork, adhesives, lining, sealant, flex duct and the like shall have a flame spread of 25 or less and developed smoke rating of 50 or less when tested in accordance with one of the following test methods: NFPA 255, ASTM E84, or UL 723.
6. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:
 - a. Sheet Metal Div., McGill AirFlow, LLC., Acousti-k27
 - b. Semco Duct and Acoustical Products, Inc.
 - c. Air Systems Manufacturing, Inc. - Las Vegas

L. Duct Access Doors:

1. Duct Access: Provide hinged access door in rectangular ducts for access to fire dampers, control equipment, etc. Access door size shall be duct diameter wide by duct

diameter high for all ducts under 24 inches. Ducts over 24 inches in diameter shall have 24-inch by 18-inch access doors. Minimum size access doors shall be 6 inches by 6 inches.

2. Provide hinged style access doors for round ductwork, NCA Manufacturing, Inc., Model AD-RD-87, Pottorff Series 60, or equal. Access doors shall be 16 gauge galvanized steel with continuous piano hinge. Locks shall be plated steel strike and catch. Provide 1" x 3/8" Polyethylene "Perma Stik" gasket all around door.

M. Flexible Air Ducts:

1. Provide exterior reinforced laminated vapor barrier, fiberglass insulation, encapsulated spring steel wire Helix, and impervious, smooth, non-perforated interior vinyl liner. Individual lengths of flexible ducts shall contain factory fabricated steel connection collars.
 - a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:
 - 1) C.A. Schroeder, Inc., Cal Flex model 2PMJ.
 - 2) ThermaFlex model M KC.
2. Factory made air ducts shall be approved for the use intended and shall conform to the requirements of UL 181 and NFPA 90A. Each portion of a factory-made air duct system shall be identified by the manufacturer with a label or other suitable identification indicating compliance with UL 181, Class 1. Ducts shall be UL listed Class 1, maximum 25/50 smoke and flame spread and shall be installed in accordance with the terms of their listing and the requirements of SMACNA HVAC Duct Construction Standards (Metal and Flexible). Factory-made air ducts shall have the following minimum R-values: R-6.0 for ductwork installed within the building insulation envelope, R-8.0 for ductwork installed outside the building insulation envelope.
3. Flexible ductwork shall be maximum of 5 feet long, and shall be extended to the fullest possible length, in order to minimize pressure drop in the duct.
4. Flexible ducts shall be selected for minimum of 6 inch positive static pressure and minimum of 1 inch negative static pressure.

N. Kitchen Exhaust Ducts (Type 2):

1. Cooking Equipment Exhaust Ducts:
 - a. Fabricate kitchen exhaust ducts and supports used for removal of vapor, heat and odors from cooking equipment of 16 gauge minimum black steel where concealed and of 18 gauge minimum Type 304 stainless steel where exposed. At Contractor's option, 18 gauge minimum Type 304 stainless steel may be used where concealed. Finish exposed stainless steel with Number 4 finish. All ductwork shall be of welded construction in accordance with Section 510 of California Mechanical Code. For duct construction, comply with SMACNA "HVAC Duct Construction Standards" and ANSI/NFPA 96 "Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations."
2. Dishwasher Exhaust Ducts:
 - a. Fabricate dishwasher exhaust ducts and supports used for steam removal from dishwasher of 18 gauge minimum 304 stainless steel. All ductwork shall be of welded construction in accordance with Section 510 of California Mechanical Code. For duct construction, comply with California Mechanical Code, SMACNA "HVAC

Duct Construction Standards," and ANSI/NFPA 96 "Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations."

3. Duct Access Panels:

- a. Provide duct access panel assembly of the same material and gauge used for the duct. Duct access panels shall conform to the following:
 - 1) Fasteners: Black steel or stainless steel to match material used for the duct. Panel fasteners shall not penetrate duct wall.
 - 2) Gasket: Comply with NFPA 96, grease-tight, high temperature ceramic fiber, rated for minimum 1500 °F.

O. Type 1 Clothes Dryer Exhaust Ducts: Provide aluminum duct and fittings in wall and ceiling as indicated on Drawings.

P. Shower exhaust ducts: Provide ducts and supports from stainless steel for a length of 20 feet from exhaust grille or register.

Q. Flexible Connectors:

1. Materials: Flame-retardant or noncombustible fabrics. Coatings and adhesives shall comply with UL 181, Class 1, with flame spread index of 25 or less, and smoke-developed index of 50 or less.
2. Metal-Edged Connectors: Factory fabricated with a fabric strip 3 inches wide attached to two strips of 3-inch-wide, 0.028-inch-thick, galvanized sheet steel or 0.032-inch-thick aluminum sheets. Provide metal compatible with connected ducts.
3. Flexible Connector Fabric: Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and ozone.
 - a. Minimum Weight: 26 oz./sq. yd.
 - b. Tensile Strength: Minimum 475 lbf/inch in the warp and minimum 375 lbf/inch in the filling.
 - c. Service Temperature: Minus 50 to plus 200 deg F.
4. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:
 - a. Ductmate Industries, Inc., model Proflex.
 - b. Ventfabrics, Inc., model Ventlon.

2.13 PIPE JOINING MATERIALS

A. Refer to Division 22 and 23 piping sections for special joining materials not listed below.

B. Brazing Filler Metals:

1. General Duty: AWS A5.8, BCup-5 Series, copper-phosphorus unless otherwise indicated. Sil-Fos 15, or equal.
2. Refrigerant Piping:
 - a. Joining copper to copper: AWS A5.8, BCup-5 Series, copper-phosphorus unless otherwise indicated. Sil-Fos 15, or equal.
 - b. Joining copper to bronze or steel: AWS A5.8, Bag-1, silver alloy unless otherwise indicated.

2.14 INSULATION MATERIALS

A. General:

1. Insulation products, including insulation, insulation facings, jackets, adhesives, sealants and coatings shall not contain polybrominated diphenyl ethers (PBDEs) in penta, octa, or deca formulations in amounts greater than 0.1 percent (by mass).
2. Products shall not contain asbestos, lead, mercury, or mercury compounds.
3. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
4. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
5. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
6. Adhesives and sealants shall comply with testing and product requirements of South Coast Air Quality Management District, Rule 1168.

B. Insulation Materials:

1. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.
 - a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:
 - 1) Aeroflex USA, Inc.
 - 2) Armacell LLC.
 - 3) K-Flex USA.
2. Mineral-Fiber, Preformed Pipe Insulation:
 - a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:
 - 1) Johns Manville; a Berkshire Hathaway company.
 - 2) Knauf Insulation.
 - 3) Manson Insulation Inc.
 - 4) Owens Corning.
 - b. Type I, 850 deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ-SSL.
3. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type III with factory-applied FSK jacket. Provide 2-inch wide stapling and taping flange.
 - a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:
 - 1) CertainTeed Corporation.
 - 2) Johns Manville.

- 3) Knauf Insulation.
- 4) Owens Corning.

2.15 FIELD APPLIED JACKETS:

- A. PVC Jacket and Factory Fabricated Fitting Covers: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming.
 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:
 2. Johns Manville, model Zeston, with Zeston 2000 fitting covers.
 3. Proto Corporation, model LoSmoke.
- B. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.
 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:
 - a. Childers Brand; H. B. Fuller Construction Products.
 - b. ITW Insulation Systems; Illinois Tool Works, Inc.
 - c. RPR Products, Inc.
 2. Finish and thickness are indicated in field-applied jacket schedules.
 3. Moisture Barrier for Outdoor Applications: 2.5-mil- thick polysurlyn.
 4. Factory-Fabricated Fitting Covers:
 - a. Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
 - b. Tee covers.
 - c. Flange and union covers.
 - d. End caps.
 - e. Beveled collars.
 - f. Valve covers.
 - g. Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

2.16 ELECTRIC, RADIANT HEATERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:
 1. Black Body Infrared.
 2. Berko; Marley Engineered Products.
 3. QMark; Marley Engineered Products.
 4. SSHC, Inc.
- B. Description: Comply with UL 2021.
 1. Aluminized steel encasement, cleanable glass surface.

- C. Wall Thermostat: Bimetal, sensing elements calibrated from 55 to 90 deg F; manually operated on-off switch with contactors, relays, and control transformers.

2.17 TEMPERATURE CONTROL SYSTEM

- A. Refer to Section 23 09 23, Direct Digital Control System for HVAC.

PART 3 - EXECUTION

3.1 SPLIT SYSTEM AC, HEAT PUMP, AND VRF SYSTEMS INSTALLATION

A. General:

1. Install units level and plumb.
2. Install evaporator-fan components as detailed on Drawings.
3. Install ground or roof- mounted condensing units as detailed on Drawings.
4. Install seismic restraints as required by applicable codes. Refer to Article, Submittals, in Section 23 00 50, Basic HVAC Materials and Methods, for delegated design requirements for seismic restraints.
5. Install and connect refrigerant piping as detailed in unit manufacturers' literature. Install piping to allow access to unit.
6. Install cooling coil condensate primary drain pan piping, and overflow, if provided, and run to nearest code-compliant receptacle, or as indicated on Drawings. Install secondary drain pan for units installed over permanent and suspended-tile ceilings. Install secondary drain pan piping and terminate 1/2 inch below ceiling, with escutcheon, in a readily visible location or as shown on Drawings.
7. Install air filters at each indoor unit. Install washable, permanent filters at indoor units designed to accept washable, permanent filters. Refer to Drawings schedule, and Article, Air Filters, in this Section, for filter requirements for ducted, above-ceiling units incorporating mixing boxes.
8. Duct Connections: Duct installation requirements are specified in Article, Ductwork, in this Section. Drawings indicate the general arrangement of ducts. Connect supply and return ducts to split-system air-conditioning units with flexible duct connectors. Flexible duct connectors are specified in Article, Ductwork, in this Section.

B. Variable Refrigerant Flow Split System Heat Pumps:

1. The system shall be installed by a factory-trained and certified contractor, in strict conformance with unit manufacturer's instructions.
2. Install indoor heat recovery controllers as detailed on Drawings. Install condensate drain pan piping and run to nearest code-compliant receptacle, or as indicated on Drawings.
 - a. Indoor Heat Recovery Controllers Identification:
 - 1) Comply with requirements for identification in Section 23 00 50, Basic HVAC Materials and Methods.
 - 2) Identify each control cable on each end and at each terminal with a number-coded identification tag. Each cable shall have a unique tag.
 - 3) Identify each refrigerant connection with label or tag corresponding to the indoor fan coil unit served by the refrigerant piping branch. Use equipment numbers scheduled on Drawings.

3. Install ball-type refrigerant service valves in refrigerant piping at downstream connections of indoor heat recovery units.
4. Install ground or roof- mounted condensing units as detailed on Drawings. Connected condensing units shall allow space for coil cleaning and other required maintenance tasks.

3.2 REFRIGERANT PIPING INSTALLATION

A. General:

1. Install refrigerant piping according to ASHRAE 15. Install and connect refrigerant piping as detailed in unit manufacturers' literature. Install piping to allow access to unit.
2. Install piping straight and free of kinks, restrictions or traps.
3. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.
4. Slope horizontal suction piping 1 inch/10 feet towards compressor.
5. Install fittings for changes in direction and branch connections.
6. Piping under raised floors shall be kept 6 inches minimum above ground; excavate as necessary.
7. Install locking caps on refrigerant access valves located outside building, including valves located on roofs.
8. Insulate refrigerant piping, including liquid and hot gas pipes when required by system manufacturer, and including headers, branches, and other components as detailed in unit manufacturers' literature.

B. Factory Pre-charged and sealed line set piping:

1. Keep the entire system clean and dry during installation.
2. All tubing shall be evacuated and sealed at the factory. The seal must not be broken until ready for assembly.
3. If there is any evidence of dust, moisture, or corrosion, the tubing must be cleaned out by drawing a swab soaked with methyl alcohol through the tubing as many times as necessary to thoroughly clean the tubing.
4. Where line set piping is used, enclose in iron or steel piping and fittings or in EMT conduit.
 - a.

C. Field Assembled Refrigerant Piping:

1. Select system components with pressure rating equal to or greater than system operating pressure.
2. Where subject to mechanical injury, enclose refrigerant piping in EMT conduit.
3. Where field assembled refrigerant piping is exposed mounted at grade, on walls, and on roof, enclose in 16 gage galvanized steel enclosure.
4. When brazing, remove solenoid valve coils and sight glasses, also remove valve stems, seats, and packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion-valve bulb.

3.3 FAN INSTALLATION

- A. Ceiling Mounted Fans: Mount variable speed switch within fan housing. Mark final balance point on variable speed switch.
- B. Provide access doors for fans or motors mounted in ductwork.
- C. Mount all fans as detailed on Drawings and in compliance with CBC standards.
- D. Fan motors mounted in air-stream to be totally enclosed.
- E. Completely line supply, return or exhaust fan cabinets with 1 inch thick, 3/4 pound density acoustic insulation securely cemented in place.
- F. Roof fans shall be mounted level.
- G. Provide heavy-duty rubber gasket between exhaust fan mounting flange and roof curb, or as required for an airtight installation.

3.4 RELIEF VENT INSTALLATION

- A. Install relief vents to provide a level mounting for backdraft damper.

3.5 AIR INLETS AND OUTLETS INSTALLATION

- A. Provide all air inlets and outlets with gaskets and install so that there will be no streaking of the walls or ceilings due to leakage. Duct connection to outlet on exposed duct shall be full size of outer perimeter of outlet flange.
- B. Unless otherwise indicated on Drawings, provide rectangular galvanized steel plenum on top of each diffuser and ceiling return for connection to ductwork. Line plenum with internal insulation as indicated for lined ductwork. Size plenum to allow full opening into air terminal. Plenum sheet metal gauge shall be equal to gauge for rectangular equivalent of the branch duct serving the air inlet or outlet.
- C. Ceiling-mounted air inlets, outlets, or other services installed in T-Bar type ceiling systems shall be positively attached to the ceiling suspension main runners or to cross runners with the same carrying capacity as the main runners.
 - 1. Air inlets, outlets, or other services weighing not more than 56 pounds shall have two No. 12 gauge hangers connected from the terminal or service to the structure above. These wires may be slack.
 - 2. Support air inlets, outlets, or other services weighing more than 56 pounds directly from the structure above by approved hangers. Provide 4 taut 12 gauge wires each, attached to the fixture and to the structure above. The 4 taut 12 gauge wires, including their attachment to the structure above must be capable of supporting 4 times the weight of the unit.
 - 3. Secure air inlets and outlets to main runners of ceiling suspension system with two No. 8 sheet metal screws at opposing corners.
- D. Furnish all air inlets and outlets with a baked prime coat unless otherwise noted. Provide off-white baked enamel finish on ceiling-mounted air inlets and outlets. Paint exposed mounting screws to match the material being secured.
- E. Air inlets and outlets shall match all qualities of these specified including appearance, throw, noise level, adjustability, etc.

3.6 FILTER HOUSING INSTALLATION

- A. Mount filters in airtight galvanized steel housings furnished by the filter manufacturer, or shop-fabricated. Housings shall incorporate integral tracks to accommodate filters, and flanges for connection to duct or casing system.
 - 1. Sealing: Incorporate positive-sealing gasket material on channels to seal top and bottom of filter cartridge frames and to prevent bypass of unfiltered air.
 - 2. Access Doors: Hinged, with continuous gaskets on perimeter and positive-locking latch handle devices.
- B. Air filters shall be accessible for cleaning or replacement.
- C. Identify each filter access door with 1/2 inch high minimum stenciled letters.

3.7 TEMPORARY FILTERS

- A. Provide temporary filters for fans that are operated during construction; after construction dirt has been removed from the building install new filters at no additional cost to the Owner. In addition to temporary filters at filter location, provide temporary filters on all duct openings which will operate under a negative pressure.
 - 1. Filters used for temporary operation shall be the same as permanent filters for the application. Filters used for duct openings may be 1 inch thick pleated media disposable type.

3.8 DAMPER INSTALLATION

- A. All dampers automatically controlled by damper motors are specified under "Temperature Control System" except those specified with items of equipment.
- B. Provide opposed blade manual air dampers at each branch duct connection and at locations indicated on the drawings and where necessary to control air flow for balancing system. Provide an opposed blade balancing damper in each zone supply duct. Provide an access panel or Ventlok flush type damper regulator on ceiling or wall for each concealed damper.
- C. Provide 18 inch x 12 inch minimum hinged access doors in ductwork and furring for easy access to each fire damper; insulated access doors in insulated ducts. Label access doors with 1/2 inch high red letters.
 - 1. Provide Ventlok Series 100, Durodyne, or equal access doors with hardware for convenient access to all automatic dampers and other components of the system, insulated type in insulated ducts. Provide Ventlok #202 for light duty up to 2 inch thick doors, #260 heavy-duty up to 2 inch thick doors and #310 heavy-duty for greater than 2 inch thick doors. Provide #260 hinges on all hinged and personnel access doors; include gasketing.

3.9 DUCTWORK INSTALLATION

- A. Assemble and install ductwork in accordance with recognized industry practices which will achieve air tight and noiseless (no objectionable noise) systems capable of performing each indicated service. Install each run with minimum of joints. Align ductwork accurately at connections within 1/8 inch misalignment tolerance and with internal surfaces smooth. Support ducts rigidly with suitable ties, braces, hangers, and anchors of type which will hold ducts true to shape and to prevent buckling. Where possible, install ductwork to clear

construction by 1/4 inch minimum, except at air inlets and outlets. Where ductwork will not clear construction, secure duct firmly to eliminate noise in the system.

- B. Duct Joints: Install duct sealers, pop rivets or sheet metal screws at each fitting and joint. Duct sealer shall be fire retardant. Sheet metal screw for joints shall be minimum #10 size galvanized.
- C. Upper connection of support to wood structure shall be with wood screws or lag screws in shear fastened in the upper one half of the wood structural member. Fasteners shall conform to the following schedule:

For ducts with P/2=30"	#10 x 1-1/2" wood screw
For ducts with P/2=72"	1/4"x 1-1/2" lag screw
For ducts with P/2 over 73"	3/8"x 1-1/2" lag screw

- D. Upper connection in tension to wood shall not be used unless absolutely necessary. Where deemed necessary the contractor shall submit calculations to show the size fastener and penetration required to support loads in tension from wood in accordance with the following schedule:

For ducts with P/2=30"	260 pounds per hanger
For ducts with P/2=72"	320 pounds per hanger
For ducts with P/2=96"	460 pounds per hanger
For duct with P/2 larger than 120"	NOT ALLOWED

- E. Install concrete inserts for support of ductwork in coordination with formwork as required to avoid delays in work.
- F. Upper connection to manufactured truss construction must comply with truss manufacturers published requirements and Structural Engineers requirements.
- G. Where ducts pass through interior partitions and exterior walls, conceal space between construction opening and duct or duct plus insulation with sheet metal flanges of same gauge as duct. Overlap opening on four sides by at least 1-1/2 inches.
- H. Support ductwork in manner complying with SMACNA "HVAC Duct Construction Standards," hangers and supports sections. Where special hanging of ductwork is detailed or shown on Drawings, Drawings shall be followed. Angles shall be attached to overhead construction in a manner so as to allow a minimum of 2 inches of movement in all directions with no bending or sagging of the angle.
 1. Except where modified in individual paragraphs of this Section, provide hanger support with minimum 18 gauge straps, 1 inch wide. Fold duct strap over at bottom of duct.
 2. Install duct supports to rectangular ducts with sheet metal screws. Provide one screw at top of duct and one screw into strap at bottom of duct.
- I. Installation of Flexible Ductwork:

1. Provide flexible ducts with supports at 30 inch centers with 2 inch wide, 26 gauge steel hanger collar attached to the structure with an approved duct hanger. Installation shall minimize sharp radius turns or offsets.
 - a. Supports shall be in accordance with SMACNA HVAC Duct Construction Standards (Metal and Flexible).
 - b. Flexible duct bends shall be not less than 1-1/2 duct diameter bend radius.
2. Make connections to rigid duct and units with Panduit style draw band at inner liner material, and a second draw band over the outer vapor barrier material.
3. Make connection to duct with spin-in fittings, with air scoop and balance damper.

J. Installation of Kitchen Exhaust Ducts (Type 2):

1. Install commercial kitchen hood exhaust ducts without dips and traps that may hold grease.
2. Slope duct a minimum of 1 percent to drain back to the hood or dishwasher connection.
3. Install duct access panel assemblies at each change of direction and at maximum intervals of 12 feet in horizontal ducts, and at every floor for vertical ducts, and as indicated on Drawings. Locate access panel on top or sides of duct. Locate panel so that edge of opening is not less than 1-1/2 inch from all outside edges of the duct. For large horizontal ducts, install 20 inch by 20 inch access panel for personnel entry at maximum intervals of 20 feet.
4. Fabricate ducts with continuous welds for water-tight construction.
5. Grind welds to provide smooth surface free of burrs, sharp edges and weld splatter. When welding stainless steel with a No. 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to removed discoloration caused by welding.
6. Fabricate ducts for dishwasher exhaust with seams on top of duct, and with minimum joints.
7. Access panels shall be labeled with the words: "Access Panel – Do Not Obstruct."

K. Installation of Shower Exhaust Ducts:

1. Slope duct a minimum of 1 percent to drain back to the exhaust grille.

L. Paint inside of ducts, visible through grille, dull black.

M. Where ductwork is installed in finished areas of buildings that do not have ceilings, paint ductwork, support hangers, and air inlets and outlets to match adjacent architectural surfaces, or as directed by Architect.

3.10 PIPE JOINTS AND CONNECTIONS

A. General:

1. Cutting: Cut pipe and tubing square, remove rough edges or burrs. Bevel plain ends of steel pipe.
2. Remove scale, slag, dirt and debris from inside and outside of pipe before assembly.
3. Boss or saddle type fittings or mechanically extracted tube joints will not be allowed.

B. Copper Pipe and Tubing: All joints shall be brazed according to ASME Section IX, Welding and Brazing Qualifications, except pneumatic control piping, and hydronic piping having grooved-end fittings and couplings.

C. Flexible Connections:

1. Furnish and install Thermo Tech., Inc. F/J/R, Metraflex, or equal, flexible couplings with limiter bolts on piping connections to all equipment mounted on anti-vibration bases, except fan coil units under 2000 cfm, on each connection to each base mounted pump and where shown. Couplings shall be suitable for pressure and type of service.
2. Flexible connections in refrigerant lines; Flexonic, Anaconda or equal, metal hose, full size.
3. Anchor piping securely on the system side of each flexible connection.

3.11 INSULATION AND FIELD-APPLIED JACKET INSTALLATION

A. General:

1. The term "piping" used herein includes pipe, air separators, valves, strainers and fittings.
2. Test insulation, jackets, and lap-seal adhesives as a composite product and confirm flame spread of not more than 25 and a smoke developed rating of not more than 50 when tested in accordance with UL723, ASTM E84, or NFPA 255.
3. Clean thoroughly, test and have approved, all piping and equipment before installing insulation and/or covering.
4. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping, ductwork, and equipment.
5. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment as specified in insulation system schedules.
6. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
7. Install insulation with longitudinal seams at top and bottom of horizontal runs.
8. Install multiple layers of insulation with longitudinal and end seams staggered.
9. Keep insulation materials dry during application and finishing.
10. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
11. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
12. Install insulation in removable segments on equipment access doors, manholes, handholes, and other elements that require frequent removal for service and inspection. Bevel and seal insulation ends around manholes, handholes, ASME stamps, and nameplates.
13. For piping, ductwork, and equipment, with surface temperatures below ambient, apply mastic to open ends, joints, seams, breaks, and punctures in insulation.
14. Repair all damage to existing pipe, duct and equipment insulation whether or not caused during the work of this contract, to match existing adjacent insulation for thickness and finish, but conforming to flame spread and smoke ratings specified above.

15. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
 - a. Install insulation continuously through hangers and around anchor attachments.
 - b. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
 - c. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
 - d. Cover inserts with jacket material matching adjacent insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

B. Piping Insulation Installation:

1. General:

- a. Apply insulating cement to fittings, valves and strainers and trowel smooth to the thickness of adjacent covering. Cover with jacket to match piping. Extend covering on valves up to the bonnet. Leave strainer cleanout plugs accessible.
 - b. Provide removable insulation covers for items requiring periodic service or inspection.
 - c. Insulation shall be vapor tight before applying PVC jacket and fitting covers. Verify suitability with manufacturer of insulation.
 - d. Provide pre-formed PVC valve and fitting covers for indoor piping.
 - e. Provide factory-fabricated aluminum valve and fitting covers for outdoor piping.
 - f. Provide Calcium Silicate rigid insulation and sheet metal sleeve, 18 inch minimum length at each pipe hanger. Seal ends of insulation to make vapor tight with jacket.
2. Below-Ambient Services Including Chilled Water Supply and Return and Refrigerant Piping:
- a. Insulate valves and irregular surfaces to match adjacent insulation and cover with two layers of woven glass fiber cloth saturated in Foster Sealfas 30-36, 3M, or equal, extending 3 inches over the adjoining pipe insulation. Finish with a coat of Foster Sealfas 30-36, 3M, or equal. The 3 inch wide SSL end laps furnished with the insulation shall be adhered over the end joints. Seal entire surface of insulation vapor tight, including joints and ends of PVC or aluminum fitting covers.
 - b. Variable refrigerant flow (VRF) heat pump systems: Insulation for VRF system refrigerant piping shall be installed according to VRF unit manufacturer's instructions.
3. PVC Jacket Installation:
- a. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications. Seal with manufacturer's recommended adhesive.
 - 1) Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.
4. Aluminum Jacket Installation:
- a. Where insulated piping is exposed to the weather apply aluminum jacket secured with 1/2 inch stainless-steel bands on 12 inch centers. Insulation shall be vapor tight

before applying metal jacket, and aluminum fitting covers. Install jacketing with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Cover fittings with glass cloth, two coats of Foster Sealfas 30-36, and factory-fabricated aluminum fitting covers, of same material, finish, and thickness as jacket. Insulation shall be vapor tight before applying metal jacket and fitting covers.

C. Duct Insulation Installation:

1. General:

- a. Insulation applied to the exterior surface of ducts located in buildings shall have a flame spread of not more than 25 and a smoke-developed rating of not more than 50 when tested as a composite installation including insulation, facing materials, tapes and adhesives as normally applied. Material exposed within ducts or plenum shall have a flame-spread rating of not more than 25 and a smoke-developed rating of not more than 50.
- b. Duct insulation applied to the exterior surface of ducts installed outside the building insulation envelope shall meet minimum R-value of R-8 at 3 inches thickness and 3/4 pound per cubic foot density.
- c. Duct insulation applied to the exterior surface of ducts installed within the building insulation envelope shall meet minimum R-value of R-4.2 at 1-1/2 inches thickness and 3/4 pound per cubic foot density.

2. Mineral Fiber Blanket Installation:

- a. Insulate all unlined concealed supply and return ducts with fiberglass duct wrap, manufactured as a blanket of glass fibers factory laminated to a reinforced foil/kraft vapor retarding facing. Provide 2 inch stapling and taping flange. Wrap insulation entirely around duct and secure with outward clinching staples on 6 inch centers. Provide mechanical fasteners at maximum 18 inch centers for all bottoms of duct which are greater than 24 inches. Lap all insulation joints 3" minimum. Insulate ducts installed tight against other work before hanging in place. Seal all seams, both longitudinal and transverse, and all staple and mechanical fastener penetrations of facing with scrim backed foil tape or recommended sealant, to provide a vapor tight installation.

3. PVC Jacket Installation:

- a. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications. Seal with manufacturer's recommended adhesive.
 - 1) Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

D. Equipment Insulation Installation:

1. General:

- a. Insulate pumps, coil u-bends where exposed outside airstream, air separators, heating hot water and chilled water storage tanks, and other elements that are in series with the fluid flow, according to the requirements of the California Energy Code.
2. Mineral-Fiber, Pipe and Tank Insulation Installation for Tanks and Vessels: Secure insulation with adhesive and anchor pins and speed washers.

- a. Apply adhesives according to manufacturer's recommended coverage rates per unit area, and for percent coverage of tank and vessel surfaces.
 - b. Groove and score insulation materials to fit as closely as possible to equipment, including contours. Bevel insulation edges for cylindrical surfaces for tight joints. Stagger end joints.
 - c. Protect exposed corners with secured corner angles.
 - d. Install adhesively attached or self-sticking insulation hangers and speed washers on sides of tanks and vessels as follows:
 - 1) Do not weld anchor pins to ASME-labeled pressure vessels.
 - 2) Select insulation hangers and adhesive that are compatible with service temperature and with substrate.
 - 3) On tanks and vessels, maximum anchor-pin spacing is 3 inches from insulation end joints, and 16 inches o.c. in both directions.
 - 4) Do not overcompress insulation during installation.
 - 5) Cut and miter insulation segments to fit curved sides and domed heads of tanks and vessels.
 - 6) Impale insulation over anchor pins and attach speed washers.
 - 7) Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
 - e. Secure each layer of insulation with stainless-steel or aluminum bands. Select band material compatible with insulation materials.
 - f. Where insulation hangers on equipment and vessels are not permitted or practical and where insulation support rings are not provided, install a girdle network for securing insulation. Stretch prestressed aircraft cable around the diameter of vessel and make taut with clamps, turnbuckles, or breather springs. Place one circumferential girdle around equipment approximately 6 inches from each end. Install wire or cable between two circumferential girdles 12 inches o.c. Install a wire ring around each end and around outer periphery of center openings, and stretch prestressed aircraft cable radially from the wire ring to nearest circumferential girdle. Install additional circumferential girdles along the body of equipment or tank at a minimum spacing of 48 inches o.c. Use this network for securing insulation with tie wire or bands.
 - g. Stagger joints between insulation layers at least 3 inches.
 - h. Install insulation in removable segments on equipment access doors, manholes, handholes, and other elements that require frequent removal for service and inspection.
 - i. Bevel and seal insulation ends around manholes, handholes, ASME stamps, and nameplates.
 - j. For equipment with surface temperatures below ambient, apply mastic to open ends, joints, seams, breaks, and punctures in insulation.
3. Flexible Elastomeric Thermal Insulation Installation for Tanks and Vessels: Install insulation over entire surface of tanks and vessels.
- a. Apply 100 percent coverage of adhesive to surface with manufacturer's recommended adhesive.

- b. Seal longitudinal seams and end joints.
- 4. Insulation Installation on Pumps:
 - a. Fabricate metal boxes lined with insulation. Fit boxes around pumps and coincide box joints with splits in pump casings. Fabricate joints with outward bolted flanges. Bolt flanges on 6-inch centers, starting at corners. Install 3/8-inch- diameter fasteners with wing nuts. Alternatively, secure the box sections together using a latching mechanism. Do not enclose or insulate pump motor.
 - b. Fabricate boxes from G90 galvanized steel, at least 0.050 inch thick.
 - c. For below ambient services, install a vapor barrier at seams, joints, and penetrations. Seal between flanges with replaceable gasket material to form a vapor barrier.
- 5. PVC Jacket Installation:
 - a. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive.
 - 1) Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.
- 6. Aluminum Jacket Installation:
 - a. Where aluminum jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

3.12 DUCTWORK SEALING AND LEAK TESTING

- A. All ductwork shall receive a Class A seal.
- B. Seal airtight all joints and seams, including standing seams and manufactured joints and seams, of all supply, return and exhaust ducts except those exposed in conditioned space.
- C. Leakage Classes:

<u>Pressure Class</u>	<u>Leakage Class</u>	
	<u>Round Duct</u>	<u>Rectangular Duct</u>
2"W.G. or less	8	16
4"W.G. or greater	2	4

- D. All duct systems (supply, return, outside air intake, and exhaust), except those identified on compliance forms on Drawings as requiring Acceptance Testing per the requirements of the California Energy Code, shall be tested in accordance with the requirements of SMACNA "HVAC Air Duct Leakage Test Manual." Test pressure shall be equal to the pressure class of the duct. For additional duct leak testing requirements, refer to Section 23 08 00.13, "Title 24 Commissioning of HVAC."

3.13 TEMPERATURE CONTROL SYSTEM INSTALLATION

- A. Provide thermostats where indicated on drawings. All wiring shall be in conduit. Provide all relays, transformers and the like to render the control system complete and fully operable. All control conduit to be rigid steel type.

3.14 EQUIPMENT START-UP

- A. Initial start-up of the systems and pumps shall be under the direct supervision of the Contractor.
- B. Equipment start-up shall not be performed until the piping systems have been flushed and treated and the initial water flow balance has been completed.
- C. It shall be the responsibility of the Contractor to assemble and supervise a start-up team consisting of controls contractor, start-up technician, and test and balance contractor; all to work in concert to assure that the systems are started, balanced, and operate in accordance with the design.
- D. After start-up is complete, instruct the Owner's personnel in the operation and maintenance of the systems. Obtain from the Owner's representative a signed memo certifying that instruction has been received.
- E. For additional requirements, refer to article, Check, Test and Start Requirements, in Section 23 00 50, Basic HVAC Materials and Methods.

3.15 TESTING AND BALANCING

- A. For testing and balancing requirements, refer to Section 23 05 93, Testing and Balancing for HVAC.

3.16 CLEANING AND PROTECTION

- A. As each duct section is installed, clean interior of ductwork of dust and debris. Clean external surfaces of foreign substances that might cause corrosive deterioration of metal or where ductwork is to be painted.
- B. Strip protective paper from stainless steel ductwork surfaces, and repair finish wherever it has been damaged.
- C. Temporary Closure: At ends of ducts that are not connected to equipment or air distribution devices at time of ductwork installation, provide temporary closure of polyethylene film or other covering that will prevent entrance of dust and debris until connections are to be completed.
- D. As each internally lined duct section is installed, check internal lining for small cuts, tears, or abrasions. Repair all damage with fire retardant adhesive.

3.17 EQUIPMENT MOUNTING

- A. Mount and anchor equipment in strict compliance with Drawings details. Alternate anchorage methods will not be considered for roof mounted equipment.

3.18 INDOOR PIPING INSULATION SCHEDULE

- A. Refrigerant Piping:

1. All pipe sizes: Insulation shall be one of the following:
 - a. Suction piping smaller than 1-1/2 inches diameter:
 - 1) Flexible Elastomeric: 1/2 inch thick.
 - 2) Mineral-Fiber, Preformed Pipe: 1/2 inch thick.
 - b. Suction piping 1-1/2 inches diameter and larger:
 - 1) Flexible Elastomeric: 1 inch thick.
 - 2) Mineral-Fiber, Preformed Pipe: 1 inch thick.
 - c. Suction piping for heat pump applications smaller than 1 inch diameter:
 - 1) Flexible Elastomeric: 1 inch thick.
 - 2) Mineral-Fiber, Preformed Pipe: 1 inch thick.
 - d. Suction piping for heat pump applications 1 inch and larger:
 - 1) Flexible Elastomeric: 1-1/2 inches thick.
 - 2) Mineral-Fiber, Preformed Pipe: 1-1/2 inches thick.
2. When equipment manufacturers' instructions indicate that refrigerant liquid and hot-gas gas piping be insulated, insulation thickness shall be equal to, and applied as described herein for refrigerant suction piping.

3.19 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

A. Refrigerant Suction and Hot-Gas Piping:

1. All Pipe Sizes: Insulation shall be one of the following:
 - a. Flexible Elastomeric: 1-1/2 inches thick.
 - b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1-1/2 inches thick.
2. When equipment manufacturers' instructions indicate that refrigerant liquid piping be insulated, insulation thickness shall be equal to, and applied as described herein for refrigerant suction piping.

3.20 INDOOR FIELD-APPLIED PIPING JACKET SCHEDULE

A. Piping, concealed: None.

B. Piping, exposed: PVC, 20 mils thick.

3.21 OUTDOOR FIELD-APPLIED PIPING JACKET SCHEDULE

A. All Piping: Aluminum, Stucco Embossed: Thickness as follows:

<u>Outer Insulation Diameter (Inches)</u>	<u>Minimum Aluminum Jacket Thickness (Inch)</u>	
	<u>Rigid Insulation</u>	<u>Non-Rigid Insulation (Note 1)</u>
8 and Smaller	0.024	0.024
Larger Than 8 Thru 11	0.024	0.024
Larger Than 11 Thru 24	0.024	0.024
Larger Than 24 Thru 36	0.024	0.032
Larger Than 36	0.024	0.040

1. Note 1: Non-rigid Insulation is defined as having a compressive strength of less than 15 psi.

3.22 INDOOR DUCT INSULATION SCHEDULE

- A. Minimum R-Value = R-4.2.
- B. Supply and Return Ducts: Mineral Fiber Blanket, 1-1/2 inches thick, 0.75 lb/cu. ft.

3.23 OUTDOOR DUCT INSULATION SCHEDULE.

- A. Refer to article, Ductwork, for internal duct lining. Provide 2 inches thick internal duct lining where indicated on Drawings.
- B. Refer to article, Ductwork, for double-wall ductwork with interstitial insulation.

3.24 INDOOR FIELD-APPLIED DUCT JACKET SCHEDULE

- A. Insulated ducts in concealed spaces: None.
- B. Insulated ducts in exposed unconditioned spaces: PVC, 20 mils thick.

3.25 ELECTRIC, RADIANT HEATERS

- A. Install radiant-heating panels level and plumb.
- B. Support Clips: Fasten to panel and to ceiling grid members at or near each panel corner with clips designed for the application.
- C. Operate electric-heating elements through each stage to verify proper operation and electrical connections.
- D. Test and adjust controls and safeties.
- E. Protect installed radiant-heating electric panels from damage during construction.
- F. Remove and replace damaged radiant-heating electric panels.

END OF SECTION

SECTION 26 00 10

BASIC ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Table of Contents, Division 26 - Electrical:

<u>SECTION NO.</u>	<u>SECTION TITLE</u>
260010	BASIC ELECTRICAL REQUIREMENTS
260060	POWER SYSTEM STUDY
260519	BUILDING WIRE AND CABLE
260526	GROUNDING AND BONDING
260529	ELECTRICAL HANGERS AND SUPPORTS
260531	CONDUIT
260533	BOXES
260543	UNDERGROUND DUCTS AND STRUCTURES
260553	ELECTRICAL IDENTIFICATION
260943	NETWORK ADDRESSABLE LIGHTING CONTROL
262413	SWITCHBOARDS
262416	PANELBOARDS
262726	WIRING DEVICES
262816	OVERCURRENT PROTECTIVE DEVICES
262819	DISCONNECT SWITCHES
263213	PACKAGED ENGINE GENERATOR SYSTEM
263623	TRANSFER SWITCHES
264313	SURGE PROTECTIVE DEVICES
265000	LIGHTING
266113	FIRE ALARM SYSTEM

B. Work included: This Section includes general administrative and procedural requirements for Division 26. The following administrative and procedural requirements are included in this Section to supplement the requirements specified in Division 01.

1. Quality assurance.
2. Definition of terms.
3. Submittals.
4. Coordination.
5. Record documents.
6. Operation and maintenance manuals.
7. Excavation.
8. Rough-in.
9. Electrical installation.
10. Cutting, patching, painting, and sealing.
11. Field quality control.
12. Cleaning.
13. Project closeout.

- C. Related Work: Consult all other Sections, determine the extent and character of related Work, and properly coordinate Work specified herein with that specified elsewhere to produce a complete and operable installation.
1. General and supplementary conditions: Drawings and general provisions of Contract and Division 01 of the Specifications, apply to all Division 26 Sections.
 2. Earthwork: Include trenching, backfilling, boring and soil compaction as required for the installation of underground conduit, in-grade pull boxes, vaults, lighting pole foundations, etc. Refer to Division 31, Earthwork.
 3. Concrete work: Include forming, steel bar reinforcing, cast-in-place concrete, finishing and grouting as required for underground conduit encasement, light pole foundations, pull box slabs, vaults, housekeeping pads, etc. Refer to Division 03, Concrete.
 4. Miscellaneous metal work: Include fittings, brackets, backing, supports, rods, welding and pipe as required for support and bracing of raceways, luminaires, panelboards, distribution boards, switchboards, motor control centers, etc. Refer to Division 05, Miscellaneous Metals.
 5. Miscellaneous lumber and framing work: Include wood grounds, nailers, blocking, fasteners and anchorage for support of electrical materials and equipment. Refer to Division 06, Rough Carpentry.
 6. Moisture protection and smoke barrier penetrations: Include membrane clamps, sheet metal flashing, counter flashing, caulking and sealant as required for waterproofing of conduit penetrations and sealing penetrations in or through fire walls, floors, ceiling slabs and foundation walls. All penetrations through vapor barriers at slabs on grade shall be taped and made vapor tight. Refer to Division 07, Thermal and Moisture Protection.
 7. Access panels and doors: Required in walls, ceilings, and floors to provide access to electrical devices and equipment. Refer to Division 08, Access Doors also, Division 05, Metals.
 8. Painting: Include surface preparation, priming and finish coating as required for electrical cabinets, exposed conduit, pull and junction boxes, etc. where indicated as field painted in this Division. Refer to Division 09, Painting.
 9. Luminaire supports: Provide slack support wire for luminaires installed in acoustical tile or lay-in suspended ceilings. Refer to Division 09, Acoustical Treatment.
- D. Work furnished and installed under another Division requiring connections under this Division includes but is not limited to:
1. Electric motors.
 2. Package mechanical equipment: fans, fan coil units, pumps, boilers, compressors, etc.
 3. Flow switches and valve monitors for sprinkler system.
 4. Temperature control panel(s). (Line voltage only)
 5. Irrigation controller(s). (Line voltage only)
 6. Kitchen equipment and appliances.
 7. Electric signage.
 8. Electric door locks.

- 9. Motorized roll down/sliding doors and grills.
- E. Items furnished under another Division, but installed and connected under this Division includes but is not limited to:
 - 1. Wall mounted control stations for motorized roll down and sliding doors.
 - 2. Electric fire sprinkler water flow bells.
 - 3. Speed control switches for ceiling exhaust fans.

1.2 QUALITY ASSURANCE

- A. Reference to Codes, Standards, Specifications and recommendations of technical societies, trade organizations and governmental agencies shall mean that latest edition of such publications adopted and published prior to submittal of the bid. Such codes or standards shall be considered a part of this Specification as though fully repeated herein.
- B. When codes, standards, regulations, etc. allow Work of lesser quality or extent than is specified under this Division, nothing in said codes shall be construed or inferred authority for reducing the quality, requirements, or extent of the Contract Documents. The Contract Documents address the minimum requirements for construction.
- C. Work shall be performed in accordance with all applicable requirements of the latest edition of all governing codes, rules and regulations including but not limited to the following minimum standards, whether statutory or not:
 - 1. California Electrical Code (CEC).
 - 2. California Building Code (CBC).
 - 3. California Fire Code (CFC).
 - 4. California Mechanical Code (CMC).
- D. Standards: Equipment and materials specified under this Division shall conform to the following standards where applicable:

ACI	American Concrete Institute
ANSI	American National Standards Institute
ASTM	American Society for Testing Materials
CBM	Certified Ballast Manufacturers
FS	Federal Specification
IEEE	Institute of Electrical and Electronics Engineers, Inc.
IPCEA	Insulated Power Cable Engineer Association
NEMA	National Electrical Manufacturer's Association
UL	Underwriters' Laboratories
- E. Independent Testing Agency qualifications:
 - 1. Testing Agency shall be an independent testing organization that will function as an unbiased authority, professionally independent of Manufacturer, Supplier and Contractor, furnishing and installing equipment or system evaluated by Testing Agency.
 - 2. Testing Agency shall be regularly engaged in the testing of electrical equipment, devices, installations, and systems.
 - 3. Testing Agency shall meet Federal Occupational Safety and Health Administration (OSHA) requirements for accreditation of independent testing laboratories, Title 9, Part 1907.

4. On-site technical personnel shall be currently certified by the International Electrical Testing Association in electrical power distribution system testing.
 5. Testing Agency shall use technicians who are regularly employed by the firm for testing services.
 6. Contractor shall submit proof of above Testing Agency qualifications with bid documentation upon request.
- F. All base material shall be ASTM and/or ANSI standards.
- G. All electrical apparatus furnished under this Section shall conform to NEMA standards and the CEC and bear the UL label where such label is applicable.
- H. Certify that each welder performing Work has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone re-certification.

1.3 DEFINITION OF TERMS

- A. The following list of terms as used in the Division 26 documents shall be defined as follows:
1. "Provide": Shall mean furnish, install, and connect unless otherwise indicated.
 2. "Furnish": Shall mean purchase and deliver to Project site.
 3. "Install": Shall mean to physically install the items in-place.
 4. "Connect": Shall mean make final electrical connections for a complete operating piece of equipment.
 5. "As directed": Shall be as directed by the Owner or their authorized Representative.
 6. "Utility Companies": Shall mean the company providing electrical, telephone or cable television services to the Project.

1.4 SUBMITTALS

- A. Format: Furnish submittal data in electronic format for each Specification Section with a table of contents listing materials by Section and paragraph number.
- B. Submittals shall consist of detailed Shop Drawings, Specifications, block wiring diagrams, "catalog cuts" and data sheets containing physical and dimensional information, performance data, electrical characteristics, materials used in fabrication and material finish. Clearly indicate by arrows or brackets precisely what is being submitted on and those optional accessories which are included and those which are excluded. Furnish quantities of each submittal as noted in Division 01.
- C. Each submittal shall be labeled with the Specification Section Number and shall be accompanied by a cover letter or shall bear a stamp stating that the submittal has been thoroughly reviewed by the Contractor and is in full compliance with the requirements of the Contract Documents or provide a Specification Section line-by-line compliance response statement with detailed exception/ deviation response statements for all applicable provisions for the applicable Specification Section. Any Specification Section lines without a detailed exception/ deviation response statement shall be treated as the Contractor or Vendor is submitting in full compliance with the applicable Specification Section requirements. Cover letters

shall list in full the items and data submitted. Failure to comply with this requirement shall constitute grounds for rejection of data.

- D. The Contractor shall submit detailed Drawings of all electrical equipment rooms and closets if the proposed installation layout differs from the construction documents. Physical size of electrical equipment indicated on the Drawings shall match those of the electrical equipment that is being submitted for review, i.e.: switchboards, panelboards, transformers, control panels, etc. Minimum scale: 1/4" = 1'- 0". Revised electrical equipment layouts must be approved prior to release of order for equipment and prior to installation.
- E. As part of the equipment and fixture submittals, the Contractor shall provide anchorage calculations for floor and wall mounted electrical equipment and fixtures, distribution conduits and raceways, in conformance with the latest edition of the California Building Code (CBC) and ASCE 7. Use the Occupancy Category, Ground Accelerations, Site Class, Seismic Design Category, and Seismic Importance Factor as noted in the structural drawings. For components required for Life Safety or containing hazardous materials use $I_p=1.5$. Structural Calculations shall be prepared, stamped, and signed by a California Registered Structural Engineer. Specify proof loads for drilled-in anchors, if used.
- F. The Manufacturer shall recommend the method of anchoring the equipment to the mounting surface and shall provide the Contractor with the assembly dimensions, weights, and approximate centers of gravity.
- G. Review of submittals is for general conformance to design concept and general compliance with the Specification Sections. Submittal Review Comments do not imply waiver of Specifications Section requirements unless specifically noted.
- H. All resubmittals shall include a cover letter that lists the action taken and revisions made to each Drawing and equipment data sheet in response to Submittal Review Comments. Resubmittal packages will not be reviewed unless accompanied by this cover letter. Failure to include this cover letter will constitute rejection of the resubmittal package.
- I. Shop Drawings for the following systems must be prepared via a building information modeling (Revit) system for submission by the Contractor. The Engineer can provide Revit files of the electrical Contract Documents to the Contractor.
 - 1. Fire alarm system, Section 266113.
- J. Independent Testing Agency report:
 - 1. Testing Agency shall provide 3 copies of the complete testing report.
 - 2. Test report shall include the following:
 - a. Summary of Project.
 - b. Description of equipment.
 - c. Equipment used to conduct the test.
 - 1) Type.
 - 2) Manufacturer.
 - 3) Model number.
 - 4) Serial number.
 - 5) Date of last calibration.

- 6) Documentation of calibration leading to NIST standards.
- d. Description of test.
- e. Test results, as compared to Manufacturers or industry accepted standards and tolerances.
- f. Conclusion and recommendation.
- g. Signature of responsible test organization authority.
3. Furnish completed test report to Engineer no later than 30-days after completion of testing, unless otherwise directed.

K. Substitutions:

1. All requests for substitutions shall conform to the general requirements and procedure outlined in Division 01.
2. Where items are noted as "or equal," a product of equal design, construction and performance will be considered. Contractor must submit to the Engineer all pertinent test data, catalog cuts and product information required substantiating that the product is in fact equal to that specified. Only one substitution will be considered for each product specified.
3. Manufacturers' names and model numbers used in conjunction with materials, processes or equipment included in the Contract Documents are used to establish standards of quality, utility, and appearance. Materials, processes, or equipment, which in the opinion of the Engineer is equal in quality, utility, and appearance, will be approved as substitutions to that specified.
4. Whenever any material, process or equipment is specified in accordance with a Federal specification, an ASTM standard, an ANSI specification, UL rating or other association standard, the Contractor shall present an affidavit from the Manufacturer certifying that the product complies with the particular standard specification. When requested by the Engineer, support test data to substantiate compliance shall be submitted by the Contractor at no additional cost.
5. Substitutions shall be equal, in the opinion of the Architect/Engineer, to the specified product. The burden of proof of such shall rest with the Contractor. When the Architect/Engineer in writing accepts a substitution, it is with the understanding that the Contractor guaranteed the substituted article or material to be equal to the one specified and dimensioned to fit within the construction. Approved substitutions shall not relieve the Contractor of responsibilities for the proper execution of the Work or from any provisions of the Specifications.
6. The Contractor shall be responsible for all expenses in connection with the substitution materials, processes, and equipment, including the effect of the substitution on the Contractor, Subcontractor's, or other Contractor's Work. No substitution of material, processes or equipment shall be permitted without written authorization of the Architect/Engineer. Any assumptions on the acceptability of a proposed substitution prior to acceptance by the Engineer are at the sole risk of the Contractor.

1.5 COORDINATION

A. Discrepancies:

1. In the event of discrepancies within the Contract Documents, the Engineer shall be so notified, within sufficient time, as delineated in Division 01, prior to the Bid Opening to allow the issuance of an Addendum.
2. If, in the event that time does not permit notification or clarification of discrepancies prior to the Bid Opening, the following shall apply: The Drawings govern in matters of quantity and the Specifications govern in matters of quality. In the event of conflict within the Drawings involving quantities or within the Specifications involving quantities or within the Specifications involving quality, the greater quantity and higher quality shall apply. Such discrepancies shall be noted and clarified in the Contractor's Bid. No additional allowances will be made because of errors, ambiguities or omissions that reasonably should have been discovered during the preparation of the Bid.

B. Project conditions:

1. Examination of Project site: The Contractor shall visit the Project site and thoroughly review the locale, working conditions, conflicting utilities, and the conditions in which the Electrical Work will take place. Verify all existing conditions in the field. No allowances will be made subsequently for any costs that may be incurred because of any error or omission due to failure to examine the Project site and to notify the Engineer of any discrepancies between Contract Documents and actual Project site conditions.
2. Protection: Keep conduits, junction boxes, outlet boxes and other openings closed to prevent entry of foreign matter. Cover fixtures, equipment, devices, and apparatus and protect them against dirt, paint, water, chemical or mechanical damage, before and during construction period. Prior to final acceptance, restore to original condition any fixture, apparatus or equipment damaged including restoration of damaged factory applied painted finishes. Protect bright finished surfaces and similar items until in service. No rust or damage will be permitted.
3. Supervision: Contractor shall personally or through an authorized and competent representative constantly supervise the Work from beginning to completion and, within reason, keep the same foreman and workmen on the Project throughout the Project duration.

C. Preparation:

1. Drawings:
 - a. Layout: General layout indicated on the Drawings shall be followed except where other Work may conflict with the Drawings.
 - b. Accuracy: Drawings for the Work under this Section are essentially diagrammatic within the constraints of the symbology applied.

1.6 RECORD DOCUMENTS

A. Provide Project Record Drawings as described herein:

1. Drawings shall fully represent installed conditions including actual locations of outlets, true panelboard connections following phase balancing routines, correct conduit, and wire sizing as well as routing, revised luminaire schedule listing Manufacturers and products installed and revised panel schedules. Contractor shall record all changes in the Work during the course of construction on blue or black line prints. These prints shall be made subject of monthly review by the

Owner's Representative to ascertain that they are current. If not current, monthly payments may be withheld.

2. Record Drawings shall be the transfer of information on these prints to the construction documents via building information modeling (Revit) process. A set of Revit files of the electrical construction documents will be provided to the Contractor by the Engineer
 3. Record drawing submissions shall be provided to the Engineer to review upon the completion of the following phases of Work:
 - a. All underground installation.
 - b. Building electrical rough-in.
 - c. Final electrical installation.
 4. Include in the record drawing submission the following shop drawing submission with all updated installation information:
 - a. Fire alarm system.
 5. A single set of half size prints of the Record Drawings shall be submitted for review. Upon receipt of the Engineer's review comments, corrections shall be made, and the Contractor shall provide the following:
 - a. Electronic files of Drawings in PDF and Revit.
- B. Panel schedules:
1. Typewritten panel schedules shall be provided for panelboards indicating the loads served and the correct branch circuit number. Schedules shall be prepared on forms provided by the Manufacturer and inserted in the pocket of the inner door of each panelboard. See Section 262416: Panelboards for requirements.
- C. Field labels, markings, and warning signs: Provide in accordance and as required by:
1. General: CEC Article 110.21.
 2. Arc-Flash Hazard Warning: CEC Article 110.16 (A).
 3. Identification of Disconnecting Means: CEC Article 110.22 (A).
 4. Available Fault Current: CEC Article 110.24.
 5. Guarding of Live Parts: CEC Article 110.27 (C).
 6. Locked Rooms or Enclosures: CEC Article 110.34 (C).

1.7 OPERATION AND MAINTENANCE MANUALS

- A. Prior to Project closeout furnish to the Owner, six (6) hard back 3-ring binders containing all bulletins, operation and maintenance instructions, part lists, service telephone numbers and other pertinent information as noted in each Section all equipment furnished under Division 26. Binders shall be indexed into Division Sections and labeled for easy reference. Bulletins containing more information than the equipment concerned shall be properly stripped and assembled.

PART 2 - PRODUCTS (NOT APPLICABLE)

PART 3 - EXECUTION

3.1 EXCAVATION

- A. General: Cutting and digging shall be under the direct supervision of the General Contractor and included as necessary for the Work of this Section.
- B. Excavation for underground vaults and electrical structures: Conform to elevations and dimensions indicated within a tolerance of plus or minus 0.10-foot; plus, a sufficient distance to permit placing and removal of concrete formwork, installation or services, other construction and for inspection.
 - 1. Excavate, by hand, areas within dripline of large trees. Protect the root system for damage and dry-out. Maintain moist conditions for root system and over exposed roots with burlap. Paint root cuts of 1 inch in diameter and larger with emulsified asphalt tree paint.
 - 2. Take care not to disturb bottom of excavation. Excavate by hand to final grade just before concrete reinforcement is placed.
- C. Trenching: Excavate trenches for electrical installation as follows:
 - 1. Excavate trenches to the uniform width, sufficiently wide to provide ample working room and a minimum of 6 to 9 inches clearances on both side of raceways and equipment.
 - 2. Excavate trenches to depth indicated or required.
 - 3. Limit the length of open trench to that in which installations can be made and the trench backfilled within the same day.
 - 4. Where rock is encountered, carry excavation below required elevation and backfill with a layer of crushed stone or gravel prior to installation of raceways and equipment. Provide a minimum of 6 inches of stone or gravel cushion between rock bearing surface and electrical installations.
- D. Backfilling: Place soil materials in layers to required subgrade elevations for each area classification, using materials and methods specified in Division 31, Earthwork.
 - 1. Under building slabs, use drainage fill materials.

3.2 ROUGH-IN

- A. Contractor shall verify lines, levels and dimensions indicated on the Drawings and shall be responsible for the accuracy of the setting out of Work and for its strict conformance with existing conditions at the Project site.
- B. Verify final locations for rough ins with field measurements and with the requirements for the actual equipment to be connected.
- C. Refer to equipment specification in Divisions 22 through 33 for rough-in requirements.

3.3 ELECTRICAL INSTALLATION

- A. Preparation, sequencing, handling, and installation shall be in accordance with Manufacturer's written instructions and technical data particular to the product specified and/or accepted equal except as otherwise specified. Comply with the following requirements:
 - 1. Shop Drawings prepared by Manufacturer.

2. Verify all dimensions by field measurements.
3. Arrange for chases, slots, and openings in other building components during progress of construction, to allow for electrical installations.
4. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components, as they are constructed.
5. Sequence, coordinate and integrate installations of electrical materials and equipment for efficient flow of the Work. Give attention to large equipment requiring positioning prior to closing in the building.
6. Where mounting height is not detailed or dimensioned, contact the Architect for direction prior to proceeding with rough-in.
7. Coordinate connection of electrical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies and controlling agencies. Provide required connection for each service.
8. Install systems, materials, and equipment to conform with approved submittal data, including coordination Drawings, to greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that portions of the Work are indicated only in diagrammatic form. Where coordination requirements conflict with individual system requirements, refer conflict to the Architect.
9. Install systems, materials, and equipment level and plumb, parallel, and perpendicular to other building systems and components, where installed exposed in finished spaces.
10. Install electrical equipment to facilitate servicing, maintenance and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations.
11. Coordinate electrical systems, equipment, and materials installations with other building components.
12. Provide access panel or doors where devices or equipment are concealed behind finished surfaces. Furnish and install access doors per the requirements of Division 08.
13. Install systems, materials and equipment giving right-of-way priority to other systems that are required to maintain a specified slope.
14. Conform to the National Electrical Contractors Association "Standard of Installation" for general installation practice.

3.4 CUTTING, PATCHING, PAINTING AND SEALING

- A. Structural members shall in no case be drilled, bored, or notched in such a manner that will impair their structural value. Cutting of holes, if required, shall be done with core drill and only with the approval of the Architect and Structural Engineer.
- B. Protection of Installed Work: During cutting and patching operations, protect adjacent installations.
- C. Application of joint sealers:

1. General: Comply with joint sealer Manufacturers' printed application instructions applicable to products and applications indicated, except where more stringent requirements apply.
2. Installation of fire-stopping sealant: Install sealant, including forming, packing and other accessory materials, to fill openings around electrical services penetrating floors and walls, to provide fire-stops and fire-resistance ratings indicated for floor or wall assembly in which penetration occurs. Comply with installation requirements established by testing and inspecting agency.

3.5 FIELD QUALITY CONTROL

A. General testing requirements:

1. The purpose of testing is to ensure that all tested electrical equipment, both Contractor and Owner supplied, is operational and within industry and Manufacturer's tolerances and is installed in accordance with design Specifications.
2. Tests and inspections shall determine suitability for energization.
3. Perform tests in presence of the Owner's Representative and furnish test equipment, facilities and technical personnel required to perform tests.
4. Tests shall be conducted during the construction period and at completion to determine conformity with applicable codes and with these Specifications.

B. Tests: In addition to specific system test described elsewhere, tests shall include:

1. Equipment operations: Test motors for correct operation and rotation.
2. Lighting control circuits: Test lighting circuits for correct operation through their control devices.
3. Alarm and interlock systems: Produce malfunction symptoms in operating systems to test alarm and interlock systems. In addition, all specific tests described in the fire alarm system shall be performed.
4. Circuit numbering verification: Select on a random basis, various circuit breakers within the panelboards and cycle them on and off to verify compliance of the typed panel directories with actual field wiring.
5. Voltage check:
 - a. At completion of job, check voltage at several points of utilization on the system that has been installed under this Contract. During test, energize all installed loads.
 - b. If proper voltage cannot be obtained, inform the Owner and the serving Utility Company.

C. Contractor shall provide test power required when testing equipment before service energization and coordinate availability of test power with General Contractor after service energization. The Contractor shall provide any specialized test power as needed or specified herein.

D. Testing safety and precautions:

1. Safety practices shall include the following requirements:
 - a. Applicable State and Local safety operating procedures.
 - b. OSHA.

- c. NSC.
 - d. NFPA 70E.
- 2. All tests shall be performed with apparatus de-energized and grounded except where otherwise specifically required ungrounded by test procedure.
- E. Calibration of test equipment:
 - 1. Testing Agency shall have calibration program that assures test instruments are maintained within rated accuracy.
 - 2. Instruments shall be calibrated in accordance with the following frequency schedule:
 - a. Field instruments: Analog, 6-months maximum; Digital, 12-months maximum.
 - b. Laboratory instruments: 12-months.
 - c. Leased specialty equipment: 12-months where accuracy is guaranteed by lessor.
 - 3. Dated calibration labels shall be visible on test equipment.
 - 4. Records, which show date and results of instruments calibrated or tested, must be kept up to date.
 - 5. Up-to-date instrument calibration instructions and procedures shall be maintained for test instrument.
 - 6. Calibration standards shall be of higher accuracy than instrument tested.
 - 7. Equipment used for field testing shall be more accurate than instrument being tested.
- F. Coordinate with General Contractor regarding testing schedule and availability of equipment ready for testing.
- G. Notify Owner and Engineer one week in advance of any testing.
- H. Any products which fail during the tests or are ruled unsatisfactory by the Owner's Representative shall be replaced, repaired, or corrected as prescribed by the Owner's Representative at the expense of the Contractor. Tests shall be performed after repairs, replacements or corrections until satisfactory performance is demonstrated.
- I. Testing Agency shall maintain written record of tests and shall assemble and certify final test report.
- J. Include all test results in the maintenance manuals.

3.6 CLEANING

- A. Prior to energizing of electrical equipment, the Contractor shall thoroughly clean the interior of enclosures from construction debris, scrap wire, etc. using Manufacturer's approved methods and materials.
- B. Upon completion of Project, prior to final acceptance, the Contractor shall thoroughly clean both the interior and exterior of all electrical equipment per Manufacturers approved methods and materials. Remove paint splatters and other spots, dirt, and debris.

- C. Touch-up paint any marks, blemishes or other finish damage suffered during installation.

3.7 PROJECT CLOSEOUT

- A. Training: At the time of completion, a period of not less than 4-hours shall be allotted by the Contractor for instruction of building operating and maintenance personnel in the use of all systems. This 4-hour training is in addition to any instruction time called out in the Specifications for specific systems, i.e., Fire Alarm, Generator, etc. All personnel shall be instructed at one time, the Contractor making all necessary arrangements with Manufacturer's Representative. The equipment Manufacturer shall be requested to provide product literature and application guides for the users' reference. Costs, if any, for the above services shall be paid by the Contractor.
- B. Special tools: Provide one of each tool type required for proper operation and maintenance of the equipment provided under this Section. All tools shall be delivered to the Owner at the Project completion.
- C. Keying: Provide two keys for each lock furnished under this Section and turn over to Owner.

END OF SECTION

SECTION 26 00 60
POWER SYSTEM STUDY

PART 1 - GENERAL

1.1 SUMMARY

- A. Work included: Services necessary to complete the system analysis studies required for the item specified under this Division, including but not limited to:
 - 1. Short circuit study.
 - 2. Protective device evaluation study.
 - 3. Protective device coordination study.
 - 4. Arc flash and shock risk assessment.
- B. Related Work: Consult all other Sections, determine the extent and character of related Work, and properly coordinate Work specified herein with equipment specified elsewhere to perform a complete analysis study.

1.2 REFERENCES

- A. Comply with the latest edition of the following applicable Specifications and standards except as otherwise indicated or specified:
 - 1. American National Standards Institute, Inc. (ANSI):
ANSI Z535.4; Product Safety Signs and Labels
 - 2. Institute of Electrical and Electronic Engineers (IEEE):
IEEE 1584; Guide for Performing Arc-Flash Hazard Calculations
 - 3. National Fire Protection Association (NFPA):
NFPA 70E; Standard for Electrical Safety in the Workplace

1.3 SUBMITTALS

- A. Submit in accordance with the requirements of Section 260010: Basic Electrical Requirements, the following items:
 - 1. The results of the Power System Study shall be summarized in a final report. Three (3) bound copies of the final report shall be submitted.
 - 2. The report shall include the following Sections:
 - a. Description, purpose, basis and scope of the study and a single line diagram of that portion of the power system, which is included within the scope of the study.
 - b. Tabulations of circuit breaker, fuse and other protective device ratings versus calculated short circuit duties and commentary regarding it.
 - c. Protective device time versus current coordination curves, tabulations of relay and circuit breaker trip settings, fuse selection and commentary regarding it.
 - d. Fault current calculations including a definition of terms and guide for interpretation of computer printout.

- e. Recommended size for power fuses and recommended settings for ground fault relays and for all adjustable trip relays.
 - f. Confirmation in writing of compliance with Arc Energy Reduction per CEC Articles 240.67 and 240.87.
 - g. Confirmation in writing of compliance with all CEC mandated selective coordination requirements (e.g. CEC Articles 517, 620, 645, 695, 700, 701, and 708) associated with this project. Include manufacturer selective coordination tables, etc. for documentation to be submitted to the Authority Having Jurisdiction (AHJ).
 - h. Tabulations of arc flash and shock risk assessment results and commentary regarding results.
 - i. Sample arc flash and shock hazard warning label.
- 3. Contractor shall also provide an electronic copy of the report as part of the Record Document process. Electronic copy of the report shall be in PDF format and its native file format (e.g. XXX.PRJ).
- B. The study shall be submitted prior to final review of the distribution equipment Shop Drawings, prior to release of equipment for manufacture. If formal completion of the study may cause delay in equipment manufacture, approval from the Architect may be obtained for a preliminary submittal of sufficient data to ensure that the selection of device ratings and characteristics will be satisfactory. Then the formal study will be provided to verify the preliminary findings.

1.4 QUALITY ASSURANCE

- A. The system analysis studies shall be performed by the Switchboard/Switchgear Manufacturer or by an approved Independent Testing Company. The analysis shall be stamped by a professional engineer licensed in the State of California.

PART 2 - PRODUCTS (NOT APPLICABLE)

PART 3 - EXECUTION

3.1 GENERAL

- A. The studies shall include all portions of the electrical distribution system from the main normal power services down to and including the 208 volt AC distribution system. Normal system connections and those that result in maximum fault conditions shall be adequately covered in the study.

3.2 SHORT CIRCUIT STUDY AND PROTECTIVE DEVICE EVALUATION STUDY

- A. The short circuit study shall be performed with the aid of a computer program and shall be in accordance with the latest applicable IEEE and ANSI standards.
- B. The study input data shall include the maximum available short circuit contribution, resistance and reactance components of the branch impedance, the X/R ratios, base quantities selected and other source impedance.
- C. Short circuit close and latch duty values and interrupting duty values shall be calculated on the basis of maximum available current at each substation bus,

switchgear bus, medium voltage controller, switchboard, low voltage motor control center, distribution panelboard, pertinent branch circuit panel and other significant locations through the system. The short circuit tabulations shall include asymmetrical fault currents, symmetrical fault currents and X/R ratios. For each fault location, the total duty on the bus, as well as the individual contribution from each connected branch, shall be listed with its respective X/R ratio.

- D. A protective device evaluation study shall be performed to determine the adequacy of circuit breakers, switches, transfer switches and fuses by tabulating and comparing the short circuit ratings of these devices with the calculated fault currents. Appropriate multiplying factors based on system X/R ratios and protective device rating standards shall be applied. Any problem areas or inadequacies in the equipment due to short circuit currents shall be promptly brought to the Architect's attention.

3.3 PROTECTIVE DEVICE COORDINATION STUDY

- A. A protective device coordination study shall be performed to provide the necessary calculations and logic decisions required to select or to check the selection of power fuse ratings, protective relay characteristics and settings, ratios and characteristics of associated current transformers, ground fault relays and low voltage breaker trip characteristics and settings. The studies shall be in accordance with the latest applicable IEEE and ANSI standards.
- B. The coordination study shall include all medium and low-voltage classes of equipment from the building or plant service protective devices down to and including low voltage motor control centers and panelboards. The phase and ground overcurrent protection shall be included as well as settings of all other adjustable protective devices
- C. The time-current characteristics of the specified protective devices shall be drawn on log-log paper. The plots shall include complete titles, representative one-line diagram and legends, significant motor starting characteristics, complete parameters of transformers, complete operating bands of low voltage circuit breaker trip curves and fuses, phase cable damage curves, ground cable damage curves, medium-voltage cable shield damage curves, ground resistor damage curves, etc. as appropriate for the project. The coordination plots shall indicate the types of protective devices selected, proposed relay taps, time dial and instantaneous trip settings, transformer magnetizing inrush and ANSI transformer withstand parameters, cable thermal overcurrent withstand limits and significant symmetrical and asymmetrical fault currents. All restrictions of the National Electrical Code shall be adhered to and proper coordination intervals and separation of characteristic curves shall be maintained. The coordination plots for phase and ground protective devices shall be provided on a system basis. A sufficient number of separate curves shall be used to clearly indicate the coordination achieved.
- D. The selection and settings of the protective devices shall be provided separately in a tabulated form listing circuit identification, IEEE device number, current transformer ratios and connection, Manufacturer and type, range of adjustment and recommended settings. A tabulation of the recommended power fuse selection shall be provided for the medium voltage fuses where applied in the system. Any discrepancies, problem areas or inadequacies shall be promptly brought to the Architect's attention.
- E. The company performing the protective device coordination study shall provide completed and filled out circuit breaker settings labels. Label type (size, colors, text size, etc.) shall be approved by the Owner. Labels shall be similar to the following

example with industrial grade self-adhesive backing, weatherproof, and UV proof. Labels shall be provided to the commissioning agent for the commissioning agent to install during commissioning.

CIRCUIT BREAKER SETTINGS			
T/U Mfr:		T/U Model:	
LTPU:		LTD:	
STPU:		STD:	
GFPU:		GFTD:	
INST:		Zone Intlk: (Y/N)	
Name:		Date:	
Verified By:		Date:	
Study Version:			

3.4 ARC FLASH AND SHOCK RISK ASSESSMENT

- A. An arc flash and shock risk assessment shall be performed in accordance with NFPA 70E (utilizing IEEE 1584 calculation method for incident energy analysis method) at each switchboard, distribution board, panelboard, etc. in accordance with the referenced standards. NFPA 70E hazard/ risk tables for arc flash PPE category method are not acceptable for compliance with this section.
- B. The arc flash and shock risk assessment shall include all voltage classes of equipment from the service entrance down to and including the panelboards, etc. in addition to all possible scenario configurations from alternate power sources (e.g. generators, etc.).
- C. The company performing the arc flash and shock risk assessment shall provide arc flash and shock hazard warning labels for all equipment evaluated in accordance with NFPA 70E and ANSI Z535.4. Labeling shall be as follows:
 1. Label type:
 - a. White vinyl or polyester with the following warning symbol color and black text:
 - 1) Incident energy below 40 cal/cm² = Orange.
 - 2) Incident energy for 40 cal/cm² and above = Red with DANGER symbol in lieu of WARNING.
 - b. Industrial grade self-adhesive backing.
 - c. Suitable for indoor or outdoor environments for a minimum of 3-years without fading or degrading.
 2. Label information (minimum):
 - a. Nominal system voltage.
 - b. Arc flash boundary (inches).
 - c. Available incident energy and the corresponding working distance (inches).
 - d. Limited approach boundary (inches).
 - e. Restricted approach boundary (inches).
 - f. Equipment identification.
 - g. Date.

3. Labels shall be affixed to all equipment covered under the risk assessment by the company performing the arc flash and shock risk assessment.
4. Prior to printing and affixing labels, coordinate with the Owner and Architect, which scenario will be used for the labels.

3.5 PROTECTIVE DEVICE TESTING, CALIBRATION AND ADJUSTMENT

- A. The equipment Manufacturer shall provide the services of a qualified field Engineer and necessary tools and equipment to test and calibrate the protective relays, ground fault relays and circuit breaker trip devices as recommended in the Power System Study.

END OF SECTION

SECTION 26 05 19
BUILDING WIRE AND CABLE

PART 1 - GENERAL

1.1 SUMMARY

- A. Work included: Labor, materials, and equipment necessary to complete the installation required for the item specified under this Division, including but not limited to:
 - 1. Building wire.
 - 2. Cable.
 - 3. Wiring connections and terminations.
- B. Related Work: Consult all other Sections, determine the extent and character of related Work, and properly coordinate Work specified herein with that specified elsewhere to produce a complete installation.

1.2 REFERENCES

- A. Comply with the latest edition of the following applicable Specifications and standards except as otherwise indicated or specified:
 - 1. Underwriters Laboratories, Inc. (UL):
 - UL 44; Thermoset-Insulated Wires and Cables.
 - UL 62; Flexible Cord and Fixture Wire.
 - UL 83; Thermoplastic-Insulated Wires and Cables.
 - UL 183; Manufactured Wiring Systems.
 - UL 310; Electrical Quick-Connect Terminals.
 - UL 486A & B; Wire Connectors.
 - UL 486C; Splicing Wire Connectors.
 - UL 486D; Insulated Wire Connector Systems for Underground Use or in Damp or Wet Locations.
 - UL 493; Thermoplastic-Insulated Underground Feeder and Branch Circuit Cables.
 - UL 510; Polyvinyl Chloride, Polyethylene and Rubber Insulating Tape.
 - UL 854; Service-Entrance Cables.
 - UL 1569; Metal-Clad Cables.
 - UL 1581; Reference Standard for Electrical Wires, Cables and Flexible Cords.
 - UL 2196; Standard for Tests of Fire Resistive Cables.
 - 2. National Electrical Manufacturer Association (NEMA):

NEMA WC-70; Power Cables Rated 2,000 V or Less for the Distribution of Electrical Energy.

3. Institute of Electrical and Electronic Engineers (IEEE):

IEEE 82; Test Procedure for Impulse Voltage Tests on Insulated Conductors.

IEEE 576; Recommended Practice for Installation, Termination, and Testing of Insulated Power Cable as Used in Industrial and Commercial Applications.

1.3 SUBMITTALS

A. Submit in accordance with the requirements of Section 260010: Basic Electrical Requirements, the following items:

1. Data/catalog cuts for each product and component specified herein, listing all physical and electrical characteristics and ratings indicating compliance with all listed standards.
2. Clearly mark on each data sheet the specific item(s) being submitted and the proposed application.
3. Submit Manufacturer's installation instructions.
4. Final test results.

1.4 QUALITY ASSURANCE

- A. All materials, equipment and parts comprising the units specified herein shall be new, unused, and currently under production.
- B. Only products and applications listed in this Section may be used on the Project unless otherwise submitted.
- C. Independent Testing Agency qualifications: Refer to Section 260010: Basic Electrical Requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Products furnished by the following Manufacturers shall be acceptable if in compliance with all features specified herein and indicated on the Drawings.

1. Building wire:
 - a. Cerrowire
 - b. General Cable
 - c. Southwire Company
 - d. Stabiloy (aluminum only)
 - e. United Wire and Cable
2. Metal-clad cable:
 - a. AFC Cable Systems
 - b. AFC Cable Systems – MC Luminary Cable (0-10V)

- c. Southwire Company
 - 3. Flexible cords and cables:
 - a. Carol Cable Company
 - b. Cerrowire
 - c. PWC Corp
 - 4. Wiring connectors and terminations:
 - a. 3M Company.
 - b. Ideal.
 - c. Blackburn-Holub.
 - d. Burndy.
 - e. Thomas & Betts Corp.
 - f. Beau Barrier.
 - B. Substitutions: Under provisions of Section 260010: Basic Electrical Requirements.
- 2.2 BUILDING WIRE
- A. Conductor material:
 - 1. Provide annealed copper for all wire, conductor, and cable, unless otherwise indicated.
 - 2. Copper wire AWG #8 and larger shall be stranded, unless otherwise indicated.
 - 3. Copper wire AWG #10 and smaller may be solid or stranded as best suited for the installation.
 - B. Insulation material:
 - 1. All insulated wire, conductor and cable shall be 600 volt rated, unless otherwise noted on the Drawings.
 - 2. Thermoplastic-insulated building wire.
 - 3. Rubber-insulated building wire.
 - 4. Copper feeders and branch circuits larger than #6 AWG: Type THW, XHHW or dual rated THHN/THWN.
 - 5. Copper feeders and branch circuits #6 AWG and smaller: Type TW, THW, XHHW or dual rated THHN/THWN.
 - 6. Control Circuits: Type THW or dual rated THHN/THWN.
 - 7. Identify system conductors as to voltage and phase connections by means of color-impregnated insulation.
- 2.3 METAL-CLAD CABLE (MC)
- A. MC cable shall be an armored assembly of two or more dual rated THHN/THWN annealed copper conductors with a full sized green insulated ground wire.

- B. MC cable shall be an armored assembly of two or more dual rated THHN/THWN annealed copper conductors rated below 100 amps with a full sized green insulated ground wire.
- C. MC cable sheath shall be fabricated in continuous lengths from galvanized aluminum strips, spirally wound and formed to provide an interlocking design.
- D. Conductors shall be color-coded for the correct phase and voltage as specified herein.
- E. Fittings: Connectors shall be of the single screw clamp variety with steel or cast malleable iron bodies and threaded male hubs with insulated throats. Fittings shall be UL listed for use with MC cable type specified.
- F. Luminary Cable:
 - 1. MC cable used for 0-10 volt signal wiring for lighting dimming applications shall have the 0-10 volt wires twisted at a different twist ratio than that of the current carrying conductors.
 - 2. Provide violet / pink insulation coloring for 0-10 volt conductors.

2.4 FLEXIBLE CORDS AND CABLES (TYPE'S')

- A. Provide flexible cords and cables of size, type and arrangement as indicated on the Drawings.
- B. Type 'S' flexible cords and cables shall be manufactured in accordance with CEC Article 400 and composed of two or more conductors and a full size green insulated ground wire with an outer jacket of rubber or neoprene as noted.
- C. Flexible cords and cables shall be fitted with wire mesh strain relief grips either as an integral component of the connector or as an independently supported unit.
- D. Suspended flexible cords and cables shall incorporate safety spring(s) unless otherwise noted.

2.5 WIRING CONNECTIONS AND TERMINATIONS

- A. Bolted pressure connectors: Provide wide range-taking connectors with cast bronze compression bolts, designed for parallel taps, tees, crosses or end-to-end connections.
- B. Electrical spring wire connectors:
 - 1. Provide multi-part construction incorporating a non-restricted, zinc coated square cross-section steel spring enclosed in a steel sheet with an outer jacket of plastic and insulating skirt.
 - 2. Self-striping pigtail and tap U-contact connectors shall not be used.
- C. Push-in wire connectors:
 - 1. Multi-port push-in wire connectors for a maximum of 8-wires, as required for specific application. Connectors are manufactured to accommodate a wide range of sizes with either solid or stranded conductors, up to a maximum wire size of #10 AWG. Low insertion force required for ease of installation.

2. Housing shall be 105-degrees C and transparent for visual connection verification.
 3. 600 volt maximum rating with copper contacts.
 4. UL Listed to 486C and UL 467 Listed for grounding and bonding applications.
- D. Compression type terminating lugs:
1. Provide tin-plated copper high-compression type lugs for installation with hand or hydraulically operated circumference-crimping tools and dies as stipulated by the lug Manufacturer or as indicated on Drawings. Notch or single point type crimping is NOT acceptable.
 2. Two-hole, long barrel lugs shall be provided for size #4/0 and larger wire where terminated to bus bars. Use minimum of three crimps per lug, on sizes where possible.
- E. Splicing and insulating tape: Provide black, ultraviolet proof, self-extinguishing, 7-mil thick vinyl general purpose electrical tape with a dielectric strength of 10,000 volts suitable for temperatures from minus 18-degrees C to 105-degrees C.
- F. Insulating putty:
1. Provide pads or rolls of non-corrosive, self-fusing, one-eighth inch thick rubber putty with PVC backing sheet. Scotch vinyl mastic pads and roll or equal.
 2. Use putty suitable for temperatures from minus 17.8-degrees C to 37.8-degrees C with a dielectric strength of 570 volts/mil minimum.
- G. Insulating resin:
1. Provide two-part liquid epoxy resin with resin and catalyst in pre-measured, sealed mixing pouch. Scotchcast 4 or equal for wet or underground vaults, boxes, etc. splices or terminations.
 2. Use resin with a set up time of approximately 30-minutes at 21.1-degrees C and with thermal and dielectric properties equal to the insulating properties of the cables immersed in the resin.
- H. Terminal strips:
1. Provide box type terminal strips in the required quantity plus 25% spare. Install in continuous rows in terminal cabinets.
 2. Use the box type terminal strips with barrier open backs and with ampere ratings as required.
 3. Identify all terminals with numbering sequence being used for a system.
- I. Crimp type connectors:
1. Provide insulated fork or ring crimp terminals with tinned electrolytic copper-brazed barrel with funnel wire entry and insulation support
 2. Fasten crimp type connectors or terminals using a crimping tool recommended by the connector Manufacturer.
 3. Provide insulated overlap splices with tinned seamless electrolytic copper barrel with funnel wire entry and insulation support.

4. Provide insulated butt splices with tinned seamless electrolytic copper barrel with center stop, funnel wire entry and insulation support.
- J. Cable ties: Provide harnessing and point-to-point wire bundling with nylon cable ties. All cable ties shall be installed using tool supplied by Manufacturer of ties.
- K. Wire lubricating compound:
 1. UL listed for the wire insulation and conduit type and shall not harden or become adhesive.
 2. Shall not be used on wire for isolated type electrical power systems.
- L. Bolt termination hardware:
 1. Bolts shall be plated, medium carbon steel heat-treated, quenched and tempered equal to ASTM A-325 or SAE grade 5; or silicon bronze alloy ASTM B-9954 Type B.
 2. Nuts shall be heavy semi-finished hexagon, conforming to ANSI B18.2.2, threads to be unified coarse series (UNC), class 2B steel or silicon bronze alloy.
 3. Flat washers shall be steel or silicon bronze, Type A plain standard wide series, confirming to ANSI B27.2. SAE or narrow series shall not be used.
 4. Belleville conical spring washers shall be hardened steel, cadmium plated or silicon bronze.
 5. Each bolt connecting lug(s) to a terminal or bus shall not carry current exceeding the following values:
 - a. 1/4" bolt: 125 amps
 - b. 5/16" bolt: 175 amps
 - c. 3/8" bolt: 225 amps
 - d. 1/2" bolt: 300 amps
 - e. 5/8" bolt: 375 amps
 - f. 3/4" bolt: 450 amps

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Contractor shall thoroughly examine Project site conditions for acceptance of wire and cable installation to verify conformance with Manufacturer and Specification tolerances. Do not commence with installation until all conditions are made satisfactory.

3.2 APPLICATION

- A. All wire, conductor and cable with their respective connectors, fittings and supports shall be UL listed for the installed application and ambient condition.
- B. Feeders and branch circuits in wet locations shall be rated 75-degree C.
- C. Feeders and branch circuits in dry locations shall be rated 90-degree C.
- D. Minimum conductor size:

1. Provide minimum AWG #12 for all power and lighting branch circuits.
 2. Provide minimum AWG #14 for all line voltage signal and control wiring unless otherwise indicated.
- E. Color coding:
1. For 120/208 volt, 3-phase, 4-wire systems:
 - a. Phase A - Black
 - b. Phase B - Red
 - c. Phase C - Blue
 - d. Neutral - White
 - e. Ground - Green
 2. For 0-10 volt Dimming Wires:
 - a. - 0-10 volt – Pink
 - b. + 0-10 volt - Violet
 3. Switch leg individually installed shall be the same color as the branch circuit to which they are connected, unless otherwise noted.
 4. Travelers for 3-way and 4-way switches shall be a distinct color and pulled with the circuit switch leg or neutral.
 5. Grounded neutral conductors #6 AWG or smaller must be color coded with a white or gray continuous outer finish (no taping). Grounded conductors #4 AWG or larger are allowed to be taped for identification.

3.3 WIRING METHODS

- A. Install wires and cables in accordance with Manufacturer's written instructions, CEC Article 310 Part III, as indicated on Drawings and as specified herein.
- B. Install all single conductors in raceway system, unless otherwise noted.
- C. Parallel circuit conductors and terminations shall be equal in length and identical in all ways.
- D. Provide adequate length of conductors within electrical enclosures and train the conductors to terminal points with no excess. Bundle multiple conductors, with conductors larger than #10 AWG cabled in individual circuits. Make terminations so there is no bare conductor at the terminal.
- E. 20 amp power and lighting branch circuit containing no more than four (4) current carrying conductors (phases and neutrals). Use #10 AWG conductor for 120/208 volt circuits located outside a 75-foot radius of panel source, unless otherwise noted.
- F. 20 amp power and lighting branch circuits containing no more than eight (8) current carrying conductors (phases and neutrals). Use #10 AWG conductors for 120/208 volt circuits located outside a 65-foot radius of panel source.
- G. Provide #10 AWG pig tails on all 20 amp and 30 amp wiring devices served by #8 AWG conductors and larger.

- H. Splice cables and wires only in outlet boxes, junction boxes, pull boxes, manholes or handholes. Group and bundle with tie wrap each neutral with its associated phase conductor where more than one neutral is present in a conduit.
- I. Install cable supports for all vertical feeders in accordance with the CEC Article 300. Provide split wedge type fittings, which firmly clamp each individual cable and tighten due to cable weight.
- J. Neatly form, train, and tie the cables in individual circuits. For panelboards, cabinets, wireways, switches, and equipment assemblies.
- K. Seal cable or wire, entering a building from underground , between the wire or cable and raceway, where it exits the raceway, with a sealant identified for use with the cable insulation, bare conductor, shield, or other component within the raceway.
- L. Provide UL-listed factory-fabricated, solderless metal connectors of size, ampacity rating, material, type, and class for applications and for services indicated. Use connectors with temperature ratings equal to or greater than the wires that are being terminated.
- M. Stranded wire shall be terminated using fitting, lugs or devices listed for the application. However, in no case shall stranded wire be terminated solely by wrapping it around a screw or bolt.
- N. Flexible cords and cables supplied, as part of a pre-manufacturer fixture or unit assembly shall be installed according to Manufacturers published installation instructions.

3.4 WIRING INSTALLATION IN RACEWAYS

- A. Install wire in raceway in accordance with IEEE 576, Manufacturer's written instructions, as indicated on the Drawings and as specified herein after interior of building has been physically protected from the weather and all mechanical Work likely to injure conductors has been completed. Pull all conductors into a raceway at the same time. Exercise care in pulling conductors so that insulation is not damaged. Use UL listed, non-petroleum base and insulating type pulling compound as needed.
- B. Completely mandrel all underground or concrete encased conduits prior to installing conductors.
- C. Completely and thoroughly swab raceway system before installing conductors.
- D. Do not use block and tackle, power driven winch or other mechanical means for pulling conductors of size smaller than #1 AWG.
- E. Wire pulling:
 - 1. Provide installation equipment that will prevent the cutting or abrasion of insulation during pulling of cables.
 - 2. Use rope made of nonmetallic material for pulling feeders.
 - 3. Attach pulling lines for feeders by means of either woven basket grips or pulling eyes attached directly to the conductors.
 - 4. Pull in together multiple conductors or cables in a single conduit.

5. Pulling tensions and sidewall pressures shall not exceed 60% of the manufacturer's recommended maximum values. Pulling tension shall be continuously monitored during the pull by a calibrated dynamometer. If pulling tension is exceeded during the pull, immediately notify the engineer to determine if the cables will be considered damaged and require contractor replacement.
- F. Install and test all cables in accordance with Manufacturer's instructions and warranty.

3.5 MC CABLE INSTALLATION

- A. The Drawings indicate above suspended ceiling power distribution junction boxes for conversion from hardwire to MC cable wiring system. Install these boxes such that they are accessible from below. MC cable shall be run to each device as described in documents. MC cable runs have not been indicated.
- B. Use of MC Cable is restricted as follows:
 1. Do not use MC Cable for feeders.
 2. Do not use MC Cable for homeruns back to panel.
 3. Do not install MC Cable above inaccessible ceiling space.
 4. Do not install exposed MC Cable.
- C. Install MC cable in accordance with Manufacturer's instructions and in strict accordance with CEC Article 330. Secure and support MC cable with straps, independent hanger wire per CEC 300.11 (B), or cable ties listed for the purpose. Follow Manufacturer's explicit instructions when connecting the cable to fittings and boxes. Connectors shall be firmly secured to the cable, but not over-tightened. Connector shall be firmly attached to the metal boxes.
- D. Support MC cables every 6-feet and within 12-inches of boxes, per CEC Article 330, using separate spring metal clip or metal cable ties (not steel tie wire) for each MC cable. MC cables shall not be bundled together.
- E. Hanger wire used to support suspended ceilings may not be used to directly support MC cables.
- F. Do not rest MC cables on ceiling tiles or allow contact with mechanical piping systems.
- G. Bend the MC cable per CEC Article 330.
- H. Provide separate sleeves and/or fire barriers where MC cable penetrated firewalls, unless MC cable is UL listed for the application.

3.6 WIRE SPLICES, JOINTS AND TERMINATION

- A. Join and terminate wire, conductors, and cables in accordance with UL 486A, C, CEC and Manufacturer's instructions.
- B. Thoroughly clean wires before installing lugs and connectors.

- C. Make splices, taps and terminations to carry full ampacity of conductors without perceptible temperature rise.
- D. Splices and terminations shall be made mechanically and electrically secure.
- E. Where it's determined that unsatisfactory splice or terminations have been installed, remove the devices and install approved devices at no addition cost.
- F. Terminate wires in Terminal Cabinets, relay, and contactor panels, etc. using terminal strip connectors.
- G. Insulate spare conductors with electrical tape and leave sufficient length to terminate anywhere in the panel or cabinet.
- H. Install cable ties and maintain harnessing.
- I. Encapsulate splices in exterior outlets, pull boxes and junction boxes using specified insulating resin kits. Make all splices watertight for exterior equipment and equipment in pump rooms.
- J. Make up all splices and taps in accessible junction or outlet boxes with connectors as specified herein. Pigtails and taps shall be the same color as the feed conductor. Form conductor prior to cutting and provide at least 6-inches of tail and neatly packed in box after splice is made up.
- K. Branch circuits (#10 AWG and smaller):
 - 1. Connectors: Solderless, screw-on, reusable spring pressure cable type, 600 volt, 105-degree C. with integral insulation, approved for copper conductors.
 - 2. The integral insulator shall have a skirt to completely cover the stripped wires.
 - 3. The number, size and combination of conductors as listed on the Manufacturers packaging shall be strictly complied with.
- L. Feeder circuits: (#6 to 750 kCMIL)
 - 1. Join or tap conductors from #6 AWG to 750 kCMIL using bolted pressure connectors or insulate mechanical compression (hi-pressure) taps with pre-molded, snap-on insulating boots or specified conformable insulating pad and over wrapped with two half-lapped layers of vinyl insulating tape starting and ending at the middle of the joint.
 - 2. Terminate conductors from size #6 AWG to 750 kCMIL copper using bolted pressure or mechanical compression lugs in accordance with Manufacturer recommendation or as specified elsewhere.
 - 3. Field installed compression connectors for cable sizes 250 kCMIL and larger shall have not less than two clamping elements or compression indents per wire.
 - 4. Insulate splices and joints with materials approved for the particular use, location, voltage, and temperature. Insulate with not less than that of the conductor level that is being joined.
- M. Termination hardware assemblies:
 - 1. AL/CU lugs connected to aluminum plated or copper buss, shall be secured using a steel bolt, flat washer (two per bolt), Belleville washer and nut.

2. Copper lugs connected to copper bus, shall be secured using silicon bronze alloy bolt, flat washer (two per bolt), Belleville washer and nut.
3. The crown of Belleville washers shall be under the nut.
4. Bolt assemblies shall be torque to Manufacturer recommendation. Where manufacture recommendations are not obtainable, the following values shall be used:
 - a. 1/4" - 20 bolt at 80-inch pounds torque.
 - b. 5/16" - 18 bolt at 180-inch pounds torque.
 - c. 3/8" - 16 bolt at 20-foot pounds torque.
 - d. 1/2" - 13 bolt at 40-foot pounds torque.
 - e. 5/8" - 11 bolt at 55-foot pounds torque.
 - f. 3/4" - 10 bolt at 158-foot pounds torque.

3.7 IDENTIFICATION

- A. Refer to Section 260553: Electrical Identification for additional requirements.
- B. Securely tag all branch circuits. Mark conductors with specified vinyl wrap-around markers. Where more than two conductors run through a single outlet, mark each conductor with the corresponding circuit number.
- C. Color code conductors' size #8 and larger using specified phase color markers and identification tags.
- D. Provide all terminal strips with each individual terminal identified using specified vinyl markers.
- E. In manholes, pull boxes and handholes, provide tags of the embossed brass type and show the cable type and voltage rating. Attach the tags to the cables with slip-free plastic cable lacing units.

3.8 FIELD QUALITY CONTROL

- A. Independent testing: Contractor shall arrange and pay for the services of an independent Testing Agency to perform all quality control electrical testing required herein. Independent Testing Agency shall meet the requirements as outlined in Section 260010: Basic Electrical Requirements.
- B. Prefunctional testing:
 1. Visual and mechanical inspection:
 - a. Compare cable data with Contract Documents.
 - b. Inspect exposed sections of wires and cables for physical damage and proper connections.
 - c. Verify tightness of accessible bolted connections with calibrated torque wrench in accordance with Manufacturer's published data.
 - d. Inspect compression applied connectors for correct cable match and indentation.

- e. Verify visible cable bend meet or exceed ICEA and Manufacturer's minimum allowable bending radius.
 - f. If cables are terminated through window type current transformers, inspect to verify neutral and ground conductors are correctly placed for operation of protective devices.
 - g. Ensure wire and cable identification has been installed as specified herein.
2. Electrical testing:
- a. Contractor shall perform feeder and branch circuit insulation test after installation and prior to connection to utilization devices such as fixtures, motors, or appliances. Testing shall be as follows:
 - 1) 100% of all feeders 100 amp rated and above.
 - 2) 50% of all feeders smaller than 100 amps.
 - 3) 10% of all branch circuits at each individual panelboard.
 - b. Perform insulation-resistance test using megohm meter with applied potential of 1000 volt DC for a continuous duration of 60-seconds. Test conductors' phase-to-phase and phase-to-ground. Conductors shall test free from short-circuit and ground faults.
 - c. Perform continuity test of all feeder and branch circuits to ensure correct cable connections. Test all neutrals for improper grounds.
 - d. Contractor shall furnish instruments, materials, and labor for these tests.
3. Test values: Investigate resistance values less than 50-megohms.
4. Furnish test results in typewritten report form for review and inclusion in the operation and maintenance manuals.

END OF SECTION

SECTION 26 05 26
GROUNDING AND BONDING

PART 1 - GENERAL

1.1 SUMMARY

- A. Work included: Labor, materials, and equipment necessary to complete the installation required for the item specified under this Division, including but not limited to:
 - 1. Power system grounding.
 - 2. Site lighting grounding.
 - 3. Telecommunication system grounding.
 - 4. Electrical equipment and raceway grounding and bonding.
- B. Related Work: Consult all other Sections, determine the extent and character of related Work, and properly coordinate Work specified herein with that specified elsewhere to produce a complete installation.
 - 1. Division 05: Building Steel.
 - 2. Division 22: Cold Water Piping.

1.2 REFERENCES

- A. Comply with the latest edition of the following applicable Specifications and standards except as otherwise indicated or specified:
 - 1. Underwriters Laboratories, Inc. (UL):
 - UL 467; Grounding and Bonding Equipment.
 - 2. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
 - IEEE No. 142; Recommended Practice for Grounding of industrial and Commercial Power Systems.
 - IEEE No. 81 Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System.

1.3 SYSTEM DESCRIPTION

- A. Ground the electrical service system neutral at service entrance equipment as described herein and indicated on Drawings.
- B. Ground each separately derived system neutral as described herein and indicated on Drawings.
- C. Provide telecommunications system grounding conductor as described herein, Section 270526 and indicated on Drawings.
- D. Except as otherwise indicated, the complete electrical installation including the neutral conductor, metallic conduits and raceways, cable trays, boxes, cabinets and equipment shall be completely and effectively grounded in accordance with all code requirements, whether or not such connections are specifically indicated or specified.

E. Resistance:

1. Resistance from the main switchboard ground bus through the ground electrode to earth shall not exceed 5-OHMS unless otherwise noted.
2. Resistance from the farthest panelboard, switchboard, etc. ground bus through the ground electrode to earth shall not exceed 20-OHMS

1.4 SUBMITTALS

- A. Submit in accordance with the requirements of Section 260010: Basic Electrical Requirements, the following items:
1. Data/catalog cuts for each product and component specified herein, listing all physical and electrical characteristics and ratings indicating compliance with all listed standards.
 2. Clearly mark on each data sheet the specific item(s) being submitted and the proposed application.
 3. Submit Manufacturer's installation instructions.

1.5 QUALITY ASSURANCE

- A. All materials, equipment and parts comprising the units specified herein shall be new, unused, and currently under production.
- B. Only products and applications listed in this Section may be used on the Project unless otherwise submitted.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Products furnished by the following Manufacturers shall be acceptable if in compliance with all features specified herein and indicated on the Drawings.
1. Ground Rods:
 - a. Weaver.
 - b. Erico "Cadweld" Products, Inc.
 2. Ground Wells:
 - a. Christy Concrete Products, Inc.
 - b. Forni Corp.
 3. Ground Bushings, Connectors, Jumpers and Bus:
 - a. O-Z/Gedney.
 - b. Thomas & Betts Corp.
- B. Substitutions: Under provisions of Section 260010: Basic Electrical Requirements.

2.2 GROUND CONDUCTORS

- A. Refer to Specification Section 260519: Building Wire and Cable for conductor specifications.
- B. General purpose insulated:

1. UL approved and code sized copper conductor, with dual rated THHN/THWN insulation, color identified green.
 2. Where continuous color-coded conductors are not commercially available, provide a minimum 4" long color band with green, non-aging, plastic tape in accordance with CEC.
- C. Bare conductors in direct contact with earth or encased in concrete: #4/0 AWG copper minimum, U.O.N.
- D. Bonding pigtails: Insulated copper conductor, identified green, sized per code, and provide with termination screw or lug. Provide solid conductors for #10 AWG or smaller and stranded conductors for #8 AWG or larger.
- 2.3 DRIVEN (GROUND) RODS
- A. Copper clad steel, minimum 3/4-inch diameter by 8 feet long, unless otherwise noted.
- 2.4 GROUND WELL BOXES FOR GROUND RODS
- A. Precast concrete box nominal 9" throat diameter x 14" deep with light duty concrete cover for non-traffic areas or steel plate for traffic areas. Cover shall be embossed or engraved with "GROUND ROD".
- 2.5 INSULATED GROUNDING BUSHINGS
- A. Plated malleable iron or steel body with 150-degree Centigrade molded plastic insulating throat and lay-in grounding lug.
- 2.6 CONNECTIONS TO PIPE
- A. For cable to pipe: UL and CEC approved bolted connection.
- 2.7 CONNECTIONS TO STRUCTURAL STEEL, GROUND RODS OR SPLICES
- A. Where required by the Drawings, grounding conductors shall be spliced together, connected to ground rods or connected to structural steel using exothermic welds or high-pressure compression type connectors.
1. Exothermic welds shall be used for cable-to-cable and cable-to-ground rod and for cable to structural steel surfaces. Exothermic weld kits shall be as manufactured by Cadweld or equal. Each particular type of weld shall use a kit unique to that type of weld.
 2. High-pressure compression type connectors shall be used for cable-to-cable and cable-to-ground rod connections.
- 2.8 EXTRA FLEXIBLE, FLAT BONDING JUMPERS
- A. Where required by Code, indicated on the Drawing, and specified herein.
- 2.9 BUILDING GROUND BUS REQUIREMENTS
- A. Main building power system ground bus:

1. Provide one 24" wide x 4" high x 1/4" thick copper bus bar as a minimum. Mount on wall in main electrical room utilizing insulating stand-offs at 18" above finished floor.
 2. Furnish complete with cast copper alloy body lugs for connecting grounding system conductors. Attach lugs to bus with appropriate size cadmium bronze bolt, flat washer, and Belleville washer. Torque all lug connections.
 3. All holes shall be drilled and tapped for single-hole lugs. Provide 6 spare lugs and lug spaces.
- B. Building power system reference ground bus:
1. The reference ground bus is furnished as part of the main electrical switchboard for the building, along with neutral disconnect and bus, and is in addition to the main building power system ground bus outlined above. The building grounding electrode shall make a direct connection to the building referenced ground bus in the main switchboard.
 2. Provide a #4/0 AWG copper ground conductor connection between the building reference ground bus in switchboard and the main building ground bus wall mounted in main electrical room.
- C. Telecommunication system ground bus requirements:
1. Refer to 270526.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Contractor shall thoroughly examine Project site conditions for acceptance of grounding system installation to verify conformance with Manufacturer and Specification tolerances. Do not commence with installation until all conditions are made satisfactory.

3.2 INSTALLATION

- A. Grounding electrodes:
1. Metal underground water pipe: Cold water metal piping system: Where the underground cold water service line is metal, in direct contact with the earth for 10-feet or more, the Contractor shall install a grounding electrode conductor from the main incoming cold water line ahead of the meter and extend to the main building reference ground bus in the main electrical room. The electrode shall be sized per CEC Article 250. Electrode connection should be accessible.
 2. Concrete encased grounding electrode (UFER ground): Provide a #4/0 AWG minimum bare copper conductor encased along the bottom of concrete foundation or footings which are in direct contact with the earth and where there is no impervious water-proofing membrane between the footing and the soil. The electrode shall extend through a horizontal length of 30 feet minimum and shall be encased in not less than 2 or more than 5 inches of concrete separating it from surrounding soils. The electrode shall emerge from the concrete slab through a protective non-metallic sleeve and shall be extended to the main building reference ground bus.

3. Supplementary grounding electrode (ground ring, grid and driven rods): Provide, as indicated on the Drawings, driven ground rod(s) installed in listed ground well box(s) and filled with gravel after connection is made. Interconnect ground rod with structural steel and adjacent rods with minimum #2 AWG bare copper conductor. Ground rod shall not be less than 10 foot from any other electrode of another electrical system or from adjacent ground rod(s).
- B. Grounding electrode conductor: Provide grounding electrode conductor as indicated on the Drawings or sized per CEC Article 250, whichever is greater.
- C. Power system grounding:
1. Provide, unless otherwise indicated, a main building power system ground bus mounted on the wall in the main electrical room. Connect the following items using CEC sized copper grounding conductors to lugs on the main building ground bus:
 - a. Grounding conductor from building reference ground bus in main service switchboard.
 - b. Bonding conductor to metallic cold-water piping system.
 - c. Bonding conductor to building structural steel.
 - d. Separately derived system grounding conductors in same room.
 2. At the building power system reference ground bus in the main service switchboard, connect the grounding electrode conductor from concrete encased UFER ground or other grounding electrode systems as indicated on the Drawing or herein.
- D. Separately derived electrical system grounding:
1. Ground each separately derived system per requirements in CEC Article 250 as a minimum, unless greater requirements are required elsewhere in the Contract Documents.
 2. Transformers: Provide copper terminal bar for grounding and bonding the transformer in accordance with CEC Articles 250.30 and 450.10. Bond the terminal bar to the enclosure and connect the following to the terminal bar:
 - a. Primary feeder equipment ground conductor(s).
 - b. Secondary feeder supply-side bonding jumper(s).
 - c. Grounding electrode conductor.
 - d. Main bonding jumper to neutral (when present).
- E. Equipment bonding/grounding:
1. Provide a CEC sized insulated copper ground conductor in all 120 volt AC through 600 volt AC feeder and branch circuit distribution conduits and cables.
 2. Provide a separate grounding bus at panelboards, switchboards. Connect all metallic enclosed equipment so that with maximum fault current flowing, shall be maintained at not more than 35 volts above ground.
 3. Conduit terminating in concentric, eccentric, or oversized knockouts at panelboards, cabinets, gutters, etc. shall have grounding bushings and bonding jumpers installed interconnecting all such conduits.

4. Provide bonding jumpers across expansion and deflection couplings in conduit runs, pipe connections to water meters, dielectric couplings in metallic cold-water piping system.
 5. Provide internal ground wire in flexible conduit connected at each end via grounding bushing.
- F. Site lighting grounding: Bond all metallic light poles and bollards. Provide ground rods where indicated on the Drawings.
- G. Telecommunication system grounding:
1. Refer to 270526.

3.3 FIELD QUALITY CONTROL

- A. Independent Testing: Contractor shall arrange and pay for the services of an independent Testing Agency to perform all quality control electrical testing required herein.
- B. Prefunctional testing:
1. Provide Testing Agency with Contract Documents for their review prior to the commencement of ground testing.
 2. Visual and mechanical inspection:
 - a. The Testing Agency shall inspect the grounding electrode and connections prior to concrete encasement, burial, or concealment.
 - b. Check tightness and welds of all ground conductor terminations.
 - c. Verify installation complies with the intent of the Contract Documents
 3. Obtain and record ground resistance measurements both from electrical equipment ground bus to the ground electrode and from the ground electrode to earth. Furnish and install additional bonding and add grounding electrodes as required complying with resistance limits specified under this Section of the Specification.
 4. A typewritten record of measured resistance values shall be submitted for review and included with the operation and maintenance manual furnished to the Owner at the time of Project closeout and before certificate of final payment is issued.

END OF SECTION

SECTION 26 05 29

ELECTRICAL HANGERS AND SUPPORTS

PART 1 - GENERAL

1.1 SUMMARY

- A. Work included: Labor, materials, and equipment necessary to complete the installation required for the item specified under this Division, including but not limited to:
 - 1. Conduit supports.
 - 2. Equipment supports.
 - 3. Fastening hardware.
- B. Related Work: Consult all other Sections, determine the extent and character of related Work, and properly coordinate Work specified herein with that specified elsewhere to produce a complete installation.
 - 1. Division 03: Cast-in-place concrete. Concrete equipment pads.
 - 2. Division 05: Miscellaneous metals. Hangers for electrical equipment.
 - 3. Division 09: Ceiling suspension systems. Slack support wires.

1.2 REFERENCES

- A. Comply with the latest edition of the following applicable Specifications and standards except as otherwise indicated or specified:
 - 1. Underwriters Laboratories, Inc. (UL):
 - UL 2239; Hardware for the Supports of Conduit, Tubing and Cable.

1.3 SYSTEM DESCRIPTION

- A. Provide devices specified in this Section and related Sections for support of electrical equipment furnished and installed under Division 26.
- B. Provide support systems that are adequate for the weight of equipment, conduit and wiring to be supported.

1.4 SUBMITTALS

- A. Submit in accordance with the requirements of Section 260010: Basic Electrical Requirements, the following items:
 - 1. Data/catalog cuts for each product and component specified herein.
 - 2. Clearly mark on each data sheet the specific item(s) being submitted and the proposed application.
 - 3. Submit Manufacturer's installation instructions.

1.5 QUALITY ASSURANCE

- A. All materials, equipment and parts comprising the units specified herein shall be new, unused, and currently under production.

- B. Only products and applications listed in this Section may be used on the Project unless otherwise submitted.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Products furnished by the following Manufacturers shall be acceptable if in compliance with all features specified herein and indicated on the Drawings.
 - 1. Concrete fasteners:
 - a. Phillips "Red-Head".
 - b. Remington.
 - c. Ramset.
 - 2. Concrete inserts and construction channel:
 - a. Unistrut Corp.
 - b. GS Metals "Globe Strut."
 - c. Thomas & Betts "Kindorf" Corp.
 - 3. Conduit straps:
 - a. O-Z/Gedney.
 - b. Erico "Caddy" Fastening Products.
 - c. Thomas & Betts "Kindorf" Corp.

- B. Substitutions: Under provisions of Section 260010: Basic Electrical Requirements.

2.2 CONCRETE FASTENERS

- A. Provide expansion-shield type concrete anchors.
- B. Provide powder driven concrete fasteners with washers. Obtain approval by Architect and Structural Engineer prior to use.

2.3 CONCRETE INSERTS

- A. Provide pressed galvanized steel, concrete spot insert, with oval slot capable of accepting square or rectangular support nuts of ¼ inch to ½ inch diameter thread for rod support.

2.4 THREADED ROD

- A. Provide steel threaded rod, sized for the load unless otherwise noted on the Drawings or in the Specifications.

2.5 CONSTRUCTION CHANNEL

- A. Provide 1.5-inch by 1.5-inch, 12-gauge galvanized steel channel with 17/32-inch diameter bolt holes and 1-1/2 inch on center in the base of the channel.

2.6 CONDUIT STRAPS

- A. One-hole strap, steel, or malleable iron, with malleable iron clamp-back spacer for surface mounted wall and ceiling applications.
 - 1. Use malleable strap with spacers for exterior and wet locations.
 - 2. Use steel strap without spacers for interior locations.
- B. Steel channel conduit strap for support from construction channel.
- C. Steel conduit hanger for pendant support with threaded rod
- D. Steel wire conduit support strap for support from independent #12-gauge hanger wires.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Contractor shall thoroughly examine Project site conditions for acceptance of supporting device installation to verify conformance with Manufacturer and Specification tolerances. Do not commence with installation until all conditions are made satisfactory.

3.2 PREPARATION

- A. Coordinate size, shape, and location of concrete pads with Division 03, Cast-in-place concrete.
- B. Layout support devices to maintain headroom, neat mechanical appearance and to support the equipment loads.
- C. Where indicated on the Contract Documents, install freestanding electrical equipment on concrete pads.

3.3 INSTALLATION

- A. Furnish and install supporting devices as noted throughout Division 26.
- B. Electrical device and conduit supports shall be independent of all other system supports that are not structural elements of the building, unless otherwise noted.
- C. Fasten hanger rods, conduit clamps, outlet, and junction boxes to building structure using precast inserts, expansion anchors, preset inserts, or beam clamps.
- D. Use toggle bolts or hollow wall fasteners in hollow masonry, plaster or gypsum board partitions and walls.
- E. Use expansion anchors or preset inserts in solid masonry walls.
- F. Use self-drilling anchors, expansion anchor or preset inserts on concrete surfaces.
- G. Use sheet metal screws in sheet metal studs and wood screws in wood construction.
- H. Do not fasten supports to piping, ductwork, mechanical equipment, conduit, or acoustical ceiling suspension wires.

- I. Do not drill structural steel members unless first approved in writing by the Architect or Structural Engineer.
- J. Fabricate supports from structural steel or steel channel, rigidly welded, or bolted to present a neat appearance. Use hexagon head bolts with spring lock washers under all nuts.
- K. Install surface-mounted cabinets and panelboards with minimum of four anchors. Provide additional support backing in stud walls prior to sheet rocking as required to adequately support cabinets and panels.
- L. Bridge studs top and bottom with channels to support flush mounted cabinets and panelboards in stud walls.

3.4 ERECTION OF METAL SUPPORTS

- A. Cut, fit and place miscellaneous metal fabrications accurately in location, alignment and elevation to support and anchor electrical materials and equipment.
- B. Field Welding: Comply with AWS "Structural Welding Code."

3.5 WOOD SUPPORTS

- A. Cut, fit, and place wood grounds, nailers, blocking and anchorage accurately in location, alignment and elevation to support and anchor electrical materials and equipment.

3.6 ANCHORAGE

- A. All floor mounted, free standing electrical equipment such as generators, switchboards, distribution boards, etc. shall be securely fastened to the floor structure.
- B. Anchorage of electrical equipment shall comply with the seismic requirements as outlined in Section 260010: Basic Electrical Requirements.

END OF SECTION

SECTION 26 05 31

CONDUIT

PART 1 - GENERAL

1.1 SUMMARY

- A. Work included: Labor, materials, and equipment necessary to complete the installation required for the item specified under this Division, including but not limited to:
 - 1. Rigid steel conduit and fittings.
 - 2. PVC insulated rigid steel conduit and fittings.
 - 3. Intermediate metal conduit and fittings.
 - 4. Electrical metallic tubing and fittings.
 - 5. Rigid non-metallic conduit and fittings.
 - 6. Flexible metallic conduit and fittings.
 - 7. Liquidtight flexible metallic conduit and fittings.
 - 8. Miscellaneous conduit fittings and products.
- B. Related Work: Consult all other Sections, determine the extent and character of related Work, and properly coordinate Work specified herein with that specified elsewhere to produce a complete installation.
 - 1. Division 01: Cutting and patching.
 - 2. Division 31: Earthwork. Excavation and backfill for conduit and utilities on Project site.
 - 3. Division 03: Cast-in-place concrete. Protective envelope for underground conduit installations.
 - 4. Division 07: Sheet metal flashing and trim.
 - 5. Division 09: Painting. Exposed conduit and other devices.

1.2 REFERENCES

- A. Comply with the latest edition of the following applicable Specifications and standards except as otherwise indicated or specified:
 - 1. American National Standards Institute, Inc. (ANSI):
 - ANSI C80.1; Rigid Steel Conduit, Zinc-Coated.
 - ANSI C80.3; Electrical Metallic Tubing, Zinc Coated.
 - 2. Underwriters Laboratories, Inc. (UL):
 - UL 1; Flexible Metal Conduit.
 - UL 6; Rigid Metal Conduit.
 - UL 360; Liquid-Tight Flexible Steel Conduit.
 - UL 514B; Conduit, Tubing and Cable Fittings.
 - UL 635; Insulating Bushings.

UL 651; Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings.

UL 797; Electrical Metallic Tubing - Steel.

UL 1242; Intermediate Metal Conduit - Steel.

3. National Electrical Manufacturer Association (NEMA):

NEMA RN1; PVC Externally coated Galvanized Rigid Steel Conduit.

NEMA TC 2; Electrical Plastic Tubing and Conduit.

NEMA TC 3; PVC Fittings for use with Rigid PVC Conduit.

1.3 SUBMITTALS

A. Submit in accordance with the requirements of Section 260010: Basic Electrical Requirements the following items:

1. Data/catalog cuts for each product and component specified herein, listing all physical and electrical characteristics and ratings indicating compliance with all listed standards.
2. Clearly mark on each data sheet the specific item(s) being submitted and the proposed application.
3. Submit Manufacturer's installation instruction. Provide written instructions for raceway products requiring glues, special tools, or specific installation techniques.

1.4 QUALITY ASSURANCE

- A. All materials, equipment and parts comprising the units specified herein shall be new, unused, and currently under production.
- B. Only products and applications listed in this Section may be used on the Project unless otherwise submitted and approved.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Products furnished by the following Manufacturers shall be acceptable if in compliance with all features specified herein and indicated on the Drawings.

1. Metal conduit:
 - a. Allied Tube and Conduit Co.
 - b. Triangle PWC, Inc.
 - c. Western Tube and Conduit Corp.
 - d. Spring City Electrical Manufacturing Co.
 - e. Occidental Coating Co. (OCAL).
 - f. Alflex Corp.
 - g. American Flexible Metal Conduit Co.
 - h. Anaconda.
2. Nonmetallic conduit:

- a. Prime Conduit.
- b. JM Eagle.
- c. Cantex.
- 3. Fittings:
 - a. Appleton Electric Co.
 - b. OZ/Gedney.
 - c. Thomas & Betts Corp.
 - d. Spring City Electrical Manufacturing Co.
 - e. Occidental Coating Co. (OCAL).
 - f. Carlon.

B. Substitutions: Under provisions of Section 260010: Basic Electrical Requirements.

2.2 GALVANIZED RIGID STEEL CONDUIT (GRS)

- A. Conduit: Full weight, threaded, hot-dip galvanized steel, conforming to ANSI C80.1 and UL 6.
- B. Standard threaded couplings, locknuts, bushings, and elbows: Only materials of steel or malleable iron are acceptable. Locknuts shall be bonding type with sharp edges for digging into the metal wall of an enclosure.
- C. Three-piece couplings: Hot dip galvanized, cast malleable iron.
- D. Insulating bushings: Threaded polypropylene or thermosetting phenolic rated 150-degree C minimum.
- E. Insulated grounding bushings: Threaded cast malleable iron body with insulated throat and steel "lay-in" ground lug with compression screw.
- F. Insulated metallic bushings: Threaded cast malleable iron body with plastic insulated throat rated 150-degrees C.
- G. All fittings and connectors shall be threaded.

2.3 PVC INSULATED GALVANIZED RIGID STEEL CONDUIT (PVC GRS)

- A. Conduit: Full weight, threaded, hot-dip galvanized steel, conforming to ANSI C80.1 and NEMA RN-1 with nominal 20 or 40 mil thermoplastic vinyl coating, heat fused and bonded to the exterior of the conduit.
- B. Fittings: Conduit couplings and connectors shall be as specified for galvanized rigid steel conduit and shall be factory PVC coated with an insulating jacket equivalent to that of the coated material.

2.4 INTERMEDIATE METAL CONDUIT (IMC)

- A. Conduit: Hot dip galvanized steel meeting the requirements of CEC Article 342 and conforming to ANSI C80.6 and UL 1242.

- B. Fittings: Conduit couplings, connector and bushing shall be as specified for galvanized rigid steel conduit. Integral retractable type IMC couplings are also acceptable.

2.5 ELECTRICAL METALLIC TUBING (EMT)

- A. Conduit: Shall be formed of cold rolled strip steel, electrical resistance welded continuously along the longitudinal seam and hot dip galvanized after fabrication. Conduit shall conform to ANSI C80.3 Specifications and shall meet UL requirements.
- B. Set screw type couplings: Hot dip galvanized, steel or cast malleable iron, UL listed concrete tight. Use set screw type couplings with four setscrews each of conduit sizes over 2 inches. Setscrews shall be of case-hardened steel with hex-head and cup point to firmly seat in wall of conduit for positive grounding.
- C. Set screw type connectors: Hot dip galvanized, steel or cast malleable iron UL listed concrete tight with male hub and insulated plastic throat, 150-degree C temperature rated. Setscrew shall be same as for couplings.
- D. Raintight couplings: Hot dip galvanized, steel or cast malleable iron; UL listed raintight and concrete tight, using gland and ring compression type construction.
- E. Raintight connectors: Hot dip galvanized, steel or cast malleable iron, UL listed raintight and concrete tight, with insulated throat, using gland and ring compression type construction.

2.6 RIGID NON-METALLIC CONDUIT (PVC)

- A. Conduit:
 - 1. Rigid polyvinyl chloride, Schedule 40 or 80 conforming to NEMA TC1 and UL 651, latest edition. UL listed for exposed and direct-burial applications and for 90 degrees C conductor insulation. Conduit shall include an integral bell fitting at one end.
- B. Fittings: Couplings, adaptors, transition fittings, etc., shall be molded PVC, slip on, solvent weld type conforming to NEMA TC3 for Schedule 40 or 80 and NEMA TC 9 for type EB or DB.

2.7 FLEXIBLE METALLIC CONDUIT (FMC)

- A. Conduit: Shall be fabricated in continuous lengths from galvanized steel strip, spirally wound and formed to provide an interlocking design and conforming to UL 1.
- B. Fittings: Connectors shall be of the single screw clamp variety with steel or cast malleable iron bodies and threaded male hubs with insulated throats. Exception: Pressure cast screw-in connectors shall be acceptable for luminaire connection in suspended ceilings and cut-in outlet boxes within existing furred walls.

2.8 LIQUIDTIGHT FLEXIBLE METALLIC CONDUIT (LFMC)

- A. Conduit: Shall be fabricated in continuous lengths from galvanized steel strips, interlocking spirally wound, covered with extruded liquidtight jacket of polyvinyl chloride (PVC) and conforming to UL 360. Provide conduit with a continuous copper-bonding conductor wound spirally between the convolutions.

- B. Fittings: Connector body and gland nut shall be of cadmium plated steel or cast malleable iron, with tapered, male, threaded hub; insulated throat and neoprene "O" ring gasket recessed into the face of the stop nut. The clamping gland shall be of molded nylon with an integral brass push-in ferrule.

2.9 MISCELLANEOUS CONDUIT FITTINGS AND PRODUCTS

- A. Watertight conduit entrance seals: Steel or cast malleable iron bodies and pressure clamps with PVC sleeve, neoprene sealing grommets and PVC coated steel pressure rings. Fittings shall be supplied with neoprene sealing rings between the body and PVC sleeve.
- B. Watertight cable sealing bushings: One piece, compression molded sealing ring with PVC coated steel pressure disks, stainless steel sealing screws and zinc plated cast malleable iron locking collar.
- C. Expansion fittings: Multi-piece unit comprised of a hot dip galvanized malleable iron or steel body and outside pressure bussing designed to allow a maximum of 4" conduit movement (2" in either direction). Furnish with external braid tinned copper bonding jumper. Unit shall be UL listed for wet or dry locations.
- D. Expansion/deflection couplings: Multi-piece unit comprised of a neoprene sleeve with internal flexible tinned copper braid attached to bronze end couplings with stainless steel bands. Coupling shall accommodate 0.75-inch deflection, expansion or contraction in any direction and allow 30-degree angular deflections. Flexible, corrosion-resistant, watertight, moisture and heat resistant molded rubber jacket and stainless-steel jacket clamps. Unit shall comply with UL467 and UL514. Manufacturer shall be OZ/Gedney Type DX, Steel City Type EDF or equal.
- E. Fire rated penetration seals:
 - 1. UL building materials directory classified.
 - 2. Conduit penetrations in fire rated separation shall be sealed with a UL classified fill, void or cavity material.
 - 3. The fire rated sealant material shall be the product best suited for each type of penetration and may be a caulk, putty, composite sheet, or wrap/strip.
- F. Standard products not herein specified:
 - 1. Provide listing of standard electrical conduit hardware and fittings not herein specified for approval prior to use or installation, i.e. locknuts, bushings, etc.
 - 2. Listing shall include Manufacturers name, part numbers and a written description of the item indicating type of material and construction.
 - 3. Miscellaneous components shall be equal in quality, material and construction to similar items herein specified.
- G. Hazardous area fittings: UL listed for the application.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Contractor shall thoroughly examine Project site conditions for acceptance of conduit system installation to verify conformance with Manufacturer and Specification

tolerances. Do not commence with installation until all conditions are made satisfactory.

3.2 APPLICATION

A. Galvanized rigid steel conduit (GRS) can be used in the following applications:

1. For feeders and branch circuits located indoors, concealed or exposed above suspended ceilings, in damp/wet locations, in crawl spaces, in attics, chases, furred spaces, equipment rooms, loading docks or in hazardous locations in accordance with CEC and local Codes.
2. For feeders and branch circuits concealed in concrete floors and walls when not in contact with earth.

B. PVC insulated galvanized rigid steel conduit can be used in the following applications:

1. Use 40-mil coating for feeders and branch circuits in damp or wet locations.
2. Use 20- or 40-mil for feeders and branch circuits concealed in concrete walls or slabs in contact with earth.
3. Use 20- or 40-mil for runs beneath floor slabs on grade.
4. Use 40-mil for all below grade penetrations through floor slabs on grade or exterior walls.

C. Intermediate metal conduit (IMC): Can be used for the same application as galvanized rigid steel conduit as specified herein, except for hazardous locations prohibited by CEC or Local Codes.

D. Electrical metallic tubing (EMT): Can be used exposed or concealed for interior electrical feeders 4" and smaller, interior power and lighting branch circuits and low tension distribution system where run above suspended ceilings, in concrete slabs and walls not in contact with earth; in stud walls, furred spaces and crawl spaces. EMT shall not be installed exposed below 6 feet above the finish floor except within electrical, communication or signal rooms or closets.

E. Rigid non-metallic conduit (PVC): Can be used in the following applications:

1. Schedule 40 or 80 for feeders and branch circuits run beneath ground floor slab except that bends and penetrations through the floor must be PVC coated galvanized rigid steel.
2. Schedule 40 or 80 for exterior branch circuits directly buried in earth, 18" minimum below grade. PVC may be used below exterior slabs not subject to vehicular traffic.
3. PVC may be used below exterior slab subjects to vehicular traffic when encased in a minimum of 2 inches of concrete.
4. PVC elbows shall be radius sweep type schedule 40 for bends 45° or less and large radius sweep type schedule 80 for bends 46° or greater.
5. In general, PVC may not be run exposed in concrete walls or in floor slabs unless expressly indicated on the Drawings.

F. Flexible metallic conduit (FMC): Can be used only in dry locations for connections from an adjacent outlet box or conduit to all motors, transformers, vibrating equipment or machinery, controllers, solenoid valves, float and flow switches or

similar devices and to luminaires installed in suspended ceilings, minimum sizes shall be 3/8" for luminaires and control wiring and 1/2" for motor and transformer connections. U.O.N.

- G. Liquidtight flexible metallic conduit (LFMC): Can be used in wet or damp locations for connections from adjacent outlet box or conduit to all motors, transformers, vibrating equipment or machinery, controllers, solenoid valves, float and flow switches or similar devices. These areas are typically food preparation and dishwashing areas, sump wells, loading docks, pump rooms, exterior areas, etc. Minimum sizes shall be 1/2" and 1" for communications.
- H. Fire-Resistive Cable Systems: Refer to CEC Article 728. All devices utilized, mountings, and supports shall be listed as part of the fire-resistive system.

3.3 PREPARATION

- A. Locations of conduit runs shall be planned in advance of the installation and coordinated with ductwork, plumbing, ceiling and wall construction in the same areas and shall not unnecessarily cross other conduits or pipe, nor prevent removal of ceiling tiles or panels, nor block access to mechanical or electrical equipment.
- B. Where practical, install conduits in groups in parallel vertical or horizontal runs and at elevations that avoid unnecessary offsets.
- C. All conduits shall be run parallel or at right angles to the centerlines of columns and beams, whether routed exposed, concealed above suspended ceiling or in concrete slabs.
- D. Conduits shall not be placed closer than 12-inches to a flue, parallel hot water, steam line or other heat producing source or three inches from such lines when crossing perpendicular to the runs.
- E. Communications conduits shall not be placed closer than 12 inches to power, a flue, parallel hot water, steam line or other heat producing source or three inches from such lines when crossing perpendicular to the runs.
- F. Exposed conduit installation shall not encroach into the ceiling height headroom of walkways or doorways. Where possible, install horizontal raceway runs above water and below steam piping.
- G. The largest trade size conduits in concrete floor and wall slabs shall not exceed 1/3 the floor or wall thickness and conduits shall be spaced a minimum of three conduit diameters apart unless otherwise noted on the Drawings. All conduits shall be installed in the center of concrete slabs or wall and shall not be placed between reinforcing steel and the bottom of floor slabs.
- H. In long runs of conduit, provide sufficient pull boxes inside buildings to facilitate pulling wires and cables, with spacing not to exceed 150-feet. Support pull boxes from structure independent of conduit supports. These pull boxes are not indicated on the Drawings.
- I. Provide all reasonably inferred standard conduits fitting and products required to complete conduit installation to meet the intended application whether noted, indicated, or specified in the Contract Documents or not.

- J. Connect recessed luminaires to conduit runs with maximum six feet of flexible metal conduit or MC cable extending from a junction box to the luminaire.

3.4 INSTALLATION

- A. Install conduit in accordance with Manufacturer's written instructions, as indicated on Drawings and as specified herein.
- B. Minimum Conduit Size: Unless otherwise noted herein or on Drawings, minimum conduit size shall be 1/2" for interior applications and 3/4" for exterior and underground applications.
- C. All conduit sizes indicated on the Drawings are sized for copper conductors with THHN/THWN insulation. If conductor type or size is changed the Contractor shall be responsible for resizing conduits upward to meet Code.
- D. In general, all conduit work shall be concealed where possible. Exceptions shall be electrical, communication and mechanical rooms, exposed ceiling areas, and parking garages.
- E. Conduit connections to motors and surface cabinets shall be concealed, except for electrical, communication and mechanical rooms, or unless exposed Work is clearly called for on the Drawings.
- F. Install conduits in complete runs before pulling in cables or wires.
- G. Install conduit free from dented, bruises or deformations. Remove and replace any damaged conduits with new undamaged material.
- H. Conduits shall be well protected and tightly covered during construction using metallic bushings and bushing "pennies" to seal open ends.
- I. In making joints in rigid steel conduit, ream conduit smooth after cutting and threading. Coat all field-threaded joints with UL approved conductive type compound to ensure low resistance ground continuity through conduit and to prevent seizing and corrosion.
- J. Clean any conduit in which moisture or any foreign matter has collected before pulling in conductors. Paint all field-threaded joints to prevent corrosion.
- K. In all empty conduits or ducts, install a "True Tape" conduit measuring tape line to provide overall conduit length for determining length of cables/conductors for future use.
- L. Conduit systems shall be mechanically and electrically continuous throughout. Install code size, insulated, copper, green-grounding conductors in all conduit runs for branch circuits and feeders. This conductor is not indicated on the Drawings. Refer to Section 260526: Grounding and Bonding.
- M. Metallic conduit shall not be in contact with other dissimilar metal pipes (i.e. plumbing).
- N. Make bends with standard conduit bending hand tool or machines. The use of any item not specifically designed for the bending of electrical conduit is strictly prohibited.

- O. A run of conduit between terminations at wire pulling points shall not contain more than the equivalent of four quarter bends (360-degrees, total).
- P. Emergency power raceway system: Install entirely independent of other raceway systems, except where specifically allowed by CEC Article 517.

3.5 PENETRATIONS

- A. Locate penetrations and holes in advance where they are proposed in the structural sections such as footings, beams, wall, etc. Penetrations are acceptable only when the following occurs:
 - 1. Where indicated on the Structural Drawings.
 - 2. As approved by the Structural Engineer prior to construction and after submittal of Drawing showing location, size, and position of each penetration.
- B. Cutting or holes:
 - 1. Cut holes through concrete, masonry block or brick floors and floors of structure with a diamond core drill or concrete saw. Pneumatic hammer, impact electric, hand or manual hammer type drills are not allowed, except where permitted by the Structural Engineer as required by limited working space. Obtain the approval of the Structural Engineer prior to drilling through structural sections.
 - 2. Provide sleeves or "can outs" for cast-in-place concrete floors and walls. Following conduit installation, seal all penetrations using non-iron bearing, chloride free, non-shrinking, dry-pack grouting compounds; or fire rated penetration-sealing materials.
 - 3. Cut holes for conduit penetrations through non-concrete and non-masonry walls, partitions, or floors with a hole saw. The hole shall be only as large as required to accommodate the size of the conduit.
 - 4. Provide single piece escutcheon plates around all exposed conduit penetrations in public places.
- C. Sealing:
 - 1. Non-rated penetrations: Pack opening around conduits with non-flammable insulating material and seal with gypsum wallboard taping compound.
 - 2. Fire stop: Where conduits, wireways and other electrical raceways pass through fire rated partitions, walls, smoke partitions or floor; install a UL classified fire stop material to provide an effective barrier against the spread of fire, smoke, and gases. Completely fill and seal clearances between raceways and openings with the fire stop material.
- D. Waterproofing: At floor, exterior wall, and roof conduit penetrations, completely seal clearances around the conduit and make watertight as specified in Division 07: Sealants and Caulking.
 - 1. Install specified watertight conduit entrance seals at all below grade wall and floor penetrations. Conduits penetrating exterior building walls and building floor slab shall be PVC coated rigid galvanized steel.
 - 2. For roof penetrations furnish and install roof flashing, counter flashing and pitch-pockets as specified under Roofing and Sheet Metal Sections of the Specifications.

3. Provide membrane clamps and cable sealing fittings for any conduit that horizontally penetrates the waterproof membrane.
4. Conduits that horizontally penetrate a waterproof membrane shall fall away from and below the penetration on the exterior side a minimum of two times the conduit diameters.

3.6 CONCEALED IN CONCRETE

- A. Install conduits approximately in the center of the slab so that there will be a minimum of 3/4-inch of concrete around the conduits.
- B. Installation of conduit in structural concrete that is less than three inches thick is prohibited. Topping slabs, maintenance pads and curbs are exempted.
- C. Tie conduits to reinforcing rods or otherwise secure them to prevent sagging or shifting during concrete placement. Run conduit larger than 1-inch trade size, parallel with or at right angles to the main reinforcement; where at right angles to the reinforcement, the conduit shall be close to one of the supports of the slab.
- D. Where nonmetallic conduit or tubing is used, raceways must be converted to PVC coated rigid steel conduit before rising above floor.
- E. Make couplings and connections watertight.
- F. Protect stub-ups from damage where conduits rise from floor slabs. Arrange so curved portion of bends is not visible above the finished slab.
- G. Do not install aluminum conduit embedded in or in contact with concrete.
- H. Provide schedule 40 non-metallic sleeve through concrete or masonry walls where aluminum conduit penetrations are required.

3.7 TERMINATIONS AND JOINTS

- A. Use raceway fittings that are of types compatible with the associated raceway and suitable for the use and location. For intermediate steel conduit, use threaded rigid steel conduit fittings except as otherwise indicated.
- B. Raceways shall be joined using specified couplings or transition couplings where dissimilar raceway systems are joined.
- C. Conduits shall be securely fastened to cabinets, boxes and gutters using two locknuts and an insulating bushing or specified insulated connectors. Where joints cannot be made tight, use bonding jumpers to provide electrical continuity of the raceway system. Where terminations are subject to vibration, use bonding bushings or wedges to assure electrical continuity. Where subject to vibration or dampness, use insulating bushings to protect conductors. Install grounding bushings or bonding jumpers on all conduits terminating at concentric or eccentric knockouts.
- D. Conduit terminations exposed at weatherproof enclosures and cast outlet boxes shall be made watertight using specified connectors and hubs.
- E. Stub-up connections: Extend conduits through concrete floor for connection to freestanding equipment with an adjustable top or coupling threaded inside for plugs and set flush with the finished floor. Extend conductors to equipment with rigid steel

- conduit; flexible metal conduit may be used 6 inches above the floor. Where equipment connections are not made under this contract, install screwdriver operated threaded flush plugs with floor.
- F. Install specified cable sealing bushings on all conduits originating outside the building walls and terminating in switchgear, cabinets, or gutters inside the building. Install cable sealing bushings or raceway seal for conduit terminations in all grade level or below grade exterior pull, junction, or outlet boxes.
- G. Raceway seal: Inject into wire filled raceways, a pre-formulated rigid 2 lbs. density polyurethane foam which expands a minimum 35 times its original bulk. Foam shall have the physical properties of water vapor transmission of 1.2 to 3.0 perms: water absorption less than 2% by volume, fungus and bacterial resistant. Foam shall permanent seal against water, moisture, insects, and rodents. Install raceway sealing foam at the following points:
1. Where conduits enter buildings from below grade.
- H. Install expansion couplings where any conduit crosses a building separation or expansion joint as follows:
1. Conduits three inches and larger, shall be rigidly secured to the building structure on opposite sides of a building expansion joint and provided with expansion or deflection couplings. Install the couplings in accordance with the Manufacturer's recommendations.
 2. Conduits smaller than three inches shall be rigidly secured to the building structure on opposite sides of a building expansion joint with junction boxes on both sides of the joint. Connect conduits to junction boxes with 15 inches of slack flexible conduit. Flexible conduit shall have a green copper ground-bonding jumper installed. For concrete embedded conduit, use expansion and deflection couplings as specified above for three inches and larger conduits.
- I. Use short length (maximum of 6ft) of the appropriate FMC or LFMC conduit for connections to motors and other electrical equipment subject to movement, vibration, misalignment, cramped quarters, or noise transmission. Provide liquidtight flexible metal conduit for installation in exterior locations, moisture or humidity-laden atmosphere, corrosive atmosphere, water hose or spray wash-down operations and locations subject to seepage or dripping of oil, grease, or water. Provide a green ground wire with FMC or LFMC conduit.

3.8 HAZARDOUS LOCATIONS

- A. Use rigid steel conduit only.
- B. Install UL approved sealing fittings that prevent passage of explosive vapors in accordance with the Manufacturers written instructions. Locate fittings at suitable, approved, accessible locations and fill them with UL-listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank coverplate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points and elsewhere as indicated:
1. Where conduits enter or leave hazardous locations.
 2. At luminaires, switches, receptacles and as required by the CEC.

3.9 SUPPORTS

- A. Provide supports for raceways as specified in Section 260529: Electrical Hangers and Supports.
- B. All raceways systems shall be secured to building structures using specified fasteners, clamps and hangers spaced according to the CEC.
- C. Support single runs of conduit using one-hole pipe straps. Where run horizontally on walls in damp or wet locations, install "clamp backs" to space conduit off the surface.
- D. Multiple conduit runs shall be supported using "trapeze" hangers fabricated from specified construction channel, mounted to 3/8-inch diameter, threaded steel rods secured to building structures. Fasten conduit to construction channel with standard one-hole pipe clamps or the equivalent. Provide lateral seismic bracing for hangers.
- E. Individual 1/2" and 3/4" conduits installed above suspended ceilings may be attached to the ceiling's hanger wire using spring steel support clips provided that not more than two conduits are attached to any single support wire.
- F. Support exposed vertical conduit runs at each floor level, independent of cabinets or switches to which they run, by means of acceptable supports.
- G. Fasteners and supports in solid masonry and concrete:
 - 1. Use steel or malleable iron concrete inserts set in place prior to placing the concrete.
 - 2. After concrete installation:
 - a. Steel expansion anchors not less than 1/4 inch bolt size and not less than 1-1/8" embedment.
 - b. Power set fasteners not less than 1/4 inch diameter with depth of penetration not less than three inches.
 - c. Use vibration and shock resistant anchors and fasteners for attaching to concrete ceilings.
- H. Hollow masonry: Toggle bolts are permitted. Bolts supported only by masonry block are not acceptable.
- I. Metal structures: Use machine screw fasteners or other devices specifically designed and approved for the application.

END OF SECTION

SECTION 26 05 33

BOXES

PART 1 - GENERAL

1.1 SUMMARY

- A. Work included: Labor, materials, and equipment necessary to complete the installation required for the item specified under this Division, including but not limited to:
 - 1. Wall and ceiling outlet boxes.
 - 2. Pull and junction boxes.
- B. Related Work: Consult all other Sections, determine the extent and character of related Work, and properly coordinate Work specified herein with that specified elsewhere to produce a complete installation.
 - 1. Division 08: Access doors. Wall and ceiling access doors.

1.2 REFERENCES

- A. Comply with the latest edition of the following applicable Specifications and standards except as otherwise indicated or specified.
 - 1. American National Standards Institute/National Electrical Manufacturer Association:
 - ANSI/NEMA OS-1; Sheet-Steel Outlet Boxes, Device Boxes, Covers and Box Supports.
 - ANSI/NEMA OS-2; Nonmetallic Outlet Boxes, Device Boxes, Covers and Box Supports.
 - NEMA 250; Enclosures for Electrical Equipment (1000 volts maximum).
 - 2. Underwriters Laboratories (UL):
 - UL 50; Enclosures for Electrical Equipment, Non-Environmental Considerations.
 - UL 514A; Metallic Outlet Boxes.
 - UL 1773; Termination Boxes.

1.3 SUBMITTALS

- A. Submit in accordance with the requirements of Section 260010: Basic Electrical Requirements, the following items:
 - 1. Data/catalog cuts for each product and component specified herein, listing all physical and electrical characteristics and ratings indicating compliance with all listed standards.
 - 2. Clearly mark on each data sheet the specific item(s) being submitted and the proposed application.
 - 3. Submit Manufacturer's installation instructions.

1.4 QUALITY ASSURANCE

- A. All materials, equipment and parts comprising the units specified herein shall be new, unused, and currently under production.
- B. Only products and applications listed in this Section may be used on the Project unless otherwise submitted.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Products furnished by the following Manufacturers shall be acceptable if in compliance with all features specified herein and indicated on the Drawings.
 - 1. Outlet and junction boxes:
 - a. Spring City Electrical Manufacturing Co.
 - b. Thomas & Betts Corp.
 - c. Raco, Inc.
 - 2. Cast boxes:
 - a. Appleton Electric Co.
 - b. Crouse-Hinds.
 - 3. Floor boxes:
 - a. Hubbell Inc.
 - b. Walker.
 - c. Raceway Components, Inc.
 - 4. Pullboxes:
 - a. Circle AW Products.
 - b. Hoffman Engineering Co.
 - 5. Precast concrete boxes:
 - a. Oldcastle Enclosure Solutions.
 - b. Jensen Precast.
- B. Substitutions: Under provisions of Section 260010: Basic Electrical Requirements.

2.2 OUTLET BOXES

- A. Standard outlet box:
 - 1. Provide galvanized, one-piece die formed or drawn steel or welded, knockout type box of size and configuration best suited to the application indicated on the Drawings.
 - 2. 4-inch square by 1.5-inch deep shall be minimum box size.
 - 3. ANSI/NEMA OS 1.
- B. Concrete box:
 - 1. Provide galvanized steel, 4-inch octagon rings with mounting lugs, backplate and adapter ring as required.

2. Select height as necessary to position knockouts above concrete reinforcing steel.
 3. ANSI/NEMA OS 1.
- C. Tile box:
1. Provide outlet boxes for installation in tile or concrete block walls.
 2. Standard outlet boxes with raised, square corners and device covers are acceptable.
 3. ANSI/NEMA OS 1.
- D. Cast metal outlet body:
1. Provide 4-inch round, galvanized cast iron alloy with threaded hubs and mounting lugs as required.
 2. Provide boxes with cast cover plates of the same material as the box and neoprene cover gaskets.
- E. Conduit outlet body: Provide Cadmium plated cast iron alloy, oblong conduit outlet bodies with threaded conduit hubs and neoprene gasket, cast iron covers.

2.3 PULL AND JUNCTION BOXES

- A. Sheet metal pull and junction box:
1. Provide standard outlet or concrete ring boxes wherever possible; otherwise use minimum 16-gauge galvanized sheet metal, NEMA 1 boxes, sized to Code requirements with covers secured by cadmium plated machine screws located 6 inches on centers.
 2. ANSI/NEMA OS 1.
- B. Cast metal pull and junction box: Provide standard cast malleable iron outlet or device boxes wherever possible; otherwise use cadmium plated, cast malleable iron boxes with bolt-on, interchangeable conduit hub plates with neoprene gaskets.
- C. Flush mounted pullboxes and junction boxes: Provide overlapping covers with flush head cover retaining screws, prime coated.
- D. Precast concrete boxes: Provide high density reinforced concrete pull and junction box with end and side knockouts and non-settling shoulders. Use cast iron lid with hold down bolts or use traffic rated covers in areas subject to vehicular traffic.

2.4 FLOOR BOXES

- A. Refer to Section 262726: Wiring Devices for floor mounted service boxes.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Contractor shall thoroughly examine Project site conditions for acceptance of box installation to verify conformance with Manufacturer and Specification tolerances. Do not commence with installation until all conditions are made satisfactory.

3.2 PREPARATION

- A. Install all outlet boxes flush with building walls, ceilings, and floors except where boxes are installed in mechanical and electrical rooms, in cabinetry, above accessible ceilings or where exposed Work is called for on the Drawings.
- B. Locate pullboxes and junction boxes in concealed locations above removable ceilings or exposed in electrical rooms, utility rooms or storage areas.
- C. Install outlet boxes at the locations and elevations indicated on the Drawings or specified herein. Make adjustments to locations as required by structural conditions and to suit coordination requirements of other trades.
- D. Locate switch outlet boxes on the latch side of doorways unless otherwise indicated.
- E. Locate outlet boxes above hung ceilings having concealed suspension systems, adjacent to openings for removable recessed luminaires.
- F. Do not install outlet boxes back-to-back, separate boxes by at least 6". In fire-rated walls separate boxes by at least 24" and wall stud.
- G. Adjust position of outlet boxes in finished masonry walls to suit masonry course lines. Coordinate cutting of masonry walls to achieve neat openings for boxes.

3.3 INSTALLATION

- A. Install boxes in accordance with Manufacturer's written instructions, as indicated on Drawings and as specified herein.
- B. Locate electrical boxes as indicated on Drawings and as required for splices, taps, wire pulling, equipment connections and Code compliance.
- C. Install junction or pullboxes where required to limit bends in conduit runs to not more than 360 degrees or where pulling tension achieved would exceed the maximum allowable for the cable to be installed. Note that these boxes are not indicated on the Drawings.
- D. Install raised covers (plaster rings) on all outlet boxes in stud walls or in furred, suspended, or exposed concrete ceilings. Covers shall be of a depth to suit the wall or ceiling finish.
- E. Leave no unused openings in any box. Install close-up plugs as required to seal openings.
- F. Provide cast metal boxes with gasketed cast metal cover plates where boxes are exposed in damp or wet locations.
- G. Welded outlet boxes shall only be used in concealed interior installations.
- H. Provide precast concrete boxes in exterior planting areas, walkways, roads etc.
- I. Provide an access panel in permanent ceiling or wall where boxes are installed and will be inaccessible.
- J. For boxes mounted in exterior walls, make sure that there is insulation behind outlet boxes to prevent condensation in boxes.

- K. For outlets mounted above counters, benches or backsplashes, coordinate location and mounting heights with built-in units. Adjust mounting height to agree with required location for equipment served.
- L. Use conduit outlet bodies to facilitate pulling of conductors or to make changes in conduit direction only. Do not make splices in conduit outlet bodies.
- M. Add additional sheet rock as necessary to maintain original fire rating of walls where boxes are installed.
- N. Install galvanized steel coverplates on boxes in unfinished areas, above accessible ceilings and on surface mounted outlets.

3.4 SUPPORTS

- A. Provide boxes installed in metal stud walls with brackets designed for attaching directly to the studs or mount boxes on specified box supports.
- B. Mount boxes, installed in suspended ceilings of gypsum board or lath and plaster construction, to 16-gauge metal channel bars attached to main ceiling runners.
- C. Support boxes independently of conduit system.
- D. Support boxes, installed in suspended ceilings supporting acoustical tiles or panels, directly from the structure above wherever pendant mounted luminaires are to be installed from the box.
- E. Support boxes mounted above suspended acoustical tile ceilings, directly from the structure above.

END OF SECTION

SECTION 26 05 43

UNDERGROUND DUCTS AND STRUCTURES

PART 1 - GENERAL

1.1 SUMMARY

- A. Work included: Labor, materials, and equipment necessary to complete the installation required for the item specified under this Division, including but not limited to:
 - 1. Underground conduits and ducts.
 - 2. Duct banks.
 - 3. Handhole and Vaults.
 - 4. Other underground utility structures.
 - 5. Excavation, trenching and backfill.
- B. Related Work: Consult all other Sections, determine the extent and character of related Work, and properly coordinate Work specified herein with that specified elsewhere to produce a complete installation.
 - 1. Division 31 - Earthwork: General requirements for Excavation and Backfill and related items for ducts, manholes, pullboxes and handholes.
 - 2. Division 03 - Cast-in-place concrete: Protective envelope for ducts.

1.2 REFERENCES

- A. Comply with the latest edition of the following applicable Specifications and standards except as otherwise indicated or specified:
 - 1. American Concrete Institute (ACI):
 - ACI 318; Building Code Requirements for Structural Concrete
 - 2. American National Standards Institute, Inc. (ANSI):
 - ANSI C80.1; Rigid Steel Conduit, Zinc-Coated.
 - 3. American Society for Testing And Materials (ASTM):
 - ASTM C31; Standard Practice for Making and Curing Concrete Test Specimens in the Field
 - ASTM C39; Test Method for Compressive Strength of Cylindrical Concrete Specimens
 - ASTM C172; Standard Practice for Sampling Freshly Mixed Concrete
 - ASTM C192; Practice for Making and Curing Concrete Test Specimens in the Laboratory
 - ASTM C231; Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
 - ASTM C478; Specification for Precast Reinforced Concrete Manhole Sections
 - ASTM C805; Test Method for Rebound Number of Hardened Concrete

ASTM C857;	Practice for Minimum Structural Design Loading for Underground Precast Concrete Utility Structures
ASTM C858;	Specification for Underground Precast Concrete Utility Structures
ASTM C877;	Specification for External Sealing Bands for Concrete Pipe, Manholes and Precast Box Sections
ASTM C891;	Practice for Installation of Underground Precast Concrete Utility Structures
ASTM C990;	Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants
ASTM C1037;	Practice for Inspection of Underground Precast Concrete Utility Structures
ASTM C1064;	Standard Test Method for Temperature of Freshly Mixed Concrete
ASTM C1231;	Standard Practice for Use of Unbonded Caps in Determination of Compressive Strength of Hardened Concrete Cylinder
ASTM C1611;	Standard Test Method for Slump Flow of Self-Consolidating Concrete
4. Underwriters Laboratories, Inc. (UL):
- | | |
|---------|--|
| UL 6; | Rigid Metal Conduit. |
| UL 651; | Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings. |
5. National Electrical Manufacturer Association (NEMA):
- | | |
|------------|---|
| NEMA RN1; | PVC Externally-coated Galvanized Rigid Steel Conduit. |
| NEMA TC 2; | Electrical Plastic Tubing and Conduit. |
| NEMA TC 3; | PVC Fittings for use with Rigid PVC Conduit. |
| NEMA TC6; | PVC Plastic Utilities Duct (EB and BD Type). |

1.3 DEFINITIONS

- A. Duct: Electrical conduit and other raceway, either metallic or nonmetallic, used underground embedded in earth.
- B. Duct bank: Two or more conduits or another raceway installed underground in same trench.
- C. Handhole: An underground junction box in a duct or duct bank.
- D. Vault: An underground utility structure, large enough for a person to enter, connecting with ducts to afford facilities for installing, operating and maintaining equipment and wiring.

1.4 SUBMITTALS

- A. Submit in accordance with the requirements of Section 260010: Basic Electrical Requirements, the following items:
 - 1. Data/catalog cuts for each product and component specified herein, listing all physical and electrical characteristics and ratings indicating compliance with all listed standards.
 - 2. Clearly mark on each data sheet the specific item(s) being submitted and the proposed application.
 - 3. Shop Drawings showing details and design calculations for precast vaults and handholes, including reinforced steel.
 - 4. Submit Manufacturer's installation instructions.
 - 5. Complete bill of material listing all components.
 - 6. Certificate for concrete and steel used in underground precast concrete utility structures, according to ASTM C858.
 - 7. Inspection report for factory inspections, according to ASTM C1037.

1.5 QUALITY ASSURANCE

- A. All materials, equipment and parts comprising the units specified herein shall be new, unused, and currently under production.
- B. Only products and applications listed in this Section may be used on the Project unless otherwise submitted and approved.
- C. Precast concrete vaults shall be designed and fabricated by an experienced and acceptable precast concrete manufacturer. The manufacturer shall have been regularly and continuously engaged in the manufacture of precast concrete units similar to that indicated in the project specifications or drawings for at least 10 years.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Products furnished by the following Manufacturers shall be acceptable if in compliance with all features specified herein and indicated on the Drawings.
 - 1. Underground precast concrete utility structures:
 - a. Oldcastle Enclosure Solutions.
 - b. Jensen Precast.
 - 2. Conduits, ducts and fittings:
 - a. Prime Conduit.
 - b. JM Eagle.
 - c. Cantex.
 - d. Occidental Coating Company (OCAL).
- B. Substitution: Under provisions of Section 260010: Basic Electrical Requirements.

2.2 CONDUIT AND DUCT

- A. Refer to Section 260531: Conduit.

- B. Galvanized rigid steel conduit (GRS) in underground installations:
 - 1. PVC insulated galvanized rigid steel conduit (PVC GRS):
 - a. Conduit: Full weight, threaded, hot-dip galvanized steel, conforming to ANSI C80.1 and NEMA RN-1 with nominal 20 or 40 mil thermoplastic vinyl coating, heat fused and bonded to the exterior of the conduit.
 - b. Fittings: Conduit couplings and connectors shall be steel or malleable iron as required with factory PVC coating and insulated jacket equivalent to that of the coated material.
 - 2. Tape insulated galvanized rigid steel conduit (Tape GRS):
 - a. Conduit: Full weight, threaded, hot-dip galvanized steel, conforming to ANSI C80.1 and NEMA RN-1 with half lapping of PVC 10 mil tape over the exterior of the conduit. Half lap all raceways a minimum of one time and extend to 12-inches above grade.
 - b. Fittings: Conduit couplings and connectors shall be steel or malleable iron as required with half lapping of PVC 10 mil tape over the exterior of the fittings. Half lap shall extend to 12-inches above grade.
- C. Elbows:
 - 1. Low voltage systems (1000 volts and less):
 - a. Minimum radius bends shall be factory standard-inches or greater, if indicated on the drawings or required by the cable manufacturer.
- D. Duct supports: Rigid PVC spacers selected to provide minimum duct spacing and concrete cover depths, while supporting ducts during concrete pour.
- E. Duct sealing compound: Non-hardening, safe for human skin contact, not deleterious to cable insulation, workable at temperatures as low as 35 degree F, withstands temperature of 300 degrees F without slump and adheres to clean surfaces of plastic ducts, metallic conduits, conduit coatings, concrete, cable sheaths and jackets, etc.

2.3 PULLBOXES AND HANDHOLES

- A. Construction: High densities precast reinforced concrete box, extension, base, and cover. Furnish box with end and side knockouts and non-settling shoulders. Cover shall have hold-down bolts and two lifting eyes.
- B. Size: As indicated on the Drawings.
- C. Cover markings: Covers shall read "ELECTRICAL", "COMMUNICATIONS", or "SIGNAL" as appropriate.
- D. Rated covers: Use cast iron lid with H20 traffic rating when subject to vehicular traffic.

2.4 VAULTS

- A. Precast concrete: Concrete mix and reinforcing placement shall be in accordance with ACI 318. Design tops and wall structures for AASHTO H20 highway loading, with 30 percent loading added for impact. Walls shall withstand all soil pressures,

taking into consideration the soil encountered and ground water level present at the Project site. Assume ground water level three feet below ground surface unless a higher water table is indicated in soils report.

B. Construction:

1. Monolithic or modular assembled sections.
2. Assembled sections shall have mating edges with tongue and groove joints. Joints shall firmly interlock adjoining components and provide waterproof junctions. Seal joints watertight using preformed plastic strip.
3. Provide lifting devices cast into units for proper handling of units.
4. Identify all structures with Manufacturer's name embedded in or otherwise permanently attached to an interior wall face.
5. Include concrete knockout panels for conduit entrance and sleeve for ground rod.

C. Size and dimensions: As indicated on Drawings.

D. Accessories:

1. Frames and covers: Cast iron with cast-in legend "ELECTRICAL", "COMMUNICATIONS", or "SIGNAL" as appropriate. Machine cover-to-frame bearing surfaces.
2. Pulling eyes in walls: Eyebolt with reinforcing bar fastening insert. 2-inch diameter eye, 1-inch by 4-inch bolt. Working load embedded in 6-inch, 4000-PSI concrete: 13,000 pounds minimum tension.
3. Pulling and lifting irons in floor: 7/8-inch diameter, hot-dipped galvanized, bent steel rod, stress relieved after forming and fastened to reinforced rod. Exposed triangular opening. Ultimate yield strength: 40,000 pounds shear and 60,000 pounds tension.
4. Bolting inserts for cable stanchions: Flared, threaded inserts of non-corrosive, chemical resistant, nonconductive thermoplastic material; 1/2-inch internal diameter by 2.75-inch deep, flared to 1.24-inch minimum at base. Tested ultimate pull-out strength at 12,000 pounds minimum.
5. Expansion anchors for installation after concrete is cast: Zinc-plated carbon steel wedge type with stainless-steel expander cup 1/2-inch bolt size, 5,300 pound rated pull-out strength and 6800 pound rated shear strength minimum.
6. Cable stanchions: Hot-rolled, hot-dipped, galvanized "T" section steel, two 1/4-inches size, punched with 14-holes on 1.5-inch centers for cable arm attachment.
7. Ground rods: Solid copper, 3/4-inch diameter by 10-feet length (minimum).
8. Ground wire: Stranded bare copper conductor, #6 AWG (minimum). Size in accordance with CEC Article 250.

2.5 CONSTRUCTION MATERIALS

- A. Mortar: Conform to ASTM C270, Type M, except for quantities less than 2.0 Cu. Ft., where packaged mix complying with ASTM C387, Type M may be used.
- B. Concrete: Conform to Division 03: Cast-in-place concrete for concrete and reinforcing.
1. Strength: 3,000-PSI minimum 28-day compressive strength.

2. Aggregate for duct encasement: 3/8-inch maximum size.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Contractor shall thoroughly examine Project site conditions for acceptance of duct and manhole installation to verify conformance with Manufacturer and Specification tolerances. Do not commence with installation until all conditions are made satisfactory.

3.2 EARTHWORK

- A. Excavation and backfill: Conform to Division 31, Earthwork.
- B. Excavation for underground electrical structures: Conform to elevations and dimensions indicated within a tolerance of plus or minus 0.10 foot; plus, a sufficient distance to permit placing and removal of concrete formwork, installation or services, other construction and for inspection.
 1. Excavate, by hand, areas within dripline of large trees. Protect the root system for damage and dry-out. Maintain moist conditions for root system and over exposed roots with burlap. Paint root cuts of 1 inch in diameter and larger with emulsified asphalt tree paint.
 2. Take care not to disturb bottom of excavation. Excavate by hand to final grade just before concrete reinforcement is placed.
- C. Trenching: Excavate trenches for electrical installation as follows:
 1. Excavate trenches to the uniform width, sufficiently wide to provide ample working room and a minimum of 6 to 9 inches clearances on both sides of raceways and equipment.
 2. Excavate trenches to depth indicated or required.
 3. Limit the length of open trench to that in which installations can be made and the trench backfilled within the same day.
 4. Where rock is encountered, carry excavation below required elevation and backfill with a layer of crushed stone or gravel prior to installation of raceways and equipment. Provide a minimum of 6 inches of stone or gravel cushion between rock bearing surface and electrical installations.
- D. Backfilling and filling: Place soil materials in layers to required sub-grade elevations for each area classification, using materials and methods specified in Division 31: Earthwork.
 1. Under building slabs, use drainage fill materials.

3.3 CONDUIT AND DUCT INSTALLATION

- A. Install duct lines in accordance with Manufacturer's written instructions, as indicated on the Drawings and as specified herein.
- B. Application:
 1. Direct burial ducts: Schedule 40, minimum 24-inches below finished grade.

2. Below building slab-on-grade: Schedule 40, minimum 4-inches below bottom of slab except that bends and penetrates through floor slab shall be insulated galvanized rigid steel conduit.
 3. Below roads and paved surfaces:
 - a. Schedule 80, minimum 36-inches below finished grade.
 4. Penetrations of building and equipment slabs: Insulated galvanized rigid steel conduit.
- C. Slope duct to drain towards vaults and handholes and away from building and equipment entrances. Pitch not less than 4-inches per 100-feet.
- D. Curved sections in duct lines shall consist of long sweep bends with a minimum radius of 25-feet in the horizontal and vertical directions. The use of manufactured bends is limited to building entrances and equipment stub-ups.
- E. For communications and signal conduits, do not exceed a combined bend radius of greater than 180 degrees between pull points.
- F. Underground conduit stub-ups to inside of building and exterior equipment shall be insulated galvanized rigid steel conduit.
- G. Make joints in ducts and fittings watertight according to Manufacturer's instructions. Stagger couplings so those of adjacent ducts do not lie in the same plane.
- H. Terminate duct lines at vaults and handholes with end bells spaced 10-inches on center for 5-inch ducts and varied proportionately for other duct sizes. Change from regular spacing to end-bell spacing 10-feet from the end bell without reducing duct line slope and without forming trap in the line. Grout end bells into vaults walls from both sides to provide watertight entrance.
- I. Separation between direct buried duct lines shall be 3-inches minimum for like systems and 612-inches minimum between power and signal ducts.
- J. For direct burial installations install continuous warning strip of heavy gage plastic imprinted "electrical ducts below", approximately 12-inch wide at 12-inches above ducts.
- K. Mandrel all ducts upon completion of installation and prior to pulling cables.

3.4 HANDHOLE AND PULL BOX INSTALLATION

- A. Install handholes in accordance with Manufacturer's written instructions, as indicated on Drawings and as specified herein.
- B. Handholes shall be installed flush with finished grade or surface. Install on a level 6-inch bed of well-tamped gravel or crushed stone.
- C. Orientation of handholes shall be coordinated in advance with Landscape Architect and arranged to minimize connecting duct bends and deflections.

3.5 VAULT INSTALLATION

- A. Install precast assembly in accordance with Manufacturer's written instructions, as indicated on Drawings and as specified herein.

- B. Install cast iron frame and cover. Set frames in paved areas and traffic ways flush with finished grade. Set other frames 1-inch above finished grade.
- C. Units shall be installed on a level 12-inch bed of well-tamped gravel or crushed stone.
- D. Install drains in bottom of units where indicated.
- E. Install removable hardware, including pulling eyes, cable stanchions, cable arms and insulators, as required for installation and support of cable and conductors and as indicated.
- F. Provide cable rack support as indicated and required. Support intervals shall not exceed 36-inches. Each rack shall include cable support insulators.
- G. Drive ground rod into earth, through the floor sleeve, after manhole is set in place. Fill the sleeve with a sealant to make a watertight seal.
- H. Install ground wire around the inside perimeter of manhole and anchor to wall. Connect the wire to the ground rod by exothermic welding process to form solid metal joint. Bond the ground wire to the exposed non-current carrying metal parts of racks and like items in the manhole.
- I. Do not drill deeper than 3-7/8" for anchor bolts installed in the field. Use a minimum of 2 anchors for each cable stanchion.

3.6 FIELD QUALITY CONTROL

- A. Testing: Demonstrate capability and compliance with requirements upon completion of installation of underground duct and structures.
 - 1. Grounding: Test vault grounding to ensure electrical continuity of bonding and grounding connections. Measure ground resistance at each ground rod and report results.
 - 2. Duct integrity: Rod ducts with a mandrel 1/4-inch smaller in diameter than internal diameter of ducts. Where rodding indicates obstructions in ducts, remove the obstructions and retest.

3.7 CLEANING

- A. Pull brush through full length of ducts. Use round bristle brush with a diameter 1/2-inch greater than internal diameter of duct.
- B. Clean internal surfaces of handholes and vaults including sump. Remove foreign material.

END OF SECTION

SECTION 26 05 53
ELECTRICAL IDENTIFICATION

PART 1 - GENERAL

1.1 SUMMARY

- A. Work included: Labor, materials, and equipment necessary to complete the installation required for the item specified under this Division, including but not limited to:
 - 1. Electrical equipment nameplates.
 - 2. Panelboard directories.
 - 3. Wire and cable identification.
 - 4. Buried electrical line warnings.
 - 5. Junction box identification.
 - 6. Warning and caution signs.
 - 7. Inscribed device coverplates.
- B. Related Work: Consult all other Sections, determine the extent and character of related Work, and properly coordinate Work specified herein with that specified elsewhere to produce a complete installation.
 - 1. Division 09: Painting.

1.2 SUBMITTALS

- A. Submit in accordance with the requirements of Section 260010: Basic Electrical Requirements, the following items:
 - 1. Data/catalog cuts for each product and component specified herein.
 - 2. Schedules for nameplates to be furnished.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Products furnished by the following Manufacturers shall be acceptable if in compliance with all features specified herein and indicated on the Drawings.
 - 1. Conduit and wire markers:
 - a. Thomas & Betts Corp.
 - b. Brady.
 - c. Griffolyn.
 - 2. Inscription Tape:
 - a. Kroy.
 - b. Merlin.
- B. Substitutions: Under provisions of Section 260010: Basic Electrical Requirements.

2.2 NAMEPLATES

- A. Type NP: Engraved, plastic laminated labels, signs, and instruction plates. Engrave stock melamine plastic laminate 1/16-inch minimum thickness for signs up to 20-square inches or 8-inches in length; 1/8-inch thick for larger sizes. Engraved nameplates shall have white letters and be punched for mechanical fasteners.
- B. Color and letter height as specified in Part 3: Execution.

2.3 LEGEND PLATES

- A. Type LP: Die-stamped metal legend plate with mounting hole and positioning key for panel mounted operator devices, i.e. motor control pilot devices, hand-off-auto switches, reset buttons, etc.
- B. Stamped characters to be paint filled.

2.4 BRASS TAGS

- A. Type BT: Metal tags with die-stamped legend, punched for fastener.
- B. Dimensions: 2" diameter 19 gauge.

2.5 PANELBOARD DIRECTORIES (400 AMP OR LESS)

- A. Directories: A 6" x 8" minimum size circuit directory frame and card with clear plastic covering shall be provided inside the inner panel door.
- B. Circuit numbering: Starting at the top, odd numbered circuits in sequence down the left-hand side and even numbered circuits down the right-hand side. Multi-section panelboards shall have continuous consecutive circuit numbers, i.e. Section 1 (circuit numbers 1-42), Section 2 (circuit numbers 43-84), Section 3 (circuit numbers 85-126) for all 42-pole panelboards. For 84-pole panelboards the numbering is Section 1 (circuit numbers 1-84), Section 2 (circuit numbers 85-168), etc.

2.6 WIRE AND TERMINAL MARKERS

- A. Provide self-adhering, pre-printed, machine printable or write-on, self-laminating vinyl wrap around strips.
- B. Blank markers shall be inscribed using the printer or pen recommended by Manufacturer for this purpose.

2.7 CONDUCTOR PHASE MARKERS

- A. Colored vinyl plastic electrical tape, 3/4" wide, for identification of phase conductors. Scotch 35 Brand Tape or equal.

2.8 UNDERGROUND CONDUIT MARKER

- A. 6-inch wide, yellow polyethylene tape, with continuous black imprinting reading "Caution - Buried Electric Line Below".

2.9 INSCRIBED DEVICE COVERPLATES

- A. Coverplate material shall be as specified in Section 262726: Wiring Devices.

B. Methods of inscription: (Unless otherwise noted)

1. Type-on-tape:
 - a. Imprinted or thermal transfer characters onto tape lettering system.
 - b. Tape trimmer.
 - c. Matte finish spray-on clear coating.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Contractor shall thoroughly examine Project site conditions for acceptance of identification device installation to verify conformance with Manufacturer and Specification tolerances. Do not commence with installation until all conditions are made satisfactory.

3.2 NAMEPLATES

- A. Installation:
1. Degrease and clean surfaces to receive nameplates.
 2. Install nameplates parallel to equipment lines.
 3. Secure nameplates to equipment fronts using machine screws.
- B. Provide type 'NP' color coded nameplates that present, as applicable, the following information:
1. Equipment or device designation
 2. Amperage, KVA or horsepower rating, where applicable.
 3. Voltage or signal system name.
 4. Source of power or control.
- C. Nameplates for power system distribution equipment and devices are to be black.
- D. Nameplates for signal systems equipment and devices are to be black except as follows:
1. Fire alarm and life safety - Red.
 2. Security/card access/CCTV systems - Green.
 3. Clock, intercom, sound, MATV, CATV - Blue.
- E. Minimum letter height shall be as follows:
1. For panelboards, switchboards, etc.: ½ inch letters to identify equipment designation. Use ¼ inch letters to identify voltage, phase, wires, etc.
 2. For individual circuit breakers, switches and motor starters in panelboards, distribution boards, and switchboards use 3/8-inch letters to identify equipment designation. Use 1/8-inch letters to identify all other.
 3. For individual mounted circuit breakers, disconnect switches, enclosed switches and motor starters use 3/8-inch letters to identify equipment designation. Use 1/8" letters to identify all other.

4. For transformers use ½-inch letters to identify equipment designation. Use ¼-inch letters to identify primary and secondary voltages, etc.
5. For equipment cabinets, terminal cabinets, control panels and other cabinet enclosed apparatus use 3/8-inch letters to identify equipment designation.

3.3 LEGEND PLATES

- A. Provide panel-mounted operators devices such as pilot lights, reset buttons, "HAND-OFF-AUTO" switches, etc.

3.4 BRASS TAGS

- A. Provide type BT tags for individual ground conductors to exposed ground bus indicating connection i.e. "UFER", "Cold water bond", etc.
- B. Provide tags for all feeder cables in underground vaults and pull boxes.
- C. Provide tags for empty conduits in underground vault, pull boxes and stubs.

3.5 PANELBOARD DIRECTORIES (400 AMP OR LESS)

- A. Provide typewritten directories arranged in numerical order denoting loads served by room number or area for each circuit.
- B. Verify room numbers or area designation with Project Manager.
- C. Mount panelboard directories in a minimum 6" x 8" metal frame under clear plastic cover inside every panelboard.

3.6 WIRE AND CABLE IDENTIFICATION

- A. Provide wire markers on each conductor in panelboards, pull boxes, outlet, and junction boxes and at load connection. Identify with branch circuit or feeder number for power and lighting circuits and with control wire number as indicated on equipment Manufacturer's Shop Drawings for control wiring.
- B. Provide colored phase markers for conductors as noted in Section 260519: Building Wire and Cable. Apply colored, pressure sensitive plastic tape in half-lapped turns for a distance of 3-inches from terminal points and in boxes where splices or taps are made. Apply the last two laps of tape with no tension to prevent possible unwinding. Do not cover cable identification markings by taping.

3.7 UNDERGROUND CONDUIT MARKERS

- A. During trench backfilling, for exterior underground power, signal, and communications lines, install continuous underground plastic line marker, located directly above line at 6 to 8 inches below finished grade. Where multiple lines installed in a common trench or concrete envelope, do not exceed an overall width of 16 inches; install a single line marker.

3.8 JUNCTION BOX IDENTIFICATION

- A. The cover of junction, pull and connection boxes for both power and signal systems, located above suspended ceilings and below ceilings in non-public areas, shall be clearly marked with a permanent ink felt pen. Identify the circuit(s) (panel

designation and circuit numbers) contained in each box, unless otherwise noted or specified.

3.9 WARNING, CAUTION, AND INSTRUCTION SIGNS

- A. Provide warning, caution or instruction signs where required by CEC, where indicated or where reasonably required to assure safe operation and maintenance of electrical systems and of the items to which they connect. Install engraved plastic laminated instruction signs with approved legend where instructions or explanations are needed for system or equipment operation. Install butyrate signs with metal backing for outdoor items.
- B. Emergency Operating Signs: Install engraved laminate signs with white letters on red background with minimum 3/8-inch high lettering for emergency instructions on power transfer, load shedding or other emergency operations.

3.10 INSCRIBED DEVICE COVERPLATE

A. General:

- 1. Lettering type: Helvetica, 12 point or 1/8" high.
- 2. Color of characters shall be black.
- 3. Locate the top of the inscription 1/2" below the top edge of the coverplate.
- 4. Inscription shall be centered and square with coverplate.

B. Application:

- 1. Provide inscribed coverplates for devices as outlined below:
 - a. Receptacles.
 - b. Outlets in surface raceways.
 - c. Multi-ganged (four or more) switch arrangement.
 - d. Special purpose switches, i.e. projection screens, shades, exhaust fans, etc.
 - e. Telecommunication outlets.
- 2. Type-on-tape installation:
 - a. Tape shall be trimmed to the height of the letters.
 - b. Trim tape length to 1/4-inch back from each edge of coverplate.
 - c. Contractor hands shall be clean or covered with surgical type glove prior to application of tape. Tape installations with visible fingerprints or smudges will not be acceptable.

END OF SECTION

SECTION 26 09 43

NETWORK ADDRESSABLE LIGHTING CONTROL

PART 1 - GENERAL

1.1 SUMMARY

- A. Work included: Labor, materials, and equipment necessary to complete the installation required for the item specified under this Division, including but not limited to:
1. System software.
 2. Central headend.
 3. Network gateway.
 4. Lighting control modules.
 5. Plug load control modules.
 6. Control stations.
 7. Occupancy sensors.
 8. Daylight sensors.
 9. Relay panels.
 10. Emergency bypass relays or transfer device.
 11. Demand Response Virtual End Node (VEN).
 12. BACnet interface module.
 13. Network communication cabling.
 14. Startup and field quality control.
 15. Commissioning.
- B. Related Work: Consult all other Sections, determine the extent and character of related Work and properly coordinate Work specified herein with that specified elsewhere to produce a complete installation.
1. Division 25 – Building automation system (BAS): Lighting control interface.

1.2 REFERENCES

- A. Comply with the latest edition of the following applicable Specifications and standards except as otherwise indicated or specified:
1. National Electrical Manufacturer Association (NEMA):

NEMA 250;	Enclosures for Electrical Equipment.
NEMA ICS 1;	Industrial Control and Systems.
NEMA ICS 4;	Terminal Blocks and Industrial use.
NEMA ICS 6;	Enclosures for Industrial Controls and Systems.
 2. Underwriters Laboratories, Inc. (UL):

UL 50;	Enclosures for Electrical Equipment, Non-Environmental Considerations

UL 773A;	Nonindustrial Photoelectric Switches for Lighting Control.
UL 916;	Energy Management.
UL 924	Standard for emergency lighting and power equipment.
UL1008	Transfer switch equipment.

1.3 SYSTEM DESCRIPTION

- A. A software based addressable lighting control system that interconnects and networks lighting components such as occupancy and daylight sensors, control stations, etc. to control luminaires connected to the system. All components are networked together and tied back to the headend for two-way communication.
- B. Control of luminaires will come from central or distributed control modules capable of on/off control and 0-10 volt dimming.
- C. The system software shall be capable of adjusting all parameters such as time schedules, dimming presets, time delays, etc. The control parameters shall be available to end users as well as installers during setup and commissioning.
- D. The control system is connected independent of electrical lighting circuits.
- E. The system shall utilize either hardwired or wireless components.

1.4 SUBMITTALS

- A. Submit in accordance with the requirements of Section 260010: Basic Electrical Requirements, the following items:
 - 1. Data/catalog cuts for each product and component specified herein, listing all physical and electrical characteristics and ratings indicating compliance with all listed standards.
 - 2. Describe system operation, equipment and dimensions and indicate features of each component.
 - 3. Clearly mark on each data sheet the specific item(s) being submitted and the proposed application.
 - 4. Shop Drawings to include:
 - a. Lighting plans, showing location of all devices as installed.
 - b. Point-to-Point wiring diagram in either a floor plan or block or riser format showing all low-voltage lighting control components, conduit and wire types and sizes with cable legend.
 - c. Include elevations of major components (headend, panels, etc.)
 - 5. Furnish structural calculations for equipment anchorage as described in Section 260010: Basic Electrical Requirements.
 - 6. Submit Manufacturer's installation instructions.
 - 7. Complete bill of materials listing all components.
 - 8. Warranty.

1.5 OPERATION AND MAINTENANCE MANUAL

A. Supply operation and maintenance manuals in accordance with the requirements of Section 260010: Basic Electrical Requirements to include the following:

1. Operation and maintenance manuals shall include the following:
 - a. A detailed explanation of the operation of the system.
 - b. Instructions for routine maintenance.
 - c. Pictorial parts list and part numbers.
 - d. Shop drawings to include the following:
 - 1) Lighting plans showing all devices.
 - 2) Show network communication cabling and prefabricated lengths.
 - 3) Indicate device addresses.
 - 4) Riser diagram indicating system backbone and headend connections.
2. Telephone numbers for the authorized parts and service distributors.
3. Final testing report.

1.6 QUALITY ASSURANCE

- A. All materials, equipment and parts comprising the units specified herein shall be new, unused, and currently under production.
- B. Only products and applications listed in this Section may be used on the Project unless otherwise submitted.

1.7 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Delivery: Addressable lighting control components shall not be delivered to the Project site until protected storage space is available. Storage outdoors covered by rainproof material is not acceptable. Equipment damaged during shipment shall be replaced and returned to Manufacturer at no cost to Owner.
- B. Storage: Store in a clean, dry, ventilated space free from temperature extremes. Maintain factory wrapping or provide a heavy canvas/plastic cover to protect units from dirt, water, construction debris and traffic. Provide heat where required to prevent condensation.
- C. Handling: Handle in accordance with Manufacturer's written instructions. Be careful to prevent internal component damage, breakage, denting and scoring. Damaged units shall not be installed. Replace damaged units and return equipment to Manufacturer.

1.8 WARRANTY

- A. Units and components offered under this Section shall be covered by a minimum 2-year parts and labor warranty for malfunctions resulting from defects in materials and workmanship. Warranty shall begin upon acceptance by the Owner.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Products furnished by the following Manufacturers shall be acceptable if in compliance with all features specified herein and indicated on the Drawings.

1. Network addressable lighting control system:

- a. Wattstopper "DLM".
- b. Lutron "Quantum".
- c. Acuity "nLight".
- d. Douglas "Dialog".
- e. ETC "Echo".
- f. Eaton "Greengate Room Controller".

B. Substitutions: Under provisions of Section 260010: Basic Electrical Requirements.

2.2 GENERAL

- A. The lighting control system software shall be windows based and able to reside on a computer, server, or virtual server. The software or server shall have remote in capabilities to allow facility end users, setup technicians, and contractors to adjust all parameters of the control system from a remote location.
- B. Daylight sensors and the control software shall rationalize changes to light levels when daylight is available and shall maintain a steady light level when subjected to fluctuating ambient conditions.
- C. The control system shall be programmable for scheduling lights "ON/OFF" via the system software interface, to include:
 - 1. Override: Manual adjustments and occupancy sensor detection shall temporarily override off status imposed by time clock schedule.
 - 2. Response to Power Failure: In the event of a power failure, the system shall maintain the memory of the astronomical time clock and all scheduled events. Upon power returning the system shall execute schedules that would still be in progress had they begun during the power outage.
 - 3. Flick warning: Five minutes prior to a scheduled light "OFF" event or at the end of a temporary override, the system shall provide two short light level drops as a warning to the affected occupants.
- D. During an emergency condition (loss of normal power), the system shall not impede the emergency luminaires to function properly, i.e. the control system shall control emergency luminaires to turn on at full light output and lock out user controls.
- E. The control system shall allow occupancy sensor, when relaying a vacant status to either turn lights off or dim lights to a preset level.
- F. Control system's firewall technology shall maintain network security.
- G. An automatic demand response load shedding mode shall be available where, when activated through the system, the control unit will reduce its output to a programmable maximum electrical demand load. The control system shall not shed more load than required and load shedding priority shall be centrally configurable by control zone. The system shall have the ability to override a demand response event at the headend level, but the individual user shall not have the ability to override system light levels above the preset demand response light levels.

- H. The control system components shall comply with the latest edition of the California Building Energy Efficiency Standards, California Building Code, Part 6 and be certified by The California Energy Commission.

2.3 SYSTEM SOFTWARE

A. General:

1. The central control software is used to commission, configure, and manage the lighting control system. It enables configuration of every system parameter in the building and establishes the baseline settings for the following features:
 - a. Daylight harvesting.
 - b. Occupancy control.
 - c. Time scheduling.
 - d. Task tuning.
 - e. Manual control.
 - f. Demand Response.
2. The central control software utilizes a floor plan bases interface that permits a user to easily navigate between zones and floors of a building with zoom “in and zoom “out” capabilities. A zone tree shall also be available to make global changes for groups and space types.
3. Advanced system features such as creation of zone hierarchies, overlapping and support zone definitions, user access rights, timeout settings for occupancy sensors, calibration of light levels for daylight harvesting and the settings of multiple configured time schedule profiles are controlled through this software.
4. No pre-assigned addresses are required upon installation of hardware devices.

B. Operation:

1. Operating system: Microsoft Windows.
2. Hard drive space: As required by manufacturer.
3. RAM: As required by manufacturer.
4. Network connection with access to network-enabled lighting control system.

2.4 CENTRAL HEADEND

A. General:

1. The central headend shall be the interface between the system software and all devices on the control system. It shall store all the system settings and parameters, including attributes for zones, luminaires, control devices, time schedules, etc.
2. The central headed shall tie to the server or computer running the system software.
3. All devices on the system shall communicate back to the headend.
4. Upon loss of network connection to the system software the headend shall maintain all system functionality.

2.5 NETWORK GATEWAY

- A. The network gateway is the interface between the system components (control modules, sensors, switches, etc.) and the central headend.
- B. Network cables shall connect all devices to the gateway. The gateway shall tie into the headend with a single cable. Wireless systems shall transmit and receive signals with the gateway and the gateway shall be hardwired back to the headend.
- C. Multiple gateways shall be provided as required by the manufacturer.
- D. The term "network gateway" is generic. Each manufacturer will have a different name for this device.

2.6 LIGHTING CONTROL MODULES

- A. General:
 - 1. Lighting control modules provide an interface between the control system and luminaires. Modules take inputs from the system and convert the commands through the power and control wiring to the fixture providing "ON/OFF/DIMMING" functions.
 - 2. Lighting control modules contain a 16 amp minimum rated relay(s) for "ON/OFF" control as well as a 0-10 volt dimming signal.
 - 3. In the event of a power failure, control modules connected to luminaires shall default to the "on" state at full light output.
- B. The following lighting control modules shall be available with the system, at a minimum:
 - 1. Single zone 0-10 volt control module with a relay.
 - 2. Multi-zone 0-10 volt control module with one relay per 0-10 volt zone ("Room Controller").
- C. Mounting:
 - 1. Single zone modules shall have a 1/2" nipple to mount directly to a 1/2" knockout on a junction box.
 - 2. Multi-zone modules shall mount stand alone or onto a 4-inch square junction box.

2.7 PLUG LOAD CONTROL MODULES

- A. General:
 - 1. Plug load Control modules provide an interface between the control system and controlled outlets. Modules take inputs from the system and convert the commands through the power wiring to the receptacle(s) being controlled.
 - 2. Control modules contain a 20 amp rated relay(s) for "ON/OFF" control.
- B. Mounting:
 - 1. Modules shall have a 1/2" nipple to mount directly to a 1/2" knockout on a junction box.

2.8 CONTROL STATIONS

- A. General:

1. The controllers are configurable wall mounted devices that provide local “ON/OFF/DIMMING” control to lighting zones.
 2. Each device can be set-up and modified through the control systems software interface.
- B. Dimmer switch controller:
1. Software configurable dimmer switch that provides “ON/OFF” switching and the capability to dim.
 2. Dimming to be continuous over the full range of the driver or ballast it is controlling.
- C. Dimming scene controller:
1. Multi-button controller allowing the end user to recall zones or scenes for “ON/OFF/DIMMING” control.
 2. Scenes are made up of multiple zones, where each zone is dimmed to a specific light output.
 3. Scene configuration can be changed via control systems software.
 4. The scene controller shall also allow for a custom labeling feature that allows scene labels on the controller to be easily modified.
- D. Specifics:
1. Mounting:
 - a. Controllers utilize a standard single-gang device strap configuration for ease in mounting. Where multiple controllers are ganged together, they shall allow for a single multi-gang cover plat to be used.
 - b. Mounts to standard switch box or cut-in ring.
 2. Controllers shall tie to the system in one of the following ways:
 - a. Hardwired low voltage, wiring and connections per manufacturer’s requirements.
 - b. Wireless with a 10-year minimum battery life. Mechanically triggered wireless switches shall not be allowed unless approved by The Owner.

2.9 OCCUPANCY SENSOR

A. General:

1. Occupancy sensors shall automatically detect movement within a space, reporting the state of occupancy to the headend and system software, which will push commands to control modules for “ON/OFF/DIMMING” control of lighting zones and “ON/OFF” control of the controlled receptacle circuits within that space.
2. All setpoints for the occupancy sensor shall be accessible and changed through the system software.
3. Occupancy sensors do not directly control luminaires. This allows for the raw data reported back to the system software to be used for multi-zones of lighting (i.e., one sensor for multiple control zones).
4. Sensors shall capable of being linked together in software to provide a larger coverage area.

5. Provide enough occupancy sensors as required for complete area coverage they are installed in, regardless of how many sensors are shown on the Drawings.
- B. Specifics:
1. Sensor shall have a coverage of 1,000 square feet. Manufacturer to provide additional sensors if coverage is less than 1,000 square feet.
 2. Sensors shall be infrared or dual technology or microphonic. Dual technology sensors shall be capable of disabling either infrared or ultrasonic sensing.

2.10 DAYLIGHT SENSOR

- A. General:
1. Daylight sensors shall automatically measure the amount of ambient light within a space, reporting back to the headend and system software, which will push commands to control modules for "ON/OFF/DIMMING" control of lighting zones and "ON/OFF" control of the controlled receptacle circuits within that space.
 2. Setpoints for the sensors shall be adjusted through the system software. The setpoints refer to the range at which electric luminaires will dim in response to the amount of light the sensor detects.
 3. Daylight sensors do not directly control luminaires. This allows for the raw data reported back to the system software to be used for multi-zones of lighting (i.e., one sensor for multiple daylight zones).
 4. Daylight sensors shall continuously monitor the ambient light level.
 5. Interior daylight sensors shall operate on a "closed loop" protocol, measuring both daylight and electric light contributions.
 6. Exterior daylight sensors shall operate on an "open loop" protocol, measuring only daylight contributions.
- B. Specifics:
1. Sensor shall mount directly to any surface, no junction box required.
 2. Integrated sensors on luminaires shall be installed at the lighting manufacturer's factory.
 3. Sensors shall tie to the system in one of the following ways:
 - a. Hardwired low voltage, wiring and connections per manufacturer's requirements.
 - b. Wireless with a 10-year minimum battery life.
 4. Exterior sensors shall be outdoor rated.

2.11 RELAY PANEL

- A. Addressable relay panel that fully integrates with the addressable control system, consisting of individual relays, control module, power supplies, network connection interface, etc.
- B. Cabinet: NEMA 1 enclosure sized to accept the quantity of relays as noted on the Drawings.

- C. Control relays: Heavy-duty momentary pulsed mechanically latching contactors. Operating voltage is 24 volt AC; contacts are rated at 20 amp at 120 or 277 volt AC.
- D. Power supply: 120/277 volt AC input transformer with 24 volt AC, 60Hz, 1.6 amp (40 VA) Class II power supplies output.
- E. Network connection: Per manufacturer.
- F. Panel shall be UL924 rated. Systems which integrate a UL924 sensing module for the entire panel or system shall not require the panel to be UL924 rated.
- G. Panel shall allow for barriers between voltage classes, 120 volt, 277 volt, normal, and emergency.

2.12 EMERGENCY BYPASS RELAYS

A. General:

1. System manufacturer shall provide emergency bypass relays as shown on the Drawings.
2. The bypass relay device shall take an uncontrolled normal sensing hot, uncontrolled emergency hot, and controlled normal circuit as inputs.
3. The device shall bypass the controlled normal hot and control signal at the loss of power from the normal sensing hot and allow the uncontrolled emergency hot to power the downstream luminaires.
4. The device shall be capable of accepting a 0-10 volt control signal and breaking if the downstream fixtures are 0-10 volt controlled.

B. Specifics:

1. Mounting: directly onto a junction box or integral to the luminaire.
2. UL924 rated for switched and dimmed loads.
3. Where more than six bypass relays are located in a central location provide an enclosure to mount all devices.

2.13 EMERGENCY TRANSFER DEVICE

A. General:

1. System manufacturer shall provide emergency transfer devices as shown on the Drawings.
2. The transfer devices shall take an uncontrolled normal sensing hot, uncontrolled emergency hot, and controlled normal circuit as inputs.
3. The device shall transfer be an open transition "make before break" type. The normal controlled circuit shall transfer to emergency circuit at the loss of power from the normal sensing hot and allow the uncontrolled emergency hot to power the downstream luminaires.
4. The device shall be capable of accepting a 0-10 volt control signal and breaking if the downstream fixtures are 0-10 volt controlled.

B. Specifics:

1. Mounting: directly onto a junction box.
2. UL1008 rated for switched and dimmed loads.

3. Where more than six transfer devices are located in a central location provide an enclosure to mount all devices or provide a panel housing multiple transfer devices.

2.14 DEMAND RESPONSE VIRTUAL END NODE (VEN).

- A. As part of the lighting control system the manufacturer shall provide a demand response virtual end node (VEN) in compliance with Open ADR 2.0.
- B. The VEN shall be capable of accepting an auto demand response signal from a utility and communicate the signal with the headend in order to enter a demand response preset scene and demonstrate compliance with the demand response requirements of Title 24.

2.15 BACNET INTERFACE

- A. BACnet interface module:
 1. Enables the integration of the control system with any BACnet compatible building automation system. The control system operates autonomously while lighting status, lighting levels and energy usage are all shared and possible controlled via BACnet. Connection between the two systems is established via BACnet/IP.
 2. Enables BACnet switching and dimming control.
 3. Provides load shedding control over the lighting system.
 4. Shares occupancy sensor information obtained by the control system with a BACnet client for HVAC system integration.
 5. Utilizes a centralized BACnet time schedule.
- B. The BACnet interface module creates access points with names and descriptions that can be customized to accommodate any client's naming scheme. It also exports standard BACnet object properties in a clear, structured manner and can define an unlimited number of groups of luminaires.
- C. The control system BACnet interface module shall adhere to ANSI/ASHRAE Standard 135-2004 "BACnet" (ISSN 1041-2336).

2.16 NETWORK COMMUNICATION CABLING

- A. General:
 1. The network communication technology is a bus configured system design, which allows for communication and control of the lighting system on the network.
 2. The network communication cabling integrates network addressable devices such as occupancy sensors, photocell sensors, control modules, control stations, headend equipment with each other to make a complete addressable lighting control system.
 3. The network communication cabling provides low-voltage power to all devices on the network, eliminating the need for external power supplies and power packs for devices such as occupancy sensors. Where a device requires 120 volt power it shall be noted on the submittal and shop drawings.

4. Cabling shall be topology free.
5. Cabling shall be plenum rated.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Contractor shall thoroughly examine Project site conditions for acceptance of low-voltage lighting control installation to verify conformance with Manufacturer and Specification tolerances. Do not commence with installation until all conditions are made satisfactory.

3.2 INSTALLATION

- A. Install the addressable lighting control system in accordance with the Manufacturer's written instructions, as indicated on the shop drawings and as specified herein.
- B. All interior luminaires shall be controlled via the control system unless otherwise noted on the plans. Refer to the drawing symbols list for the differentiation between networked luminaire devices and standalone devices.

3.3 SHOP DRAWINGS

- A. Contractor shall verify that the shop drawings are in accordance with the Division 26 specifications, the lighting control sequence of operations, as well as all field conditions.
- B. Install all devices per the approved shop drawings. Where devices deviate from the shop drawings note it on an as-built drawing.
- C. Any device required to be accessible that is shown on the shop drawing in a non-accessible location shall be moved.
- D. Where devices are required and not shown on the shop drawings, include these devices on the as-built shop drawing.

3.4 SYSTEM SOFTWARE

- A. Coordinate with the owner prior to ordering where the system software will reside. Ensure the computer or server meet the system requirements from the manufacturer. Ensure all firewall requirements from the owner and manufacturer are met.

3.5 CENTRAL HEADEND

- A. Install the central headend in a location easily accessible to the building owner.
- B. Label the headend with a type on tape label "LIGHTING CONTROL HEADEND"
- C. Contractor shall provide a dedicated 120 volt, 20 amp circuit for the central headend equipment.

3.6 OCCUPANCY SENSOR

- A. Occupancy sensors shall be placed in a location that provides maximum coverage and minimizes false positives such as being triggered through an open door.

- B. Refer to the architectural RCPs and locate sensors as shown or if not shown, locate in line with other ceiling devices while still maximizing area coverage.
- C. Where the coverage of a sensor is inadequate for the space it is being installed in, the manufacturer shall provide additional sensors for the contractor to install. The cost of these sensors and installation shall be included at the time of bid.

3.7 DAYLIGHT SENSORS

- A. Locate daylight sensors per the manufacturer's requirements in order to provide accurate electric and daylight light levels.
- B. Coordinate the final location of the sensor with other devices in the area.

3.8 CONTROL MODULES

- A. Install all control modules per the shop drawings and manufacturer's requirements. Ensure devices are in an accessible location. Avoid locations where the devices are visible to the public.

3.9 AUXILIARY DEVICES

- A. Where devices, not covered under these Division 26 specifications, are required to provide a complete lighting control system, furnish and install such devices per the manufacturer's instructions.

3.10 STARTUP AND FIELD QUALITY CONTROL

- A. General:
 - 1. All work related to the startup of the addressable lighting control system shall be by a factory-authorized agent of the Manufacturer of the system along with the assistance of the electrical contractor.
 - 2. All programming, testing, trouble shooting, etc. shall be included in this contract.
- B. Prefunctional resting:
 - 1. Visual and mechanical inspection:
 - a. Inspect for physical damage, defects alignment and fit.
 - b. Perform mechanical operational tests in accordance with Manufacturer's instructions.
 - c. Compare nameplate information and connections to Contract Documents.
 - d. Check tightness of all control and power connections.
 - e. Check that all covers, barriers, and doors are secure.
 - 2. Contractor shall provide all necessary programming assistance to set up and program the lighting control system.
 - 3. Electrical tests:
 - a. The system shall be completely tested in accordance with operational parameters, tolerances, and Manufacturer's instructions. Any problem shall be documented and corrected.

- b. Test all control circuits and verify proper operation of all lighting circuits throughout the control system.
 - c. Ensure the lighting zone controls match that of the Contract Documents.
 - d. Verify the proper integration with the mechanical control system for override control and monitoring of low-voltage lighting control system.
 - e. Provide a complete report listing every device, the date it was tested, the results and the date retested (if failure occurred during the previous test). The test report shall indicate that every device tested successfully.
- C. Contractor shall replace at no costs to the Owner all devices which are found defective or do not operate within factory specified tolerances.
- D. Contractor shall submit the testing final report for review prior to Project closeout and final acceptance by the Owner. Test report shall indicate test dates, devices tested, results, observation, deficiencies, and remedies. Test report shall be included in the operation and maintenance manuals.

3.11 COMMISSIONING

A. General:

- 1. Once startup of the system is complete and no defects to the system are detected the commissioning process shall begin; furthermore, it is acceptable to program the system per the commissioning requirements during the startup phase.
- 2. All work related to the commissioning of the addressable lighting control system shall be by a factory-authorized agent of the Manufacturer of the system along with the assistance of the electrical contractor.
- 3. At least three weeks prior to any commissioning verification, notify the Engineer so that arrangement can be made for witnessing test, if deemed necessary. All pretesting shall have been tested satisfactorily prior to the Engineer's witnessed test.

B. Occupancy sensors:

- 1. All occupancy sensors shall have a sensitivity appropriate for the space. Contractor shall be responsible for testing the sensitivity of the sensor in the space and adjusting as needed.
- 2. Where no direction is provided in a sequence of operation or by the owner set the occupancy sensor timeout to 15 minutes.

C. Daylight sensors:

- 1. Where no direction is provided in a sequence of operation or by the owner, the daylight sensor setpoint to dim the electric light should be at 150% of the maximum electric light output.

D. Scene controllers:

- 1. Where no scenes have been described in a sequence of operation or by the owner the contractor shall provide the following scenes as appropriate for the space:
 - a. Scene 1: All luminaires on at 100%
 - b. Scene 2: Luminaires near screen displays off, all other luminaires on at 75%.

- c. Scene 3: All indirect luminaires off, all direct luminaires on at 100%.
- d. Scene 4: All direct luminaires off, all indirect luminaires on at 100%.
- e. Scene 5: All luminaires off.

E. Time schedules:

- 1. All time schedules in the system shall be done through the astronomical time clock. The building location and date shall be programmed to ensure proper time schedule functions.
- 2. If no sequence of operations is provided program time schedules as follows:
 - a. Interior spaces: Per owner's direction, do not assume hours of operation.
 - b. Exterior spaces: on 30 minutes before sunset, and off 30 minutes after sunrise.

F. Third party commissioning:

- 1. The purpose of third-party commissioning shall be to verify the system's functionality and parameters as detailed on the Drawings and specifications. The contractor and factory agent are still responsible for performing the startup and commissioning of the system.

G. Contractor shall be responsible for all acceptance testing requirements related to the lighting control system as outlined in the California Energy Code Title 24 Part 6.

3.12 TRAINING

- A. Factory authorized service representative shall conduct a 2-hour training session for Owner's Representatives upon completion and acceptance of system. Instruction shall include operation, programming, and maintenance of equipment.
- B. Contractor shall schedule training with a minimum of 7 days advanced notice.

END OF SECTION

SECTION 26 24 13

SWITCHBOARDS

PART 1 - GENERAL

1.1 SUMMARY

- A. Work included: Labor, materials, and equipment necessary to complete the installation required for the item specified under this Division, including but not limited to:
 - 1. Main service switchboard.
 - 2. Distribution switchboards (800 amps and greater).
- B. Related Work: Consult all other Sections, determine the extent and character of related Work, and properly coordinate Work specified herein with that specified elsewhere to produce a complete installation.
 - 1. Division 09: Painting. Touch-up of painted surfaces.

1.2 REFERENCES

- A. Comply with the latest edition of the following applicable Specifications and standards except as otherwise indicated or specified:
 - 1. American National Standards Institute, Inc. (ANSI):
 - ANSI C12; Code for Electricity Metering.
 - ANSI C37.5; Current and Potential Transformers.
 - ANSI C39.1; Electrical Analog Indicating Instruments.
 - ANSI C57.13; Requirements for Instrument Transformers.
 - 2. Underwriters Laboratories, Inc. (UL):
 - UL 486E; Equipment Wiring Terminals for Use with Aluminum and/or Copper Conductors.
 - UL 489; Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures.
 - UL 869A; Service Equipment.
 - UL 891; Dead-Front Switchboards.
 - UL 1053; Ground-Fault Sensing and Relaying Equipment.
 - 3. National Electrical Manufacturer Association (NEMA):
 - NEMA AB1; Molded Case Circuit Breakers.
 - NEMA PB 2; Deadfront Distribution Switchboards.
 - NEMA PB 2.1; General Instruction for Proper Handling, Installation, Operation and Maintenance of Deadfront Distribution Switchboards Rated 600 Volts or less.
 - NEMA SG5; Power Switchgear Assemblies.

1.3 SUBMITTALS

- A. Submit in accordance with the requirements of Section 260010: Basic Electrical Requirements, the following items:
 - 1. Data/catalog cuts for each product and component specified herein, listing all physical and electrical characteristics and ratings indicating compliance with all listed standards.
 - 2. Shop Drawings to include:
 - a. Front, plan, and side view elevations with overall dimensions.
 - b. Conduit entrance locations and requirements.
 - c. Nameplate legends; size and number of bus bars per phase, neutral and ground.
 - d. Switchboard instrument details and accessories.
 - e. Electrical characteristics including voltage, frame size and trip rating and withstand ratings.
 - 3. Furnish structural calculations for equipment anchorage as described in Section 260010: Basic Electrical Requirements.
 - 4. Submit Manufacturer's installation instructions.
 - 5. Complete Bill of Material listing all components.
 - 6. Final test results.
 - 7. Warranty.
- B. Dimensions and configurations of switchboards shall conform to the space allocated on the Drawings. The Contractor shall submit a revised layout if equipment furnished varies in size from that indicated on Drawings for the Engineer's approval.
- C. Service entrance switchboard utility metering sections shall be submitted to the local electrical utility company for approval prior to submission to the Engineer. A letter of acceptance from utility company shall be included in submittal package.

1.4 OPERATION AND MAINTENANCE MANUAL

- A. Supply operation and maintenance manuals in accordance with the requirements of Section 260010: Basic Electrical Requirements, to include the following:
 - 1. A detailed explanation of the operation of the system.
 - 2. Instructions for routine maintenance.
 - 3. Pictorial parts list and part numbers.
 - 4. Pictorial and schematic Electrical Drawings of wiring systems, including operating and safety devices, control panels, instrumentation, and annunciators.
 - 5. Telephone numbers for the authorized parts and service distributors.
 - 6. Include all service bulletins and torque Specifications for all terminations.
 - 7. Final testing report.

1.5 QUALITY ASSURANCE

- A. All materials, equipment and parts comprising the units specified herein shall be new, unused, and currently under production.

- B. Only products and applications listed in this Section may be used on the Project unless otherwise submitted.
- C. Independent Testing Agency qualifications: Refer to Section 260010: Basic Electrical Requirements.

1.6 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Delivery: Switchboard components shall not be delivered to the Project site until protected storage space is available. Storage outdoors covered by rainproof material is not acceptable. Equipment damaged during shipment shall be replaced and returned to Manufacturer at no cost to Owner. Components shall be properly packaged in factory-fabricated containers and mounted on shipping skids.
- B. Storage: Store in a clean, dry, ventilated space free from temperature extremes. Maintain factory wrapping or provide a heavy canvas/plastic cover to protect units from dirt, water, construction debris and traffic. Provide heat where required to prevent condensation.
- C. Handling: Handle in accordance with NEMA PB2.1 and Manufacturer's written instructions. Be careful to prevent internal component damage, breakage, denting and scoring. Damaged units shall not be installed. Replace damaged units and return equipment to Manufacturer.

1.7 WARRANTY

- A. Units and components offered under this Section shall be covered by a 1-year parts and labor warranty for malfunctions resulting from defects in materials and workmanship. Warranty shall begin upon acceptance by the Owner.

1.8 EXTRA MATERIAL

- A. Provide one spray can of matching finish paint for touching up damaged surfaces after installation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Products furnished by the following Manufacturers shall be acceptable if in compliance with all features specified herein and indicated on the Drawings.
 - 1. ABB/ General Electric.
 - 2. Eaton.
 - 3. Industrial Electric Mfg.
 - 4. Siemens.
 - 5. Square D.
- B. Substitutions: Under provisions of Section 260010: Basic Electrical Requirements.

2.2 SWITCHBOARDS - GENERAL

- A. Enclosure:

1. Each switchboard shall consist of a dead front, completely metal enclosed self-supporting structure. Construction shall consist of vertical sections of the universal frame type bolted together and braced with self-tapping bolts. Sides, top and rear shall be covered with captive-bolt fastened steel plates having formed edges all around. Front plates shall be sectionalized and removable. All plates shall be fabricated from 12-gage steel and shall have die-formed edges all around. The switchboard frame shall be suitable for use as floor sills in indoor installations. Corners shall be reinforced with rigged gussets internal and external to the structural members.
 2. Switchboards shall have depth as required to house all equipment contained within it. Switchboard shall be constructed so that the back and front of all sections align. Construction of the board shall allow maintenance of incoming line terminations, device connections and all bus bolted connections.
 3. All devices shall be accessible and removable from the front unless rear access is indicated on the Drawings.
 4. Provide necessary hardware to permit locking every overcurrent protective device handle in the "OFF" position.
 5. Provide hinged access doors to all termination, meter, and relay compartments with knurled and slotted large head captive-bolts. The design shall allow access to compartments without tools and without removing any panels.
 6. Furnish cable pull sections or top cable pull boxes where indicated on the Drawings complete with cable tie down supports. Where cable pull section or pull boxes contain utility service cables, provide utility acceptable sealing means.
 7. Switchboard shall be suitable for use as service entrance equipment and be labeled in accordance with UL requirements.
 8. Utility metering compartment section shall be fabricated to meet all utility company requirements. Where separate vertical section is required for utility metering, match and align with switchboard enclosure.
 9. Clearances: Comply with CEC Article 408.18 for clearances and connections. Equipment requiring rear or side access to make field connections shall be so marked by the manufacturer on the front of the equipment in accordance with CEC Article 408.18 (C).
- B. Bus assembly and terminations:
1. The switchboard bussing shall be highly conductive silver-plated copper with sufficient cross-sectional area to meet UL Standard 891 temperature rise requirements.
 2. Bus arrangement shall be Phase A-B-C-N left-to-right, top-to-bottom and front-to-rear as viewed from the front. Horizontal and vertical bus ampere rating shall be uniform from end-to-end.
 3. All bussing to and from an overcurrent protective device shall be rated to the frame sizing, not the trip rating.
 4. Where "SPACE" is indicated in the switchboards, cross connectors and mounting hardware shall be installed to match the frame size ampere rating noted on the Electrical Drawings. All "SPACES" shall be ready for installation of overcurrent protective devices at a future time.

5. Shipping splits and provisions for future bus extension shall be provided with necessary bus splices.
 6. Each switchboard shall contain a full length, bottom/front located copper ground bus that is securely connected to each vertical section. Ground bus shall be sized in accordance with UL 891, Table 25.1.
 7. Termination lugs: High compression circumference crimped type rated for use with aluminum/copper conductors.
 8. Switchboards shall be fully rated for a minimum of AIC Rating as indicated on the Drawings.
 9. Neutral bus shall be 100 percent rated unless otherwise indicated on the Drawings.
 10. Main service switchboards:
 - a. Removable neutral link: Provide removable bolted bus section for the purpose of disconnecting the ground circuit conductor from the premises wiring at the supply side of the service in accordance with CEC Article 230-75.
 - b. Main bonding jumper: Connection between the grounded circuit conductor and the equipment ground conductor at the supply side of the service. Size in accordance with CEC Table 250-102(C)(1).
- C. Switching and overcurrent protective devices:
1. Refer to Section 262816: Overcurrent Protective Devices.
 2. Main overcurrent protective device(s) shall be fixed mounted molded case circuit breaker with interrupting rating and frame and trip ratings as indicated on Drawings.
 3. Feeder overcurrent protective device(s) shall be fixed molded case circuit breaker with frame and trip rating as indicated on Drawings.
 4. Devices interrupting rating shall match that of switchboard for which the device is installed.
 5. Series ratings of overcurrent protective devices is not acceptable unless specifically noted on the Drawings.
 6. Devices shall be manually operated unless shunt trip and/or electrically operated devices are indicated on Drawings.
- D. Instrumentation and controls:
1. All internal devices (relays, transformers, etc.) shall be tagged as to rating and function with permanently fastened engraved nameplates.
 2. Control and signal circuits: Control devices, i.e.: contactors, relays, time clocks, etc. shall be mounted in a separate compartment that is fully barrier from the overcurrent protective device compartments. Control devices shall be accessible through a separate hinged cover panel.
 3. Relays: All relays shall be industrial control grade with a "ON" indicating neon light, hold down springs, minimum of 10 amp rated contacts and a minimum of four form C contacts. Relays used for control power transfer shall have 20 amp rated contacts. Do NOT use paralleled relays for relays with greater than 4-poles, use relays with the required number of poles. This is to prevent the situation where one relay fails, and half of the intended function is lost, which could be dangerous.

E. Refer to Electrical Drawings for the following:

1. Mounting style; voltage; terminal lug size, location, and quantity; bus ampacity; interrupting capacity of bus and overcurrent protective devices, quantity, poles, and rating of overcurrent protective devices. Note that the AIC value noted on the Drawings for distribution equipment is the minimum rating of all components; values are in RMS symmetrical amps.
2. If indicated on the Electrical Drawings, provide contactors, relays, time clocks, etc. mounted within switchboard.

F. Miscellaneous requirements:

1. Circuit numbering: Starting at the top, odd numbered circuits in sequence down the left-hand side and even numbered circuits down the right-hand side.
2. Nameplates: Engraved nameplates shall be provided for each device and all "SPACES" located in the switchboard. An engraved nameplate shall also be provided indicating the switchboard designation. See Section 260553: Electrical Identification for requirements.
3. All control wires shall be labeled with wire markers and referenced to the control wiring diagrams. Provide colored wires with colored stripes to facilitate troubleshooting and locating both ends of wires. Do not use wires with all the same wire color. Use fork, crimp type terminations on all control wires.
4. Provide a test block and plugs for voltage and current monitoring at each main switch. Provide engraved legend plates to indicate function of each test point.
5. Vertically mounted mains shall have the operating handle in the up position when energized.

G. Finish:

1. Five step zinc phosphate pre-treatment, one coat of rust inhibiting dichromate primer and one coat of baked-on enamel finish, ANSI 61 (light gray).
2. A seven-step spray wash electroplate primer with final baked-on enamel finish; ANSI 61 (light gray) is an acceptable finish alternative.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Contractor shall thoroughly examine Project site conditions for acceptance of switchboard installation to verify conformance with Manufacturer and Specification tolerances. Do not commence with installation until all conditions are made satisfactory.

3.2 PREPARATION

- A. Ensure all conduit stub-ups for bottom entry into switchboard are in place and located as required per Shop Drawings.
- B. Whether noted on the Drawings or not, provide a 4-inch high concrete housekeeping pad beneath equipment. Coordinate actual sizes of equipment based on approved Shop Drawings and extend pad 4-inches in all directions beyond overall dimension of base. Where equipment includes a PG&E metering section, pad shall be only a

maximum of 2-inch high and extend out from front face of equipment a maximum of 2-inches to edge of pad. Provide reinforcing bars as required structurally within pad to ensure proper support of equipment.

3.3 INSTALLATION

- A. Install switchboards in accordance with Manufacturer's written instructions, as indicated on the Drawings and as specified herein.
- B. Handling, storage, installation and energize of switchboards shall be carried out in accordance with latest edition of NEMA Publications PB 2.1.
- C. Freestanding switchboards shall be accurately aligned, leveled, and bolted in place on full-length channels securely fastened to concrete floor.
- D. Switchboards shall be anchored and braced to withstand seismic forces as calculated per Section 260010: Basic Electrical Requirements.
- E. Provide mounting hardware brackets, bus bar drilling and filler pieces for all unused spaces.
- F. "Train" interior wiring; bundle and clamp, using specified plastic wire wraps specified under Section 260519: Building Wire and Cable.
- G. Replace any panel pieces, doors or trims having dents, bends, warps, or poor fit that may impede ready access, security, or integrity.
- H. Conduits terminating in concentric, eccentric, or oversized knockouts at switchboards shall have ground bushings and bonding jumpers installed interconnecting all such conduits and the switchboards.
- I. Check and tighten all bolts and connections with a torque wrench using Manufacturer's recommended values.
- J. Visually inspect switchboards for rust and corrosion if signs of rust and corrosion are present, board shall be restored to new condition or replaced.

3.4 FIELD QUALITY CONTROL

- A. Manufacturer's field service: Contractor shall arrange and pay for the services of a factory-authorized service representative to supervise the initial start-up, testing, and adjustment of the switchboard.
- B. Independent testing: Contractor shall arrange and pay for the services of an independent Testing Agency to perform all quality control electrical testing, calibration and inspection required herein. Independent Testing Agency shall meet the requirements as outlined in Section 260010: Basic Electrical Requirements. Testing Agencies objectives shall be to:
 - 1. Assure switchboard installation conforms to specified requirements and operates within specified tolerances.
 - 2. Field test and inspect to ensure operation in accordance with Manufacturer's recommendations and Specifications.
 - 3. Prepare final test report including results, observations, failures, adjustments, and remedies.
 - 4. Apply label on switchboard upon satisfactory completion of tests and results.

5. Verify ratings and settings and make final adjustments.
- C. At least three weeks prior to any testing, notify the Engineer so that arrangement can be made for witnessing test, if deemed necessary. All pretesting shall have been tested satisfactorily prior to the Engineer's witnessed test.
- D. The Contractor shall supply a suitable and stable source of electrical power to each test site. The Testing Agency shall specify the specific power requirements.
- E. Testing of overcurrent protective devices shall be done only after all devices are installed and prior to system being energized.
- F. Prefunctional testing:
 1. Provide Testing Agency with Contract Documents and Manufacturer instructions for installation and testing.
 2. Visual and mechanical inspection:
 - a. Compare nameplate information and connections to Contract Documents.
 - b. Inspect for physical damage, defects alignment and fit.
 - c. Verify appropriate anchorage, required clearances and correct alignment.
 - d. Inspect doors, panels and sections for paint, dents, scratches, fit and missing hardware
 - e. Check tightness of all control and power connections.
 - f. Check that all covers, barriers, and doors are secure.
 - g. Verify correct barrier installation.
 - h. Verify that relays and overcurrent protective devices meet Drawing, power system study and specified requirements.
 - i. Perform mechanical operational tests in accordance with Manufacturer's instructions.
 - j. Exercise active components.
 - k. Inspect control power and instrument transformers.
 - l. Inspect insulators for evidence of physical damage or contaminated surfaces.
 3. Electrical tests:
 - a. Perform resistance tests through bus joints with low-resistance ohmmeter. Joints that cannot be directly measured due to permanently installed insulation wrap shall be indirectly measured from closest accessible connection.
 - b. Perform insulation-resistance tests on each bus section, phase-to-phase, and phase-to-ground, at 1000 volt DC for 60-seconds. Investigate resistance values less than 50-megohms.
 - c. Perform over-potential test on each bus section, each phase-to-ground with phases not under test grounded, in accordance with Manufacturer's published data. Test voltage shall be applied for 60-seconds.
 - d. Perform insulation-resistance tests at 1000 volt DC for 60-seconds on control wiring. Do not perform this test on wiring connected to solid-state components.

- e. Perform current injection tests on the entire current circuit in each section of switchgear.
 - 1) Perform current tests by primary injection, where possible, with magnitudes such that minimum of 1 amp flows in secondary circuit.
 - 2) Where primary injection is impractical, utilize secondary injection with minimum current of 1 amp.
 - 3) Test current at each device.
 - f. Perform tests on all instrument transformers in accordance with Manufacturer's written instructions.
 - g. Determine accuracy of meters and instruments per Manufacturer's instructions.
 - h. Perform the following tests on control power transformers:
 - 1) Perform insulation-resistance test. Perform measurements from winding-to-winding and each winding-to-ground. Test voltages shall be determined in accordance with Manufacturer's instructions.
 - 2) Perform secondary wiring integrity test. Disconnect transformer at secondary terminals and connect secondary wiring to correct secondary voltage. Confirm potential at all devices.
 - 3) Verify correct secondary voltage by energizing primary winding with system voltage. Measure secondary voltage with secondary wiring disconnected.
 - i. Potential transformer circuits:
 - 1) Perform insulation-resistance tests. Perform measurements from winding-to-winding and each winding-to-ground. Test voltages shall be determined in accordance with Manufacturer's instructions.
 - 2) Perform secondary wiring integrity test. Disconnect transformer at secondary terminals and connect secondary wiring to correct secondary voltage.
 - 3) Verify secondary voltage by energizing primary winding with system voltage. Measure secondary voltage with secondary wiring disconnected.
 - j. Ground resistance:
 - 1) Measure system neutral-to-ground insulation-resistance with neutral disconnect link temporarily removed. Replace neutral disconnect link after test.
 - 2) Measure insulation-resistance of control wiring at 1000 volt DC for 60-seconds. Refer to Manufacturer's instruction for devices with solid-state components
 - k. Test overcurrent protection devices per Section 262816: Overcurrent Protective Devices.
4. Test values:
- a. Bolt torque levels shall be in accordance with Manufacturer's requirements.
 - b. Compare bus connection resistances to values of similar connections.
 - c. Insulation-resistance values for bus, control wiring and control power transformers shall be in accordance with Manufacturer's published data. Values of insulation resistance less than Manufacturer's minimum levels

should be investigated. Over-potential tests should not proceed until insulation-resistance levels are raised above minimum values.

- d. Insulation shall withstand the over-potential test voltage applied.
 - e. Determine contact resistance in microhms. Resistance values shall not exceed high limit of normal range as indicated in Manufacturer's published data.
 - f. System neutral-to-ground insulation shall be a minimum of one megohm.
- G. In the event that the system fails to function properly during the testing as a result of inadequate pretesting or preparation, the Contractor shall bear all costs incurred by the necessity for retesting including test equipment, transportation, subsistence and the Engineer's hourly rate.
- H. Contractor shall replace at no costs to the Owner all devices which are found defective or do not operate within factory specified tolerances.
- I. Contractor shall submit the Testing Agency's final report for review prior to Project closeout and final acceptance by the Owner. Test report shall indicate test dates, devices tested, results, observation, deficiencies, and remedies. Test report shall be included in the operation and maintenance manuals.

3.5 CLEANING

- A. Prior to energizing of switchboard, the Contractor shall thoroughly clean the interior of enclosure of all construction debris, scrap wire, etc. using Manufacturer's approved methods and materials.
- B. Upon completion of Project prior to final acceptance the Contractor shall thoroughly clean both the interior and exterior of switchboard per Manufacturers approved methods and materials. Remove paint splatters and other spots, dirt, and debris.
- C. Touch-up paint any marks, blemishes or other finish damage suffered during installation.

3.6 TRAINING

- A. Factory authorized service representative shall conduct a 2-hour training seminar for Owner's Representatives upon completion and acceptance of system. Instructions shall include safe operation, maintenance, and testing of equipment with both classroom training and hands-on instruction.
- B. Contractor shall schedule training with a minimum of 7-days advance notice.

END OF SECTION

SECTION 26 24 16

PANELBOARDS

PART 1 - GENERAL

1.1 SUMMARY

- A. Work included: Labor, materials, and equipment necessary to complete the installation required for the item specified under this Division, including but not limited to:
 - 1. Branch circuit panelboards.
- B. Related Work: Consult all other Sections, determine the extent and character of related Work, and properly coordinate Work specified herein with that specified elsewhere to produce a complete installation.

1.2 REFERENCES

- A. Comply with the latest edition of the following applicable Specifications and standards except as otherwise indicated or specified.
 - 1. National Electrical Manufacturers Association (NEMA):
 - NEMA AB 1; Molded Case Circuit Breakers.
 - NEMA PB 1; Panelboards.
 - NEMA PB 1.1; General Instructions for Proper Installation, Operation, and Maintenance of Panelboards Rated 600 Volts or Less.
 - 2. Underwriters Laboratories, Inc. (UL):
 - UL 67; Panelboards.
 - UL 486E; Equipment Wiring Terminals for Use with Aluminum and/or Copper Conductors.
 - UL 489; Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures.
 - UL 870; Wireways, Auxiliary Gutters and Associated Fittings.

1.3 SUBMITTALS

- A. Submit in accordance with the requirements of Section 260010: Basic Electrical Requirements, the following items:
 - 1. Data/catalog cuts for each product and component specified herein, listing all physical and electrical characteristics and ratings indicating compliance with all listed standards
 - 2. Clearly mark on each data sheet the specific item(s) being submitted and the proposed application.
 - 3. Shop Drawings: Include elevations, cabinet dimensions, gutter sizes, layout of contactors, relays, time clocks, lug sizes, bussing diagrams; make, location and capacity of installed equipment; mounting style; finish and panelboard nameplate inscription.

4. Furnish structural calculations for equipment anchorage as described in Section 260010: Basic Electrical Requirements.
 5. Submit Manufacturer's installation instructions.
 6. Complete bill of material listing all components.
 7. Warranty.
- B. Dimensions and configurations of panelboards shall conform to the spaces allocated on the Drawings for their installation. The Contractor shall include with the submittal a layout of the electrical room if it differs from construction documents for review and approval by the Engineer prior to release of order.

1.4 OPERATION AND MAINTENANCE MANUAL

- A. Supply operation and maintenance manuals in accordance with the requirements of Section 260010: Basic Electrical Requirements, to include the following:
1. A detailed explanation of the operation of the system.
 2. Instructions for routine maintenance.
 3. Pictorial parts list and parts number.
 4. Telephone numbers for authorized parts and service distributors.
 5. Final testing reports.

1.5 QUALITY ASSURANCE

- A. All materials, equipment and parts comprising the units specified herein shall be new, unused, and currently under production.
- B. Only products and applications listed in this Section may be used on the Project unless otherwise submitted.

1.6 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Delivery: Panelboard components shall not be delivered to the Project site until protected storage space is available. Storage outdoors covered by rainproof material is not acceptable. Equipment damaged during shipment shall be replaced and returned to Manufacturer at no cost to Owner.
- B. Storage: Store in a clean, dry, ventilated space free from temperature extremes. Maintain factory wrapping or provide a heavy canvas/plastic cover to protect units from dirt, water, construction debris and traffic. Provide heat where required to prevent condensation.
- C. Handling: Handle in accordance with NEMA PB1.1 and Manufacturer's written instructions. Be careful to prevent internal component damage, breakage, denting and scoring. Damaged units shall not be installed. Replace damaged units and return equipment to Manufacturer.

1.7 WARRANTY

- A. Units and components offered under this Section shall be covered by a 1-year parts and labor warranty for malfunctions resulting from defects in materials and workmanship. Warranty shall begin upon acceptance by the Owner.

1.8 EXTRA MATERIAL

- A. Turn over two (2) sets of panelboard keys to the Owner at completion of Project. All panelboards shall be keyed alike.
- B. Provide one spray can of matching finish paint for touching up damaged surfaces after installation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Products furnished by the following Manufacturers shall be acceptable if in compliance with all features specified herein and indicated on the Drawings.
 - 1. ABB/ General Electric.
 - 2. Eaton.
 - 3. Siemens.
 - 4. Square D.
- B. Substitutions: Under provisions of Section 260010: Basic Electrical Requirements.

2.2 PANELBOARDS - GENERAL

- A. Enclosure:
 - 1. Cabinets shall be NEMA Type 1 enclosure, door, and trim of code gauge galvanized steel.
 - 2. Panelboard covers shall be door-in-door construction such that inner door exposes the overcurrent protective devices and the outer door exposes the complete panelboard interior (i.e. branch circuit conductors, lugs, neutral and ground bus, overcurrent protective devices, etc.). Outer door shall have full-length piano hinge and inner door shall have two-point hinges.
 - 3. Provide combination spring catch and lock on inside edge of the inner door trims with flush fitting joint between door and trim. Locks on all panelboards shall be keyed alike. Doors 36 inches and over in height shall be provided with three-point catch and lock. Provide quarter-turn captive bolts on the outer door.
- B. Bus assembly and terminations:
 - 1. Bus shall be bolted copper with taps arranged for distributed phase connections to branch circuit devices
 - 2. Cross connectors shall be copper, drilled and tapped for bolt-on device connections, arranged for double row placement of device and designed to permit removal or addition of overcurrent protection devices without disturbing adjacent devices or removing main bus connections.
 - 3. Neutral bus shall be 100 percent rated of phase bus bars and shall have lugs for each outgoing branch circuit or feeder requiring a neutral connection unless otherwise noted.
 - 4. Ground bus shall be full size with lugs for each outgoing branch circuit and feeder.

5. Refer to panelboard schedules on Drawings for bus rating. Bus rating shall match or be greater than main device or main lug rating.
6. As a minimum, bus bars shall be rated 22,000 AIC for 120/208 volt panelboards. Unless otherwise noted.
7. Provide full sized bussing in all sections of multi-section panelboards.
8. No panelboard section shall have greater than 42 poles.
9. Termination Lugs: Rated for use with aluminum/copper conductors.
10. All "SPACES" shall be ready for installation of future overcurrent protective device.

C. Miscellaneous requirements:

1. Circuit numbering: Starting at the top, indicate odd numbered circuits in sequence down the left-hand side and even numbered circuits down the right-hand side. Multi-section panelboards shall have continuous consecutive circuit numbers, i.e. Section 1 (circuit numbers 1 to 42) Section 2 (circuit numbers 43 to 84), Section 3 (circuit numbers 85 to 126). Provide metal embossed circuit identification of panelboards.
2. Directories: A 6" x 8" minimum size circuit directory frame and card with clear plastic covering shall be provided inside the inner panelboard door to reflect conditions at completion of Work. Directory shall be typewritten denoting loads served by room number or area for each circuit.
3. Nameplates: Provide engraved nameplate for each panelboard. See Section 260533: Electrical Identification for requirements.

D. Refer to Panelboard Schedules for the following:

1. Mounting style; service voltage; terminal lug size, location, and quantity; bus ampacity; interrupting capacity of bus and breakers; quantity, poles and rating of overcurrent protective devices.

E. Overcurrent protective devices:

1. Refer to Section 262816: Overcurrent Protection Devices.
2. Overcurrent protective devices shall be molded case circuit breakers where indicated on panelboard schedules or Electrical Drawings.
3. Main devices shall be hard bus connected to the panelboard bus bars.
4. In all cases, panelboards fed directly from a transformer shall have a main overcurrent protective device. If not indicated on the Drawings or Panelboard Schedules, provide this device sized to provide the full capacity of the transformer rating.
5. Main devices shall be vertically mounted and shall have their operating handle in the up position when energized. Main devices that are mounted in the same manner as the branch devices are NOT acceptable, i.e. main devices shall be individually mounted at the top or bottom of the phase bus bars.
6. Panelboards overcurrent protective devices layout shall conform to the layout indicated on the panelboard schedules.
7. Provide identified handle ties for single pole circuit breakers that share a neutral conductor.

F. Surge Protective Devices:

1. Refer to Section 264313: Surge Protective Devices.

G. Finish: Five step zinc phosphate pre-treatment, one coat of rust inhibiting dichromate primer and one coat of baked-on enamel finish, ANSI 61 (light gray).

2.3 DISTRIBUTION PANELBOARDS

- A. Enclosures shall be sized as required and shall meet the space restriction allocated on Drawings. Panelboard shall comply with NEMA PB 1.
- B. Provide necessary hardware to permit locking every overcurrent protective device handle in the "OFF" position.
- C. Where "SPACE" is indicated on panelboard schedules or Drawings, install cross connectors and mounting hardware to match the frame size ampere rated noted.

2.4 BRANCH CIRCUIT PANELBOARDS

- A. Enclosure shall be 20" wide x 5-3/4" deep, surface or flush mounted and shall comply with NEMA PB 1.
- B. Flush panelboards mounted adjacent to each other shall be same physical size.
- C. Where "SPACE" is indicated on panelboard schedules or Drawings, install minimum 100 amp branch circuit cross connectors and mounting hardware. For future device spaces larger than 100 amps, cross connectors shall match the frame size ampere rated noted.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Contractor shall thoroughly examine Project site conditions for acceptance of panelboard installation to verify conformance with Manufacturer and Specification tolerances. Do not commence with installation until all conditions are made satisfactory.
- B. Where panelboards are shown to be flush mounted in walls, the contractor shall insure that 6" deep studs are employed in wall construction to accommodate the 5-3/4" deep panelboard enclosure.

3.2 INSTALLATION

- A. Install panelboards in accordance with Manufacturer's written instructions, as indicated on the Drawings and as specified herein.
- B. Set panels plumb and symmetrical with building lines in conformance with PB1.1. Furnish and install all construction channel bolts, angles, etc., required to mount the equipment furnished under this Section.
- C. Mounting height shall be 6 feet.
- D. Panelboards shall be anchored and braced to withstand seismic forces as calculated per Section 260010: Basic Electrical Requirements.

- E. Provide mounting hardware brackets, busbar drillings and filler pieces for all unused spaces.
- F. "Train" interior wiring; bundle and clamp, using specified plastic wire wraps specified under Section 260519: Building Wire and Cable.
- G. Replace panel pieces, doors or trim exhibiting dents, bends, warps, or poor fit that may impede ready access, security, or integrity.
- H. Conduits terminating in concentric, eccentric, or oversized knockouts at panelboards shall have ground bushings and bonding jumpers installed interconnecting all such conduits and the panelboard.
- I. Check and tighten all bolts and connections with a torque wrench using Manufacturer's recommended values.
- J. Provide four 3/4" spare conduits stubbed-out of flush mounted panelboards to nearest accessible ceiling space.
- K. Visually inspect panelboard for rust and corrosion. If signs of rust and corrosion are present, restore or replace panelboard to new condition.
- L. In damp and wet locations, mount panelboards with a minimum one inch of air space between cabinet and the wall or other support material.
- M. Provide close up plugs in all unused openings in the cabinet.
- N. Field install handle ties on single pole circuit breakers that share a neutral conductor.
- O. Circuit breakers feeding "Fire Alarm Control Panel(s)" shall be red in color.

3.3 FIELD QUALITY CONTROLS

- A. Independent testing: Contractor shall arrange and pay for the services of an independent Testing Agency to perform all quality control electrical testing, calibration and inspection required herein. Testing Agencies objectives shall be to:
 - 1. Assure panelboard installation conforms to specified requirements and operates within specified tolerances.
 - 2. Field test and inspect to ensure operation in accordance with Manufacturer's recommendations and Specifications.
 - 3. Prepare final test report including results, observations, failures, adjustments, and remedies.
 - 4. Apply label on panelboards upon satisfactory completion of tests and results.
 - 5. Verify ratings and settings and make final adjustments.
- B. At least three weeks prior to any testing, notify the Engineer so that arrangement can be made for witnessing test, if deemed necessary. All pretesting shall have been tested satisfactorily prior to the Engineer's witnessed test.
- C. The Contractor shall supply a suitable and stable source of electrical power to each test site. The Testing Agency shall specify the specific power requirements.
- D. Testing of overcurrent protective devices shall be done only after all devices are installed and system is energized.

E. Prefunctional testing:

1. Provide Testing Agency with Contract Documents and Manufacturer instructions for installation and testing.
2. Visual and mechanical inspection:
 - a. Inspect for physical damage, defects alignment and fit.
 - b. Perform mechanical operational tests in accordance with Manufacturer's instructions.
 - c. Compare nameplate information and connections to Contract Documents.
 - d. Check tightness of all power connections.
 - e. Check that all covers, barriers, and doors are secure.
3. Electrical tests:
 - a. Insulation resistance: 1000 volt DC tests for one minute on all 600 volt and lower rated equipment, components, buses, feeder and branch circuits and control circuits. Test phase-to-phase and phase-to-ground circuits showing less than 10-megohms resistance to ground shall be repaired or replaced.
 - b. Circuit continuity: All feeders shall be tested for continuity. All neutrals shall be tested for improper grounds.
 - c. Ground resistance: Test resistance to ground of system and equipment ground connection.
 - d. Test overcurrent protection devices per Section 262816: Overcurrent Protective Devices.

F. In the event that the system fails to function properly during the testing as a result of inadequate pretesting or preparation. The Contractor shall bear all costs incurred by the necessity for retesting including test equipment, transportation, subsistence, and the Engineer's hourly rate.

G. Contractor shall replace at no costs to the Owner all devices which are found defective or do not operate within factory specified tolerances.

H. Contractor shall submit the Testing Agency's final report for review prior to Project closeout and final acceptance by the Owner. Test report shall indicate test dates, devices tested, results, observation, deficiencies, and remedies. Test report shall be included in the operation and maintenance manuals.

3.4 CLEANING

- A. Prior to energizing of panelboards, the Contractor shall thoroughly clean the interior of enclosure of all construction debris, scrap wire, etc. using Manufacturer's approved methods and materials.
- B. Upon completion of Project prior to final acceptance the Contractor shall thoroughly clean both the interior and exterior of panelboards per Manufacturers approved methods and materials. Remove paint splatters and other spots, dirt, and debris.
- C. Touch-up paint any marks, blemishes or other finish damage suffered during installation.

END OF SECTION

SECTION 26 27 26

WIRING DEVICES

PART 1 - GENERAL

1.1 SUMMARY

- A. Work included: Labor, materials, and equipment necessary to complete the installation required for the item specified under this Division, including but not limited to:
1. Wall switches.
 2. Wall dimmer controls.
 3. Occupancy/vacancy sensors, including wallbox and ceiling mounted.
 4. Time switches.
 5. Receptacles.
 6. Floor mounted service boxes.
 7. Coverplates.

1.2 REFERENCES

- A. Comply with the latest edition of the following applicable Specifications and standards except as otherwise indicated or specified.
1. National Electrical Manufacturer's Association (NEMA):
 - NEMA WD-1; General-Purpose Wiring Devices.
 - NEMA WD-2; Semiconductor Dimmers for Incandescent Lamps.
 - NEMA WD-5; Specific-Purpose Wiring Devices.
 - NEMA SSL 7A; Phase-Cut Dimming for Solid State Lighting
 2. Underwriter's Laboratories (UL):
 - UL 20 General-Use Snap Switches.
 - UL 231; Power Outlets.
 - UL 310; Electrical Quick-Connect Terminals.
 - UL 498; Attachment Plugs and Receptacles.
 - UL 514A; Metallic Outlet Boxes.
 - UL 514D; Cover Plates for Flush-Mounted Wiring Devices.
 - UL 943; Ground-Fault Circuit-Interrupters.
 - UL 1681; Wiring Device Configurations.
 - UL 1682; Plugs, Receptacles and Cable Connectors of the Pin and Sleeve Type.
 - UL 1699A; Outlet Branch Circuit Arc-Fault Circuit-Interrupters.

1.3 SUBMITTALS

- A. Submit in accordance with the requirements of Section 260010: Basic Electrical Requirements, the following items:
 - 1. Data/catalog cuts for each product and component specified herein, listing all physical and electrical characteristics and ratings indicating compliance with all listed standards.
 - 2. Clearly mark on each data sheet the specific item(s) being submitted and the proposed application.
 - 3. Provide color finishes for Architect to select from.
 - 4. Submit Manufacturer's installation instructions.
- B. Where inscribed device coverplates are noted on the Drawings or in the Specifications, conform to the requirements of Section 260553: Electrical Identification.

1.4 QUALITY ASSURANCE

- A. All materials, equipment and parts comprising the units specified herein shall be new, unused, and currently under production.
- B. Only products and applications listed in this Section may be used on the Project unless otherwise submitted.

1.5 WARRANTY

- A. Occupancy sensors offered under this Section shall be covered by a 1-year parts and labor warranty for malfunctions resulting from defects in materials and workmanship. Warranty shall begin upon acceptance by the Owner.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Products furnished by the following Manufacturers shall be acceptable if in compliance with all features specified herein and indicated on the Drawings.
 - 1. Switches, receptacles and coverplates:
 - a. Hubbell.
 - b. Pass & Seymour.
 - c. Leviton.
 - 2. Wallbox dimmer controls:
 - a. Lutron: Lumea, Skylark Contour.
 - b. Legrand P&S: radiant.
 - c. Leviton; IllumaTech.
 - d. Cooper Greengate: WBSD.
 - e. Types as specifically shown on drawings.
 - 3. Occupancy/vacancy sensors switches, time switches:

- a. Cooper Controls "Greengate"
 - b. Wattstopper
 - c. Leviton
 - d. SensorSwitch, Inc.
 - e. Hubbell Building Automation, Inc.
4. Floor mounted service boxes:
- a. Hubbell.
 - b. Walker.

B. Substitutions: Under provisions of Section 260010: Basic Electrical Requirements.

2.2 WALL SWITCHES

- A. Standards: Provide general-purpose 120/277 volt AC switches that conform to NEMA WD-1 Specifications.
- B. Color: Device color shall be as selected by the Architect, unless otherwise noted.
- C. Wall switches:
 - 1. Provide twenty amperes, 120/277 volt, Specification grade, toggle handle style, quick-make slow-break, quiet type snap switch with silver cadmium alloy contacts, binding head terminal screws, back and side wired with totally enclosed case.

2.3 WALLBOX DIMMER CONTROLS

- A. Standards: Provide dimmers that conform to NEMA WD-2 and UL 20.
- B. Color: Device color shall be as selected by the Architect, unless otherwise noted.
- C. Designed and listed for specific control types:
 - 1. 0-10 volt LED and Fluorescent
- D. Dimmers:
 - 1. Linear slide type dimmer with smooth and continuous square law dimming curve.
 - 2. Separate control of intensity and on/off.
 - 3. Minimum load limit as required for wattage controlled, to avoid low-end flicker.
 - 4. Maximum load limit as required for load type controlled; wattage or unit based.
 - 5. Dimmers shall have power failure memory to bring lights back on at same level prior to power interruption.
 - 6. Dimmers shall incorporate air-gap switch.
 - 7. Provide dimmers with single and multi-gang coverplate of high impact ABS plastic.

2.4 OCCUPANCY/VACANCY SENSOR SWITCHES

- A. Occupancy sensors: automatic on, automatic off.
- B. Vacancy sensors: manual on, automatic off.

C. General:

1. Occupancy sensors shall comply with the latest edition of the California Building Energy Efficiency Standards, California Building Code, Part 6 and be certified by The California Energy Commission. All sensors shall be listed in the most current directory of Certified Occupancy Sensing Devices or be on file with the CEC.
2. Sensors shall be dual-technology type infrared/ultrasonic or infrared/microphonic or as specified herein.
3. Neutral connection required. Sensors that rely on ground leakage current for operation shall not be provided.
4. All sensors shall have an adjustable time delay off setting and a sensitivity adjustment.
5. Ceiling mounted sensors shall operate be line voltage or low voltage with separate control unit. Control unit shall contain power supply and relays for switching loads.
6. Units shall be furnished with area coverage to suit application. No allowance shall be given for providing sensors improperly sized for the square footage of the controlled area.

D. Color: Device color shall be as selected by Architect, unless otherwise noted.

E. Wallbox mounted single level control sensors:

1. Sensor shall provide minimum coverage of 900-square feet.
2. Time delay adjustment from 30-seconds to 20-minutes. Set initial time-out setting at 4-minutes, unless otherwise specified. Set sensitivity adjustment at maximum.
3. Load capacity of 0 to 1800watts at connected voltage.
4. For use in small utility closets and similar areas where dual level switching is not indicated.

F. Wallbox mounted dual level control sensors:

1. Sensor shall provide dual level switching capability and minimum coverage of 1000-square feet.
2. Operation shall be manual (in two levels) "ON" and manual (in two levels) or automatic (full) "OFF".
3. Time delay adjustment from 30-seconds to 20-minutes. Set initial time-out setting at 20-minutes, unless otherwise specified. Set sensitivity adjustment at maximum.
4. Load capacity of 50 to 1000watts at connected voltages.
5. Integral photocell. Provide with ambient light control adjustment.
6. For use in offices and similar areas where dual level switching is indicated.

G. Wallbox mounted combination sensor and dimmer:

1. Sensor shall provide 0-10 volt dimming capability for LED loads.
2. Sensor shall provide minimum coverage of 20-feet for clear line-of-sight applications.

3. Infrared only or dual-technology sensor.
 4. Time delay adjustment from 3-minutes to 20-minutes. Set initial time-out setting at 15-minutes, unless otherwise specified. Set sensitivity adjustment at maximum.
 5. For use in private offices and similar areas where dimming is indicated.
- H. Ceiling or wall mounted single-directional sensors:
1. Sensor shall provide minimum coverage of 900-square feet.
 2. Operation shall be automatic "ON" and automatic "OFF". Provide with a manual override switch.
 3. Time delay adjustment from 30-seconds to 20-minutes. Set initial time-out setting at 10-minutes. Set sensitivity adjustment at maximum.
 4. Load capacity of 20 amps per power or slave pack at connected voltage.
 5. Power pack, if required, consisting of Class 2, 24 volt output transformer and relay in single housing, capable of powering up 2 sensors and mounted inside standard 4-inch square box.
 6. For use in small office, classroom, and similar areas.
- I. Ceiling mounted omnidirectional sensors:
1. Sensor shall provide minimum omnidirectional coverage of 1000-square feet.
 2. Operation shall be automatic "ON" and automatic "OFF". Provide with a manual override switch.
 3. Time delay adjustment from 30-seconds to 20-minutes. Set initial time-out setting at 10-minutes. Set sensitivity adjustment at maximum.
 4. Load capacity of 20 amps per power or slave pack at connected voltage.
 5. Power pack, if required, consisting of Class 2, 24 volt output transformer and relay in single housing, capable of powering up to 2 sensors and mounted inside standard 4-inch square box.
 6. For use in large storage rooms and similar areas.

2.5 TIME SWITCHES

- A. Wallbox mounted, line voltage type.
- B. Shall be compatible with all LED lighting loads, electronic ballasts, motor loads, and inductive loads. Triac and other harmonic generating devices shall not be allowed.
- C. Shall have no minimum load requirement and shall be capable of controlling up to 800watts.
- D. Shall allow manual override of the preset time-out period.
- E. Time switch shall be capable of operating as an "ON/OFF" switch.
- F. Digital time switch:
1. Shall have the option for a beep warning that shall sound every 5-seconds once the time switch countdown reaches one minute.

2. Shall have an electroluminescent backlit Liquid Crystal Display that shows the timer's countdown.
 3. Maximum setting of 30-minutes for server aisles and 10-minutes for closets.
- G. Analog time switch:
1. Spring wound rotary style.
 2. Maximum setting of 30-minutes for server aisles and 10-minutes for closets.
- H. Astronomical time switch:
1. Includes integral programming function for precise Time Zone, Longitude, and Latitude input/
 2. Weekly schedule format.
 3. Minimum 5 programmable schedules.

2.6 RECEPTACLES

- A. Standards:
1. Provide general purpose 20 amp, 125/250 volt AC receptacles that conform to NEMA WD-1 Specifications. Specialty receptacles shall conform to NEMA WD-5 Specifications as applicable.
 2. Provide NEMA 5-20R, industrial (heavy-duty) specification grade as noted herein, 20 amp, 125 volt AC, 2-pole, 3-wire grounding type receptacles.
 3. Receptacles shall be the standard conventional style device.
 4. Receptacles shall be tamper-resistant in areas specified in CEC Article 406.12 or as indicated on Drawings.
- B. Color:
1. Device color shall be selected by the Architect, unless otherwise noted.
 2. Devices connected to an emergency circuit shall be red.
- C. General purpose single outlets:
1. Provide self-grounding back and side wired with binding head staked terminal screw.
- D. General purpose duplex receptacles:
1. Provide self-grounding, back and side wired with binding head staked terminal screws and break-off strip for two-circuit wiring.
- E. Ground fault circuit interrupting (GFCI) receptacles:
1. Provide 20 amp, 125 volt AC, receptacles consisting of NEMA 5-20R duplex device with integral solid state sensing and signaling circuitry capable of detecting and interrupting a maximum 5-milli-amp line-to-ground fault current in approximately 1/40th of a second.
 2. Provide visual device with trip indication, manual reset, and test mechanisms and with point of use and multi-outlet protection.

3. Provide self-test and monitor feature with visual indicators on device face representing power status, trip condition, ground fault condition and end of life status.
 4. Provide weather resistant devices at all damp and wet locations.
- F. Controlled Receptacles:
1. Provide 20 amp, 125 volt AC, receptacles consisting of NEMA 5-20R duplex device permanently marked with universal symbol for controlled receptacle, and the word "CONTROLLED".
 2. Controlled duplex receptacles shall include split circuit hot tab for one controlled outlet, and one uncontrolled.
 3. Controlled double duplex receptacle shall consist of one uncontrolled general-purpose duplex receptacle, and one controlled duplex receptacle.
- G. USB Charger Type Duplex Receptacles
1. Provide 20 amp, 125 volt AC, tamper-resistant specification grade receptacles consisting of NEMA 5-20R duplex device with two 5 volt DC USB Type C charging ports; compatible with USB 3.0 and 3.2 devices, and capable of charging two devices simultaneously while still using receptacles.
 2. Comply with USB battery charging spec USB BC1.2
 3. Minimum 3.1 amps total charging capacity.
- H. Special purpose receptacles: Provide Specification grade devices with the NEMA configuration, voltage and current rating, number of poles and ground provisions as noted on the Drawings.

2.7 COVERPLATES

- A. General:
1. Provide all coverplates with rounded edges and corners, smooth and free of grooves, embossing or other embellishment.
 2. Provide mounting screws to match the plate finish.
 3. Provide gang type coverplates where two or more devices are installed at one location. Individual gangable coverplates are not acceptable.
 4. Provide plates of one design, standard conventional style, throughout the Project unless otherwise specified.
- B. Color: Coverplate color shall be as specified by the Architect, unless otherwise noted.
- C. Plastic coverplates:
1. Provide smooth, high impact, self-extinguishing thermoplastic coverplates and 0.100 inches thick with rounded edges and corners.
 2. Provide openings to accommodate the devices indicated on the Drawings and in the Specifications.
- D. Weatherproof coverplates:
1. Non-public areas:

- a. Provide horizontal mounted, weatherproof in-use coverplate for one duplex or one GFCI receptacle. Provide gasketed, spring loaded, vertically self-closing covers suitable for use in damp and wet locations as described in UL 514 and CEC Article 406. Covers shall allow the use of the device with the cover closed.
- b. Furnish base plates, covers, hinge pins, spring, and screws of corrosion resistant type 302 stainless steel.
- 2. Public area receptacles:
 - a. Provide horizontal mounted weatherproof in-use coverplate for one duplex or one GFCI receptacle. Provide gasketed, spring loaded, lockable, vertically self-closing covers suitable for use in damp and wet locations as described in UL 514 and CEC Article 406. Covers shall allow the use of the device with the cover closed.
 - b. Furnish base plates, covers, hinge pins, spring and screws of corrosion resistant type 302 stainless steel.
 - c. Provide two (2) keys for each locking type coverplate.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Contractor shall thoroughly examine Project site conditions for acceptance of wiring device installation to verify conformance with Manufacturer and Specification tolerances. Do not commence with installation until all conditions are made satisfactory.

3.2 PREPARATION

- A. Coordinate device heights in vending, kitchen and utility areas with benches and counters.
- B. Coordinate switch mounting location with Architectural details. Unless otherwise noted, locate switches on latch side of door.

3.3 INSTALLATION

- A. Install wiring devices in accordance with Manufacturer's written instructions, as indicated on the Drawings and as specified herein.
- B. Install devices with the vertical centerline plumb and with all edges of the device flush against the adjacent wall surfaces.
- C. Mount switches at 42 inches to center above finished floor unless otherwise noted.
- D. Mount receptacles vertically with the centerline 18-inches above finished floor and with grounding slot at bottom.
- E. Mount receptacles vertically when mounting above counters, mount with grounding slot to the left.
- F. Provide GFCI receptacles in accordance with CEC Article 210.8, whether indicated as GFCI type or not on the drawings:

- G. Derate ganged dimmer switches as instructed by Manufacturer. Do not use common neutrals in dimmer circuits.
- H. Install red receptacles where connected to an emergency circuit.
- I. Provide coverplates for all outlet boxes, switches, receptacles, etc.
- J. Install blank coverplates on all outlet boxes in which no device is required or installed.
- K. Provide coverplates that completely cover wall opening and seat against wall.

3.4 OCCUPANCY/VACANCY WALLBOX SENSORS

- A. All occupancy/vacancy sensors shall have a sensitivity appropriate for the space. Contractor shall be responsible for testing the sensitivity of the sensor in the space and adjusting as needed.
- B. Where no direction is provided in a sequence of operation or by the owner set the occupancy sensor timeout to values as indicated in Part 2 above.
- C. Install wall mounted devices with the vertical centerline plumb and alleges of device flush against adjacent wall surfaces. Mount devices at 42-inches to center above finished floor unless otherwise noted.

3.5 FIELD QUALITY CONTROL

- A. Electrical testing:
 - 1. Test proper polarity of all receptacles.
 - 2. Test ground continuity of all wiring devices.
 - 3. Test ground fault interrupting device operation.
- B. Visual and mechanical inspection:
 - 1. Check proper operation of all switches.
 - 2. Visually inspect and replace damaged or defective devices.

3.6 CLEANING

- A. Clean interior of all boxes from dirt and paint prior to installation of devices.
- B. Clean wiring devices and coverplates from dirt and paint over spray.

END OF SECTION

SECTION 26 28 16
OVERCURRENT PROTECTIVE DEVICES

PART 1 - GENERAL

1.1 SUMMARY

- A. Work included: Labor, materials, and equipment necessary to complete the installation required for the item specified under this Division, including but not limited to:
 - 1. Fuses.
 - 2. Molded case circuit breakers.
- B. Related Work: Consult all other Sections, determine the extent and character of related Work, and properly coordinate Work specified herein with that specified elsewhere to produce a complete installation.

1.2 REFERENCES

- A. Comply with the latest edition of the following applicable Specifications and standards except as otherwise indicated or specified:
 - 1. Underwriters Laboratories, Inc. (UL):
 - UL 248(1-16); Low-Voltage Fuses.
 - UL 489; Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures.
 - 2. National Electrical Manufacturer Association (NEMA):
 - NEMA AB 1; Molded Case Circuit Breakers.
 - 3. Pacific Gas & Electric (PG&E) – Section G2 – Protection and Control Requirements for Generation Entities - Power Generation Interconnection Handbook:
 - Paragraph G2.14; Emergency Generator Requirements
 - Table G2-5; Section G2 – Protection and Control Requirements for Generation Entities document.

1.3 SUBMITTALS

- A. Submit in accordance with the requirements of Section 260010: Basic Electrical Requirements, the following items:
 - 1. Data/catalog cuts for each product and component specified herein, listing all physical and electrical characteristics and ratings indicating compliance with all listed standards.
 - 2. Describe product operation, equipment and dimensions and indicate features of each component.
 - 3. Clearly mark on each data sheet the specific item(s) being submitted and the proposed application.
 - 4. Provide factory certification of trip characteristics for each type and rating of circuit breaker.

5. Provide current let-through and melting time information for each type and rating of fuses.
6. Confirmation in writing of compliance with Arc Energy Reduction per CEC Articles 240.67 and 240.87.
7. Confirmation in writing of compliance with all CEC mandated selective coordination requirements (e.g. CEC Articles 517, 620, 645, 695, 700, 701, 708) associated with this project. Include manufacturer selective coordination tables, etc. for documentation to be submitted to the Power System Study engineer and the Authority Having Jurisdiction (AHJ).
8. Submit Manufacturer's installation instructions.
9. Complete bill of material listing all components.
10. Warranty.

1.4 OPERATION AND MAINTENANCE MANUAL

- A. Supply operation and maintenance manuals in accordance with the requirements of Section 260010: Basic Electrical Requirements, to include the following:
 1. A detailed explanation of the operation of the system.
 2. Instructions for routine maintenance.
 3. Parts list and part numbers.
 4. Telephone numbers for authorized parts and service distributors.
 5. Final testing reports.

1.5 QUALITY ASSURANCE

- A. All materials, equipment and parts comprising the units specified herein shall be new, unused and currently under production.
- B. Only products and applications listed in this Section may be used on the Project unless otherwise submitted.

1.6 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Delivery: Overcurrent Protective Device components shall not be delivered to the Project site until protected storage space is available. Storage outdoors covered by rainproof material is not acceptable. Equipment damaged during shipment shall be replaced and returned to Manufacturer at no cost to Owner.
- B. Storage: Store in a clean, dry, ventilated space free from temperature extremes. Maintain factory wrapping or provide a heavy canvas/plastic cover to protect units from dirt, water, construction debris and traffic. Provide heat where required to prevent condensation.
- C. Handling: Handle in accordance with Manufacturer's written instructions. Be careful to prevent internal component damage, breakage, denting and scoring. Damaged units shall not be installed. Replace damaged units and return equipment to Manufacturer.

1.7 WARRANTY

- A. Units and components offered under this Section shall be covered by a 1-year parts and labor warranty for malfunctions resulting from defects in materials and workmanship. Warranty shall begin upon acceptance by the Owner.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Products furnished by the following Manufacturers shall be acceptable if in compliance with all features specified herein and indicated on the Drawings.
 - 1. Fuses:
 - a. Bussmann Division, Cooper Industries.
 - b. Gould Shawmut Co.
 - 2. Circuit breakers:
 - a. ABB/ General Electric.
 - b. Eaton.
 - c. Siemens.
 - d. Square D.

- B. Substitutions: Under provisions of Section 260010: Basic Electrical Requirements.

2.2 GENERAL

- A. Overcurrent protective devices shall satisfy all CEC mandated selective coordination requirements (e.g. CEC Articles 517, 620, 645, 695, 700, 701, 708) in addition to any project specific selective coordination requirements above and beyond CEC requirements.
- B. Fuses rated 1200 amps or higher shall satisfy CEC Article 240.67 requirements.
- C. Circuit breakers rated (or can be adjusted) 1200 amps or higher shall satisfy CEC Article 240.87 requirements.

2.3 FUSES

- A. General: All power fuses shall be time-delay, high interrupting (300K AIC), current limiting type, unless otherwise noted on the Drawings. All fuses shall be the product of a single Manufacturer and shall be selectively coordinated when applied in 2:1 ratio. Types of fuses shall be as follows:
 - 1. Motor branch circuit fuses (0 to 600 amps): UL Class J dual element, time delay type fuse. Motor branch circuit fuses shall be sized for Type 2 coordination for the motor controller and back-up motor overload protection and shall be coordinated with motor starter overload relay heaters. See Section 262900: Motor Controls.
- B. Control and instrument fuses shall be suitable for installing in blocks or fuseholders. Exact type and rating shall be as recommended by the Manufacturer of the equipment being protected.

- C. Fuses for installation in current limiting circuit breakers or motor circuit protectors shall meet the specific requirements of the Manufacturers of that equipment to ensure compatibility.

2.4 MOLDED CASE CIRCUIT BREAKERS

- A. Branch and feeder circuit breakers shall be molded case, bolt on and trip indicating.
- B. Where stationary molded case circuit breakers are indicated on the Drawings to be current limiting type, they shall be current limiting as defined by UL 489 and shall not employ any fusible elements.
- C. Circuit breakers shall have interrupting capacity not less than that indicated on the Drawings or if not indicated, not less than 22,000 RMS symmetrical amps for 208 volt systems.
- D. Covers shall be sealed on non-interchangeable breakers and trip unit covers shall be sealed on interchangeable trip breakers to prevent tampering. Circuit breaker ratings shall be clearly visible after installation or engraved nameplates shall be provided stating the rating. All ferrous parts shall be plated to minimize corrosion.
- E. Circuit breakers shall be toggle, quick-make and quick-break operating mechanisms with trip-free feature to prevent contacts being held closed against overcurrent conditions in the circuit. Trip position of the breakers shall be clearly indicated by operating handles moving to a center position.
- F. Provide identified handle ties for single pole circuit breakers that share a neutral conductor.
- G. Multipole breakers shall have a single handle to open and close all contacts simultaneously in both manual operation and under automatic tripping. Interpole barriers shall be provided inside the breaker to prevent any phase-to-phase flashover. Each pole of the breaker shall have means for Arc extinguishing.
- H. All terminals shall be dual rated for aluminum or copper wire.
- I. Circuit breakers with frame ratings 100 amps and smaller shall be ambient temperature compensated, thermal magnetic type unless otherwise noted. Breakers shall be of full size, 1" per pole type. Panels with more than one branch breaker larger than 100 amps shall be installed in distribution type panels.
- J. Circuit breakers with frame ratings above 100 amps through 225 shall have solid state electronic trips with true RMS reading through the 13th harmonic with 1% accuracy, interchangeable trip via front accessible current plug, adjustable instantaneous and short time be rated as indicated on Drawings at the voltage indicated.
- K. Circuit breakers with frame ratings above 225 amps shall have microprocessor-based RMS sensing trip units with the following characteristics:
 - 1. Interchangeable current rating plug or an adjustable trip setting to match the trip rating as indicated on Drawings.
 - 2. Adjustable long-time pick-up setting. Minimum of five settings from 50% to 100%.
 - 3. Adjustable long-time delay setting. Minimum of three delay bands.

4. Adjustable short time pick-up setting. Minimum of five settings from 200% to 800%.
 5. Adjustable short-time delay setting. Minimum of three delay bands with I²t IN and OUT curves.
 6. Adjustable instantaneous pick-up setting. Minimum of five settings from 200% to 1000%. Where the instantaneous feature is omitted on the Drawings, the trip unit shall have an instantaneous override feature.
 7. Zone selective interlocking (ZSI) for short-time delay and ground-fault delay trip functions, if indicated on the drawings.
 8. LED status indication to show "health" of trip unit.
 9. Three-phase ammeter, if indicated on the drawings.
 10. Trip indication targets on overload, ground fault and short circuit, if indicated on the drawings.
- L. Accessories: Provide accessories as noted on the Drawings, i.e. shunt-trip, auxiliary contacts, undervoltage trip, alarm switch, etc.
- M. Spaces in the boards shall be able to accept any combination of 1, 2 or 3-pole circuit breakers as indicated. Provide all necessary bus, device supports, and mounting hardware sized for frame, not trip rating.
- N. Series rated breakers are not acceptable unless specifically noted on the Drawings.
- O. Breaker shall be rated to operate in an ambient temperature of 40-degrees C and at 100% of their frame ampere rating on a continuous basis, if indicated on the drawings.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Contractor shall thoroughly examine Project site conditions for acceptance of overcurrent protective device installation to verify conformance with Manufacturer and Specification tolerances. Do not commence with installation until all conditions are made satisfactory.

3.2 INSTALLATION

- A. Install overcurrent protective devices in accordance with Manufacturer's written instructions, as indicated on the Drawings and as specified herein.
- B. Tighten electrical connectors and terminals; including screws and bolts, in accordance with equipment Manufacturers published torque-tightening values for equipment connectors. Where Manufacturers torque requirements are not indicated tighten connectors and terminals to comply with tightening torque specified in UL Standard 486A.
- C. Install overcurrent protective devices and accessories in accordance with Manufacturer's written instructions and with recognized industry practices to ensure that protective devices comply with requirements. All devices shall be installed in accordance with applicable CEC and NEMA standards for installation.

D. Circuit breakers serving "Fire Alarm Control Panel(s)" shall be red in color.

3.3 FIELD QUALITY CONTROL

- A. Independent testing: Contractor shall arrange and pay for the services of an independent Testing Agency to perform all quality control electrical testing, calibration and inspection required herein. Testing Agencies objectives shall be to:
1. Assure overcurrent protective device installation conforms to specified requirements and operates within specified tolerances.
 2. Field test and inspect to ensure operation in accordance with Manufacturer's recommendations and Specifications.
 3. Prepare final test report including results, observations, failures, adjustments, and remedies.
 4. Verify ratings and settings and make final adjustments.
- B. At least three weeks prior to any testing, notify the Engineer so that arrangement can be made for witnessing test, if deemed necessary. All pretesting shall have been tested satisfactorily prior to the Engineer's witnessed test.
- C. The Contractor shall supply a suitable and stable source of electrical power to each test site. The Testing Agency shall specify the specific power requirements.
- D. Testing of overcurrent protective devices shall be done only after all devices are installed and prior to system being energized.
- E. Prefunctional testing:
1. Provide Testing Agency with Contract Documents and Manufacturer instructions for installation and testing.
 2. Visual and mechanical inspection:
 - a. Inspect for physical damage, defects alignment and fit.
 - b. Perform mechanical operational tests in accordance with Manufacturer's instructions.
 - c. Compare nameplate information and connections to Contract Documents.
 - d. Check tightness of all control and power connections.
 - e. Check that all covers, barriers, and doors are secure.
 3. Electrical tests:
 - a. Circuit continuity: All feeders shall be tested for continuity. All neutrals shall be tested for improper grounds.
 - b. Test all circuit breakers with frame size 225 amps and larger in each panelboard, distribution board, switchboard, etc. unless otherwise noted via primary current injection testing. Testing shall verify the following:
 - 1) Determine that circuit breaker will trip under overcurrent conditions, with tripping time in conformance with NEMA AB 1 requirements.
 - 2) Circuit breaker pickup and delay measurements are within the manufacturers published tolerances for long time, short time, instantaneous, and ground fault.

- 3) For circuit breakers rated or can be adjusted to 1200 amps (or higher), confirm ZSI protection is acceptable or the maintenance mode switch is operational (enabled and disabled) with reduced pickup and delay measurements when enabled.

- F. Contractor shall replace at no costs to the Owner all devices which are found defective or do not operate within factory specified tolerances.
- G. Contractor shall submit the Testing Agency's final report for review prior to Project closeout and final acceptance by the Owner. Test report shall indicate test dates, devices tested, results, observation, deficiencies, and remedies. Test report shall be included in the operation and maintenance manuals.

3.4 ADJUSTING

- A. Adjust circuit breaker trip settings based on recommendations of Section 260060: Power System Study.
- B. Adjust circuit breaker trip settings for coordination with other overcurrent protective devices in system.
- C. Adjust circuit breaker trip settings for adequate protection from overcurrent and fault currents.

3.5 CLEANING

- A. Upon completion of Project prior to final acceptance the Contractor shall thoroughly clean overcurrent protective devices per Manufacturer's approved methods and materials. Remove paint splatters and other spots, dirt, and debris.

3.6 TRAINING

- A. Factory authorized service representative shall conduct a 2-hour training seminar for Owner's Representatives upon completion and acceptance of system. Instructions shall include safe operation, maintenance, and testing of equipment with both classroom training and hands-on instruction.
- B. Contractor shall schedule training with a minimum of 7-days advance notice.

END OF SECTION

SECTION 26 28 19
DISCONNECT SWITCHES

PART 1 - GENERAL

1.1 SUMMARY

- A. Work included: Labor, materials, and equipment necessary to complete the installation required for the item specified under this Division, including but not limited to:
 - 1. Disconnect Switches.
- B. Related Work: Consult all other Sections, determine the extent and character of related Work, and properly coordinate Work specified herein with that specified elsewhere to produce a complete installation.

1.2 REFERENCES

- A. Comply with the latest edition of the following applicable Specifications and standards except as otherwise indicated on specified:
 - 1. National Electrical Manufacturer Association (NEMA):
 - NEMA KS 1; Enclosed Switches.
 - 2. Underwriters Laboratories, Inc. (UL):
 - UL 99; Enclosed and Dead-Front Switches.

1.3 SUBMITTALS

- A. Submit in accordance with the requirements of Section 260010: Basic Electrical Requirements, the following items:
 - 1. Data/catalog cuts for each product and component specified herein, listing all physical and electrical characteristics and ratings indicating compliance with all listed standards.
 - 2. As a minimum the following characteristics shall be indicated:
 - a. NEMA types.
 - b. Current rating.
 - c. Number of poles.
 - d. Fuse provisions.
 - e. Enclosure dimensions.
 - f. Voltage.
 - g. Horsepower rating (if applicable).
 - h. Short circuit rating.
 - 3. Clearly mark on each data sheet the specific item(s) being submitted and the proposed application.
 - 4. Submit Manufacturer's installation instructions.

1.4 QUALITY ASSURANCE

- A. All materials, equipment and parts comprising the units specified herein shall be new, unused, and currently under production.
- B. Only products and applications listed in this Section may be used on the Project unless otherwise submitted.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Products furnished by the following Manufacturers shall be acceptable if in compliance with all features specified herein and indicated on the Drawings.
 - 1. ABB/ General Electric.
 - 2. Eaton.
 - 3. Siemens.
 - 4. Square D.
- B. Substitutions: Under provisions of Section 260010: Basic Electrical Requirements.

2.2 DISCONNECT SWITCHES

- A. Description: Provide NEMA heavy-duty type switches with dead front construction and padlock provisions for up to three locks in the "OFF" position.
- B. Switch interior: Provide switch with switchblades that are fully visible in the "OFF" position when the door is open. Provide UL listed lugs for copper conductors, lugs to be front removable. Provide plated current carrying part.
- C. Switch mechanism: Provide switches with a quick-make, quick-break, position indicating, operating handle and mechanism and a dual cover interlock to prevent unauthorized opening of the switch door in the "ON" position or closing of the switch mechanism with the door open. Furnish an electrical interlock to de-energize control wiring when the disconnect switch is opened.
- D. Enclosures: Provide switches with hinged cover in NEMA 1 general purpose, sheet steel enclosure for dry locations and NEMA 3R weatherproof galvanized enclosures for exterior, damp, or wet locations, unless otherwise noted on the Drawings. Provide an enclosure treated with a rust-inhibiting phosphate primer and finished in gray baked enamel.
- E. Ratings: Provide switches that are horsepower rated for 240 volt AC or 600 volt AC as required for the circuit involved and that meet "I-SQUARED-T" requirements. Fusible switches to have provisions for the types of fuses specified in Section 262816: Overcurrent Protective Devices. UL listed short circuit rating, when equipped with fuses to be 200,000 amps RMS symmetrical. Furnish with provisions for RK-1 fuses for switches up to 600 amps. 800 amp switches and larger to have provisions for Class L fuses.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Contractor shall thoroughly examine Project site conditions for acceptance of disconnects switch installation to verify conformance with Manufacturer and Specification tolerances. Do not commence with installation until all conditions are made satisfactory.

3.2 PREPARATION

- A. Coordinate locations of switches and equipment in the field to provide code required clearances in front of switches and to ensure that switches are insight of the controller as described in CEC Article 430.

3.3 INSTALLATION

- A. Install disconnect switches where indicated on the Drawings.
- B. Install fuses in fusible disconnect switches.
- C. Include construction channel and mounting hardware as required to support disconnect switch.

3.4 IDENTIFICATION

- A. Provide engraved, machine screw retained type 'NP' nameplate on each disconnect switch. See Section 260553: Electrical Identification.

3.5 CLEANING

- A. Upon completion of Project prior to final acceptance the Contractor shall thoroughly clean both the interior and exterior of enclosure of all construction debris, scrap wire, paint splatters, dirt, etc.

END OF SECTION

SECTION 26 32 13

PACKAGED ENGINE GENERATOR SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

- A. Work included: Labor, materials, and equipment necessary to complete the installation required for the item specified under this Division, including but not limited to:
 - 1. Packaged engine generator set.
 - 2. Engine mounted radiator
 - 3. Exhaust silencer and fittings
 - 4. Starting batteries and battery charger.
 - 5. Fuel control system.
 - 6. Control panel.
 - 7. Accessories.
- B. The Engine Generator Supplier furnishes the following items: Furnish materials to the Project site and turn over to Divisions 22 for installation and final connection. Electrical connections are under Division 26.
 - 1. Gas shutoff.
- C. Work furnished by others: Division 22 contractor shall furnish and install the following:
 - 1. All natural gas piping, shutoff valves, etc. to the generator.

1.2 REFERENCES

- A. Comply with the latest edition of the following applicable Specifications and standards except as otherwise indicated or specified:
 - 1. Institute of Electrical and Electronic Engineers (IEEE):
 - IEEE 43; Testing Insulation Resistance of Rotating Machinery
 - 2. National Electrical Manufacturer Association (NEMA):
 - NEMA MG1; Motors and Generators.
 - NEMA MG2; Safety Standards for Construction and Guide for Selection, Installation and Use of Electric Motors and Generators.
 - NEMA AB1; Molded Case Circuit Breakers.
 - NEMA ICS1; General Standards for Industrial Control and Systems.
 - NEMA ICS4; Terminal Blocks.
 - 3. Underwriters Laboratories, Inc. (UL):
 - UL 50; Enclosures for Electrical Equipment, Non-Environmental Considerations.
 - UL 467; Grounding and Bonding Equipment.

UL 489;	Molded Case Circuit Breakers and Circuit Breaker Enclosures.
UL 508;	Electric Industrial Control Equipment.
UL 891;	Dead-Front Electrical Switchboards.
UL 1004;	Electric Motors.
UL 1004B;	Electric Motors and Generators.
UL 1236;	Battery Chargers for Charging Engine-Starter Batteries.
UL 2200;	Stationary Engine Generator Assemblies.
4. National Fire Protection Association (NFPA):
- | | |
|-----------|--|
| NFPA 37; | Stationary Combustion Engines and Gas Turbines |
| NFPA 54; | National Fuel Gas Code. |
| NFPA 110; | Emergency and Standby Power Systems |

1.3 PACKAGED ENGINE GENERATOR SYSTEM REQUIREMENTS

- A. It is the intent and purpose of these Specifications to provide a packaged engine generator system rated as emergency standby per ISO 8528 of the latest commercial type and design that includes all controls, protection, wiring and accessories.
- B. For emergency standby applications, the packaged engine generator set shall automatically start, attain rated speed and voltage, serve load, and be able to supply continuous electrical service within 10-seconds after the beginning of an interruption of the normal power. In order to satisfy the maximum 10-second requirement to serve the load, maximum response time of the generator after receiving an engine start command shall be 8-seconds, such that the system can be programmed for a minimum 1-second engine start delay and allow up to 1-second for distribution system transfers (e.g. ATS's, etc.).
- C. The fuel shall be natural gas.
- D. Generator Air Quality must meet all federal and local applicable standards and timetables at the location of installation.
- E. Generator must meet Air Quality requirements as allowed by Air Quality Management District at the time of permitting. Completion of permitting through the Air Quality Management District is required.

1.4 SUBMITTALS

- A. Submit in accordance with the requirements of Section 260010: Basic Electrical Requirements the following items:
 - 1. Data/catalog cuts for each product and component specified herein, listing all physical and electrical characteristics and ratings indicating compliance with all listed standards.
 - 2. Describe system operation, equipment and dimensions and indicate features of each component.
 - 3. Clearly mark on each data sheet the specific item(s) being submitted and the proposed application.

4. Shop Drawings to include:
 - a. Front, plan, and side elevations with overall dimensions.
 - b. Conduit entrance locations and requirements.
 - c. Electrical schematic and interconnection wiring diagrams for all equipment to be supplied. Clearly mark all termination points and indicate quantity/size of all field-installed wiring.
 - d. Battery rack size, dimensions, and liquid containment system.
 - e. Battery charger.
 - f. Control panel with front elevation indicating all devices and instruments.
 - g. Emergency stop pushbutton with lockout/ tagout feature.
 - h. Nameplate legend.
 - i. Connection and support including weight.
 - j. Electrical characteristics including KW/KVA, voltage, number of phases, RPM's, overcurrent device ratings, thermal damage curve of generator, and time-current characteristic curves for generator protective device. Provide Manufacturers published transient response data of the complete engine generator set upon 50%, 75% and 100% block loads at 0.8 pf. Data shall include maximum voltage dips, frequency dips and recovery time periods.
 - k. Natural gas connections showing all specified options and pipe connection locations.
 - l. Provide kilowatt output curve, fuel consumption curve and airflow requirements for combustion, ventilating and radiator cooling air.
 - m. Remote annunciator panel elevation and dimensions with nameplate information for each indicating light.
5. Furnish structural calculations for equipment anchorage as described in Section 260010: Basic Electrical Requirements.
6. Outdoor weatherproof equipment enclosures and accessories.
7. Noise analysis for the proposed enclosure in dBA at 1-meter (3.3-feet) and 7-meters (23-feet) distance from the generator set and an acoustical sound model for the entire site indicating complete compliance with property line sound limits. The sound model shall take into consideration all existing conditions.
8. The manufacturer shall provide the forms required by the Air Quality Management District 'AQMD,' as part of the submittal process, and filled out with all information pertaining to the generator being furnished for this project. These forms shall be included as part of the submittal requirements. Additional site-specific information required on the forms shall be obtained by the electrical contractor, to complete the requirements, and then shall be submitted to AQMD. The electrical contractor is responsible for gaining final approvals and permitting from AQMD for the installation of the generator.
9. Certified test data stating that the complete unit was factory tested at the rated full load and power factor with ambient, altitude and fuel grade recorded.
10. Confirmation in writing of generator control wiring compliance with CEC Article 700.10(D)(3).
11. Submit Manufacturer's installation instructions.

12. Complete bill of material listing all components.

13. Final test results.

14. Warranty.

B. Dimensions and configurations of engine generator(s) and accessories shall conform to the space allocated on the Drawings. The Contractor shall submit a revised layout if equipment furnished varies in size from that indicated on Drawings for the Engineer's approval.

C. The generator set shall be the product of a design process utilizing prototype testing in compliance to the requirements of NFPA 110 for Level 1 applications.

1.5 OPERATION AND MAINTENANCE MANUAL

A. Supply operation and maintenance manuals in accordance with the requirements of Section 260010: Basic Electrical Requirements, to include the following:

1. A detailed explanation of the operation of the system.
2. Instructions for routine maintenance.
3. Detailed instructions for repair of the engine generator set and other major components specified in this Section.
4. Pictorial parts list and part numbers.
5. Pictorial and schematic Electrical Drawings of wiring systems, including operating and safety devices, control panels, instrumentation, and annunciators.
6. Telephone numbers for the authorized parts and service distributors.
7. Include all service bulletins and torque Specifications for all terminations.
8. Final testing reports.

1.6 QUALITY ASSURANCE

A. All materials, equipment and parts comprising the units specified herein shall be new, unused, and currently under production.

B. Only products and applications listed in this Section may be used on the Project unless otherwise submitted.

C. Independent Testing Agency qualifications: Refer to Section 260010: Basic Electrical Requirements.

1.7 WARRANTY

A. Units and components offered under this Section shall be covered by a 2-year parts and labor warranty for malfunctions resulting from defects in materials and workmanship. Warranty shall begin upon acceptance by the Owner.

1.8 SYSTEM START-UP

A. Upon completion of installation, initial start-up of the engine generator shall be performed by a factory trained dealer service representative sufficient time shall be allowed to properly check the system out and perform required minor adjustments before the Engineer's witnessed test shall begin.

1.9 MAINTENANCE

A. Extra material:

1. Special tools: Provide to the Owner the special tools and testing devices required for routine maintenance.
2. Provide one spray can of matching finish paint for touching up damaged surfaces after installation.

B. Maintenance Service:

1. Provide a 2-year Manufacturer's maintenance contract of the engine generator system. The 2-year period shall begin from the date of Engineer's acceptance on a total no-charge basis. During this period, Manufacturer's maintenance staff shall visit the installation not less than 8-times for routine inspection and preventive maintenance. The maintenance visits shall be scheduled at 3-month intervals and shall be coordinated with the Owner and performed at times selected by the Owner. A written report of each maintenance visit shall be submitted to the Owner within 10-days. The Manufacturers shall submit a preventative maintenance schedule outlining in detail the following:
 - a. Time when services are to be performed.
 - b. Work to be performed.
 - c. Shutdowns required for service.
 - d. Company or Contractor support services required.
2. The contract shall include, but not be limited to, the following:
 - a. Engine Generator Manufacturer's recommended procedures for weekly inspection and maintenance to be done by user.
 - b. Quarterly inspections by the Supplier personnel to review the weekly maintenance record being kept by user and train any new Owner operating personnel.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Products furnished by the following Manufacturers shall be acceptable if in compliance with all features specified herein and indicated on the Drawings.

1. Packaged engine generators:
 - a. Caterpillar.
 - b. Cummins.
 - c. Generac.
 - d. Kohler.
 - e. MTU.

B. Substitutions: Under provisions of Section 260010: Basic Electrical Requirements.

2.2 GENERAL REQUIREMENTS

- A. Packaged engine generator system shall be in accordance with Specifications and as indicated on the Drawings.
- B. Engine generator set shall be composed of an 1800 RPM (nominal) engine and alternator directly connected with a suitable coupling and prototype tested as a system for durability and short-circuit performance.
- C. Engine generator set shall start and be up to full speed and capable of accepting full load in less than 8-seconds.
- D. Engine generator set shall be capable of producing the KW/KVA rating as indicated on the Drawings continuously at 500-feet above sea level, 122-degrees Fahrenheit outdoor ambient temperature (122-degrees F. max., 40-degrees F min.) and with 100% rated load.
- E. Provide signs on all doors to the engine generator room "WARNING: THIS EQUIPMENT MAY START AUTOMATICALLY."
- F. Provide anti-corrosive and anti-rust coatings on all areas subject to corrosion or rust.
- G. Engine generator emissions shall meet or exceed local air quality standards as specified by any agency requiring such standards. It is the responsibility of the Engine Generator Manufacturer to verify these requirements.

2.3 ENGINE

- A. Type: Liquid-cooled inline or V-type, four stroke cycle, compression ignition natural gas internal combustion engine. Engine shall be naturally aspirated, turbo-charged or turbo-charged-inter-cooled, as required. Turbocharger shall be of the turbine type driven by engine exhaust gases and direct connected to a blower supplying engine combustion air.
- B. Rating: Standby power of sufficient horsepower to operate all engine generator accessories under load. The horsepower rating shall take into account any generator efficiency losses.
- C. Engine speed: 1800rpm.
- D. Fuel: Natural Gas (LPG). The Engine Manufacturer shall recommend and supply an engine with the proper compression ratio for the specified fuel. Gas inlet pressure shall be designed for 7-11 inches of water.
- E. Electronic governing:
 - 1. Stability: +/- 0.25% of rated frequency at any constant load from no load to full load.
 - 2. Droop: 0% (isochronous) to 10% (adjustable).
 - 3. Recovery time: 6-seconds upon application or removal of full load.
 - 4. Protection: Include Protection from voltage spikes and reverse polarity.
- F. Jacket water heater: Thermal circulation type water heater sized to comply with NFPA 110 requirements for Level 1 equipment for heater capacity and performance. Heater shall be replaceable without draining the engine coolant system and controlled by an integral adjustable thermostat, which shall be automatically deactivated while engine generator is running.

- G. Engine accessories: Provide crankcase fumes disposal breather, lube oil filter, lube oil cooler, secondary fuel and lube oil filters, intake air cleaner (dry type), flexible fuel lines, gear-driven water pump, fuel priming pump with primary fuel filter, fuel transfer pump, lube oil pump, fuel/water separator as approved by the engine manufacturer.

2.4 GENERATOR

- A. General: Generator shall be of the engine-driven, synchronous, brushless, drip-proof, random wound, tropicalized construction type with amortisseur windings in the pole faces of the rotating field. Generator shall not provide greater than 5% total harmonic distortion. Generator shall be capable of sustaining a 3-phase load of 300% rated current for 10-seconds and sustain 150% of continuous load current for two minutes with field set for normal rated load excitation.
- B. Rating: KW/KVA rating as noted on Drawings, at 0.8 power factor, 3-phase, 4-wire, wye connected, 120/208 volts, 60 Hz at 1800rpm.
- C. Stator insulation:
1. All insulation materials used in the stator shall have a minimum temperature rating of Class 180-degree C (Class H) for systems operating 600 volt and below and Class 155-degrees C (Class F) for systems operating above 600 volt per IEEE Std. 1. The stator coils shall be constructed using a magnet wire meeting NEMA MW1000-2015 Specifications.
 2. Turn-to-turn testing shall be performed on all stator windings per IEEE Std. AA 522 prior to impregnation. A high-potential test shall be conducted on the stator prior to impregnation per IEEE Std 115.
 3. The complete stator shall be processed in a Vacuum Pressure Impregnation (VPI) chamber or wet wound.
- D. Rotor construction:
1. The rotor shall be of the fully laminated, salient pole type.
 2. Low resistance amortisseur bars shall be inserted through slots in the field poles and brazed/welded to a continuous shorting ring to complete the damping circuit.
 3. Cooling fan shall be an integral part of the rotor assembly.
 4. The rotor shall be balanced at the point of manufacturer.
 5. All insulation materials used in the rotor shall have a minimum temperature rating of Class 180-degree C (Class H) for systems operating 600 volt and below and Class 155-Degrees C (Class F) for systems operating above 600 volt per IEEE Std. 1. The poles shall be of a layer wound construction using a magnet wire meeting NEMA MW1000-2015 Specifications.
 6. A high-potential test shall be conducted on the rotor prior to impregnation per IEEE Std. 115.
 7. The complete winding and rotor pole assembly shall be processed in a Vacuum Pressure Impregnation (VPI) chamber.
- E. Brushless exciter system:
1. The exciter shall be a high frequency, direct connected, rotating brushless type, three phase, full wave rectified, surge protected and shall be matched with the generator rotor and control system.

2. The rotating part of the exciter, including the rectifier assembly, shall rotate together with the alternator rotor as a complete assembly on one shaft.
 3. Both the armature and field windings shall be Vacuum Pressure Impregnated (VPI) with Epoxy resin.
 4. The brushless exciter shall be compatible with the voltage regulator.
- F. Overspeed: The system shall be free of injurious torsional and bending vibrations within a speed range from 10% below to 10% above synchronous speed. The rotor assembly shall demonstrate 125% overspeed capability at 170-degrees C. for 2-hours. Rotor dynamic, two-plane balance shall not exceed 0.002-inch peak-to-peak amplitude at operating speed. All rotating components shall be secured with SAE Grade 8 hardware.
- G. Drive configuration: The generator shall be of the single bearing design type. It shall have an adapter and disc type coupling suitable for direct connection to the standard SAE flywheel and bell housing of the engine.
- H. Bearings: The bearing shall be of a re-greaseable, single-row, ball bearing design.
- I. Voltage regulator:
1. The generator shall be equipped with a volts-per-hertz type voltage regulator that shall be by same Manufacturer as the engine generator set. The regulator shall sense all phases of generator output voltage and exhibit the following characteristics:
 - a. Generator output voltage maintained within +/- 0.5% of rated value for any load variation between no load and full load at 0.8 to 1.0 pf.
 - b. Generator output voltage drift no more than +/- 0.5% of rated value at constant temperature.
 - c. Generator output voltage drift no more than +/- 0.5% of rated value over ambient temperature range of -40-degree C to 70-degree C.
 - d. Transient overvoltage shall not exceed 20% upon removal or addition of 50% of full load at 0.8 pf. with recovery in less than 3-seconds. For 100% load step conditions, voltage shall recover within 10-seconds.
 - e. Telephone Influence Factor (TIF) of less than 50.
 - f. Electronic Interference/Radio Frequency Interference (EMI/RFI) suppressed to commercial standards.
 - g. The regulator shall include the following features:
 - 1) Voltage level raise/ lower switch shall provide generator output voltage adjustment of -10% to +10% of nominal.
 - 2) Automatic gain adjustment shall provide output voltage compensation for changes in load or frequency.
 - 3) At full throttle engine starting, output voltage shall not overshoot more than 5% of its rated value, with respect to the volts/Hz curve.
 - 4) Response time shall be less than seventeen milliseconds.
 - h. Protection shall be provided against loss of voltage sensing and long-term overcurrent conditions. The overcurrent protection function shall automatically reset when the regulator is de-energized. The regulator shall

not be damaged or result in unsafe operation when subjected to open or shorted input due to sensing loss or in short to ground or adjacent conductor. Fast blow fuses shall be included in two of the sensing leads to fully protect the regulator. The regulator shall also include internal protection for under frequency, over voltage and over excitation.

- i. The regulator module shall be sealed in a waterproof and air-proof shock resistant plastic housing or epoxy encapsulated and shall withstand:
 - 1) Temperatures between -40-degree C to 70-degree C.
 - 2) Vibration of 4.5 G's (peak) between frequencies of 18 to 2000Hz in three perpendicular planes and mechanical shock of 20 G's in all three planes.
 - 3) Salt spray as described by MIL-STD - 810C, Method 509.1 and ASTM-B117.
 - j. The voltage regulation system shall be microprocessor-controlled, 3-phase true RMS sensing, full wave rectified for inherent immunity to waveform distortion, and provide a pulse-width modulated signal to the exciter. No exceptions or deviations to these requirements will be permitted. The voltage regulator shall be adjustable by an operator without tools from the generator set operator panel for voltage and dynamic characteristics without removing any protective panels on the generator set. Settings shall be password-protected.
 - k. The voltage regulator shall be configurable for isochronous VAR control or reactive droop operation for paralleling applications.
2. The voltage regulator "burned-in" period shall be a minimum of 24 hours.
- J. Generator set with proposed engine shall be rated for a maximum of 20% voltage dip upon application of any size load, up to 50-percent of full load. The voltage shall recover to and remain within the steady state band in not more than 3.0-seconds.
- K. Generator accessories:
- 1. The generator shall contain a permanent magnet excitation system that shall derive excitation current from a pilot exciter mounted on the rotor shaft. It shall enable the generator to sustain 300% of rated current into any phase-to-phase or phase-to-neutral short circuit for 10-seconds. The circuitry shall remove excitation after 10-seconds for overload conditions in excess of 150% of full rated current.

2.5 COOLING SYSTEM

- A. General: The engine shall be furnished with a cooling system having sufficient capacity for cooling the engine when delivering full rated load at the ambient temperature and altitude specified herein.
- B. Radiator: Engine mounted radiator with an engine-driven blower type fan and centrifugal type pump for circulating coolant through system. Air shall draw from engine side and exhaust through radiator core with no more than 0.5-inches of water external restriction in addition to core restriction.
- C. Cooling system treatment: Provide protection against internal corrosion of cooling system. Installations where units will be exposed to subfreezing temperatures, a solution of 50% ethylene glycol and engine-manufacturer's recommended additives shall be used as recommended by the engine-manufacturer. Supplier shall provide

all required coolant, additives, and anti-freeze. The generator set shall ship "wet" when skid mounted radiator is used.

- D. Guards: Provide suitable guards on all moving parts of cooling system to meet safety requirements.

2.6 FUEL SYSTEM

- A. Dual fuel source service of natural gas and LPG.

- 1. Primary fuel: Natural gas.
- 2. Secondary fuel: LPG in the form of vaporized propane gas. Liquid propane shall be drawn from the bottom of the propane tank and fed to an indirect fired propane vaporizer located at the engine. The vaporizer shall be heated from the engine radiator coolant.

- B. Dual fuel control system:

- 1. The natural gas shall be monitored by a low pressure switch. When the natural gas supply pressure drops below an adjustable threshold level, the LPG vapor solenoid shut-off valve shall open and the natural gas solenoid shut-off valve shall close allowing the LPG vapor to flow through a dedicated regulator to the engine carburetor.
- 2. The natural gas and LPG vapor regulators, solenoid shut-off valves, pressure switch, piping connections, control wiring and programmable controllers associated with the dual fuel control system for automatic switching of fuel supplies under load shall be supplied and factory installed by the engine generator manufacturer, such that the Division 22 contractor is only responsible for the natural gas and propane piping connections to the weatherproof housing and all material and labor for the weatherproof housing exterior equipment necessary to supply dual fuel to the engine.
- 3. Complies with the latest edition of NFPA Pamphlet 58 Requirements For Use Of Gaseous Fuels As A Motor Fuel Outdoors.

- C. Flexible fuel lines shall be installed between the engine and the fuel supply to isolate vibration.

- D. Supply an aboveground LPG tank with the following:

- 1. Complies with latest edition and addenda of NFPA 58 and ASME Code for Pressure Vessels.
- 2. Listed by Underwriters Laboratories, Inc.
- 3. Sufficient fuel capacity to allow the engine generator to operate continuously for a minimum of 4 hours.
- 4. Associated piping, shutoff valves, flexible fuel lines, pressure gauges, emergency shut-off systems, concrete piers, etc. to safely supply fuel to the generator.
 - 1) Tank shall be delivered to the site pre-purged. Fill tank for start-up testing and after final acceptance for turn over to Owner.

- E. Fuel tank shall be fully filled with specified fuel upon acceptance of system and prior to turning Project over to Owner.

2.7 EXHAUST SYSTEM

- A. A critical grade horizontally mounted exhaust silencer and flexible exhaust connection cap shall be provided by the Engine Generator Supplier. The equipment shall be of a size as recommended by the Manufacturer in order to keep exhaust backpressure and noise levels within limits required by the Engine Manufacturer.
- B. Sound attenuation of the Engine generator set exhaust noise shall be a minimum of 25 dBA at 1-meter (3.3-feet) in octave range between 63 to 8,000 hertz.
- C. The exhaust system shall be mounted on the roof of the engine generator set weatherproof housing. Coordinate to maintain a minimum height requirement above roof. The exhaust piping shall discharge in the vertical direction with a rain cap.
- D. The exhaust system equipment shall be supported by means of supports provided on the weatherproof housing, so that its weight is not supported by the engine. These supports shall not interfere with access doors or routine maintenance procedures.
- E. Discharge: The termination point for the exhaust discharge into the atmosphere shall be according to the latest building code requirements, but not less than ten feet above the adjacent grade.
- F. Post-fabrication treatment: The exhaust silencer, piping, support system and hardware shall be spray paint black with a silicone-based, heat-resistant to 1200-degrees F, anti-corrosive, VOC compliant, water-soluble. All components shall be coated and heat cured in accordance with Manufacturer's directions prior delivery to the Project site and field assembly. Touch-up paint marred surfaces immediately after assembly. Manufacture: Aremco Corr-Paint #CP4000, SermaGard or approved equal.
- G. Silencers shall be maxim series M51, Nelson Level 400 or approved equal. Provide one silencer for each engine generator set.

2.8 STARTING SYSTEM

- A. The engine shall be equipped with an electric starting system rated 12 volts D.C. and shall include two means of automatic starter cutout upon starting. The starter shall crank the engine for three, 15 second on - 15 second off, periods (45 seconds of cranking) before activating the overcrank lock-out device.
- B. Batteries:
 - 1. Shall be Lead-Acid sized to allow continuous cranking of the engine for six 15-second on – 15-second off periods (90-seconds of cranking) in a 40-degree F. ambient temperature and maintain a minimum cell end voltage of 1.75 volts per cell.
 - 2. Batteries shall be SAB Nife, ALCAD, Delco, Trogan or approved equal with a date code less than 6-months old.
 - 3. They shall be installed with a liquid containment system to comply with the seismic requirements as describe in Section 260010: Basic Electrical Requirements and rack mounted on the engine generator set frame. Provide all interconnecting bars and extra-flexible locomotive cables with the batteries and high compression, circumferentially crimp type lugs.
 - 4. Locate batteries as close as possible to the starter.

5. Fill Lead-acid batteries with electrolyte at the Project site.
 6. Provide second set of batteries and an additional battery charger, identical to the first (100% redundant) and an automatic best battery selector system (e.g. SENS BBS-4800 or approved equal).
- C. Battery charger:
1. Furnish a 12 volt DC output, 120 volt AC, solid state, input transistor controlled, constant voltage, battery charger suitable for the Lead-Acid batteries specified and UL 1236 Listed. The output current shall be current limited to 120% of maximum and shall not require a cranking disconnect relay.
 2. Provide 5% accurate DC ammeter and 5% accurate DC voltmeter to indicate rate of charge on front door of unit.
 3. Input and output shall be fused.
 4. Unit shall not discharge battery when AC power fails.
 5. Unit shall operate and be capable of fully charging the starting batteries while the engine generator set is running and shall be capable of returning to the fully discharged battery 100 percent of its ampere-hour rating within 24-hours.
 6. The charger shall float the batteries at 2.17 to 2.20 volts per cell and equalize them at 2.33 to 2.35 volts per cell.
 7. Unit shall be sized to accommodate all control panel loads, such as meters and indicating lights, in addition to battery charging requirements.
 8. Unit shall be SENS, EnerGenius IQ, Eliminator Plus 514, sizes as required (minimum 10 amp) or approved equal.
 9. The following accessories shall be included:
 - a. Low DC battery voltage alarm relay. Contacts, 120 volt AC, 10 amps. Alarm shall be locked out during engine cranking.
 - b. High DC battery voltage alarm relay. Contacts, 120 volt AC, 10 amps.
 - c. AC input power failure alarm relay contacts, 120 volt AC, 10 amps.
 - d. DC current failure alarm relay contacts, 120 volt AC, 10 amps.
 - e. Ground Fault Alarm relay contacts, 120 volt AC, 10 amps.
 - f. Hermetically sealed semiconductors and integrated circuits.
 - g. Ambient Temperature Compensation circuit.
 - h. Green power on indicator light.
- D. Wire alarm relays #1 and #2 above together in parallel so that any one or both will remotely annunciate as "High or Low Battery Voltage".
- E. Wire alarm relays #3, #4 and #5 above together in parallel so that any one or both will remotely annunciate as "Battery Charger Malfunction".
- F. Ether-type starting aids shall not be permitted.

2.9 ENGINE GENERATOR CONTROL PANEL

- A. General: Engine generator control shall be microprocessor based and provide automatic starting, monitoring, protection, and control functions for the unit as described by this specification. The control system shall be designed and

manufactured by the generator set manufacturer. Third party controls that are brand-labeled by the generator set manufacturer may be accepted if evidence documenting reliable service and parts support is provided and accepted by the Engineer and Owner.

1. The 12 volt DC starting batteries shall power all indicating lights and shutdown controls.
 2. The controls must maintain accuracy and be capable of operating with supply voltage ranging from 8 to 30 volt DC and over a temperature range of -40-degrees C to +70-degrees C so that they are operational during cranking and at the higher voltage levels imposed by the battery charger and temperature extremes.
 3. For generator sets installed in outdoor enclosures, provide a remote operator panel at a location as designated in the drawings to allow for the following functions:
 - a. Monitoring of AC output characteristics.
 - b. Monitoring of engine operating conditions Auto/Manual switch(es) with manual start/stop capability.
 - c. Alarm indication panel displaying all alarm conditions in the generator set.
 - d. Manual adjustment of voltage and frequency.
 4. True RMS sensing meters shall employ non-linear converting circuits and shall be capable of at least a 5:1 peak to RMS ratio to ensure accuracy.
 5. Current and potential transformers, where used shall be 0.3% accuracy class and selected and coordinated to cause meter deflections in the top 25% of meter scale for nominal and rated values.
- B. The control panel shall include a graphical display with appropriate navigation devices to view all information noted above, as well as all engine status and alarm/shutdown conditions (including those from an integrated engine emission control system). The display shall include panel lighting to allow operator use in an unlighted room. The display shall also include integrated provisions for adjustment of the gain and stability settings for the governing and voltage regulation systems.
1. AC metering equipment shall be true RMS and include the following functions:
 - a. AC voltmeter (3-phase, line-to-line, and line-to-neutral values).
 - b. Bus AC voltmeter (3-phase, line-to-line, and line-to-neutral values).
 - c. AC ammeter (3-phases).
 - d. AC frequency meter.
 - e. AC kW output (total and for each phase). Display shall indicate power flow direction.
 - f. AC kVA output (total and for each phase). Display shall indicate power flow direction.
 - g. AC Power factor (total and for each phase). Display shall indicate leading or lagging condition.
 - h. Ammeter-voltmeter displays shall simultaneously display conditions for all three phases.

- i. Provide an analog AC display panel indicating all phases of AC voltage and current, power factor, kW, and frequency. The display shall be color coded "green/yellow/red" to indicate normal, impending problem, and near shutdown level conditions.
2. Generator-voltage and frequency digital raise/lower switches. Rheostats for these functions are not acceptable. The control shall provide adjustment of these parameters in a range of plus or minus 5% of the voltage and frequency operating set point (not nominal voltage and frequency values.) The voltage and frequency adjustment functions shall be disabled when the paralleling breaker is closed, and operator adjustment of voltage and frequency shall not impact on load sharing functionality.
3. Status LED indicating lamps to indicate remote start signal present at the control, existing shutdown condition, existing alarm condition, not in auto, and generator set running. A digital display shall provide indication of the following conditions:

ALARM/STATUS	LAMP COLOR	HORN ALARM
Pre-Low Oil Pressure:	Amber	Yes
Low Oil Pressure:	Red	Yes
Pre-High Jacket Water Temperature:	Amber	Yes
High Jacket Water Temperature:	Red	Yes
Low Jacket Water Temperature (<70°F):	Amber	Yes
Overspeed:	Red	Yes
Overcrank:	Red	Yes
Ground Fault:	Red	Yes
Emergency Stop:	Red	Yes
Low Gas Pressure :	Amber	Yes
Battery Charger Malfunction: (AC power failure or current failure)	Amber	Yes
System Ready:	Green	No
Not-In-Auto: (Also, for tripped or open generator output or paralleling breaker)	Red/Flash	Yes
Low or High DC Battery Voltage:	Red	Yes
Low Coolant Level:	Amber	Yes
Start Signal Malfunction:	Amber	Yes
Exhaust Aftertreatment Alarm	Red	Yes

4. Single pushbutton for testing all indicating lamps.
5. Elapsed hour meters. Provide hour meter for total hours (non-resettable) and total hours since reset. (5-digit minimum)
6. The control panel shall also indicate the condition of the following parameters:
 - a. Fuel pressure.
 - b. Engine oil pressure.
 - c. Engine coolant temperature.
 - d. Three-position function switch, "AUTO," "OFF/RESET," and "RUN."
 - e. All required fuses, current and potential transformers.
 - f. Emergency "STOP" red mushroom-head pushbutton with lockout/ tagout feature in accordance with the requirements of CEC Article 110.25. The

- device shall directly operate in compliance with the requirements of CEC Article 445.18. Provide one additional, identical "stop" pushbutton with plastic safety guard and all required interface provisions for remote mounting in a location compliant with CEC Article 445.18 (e.g. outside the equipment room or generator enclosure). Provide engraved nameplate "Generator Emergency Off." Mounting, conduit, and wire to the remote pushbutton will be provided under this contract. Operation of emergency off pushbutton shall be annunciated at control panel and remote annunciator panel(s).
- g. A fault-reset function shall be provided to clear fault indications and allow restarting of the engine after the shut- down fault(s) has been corrected. The control design shall be such that the fault indication shall remain until reset. The fault-reset function shall operate only when the function switch is in the "OFF/RESET" position for shut down fault(s).
 - h. Alarm horn with silencing button. After silencing, alarm shall automatically sound again if another alarm condition develops. "ON/OFF" switch is not acceptable.
- 7. The control panel shall be at a height convenient for viewing while standing on the floor, centered at not more than 5-feet or lower than 4-feet above the floor. For generator sets with sub-base fuel tank, provide an operator panel at a location meeting these requirements.
 - 8. Two Form C dry contacts for engine running.
 - a. One for remote annunciation.
 - b. One spare.
 - 9. Two Form C dry contacts for common failure.
 - 10. Engine shutdown relays for low oil pressure, high water temperature, overspeed, overcrank and emergency stop.
- C. AC Protective Equipment: The control system shall include over/under voltage, reverse kVAR, reverse kW, overload (kW), short circuit, over current, ground fault, loss of voltage reference, and over excitation shut down protection. Reverse kW and kVAR shall be operational when the generator is not operating. All functions shall be field-configurable through the operator panel of the generator set. Provide setting ranges and recommended settings for all functions for premium service reliability in submittal materials.
- D. Alternator Protection and Operation: The generator set shall be provided with a UL Listed/CSA Certified protective device that is coordinated with the alternator provided to prevent damage to the generator set on any possible overload or overcurrent condition external to the machine. The protective device shall be listed as a utility grade protective device under UL category NRGU. The control system shall be subject to UL follow-up service at the manufacturing location to verify that the protective system is fully operational as manufactured. Protector shall perform the following functions:
- 1. The protective device shall allow continuous operation at rated current level of the generator set without tripping. It shall initiate a generator kW overload alarm when generator has operated at an overload equivalent to 110-percent of full-rated load for 60-seconds. Indication for this alarm is integrated with other generator-set malfunction alarms.

2. Under single phase or multiple phase fault conditions, or on overload conditions, indicates an alarm conditions when the current flow is in excess of 110% of rated current for more than 10-seconds.
 3. Under single phase or multiple phase fault conditions, operates to switch off alternator excitation at the appropriate time to prevent damage to the alternator. The control logic of the protective device shall include integrated time-based functions to prevent alternator damage on multiple fault conditions that occur over short time periods.
 4. The protective system provided shall not include an instantaneous trip function.
 5. The operator panel shall indicate the nature of the fault condition as either a short circuit or an overload.
- E. The over current protective system shall include a maintenance mode in compliance to the California Electrical Code section 240.87 which disables the alternator excitation system within 50-milliseconds when output current on any phase is more than three times rated current. The mode shall be operational for any fault from the terminals of the generator throughout the distribution system. The control system shall include a native Modbus RTU/RS485 output for remote monitoring of the control.
- F. Control Heater: Generator sets that are installed in outdoor enclosures or are in tropical or coastal environments shall be provided with control heaters for anti-condensation protection.
- G. Field control terminations shall be made in a single common terminal box which is isolated from the control enclosure and includes no terminal points operating at more than 50 volts. Field connections to higher voltage devices shall be made in a separate AC control termination box.

2.10 ACCESSORIES

A. Main terminal box:

1. Engine generator set load termination junction box shall be mounted with bottom of box at 30" AFF, to allow easy installation of underground power conduits and conductors.
2. Construction shall comply with IP44 for protection against solid bodies greater than 1 mm and water splashing.
3. It shall include three rigidly mounted busbar of tin-plated copper with terminals and one isolated neutral bus-bar, all suitable for the termination of the generator output feeder, size and quantity as noted on the Drawings.
4. The bus bars shall be drilled for terminating. Provide adequate space for ease in terminating cables. Provide extension box as required, taking care to maintain code clearances. Belleville washers shall be used.

B. Connection box:

1. A suitable connection box (separate from the main terminal box) shall be furnished for space heater leads. This connection box should be located adjacent to the main terminal box, readily accessible.
2. The following protection elements shall be wired to this connection box:
 - a. Generator winding space heaters.

- b. Control panel space heaters.
- C. Anti-condensation heater: Provide 120 volt AC generator stator winding and control panel anti-condensation heaters with factory set, adjustable thermostat and lube oil or similar positive cutoff when the generator is operating. Heaters are to be easily replaceable in the field.
- D. Vibration isolators:
 - 1. Engine generator set(s) shall be installed with isolators as recommended by the engine manufacturer and rated for the seismic zone as indicated in Section 260010: Basic Electrical Requirements. Supplier shall submit earthquake mounting design data.
 - 2. Vibration isolators shall be Mason Industries, Inc. or approved equal.
- E. Wiring and conduit:
 - 1. Engine generator control wiring shall be multi-strand, plastic insulated cable resistant to heat, abrasion, oil, water, antifreeze, and diesel fuel. Each cable shall be heat stamped throughout the entire length to identify the cable's origin and termination. Cables shall be enclosed in nylon flexible conduit that is slotted to allow easy access and moisture to escape. Reusable bulkhead fittings shall be used to attach the conduit to generator mounted junction boxes.
 - 2. Provide all termination with spade or ring crimp type terminals. All termination points on terminal blocks shall be permanently and neatly labeled.
- F. Grounding:
 - 1. Provide factory installed, code sized grounding conductor from the generator ground pads to the engine generator frame and to a grounding lug in the load termination junction box sized to accept the number of ground conductors in the feeder conduits as indicated on the Drawings. Provide factory installed grounding lug, adjacent to the load termination junction box and a code sized grounding conductor from the generator neutral. The lug shall be used for field connection to the grounding electrode conductor as indicated on Drawings.
 - 2. Two none-corrosive stainless-steel grounding pads shall be welded to each alternator. The pads shall be located diagonally opposite one another.
- G. Nameplates: The alternator shall have a non-corrosive stainless-steel nameplate with not less than the minimum information called for in NEMA publication number MG1.
- H. Auxiliary circuit breakers: Provide circuit breakers mounted on the generator to serve all essential electrical equipment specified, that is required for engine generator set operation, such as the day tank and main storage fuel pumps, remote radiator fan and pumps, motorized dampers, exhaust aftertreatment, etc. Connect circuit breaker line terminals to the output terminals of the generator. Provide panelboard for greater than two circuit breakers.
- I. Weatherproof housings:
 - 1. General: The weatherproof housing shall be capable of completely enclosing and shielding from rain and wind the following equipment:
 - a. Engine generator set.

- b. Batteries and battery rack.
 - c. Battery charger.
 - d. Engine generator control panel.
 - e. Space heaters.
 - f. LPG vapor connections.
2. The weatherproof housings shall have hinged lockable access doors on all sides for complete access. Provide a latch for each door to ensure adequate closing pressure to seal against weather. Custom metal stairs shall be provided for each access door. Wall mounted LED outdoor luminaires shall be provided at each door.
 3. The weatherproof housing roof shall have built-in supports of sufficient size and quantity to completely support the exhaust silencer(s).
 4. The weatherproof housings shall be provided with lifting eyes.
 5. Provide all necessary 120 volt AC battery heaters to maintain battery temperature between 50-degree F and 60-degree F in an outdoor ambient temperature of 30-degrees F.
 6. A 120 volt AC heater with thermostat shall be provided within the engine generator set control panel to eliminate condensation. Connect to the same circuit as the lights. Set thermostat at 70-degree F.
 7. All heaters shall be automatically deactivated while the engine generator is running and not dependent on the thermostat for deactivation.
 8. Motor operated damper(s) will be provided, wired in a "fail-safe" configuration to open upon engine startup. Radiator discharge will be through a gravity operated damper and into a vertical plenum. The system shall not exceed 0.5-inch w.g. total external static pressure to ensure adequate airflow for cooling and combustion.
 9. Sound Attenuation: Sound attenuate the entire enclosure to reduce the noise level in a free field hemispherical condition, from no load to 100% rated load, such that the noise level from the enclosure does not exceed 75-dBA Leg (10-minutes) at 7-meters (23-feet) from any part of the enclosure in any direction.
 - a. Air intake: Locate at enclosure rear; air enters through sound attenuators.
 - b. Radiator air discharge: Exit enclosure through a 90-degree sound attenuated discharge plenum.
 - c. Insulation material: Mineral wool. Secured to enclosure interior surfaces causing a galvanized perforated liner.
 - d. Insulate enclosure roof, side panels and doors.
 - e. Do not insulate louvered openings.

2.11 SOURCE QUALITY CONTROL

- A. Engine generator set shall be completely factory tested under rated full load and rated power factor for performance and proper functioning of control and interfacing circuits. Test shall be a minimum of 2-hours or time required reaching operating temperature.
- B. In addition to the above, provide the following minimum factory tests:

1. Monitor voltage regulation.
 2. Verify transient and steady state governing.
 3. Verify single step load pickup.
 4. Monitor engine operating parameters: Coolant temperature, oil pressure, etc.
 5. Operate safety shutdowns.
 6. Test alternators to determine that they are free of mechanical and electrical defects. Tests shall include the following:
 - a. Resistance of all windings (cold).
 - b. Insulation resistance of all windings.
 - c. High potential on all windings.
 - d. Open circuit saturation.
 - e. Voltage balance on windings.
 - f. Current balance on windings.
 - g. Voltage transient at rated kVA (voltage regulation, stability and response).
 - h. Regulator range test (voltage adjust).
 - i. Phase sequence.
 - j. Inherent voltage regulation.
 - k. Circulating current.
 - l. Dissipation factor tests.
 7. The above tests shall be conducted in accordance with IEEE-115, NEMA MG-1 and MIL-STD 705 standards. Dissipation factor tests shall be performed per IEEE Std. 286. These tests may be conducted at the alternator point of manufacturing.
- C. All operational and alarm functions shall be factory tested prior to shipping to the field. All alarm functions shall be field tested after installation.
- D. Record all factory test data on approved Manufacturers log format and submit to Engineer for review.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Contractor shall thoroughly examine Project site conditions for acceptance of engine generator installation to verify conformance with Manufacturer and Specification tolerances. Do not commence with installation until all conditions are made satisfactory.

3.2 PREPARATION

- A. Ensure all conduit stub-ups for bottom entry into engine generator are in place and located as required per Shop Drawings.
- B. Where noted on the Drawings provide a 4-inch high concrete housekeeping pad beneath equipment. Coordinate actual sizes of equipment base with approved Shop

Drawings and extend pad 4-inches in all directions beyond overall dimension of base. Provide reinforcing bars as required structurally within pad to ensure proper support of equipment.

3.3 INSTALLATION

- A. Install engine generator in accordance with Manufacturer's written instructions, as indicated on the Drawings and as specified herein.
- B. Install equipment supplied under this Section at the locations indicated on the Drawings. Any substitute units must conform to the dimensions of the engine generator room indicated on the Drawings.
- C. Engine generator set shall be anchored and braced to withstand seismic forces as calculated per Section 260010: Basic Electrical Requirements.
- D. Coordinate installation of equipment furnished under this Section, but installed under Division 22:
 - 1. Natural gas service.
- E. Engine generator power conduits and conductors: Contractor shall remove bottom of main load termination junction box and stub-up conduits directly into box. Provide ground bonding bushings with insulated throats and code sized grounding conductor from each conduit to engine generator ground terminals.
- F. Generator control wiring shall be installed and continuously monitored per the requirements of CEC Article 700.10(D)(3).

3.4 FIELD QUALITY CONTROL

- A. Manufacturer's field service: Contractor shall arrange and pay for the services of a factory-authorized service representative to supervise the initial start-up, pretesting, and adjustment of the emergency generator.
- B. Independent testing: Contractor shall arrange and pay for the services of an independent Testing Agency to perform all quality control electrical testing, calibration and inspection required herein. Independent Testing Agency shall meet the requirements as outlined in Section 260010: Basic Electrical Requirements. Testing Agencies objectives shall be to:
 - 1. Assure engine generator installation conforms to specified requirements and operates within specified tolerances.
 - 2. Field test and inspect to ensure operation in accordance with Manufacturer's recommendations and Specifications.
 - 3. Prepare final test report including results, observations, failures, adjustments, and remedies.
 - 4. Apply label on engine generator upon satisfactory completion of tests and results.
 - 5. Verify ratings and settings and make final adjustments.
- C. At least three weeks prior to any testing notify the Engineer so that arrangement can be made for witnessing tests, if deemed necessary. All pretesting shall have been tested satisfactorily prior to the Engineer's witnessed test.

- D. The Contractor shall supply a suitable and stable source of electrical power to each test site including full-load rated load banks and cables. The Testing Agency shall specify the specific power requirements.
- E. Contractor shall verify with Mechanical Engineer, prior to energizing building emergency loads, that all time delays and building/energy management system programs for controlling large emergency mechanical motor loads are set. This is to ensure that those large motors will be sequentially added to the engine generator, after a time delay and to prevent an out-of-phase condition during transfer to emergency power.
- F. Prefunctional testing:
 - 1. Provide Testing Agency with Contract Documents and Manufacturer instructions for installation and testing.
 - 2. Visual and mechanical inspection:
 - a. Compare nameplate information and connections to Contract Documents.
 - b. Inspect for physical damage, defects, alignment and fit.
 - c. Inspect correct anchorage and grounding.
 - d. Inspect air baffles, filter media and cooling fans.
 - e. Check tightness of all control and power connections.
 - f. Check that all covers, barriers, and doors are secure.
 - g. Confirm correct application of Manufacturer's recommended lubricants.
 - h. Perform mechanical operational tests in accordance with Manufacturer's instructions.
 - 3. Pretesting:
 - a. Insulation resistance tests of buses, components, feeders and branch circuit conductors and control circuits.
 - b. Continuity tests of circuits.
 - c. Start-up test (no load):
 - 1) With prime mover in a "cold start" condition and all building emergency loads at normal operating level, initiate a normal power failure by opening all switches or breakers supplying the normal power to the building or facility. Test load shall be that load which is served by the emergency power system.
 - 2) Observe and record the time delay on start.
 - 3) Observe and record the cranking time until the prime mover starts and runs.
 - 4) Observe and record the time required coming up to operating speed.
 - 5) Record voltage and frequency overshoot.
 - 6) Perform phase-rotation test to determine compatibility with load requirements.
 - 7) Observe and record time required achieving steady-state condition with all switches transferred to the emergency position.
 - 8) Record voltage, frequency, and amperes for each phase.

- 9) Verify correct functioning of governor and regulator.
 - 10) Verify function and temperature regulation for battery and engine heaters.
 - 11) Record prime mover oil pressure, water temperature and battery charge rate at 5-minute intervals for the first 15-minutes and at 15-minute intervals thereafter.
 - 12) Continue load test with building load for one hour, observing and recording load changes and the resultant effect on voltage and frequency.
 - 13) Return normal power to the building or facility, record the time delay on retransfer to normal for each automatic transfer switch (set for 30-minutes) and the time delay on prime mover cool-down period (set at 5-minutes) and shutdown.
 - 14) After completion of the start-up test the engine generator set shall be allowed to cool for 5-minutes.
4. Electrical tests:
- a. Full-load test:
 - 1) This test shall be initiated immediately after the 5-minute cool down time period by opening all switches or breakers serving the normal power terminals on the transfer switches.
 - 2) A load shall be applied for an 8-hour full-load test. Provide load banks of sufficient size to provide a load equal to 100-percent of the generator's kW rating.
 - 3) Upon reaching 90% of rated voltage and 95% of rated frequency the transfer switch(es) shall transfer the 100-percent full-load to the engine/generator set.
 - 4) Record the data listed in start-up test items #1e, f, g and h above at first load acceptance and every 15-minutes thereafter until the completion of the 8-hour test.
 - 5) After 7.5-hours close all switches or breakers serving the transfer switches to allow an automatic engine generator cool-down period and shutdown.
 - 6) This full load test shall not result in activation of the high temperature pre-alarm or high temperature shutdown.
 - b. Cycle crank test: Utilize any method recommended by the Manufacturer to prevent the prime mover from running. Put the control switch into the "RUN" position to cause the prime mover to crank. Verify the three 15-second crank/15-second rest cycles and the subsequent overcrank lockout alarm. Immediately reset the lockout alarm and repeat the test to verify that the batteries supported the six: 15-second crank, 15-second rest periods (90-seconds of cranking). Record battery DC voltage as indicated on the battery charger at beginning and end of test.
 - c. Dual fuel control system check:
 - 1) At 100% full load, shut-off the natural gas supply.
 - 2) Record voltage and frequency deviation and record time required achieving steady-state condition with propane fuel supplying the engine generator.

- 3) After 1-hour, restore the natural gas supply.
 - 4) Record voltage and frequency deviation and record time required achieving steady-state condition with natural gas fuel supplying the engine generator.
 - 5) This full load test shall not result in activation of any engine generator shutdown alarms, shutdown, or cause any performance/ stability issues.
- d. Alarm/shutdown safety check:
- 1) General: Verify and record that all alarms and indicating lights function at both the remote annunciator panel and the control panel. Verify and record proper lockout/resets.
 - 2) Verification of the following alarms shall be done by manually closing the relay contacts with the engine stopped.
 - a) Low water temperature.
 - b) Pre-high engine water temperature.
 - c) High engine water temperature.
 - d) Pre-low engine oil pressure.
 - e) Low engine oil pressure.
 - f) Overspeed.
 - g) Low gas pressure.
 - h) Battery charger malfunction (Current failure alarm relay in the battery charger).
 - i) Low DC voltage in the batteries (Disconnect in the battery lead).
 - j) Fuel leak.
 - k) Low coolant level.
 - l) Low propane gas pressure
 - 3) Perform the following verifications with the engine stopped.
 - a) Disconnect AC power to battery charger to verify "Battery Charger Malfunction" indicating lights.
 - b) Place control switch in the "off/reset" position to verify "NOT-IN-AUTO" flashing red indicating lights.
 - c) Open generator output switches to verify flashing red "NOT-IN-AUTO" indicating lights.
- e. Emergency stop safety check:
- 1) Open engine generator output switches. Place generator control switch in "RUN" position.
 - 2) After engine generator is running for 2-minutes press the emergency stop button. Verify and record engine shutdown.
 - 3) Repeat step "a" and "b" above for each emergency stop button associated with the engine generator.
 - 4) Close the engine generator output switches.
- f. Allow for final load bank testing, as specified above, after receipt of the approved pre-final test results from the Electrical Engineer. This final testing

is to be done in the presence of the Engineer. Give two weeks prior notice to commencement.

- G. In the event that the system fails to function properly during the testing as a result of inadequate pretesting or preparation. The Contractor shall bear all costs incurred by the necessity for retesting including test equipment, transportation, subsistence, and the Engineer's hourly rate.
- H. Contractor shall replace at no costs to the Owner all devices which are found defective or do not operate within factory specified tolerances.
- I. Contractor shall submit the Testing Agency's final report to the Engineer for review prior to Project closeout and final acceptance by the Owner. Test report shall indicate test dates, devices tested, results, observation, deficiencies, and remedies. Test report shall be included in the operation and maintenance manuals.
- J. Refill fuel tank(s) to full capacity upon completion of all tests.

3.5 CLEANING

- A. Upon completion of Project prior to final acceptance the Contractor shall thoroughly clean both the interior and exterior of engine generator per Manufacturer's approved methods and materials. Remove paint splatters and other spots, dirt, and debris.
- B. Touch-up paint any marks, blemishes or other finish damage suffered during installation.

3.6 TRAINING

- A. Factory authorized service representative shall conduct a 4-hour training seminar for Owner's Representatives upon completion and acceptance of system. Instructions shall include safe operation, maintenance, and testing of equipment with both classroom training and hands-on instruction.
- B. Contractor shall schedule training with a minimum of 7-days advance notice.

END OF SECTION

SECTION 26 36 23
TRANSFER SWITCHES

PART 1 - GENERAL

1.1 SUMMARY

- A. Work included: Labor, materials, and equipment necessary to complete the installation required for the item specified under this Division, including but not limited to:
 - 1. Automatic transfer switch, delayed transition.
- B. Related Work: Consult all other Sections, determine the extent and character of related Work, and properly coordinate Work specified herein with that specified elsewhere to produce a complete installation.
 - 1. Division 09: Painting. Touch-up of painted surfaces.

1.2 REFERENCES

- A. Comply with the latest edition of the following applicable Specifications and standards except as otherwise indicated or specified:
 - 1. American National Standards Institute, Inc. (ANSI):
 - ANSI C37.90.1; IEEE Guide for Surge Withstand Capability (SWC) Tests.
 - 2. National Electrical Manufacturer Association (NEMA):
 - NEMA ICS 1; General Standards for Industrial Control and Systems.
 - NEMA ICS 2; Standards for Industrial Control Devices, Controllers and Assemblies.
 - NEMA ICS 4; Terminal Blocks.
 - NEMA ICS 6; Enclosures for Industrial Controls and Systems.
 - 3. Underwriters Laboratories, Inc. (UL):
 - UL 467; Grounding and Bonding Equipment.
 - UL 486E; Equipment Wiring Terminals for Use with Aluminum and/or Copper Conductors.
 - UL 1008; Transfer Switch Equipment.
 - 4. National Fire Protection Association (NFPA):
 - NFPA 110; Emergency and Standby Power Systems.

1.3 SUBMITTALS

- A. Submit in accordance with the requirements of Section 260010: Basic Electrical Requirements, the following items:
 - 1. Data/catalog cuts for each product and component specified herein, listing all physical and electrical characteristics and ratings indicating compliance with all listed standards.
 - 2. Describe system operation, equipment and dimensions and indicate features of each component.

3. Clearly mark on each data sheet the specific item(s) being submitted and the proposed application.
 4. Shop Drawings to Include:
 - a. Front, plan and side view elevations with overall dimensions indicated.
 - b. Location of devices and instruments and the make type, size and rating of all equipment.
 - c. Dimensional locations of conduit entry points and locations of barrier plates.
 - d. Nameplate legends.
 - e. WCR rating.
 - f. Size and number of bus bars per phase, neutral, and ground.
 - g. Detailed point-to-point wiring diagram, differentiating between Manufacturer-installed and field-installed wiring.
 5. Furnish structural calculations for equipment anchorage as described in Section 260010: Basic Electrical Requirements.
 6. Submit Manufacturer's installation instructions.
 7. Complete bill of material listing all components.
 8. Warranty.
- B. Dimensions and configurations of transfer switches shall conform to the space allocated on the Drawings. The Contractor shall submit a revised layout if equipment furnished varies in size from that indicated on Drawings for the Engineer's approval.

1.4 OPERATION AND MAINTENANCE MANUAL

- A. Supply operation and maintenance manuals in accordance with the requirements of Section 260010: Basic Electrical Requirements, to include the following:
1. A detailed explanation of the operation of the system.
 2. Instructions for routine maintenance.
 3. Detailed instructions for repair of the transfer switch.
 4. Pictorial parts list and part numbers.
 5. Pictorial and schematic Electrical Drawings of wiring systems, including operating and safety devices, control panels, instrumentation, and annunciators.
 6. Telephone numbers for the authorized parts and service distributors.
 7. Include all service bulletins and torque Specifications for all terminations.
 8. Final testing reports.

1.5 QUALITY ASSURANCE

- A. All materials, equipment and parts comprising the units specified herein shall be new, unused, and currently under production.
- B. Only products and applications listed in this Section may be used on the Project unless otherwise submitted.

1.6 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Delivery: Transfer switch components shall not be delivered to the Project site until protected storage space is available. Storage outdoors covered by rainproof material is not acceptable. Equipment damaged during shipment shall be replaced and returned to Manufacturer at no cost to Owner. Components shall be properly packaged in factory-fabricated containers and mounted on shipping skids.
- B. Storage: Store in a clean, dry, ventilated space free from temperature extremes. Maintain factory wrapping or provide a heavy canvas/plastic cover to protect units from dirt, water, construction debris and traffic. Provide heat where required to prevent condensation.
- C. Handling: Handle in accordance with Manufacturer's written instructions. Be careful to prevent internal component damage, breakage, denting and scoring. Damaged units shall not be installed. Replace damaged units and return equipment to Manufacturer.

1.7 WARRANTY

- A. Units and components offered under this Section shall be covered by a 1-year parts and labor warranty for malfunctions resulting from defects in materials and workmanship. Warranty shall begin upon acceptance by the Owner.

1.8 SYSTEM START-UP

- A. Upon completion of installation, a factory trained dealer service representative shall perform initial start-up of the transfer switch. Sufficient time shall be allowed to properly check the system out and perform required minor adjustments before the Engineer's witnessed test shall begin.

1.9 EXTRA MATERIAL

- A. Provide one spray can of matching finish paint for touching up damaged surfaces after installation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Products furnished by the following Manufacturers shall be acceptable if in compliance with all features specified herein and indicated on the Drawings.
 - 1. ABB/ General Electric/ Zenith.
 - 2. ASCO.
 - 3. Cummins.
 - 4. Russelectric Inc./ Siemens.
- B. Substitutions: Under provisions of Section 260010: Basic Electrical Requirements.

2.2 GENERAL REQUIREMENTS

- A. Transfer switch(es) shall be in accordance with Specifications and as indicated on the Drawings.
- B. Automatic open delayed transition transfer type switches:

1. Switches shall be configured as an open delayed transition (break-before-make) transfer and a microprocessor controller to provide automatic operation. Arrangement shall be double-throw power transfer switch mechanism type. The switch shall be electrically and mechanically interlocked to ensure only one source is connected at a time.
 2. Switches shall transfer the load with an interruption (open delayed transition) by momentarily disconnecting both sources of power, only when both sources are present and acceptable.
 3. The switches shall operate in this conventional mode, break-before-make (open delayed transition), when the power source serving the load fails.
 4. Where noted on the drawings as "Service Entrance", the enclosure shall be suitable for service entrance with all the proper disconnecting, protection, grounding and bonding required for service entrance equipment.
- C. Where 4-pole switches are indicated, provide 100-percent rated neutral switching capacity.
- D. Train and bundle factory wiring and identify consistently with Shop Drawings, either by color code or by numbered or lettered wire and cable tape markers at terminations.
1. Designated terminals accommodate field wiring.
 2. Power terminal arrangement and field wiring space.
 3. Pressure-type terminals, suitable for copper or aluminum conductors, sized as indicated.
 4. Control wiring equipped with lugs suitable for connection to terminal strips.
- E. Transfer switch ratings:
1. Voltage: As indicated on the Drawings.
 2. Switched poles: 4-pole, switched neutral.
 3. Switch operation: Open delayed transition.
 4. Continuous rating: As indicated on the Drawings.
 5. Fault-current closing and withstand current rating (WCR): UL 1008; rated to withstand the available RMS symmetrical short circuit current. Rating shall match or exceed the value indicated on Drawings or exceed the maximum available fault current at distribution equipment serving transfer switch.

2.3 AUTOMATIC TRANSFER SWITCH (ATS)

- A. The ATS shall be electrically operated and mechanically held. The electrical operator shall be a momentarily energized, solenoid mechanism.
- B. The ATS shall be positively locked and unaffected by momentary outages, so that contact pressure is maintained at a constant value and contact temperature rise is minimized for maximum reliability and operating life.
- C. All main contacts shall be silver composition. Switches rated 600 amps and above shall have segmented, blow-on construction for high withstand and close-on capability and be protected by separate arcing contacts.

- D. Inspection of all contacts shall be possible from the front of the switch without disassembly of operating linkages and without disconnection of power conductors. Switches rated 600 amps and higher shall have front removable and replaceable contacts. All stationary and moveable contacts shall be replaceable without removing power conductors and/or bus bars.
- E. Where neutral conductors are to be solidly connected, a neutral conductor plate with fully rated AL-CU pressure connectors shall be provided.
- F. The ATS shall be equipped with a safe manual operator, permanently attached to the motor operator, designed to prevent injury to operating personnel. The manual operator shall provide the same contact-to-contact transfer speed as the electrical operator to prevent a flashover from switching the main contacts slowly.
- G. The ATS control section shall be supplied with a protective cover and be mounted at a location within the enclosure suitable for ease of maintenance. Sensing and control logic shall be solid-state type. Printed circuit boards shall be keyed to prevent incorrect installation. Interfacing relays shall be industrial control grade plug-in type with dust covers.
- H. All switch and relay contacts, coils, springs, and control elements shall be removable from the front of the transfer switch without removal of the switch from the enclosure and without disconnection of drive linkages or power conductors.
- I. All control relays shall be continuous duty; industrial type with wiping contacts rated at least 10 amperes.
- J. The thermal capacity of the main contacts shall not be less than 20 times the continuous duty rating for a minimum of 3-electrical cycles as established by certified test data.

2.4 ATS CONTROL OPERATION

- A. The controller's sensing and logic shall be provided by a single built-in microprocessor for maximum reliability, minimum maintenance, and the ability to communicate serially through a serial communication module.
- B. A single controller shall provide twelve selectable nominal voltages for maximum application flexibility and minimal spare part requirements. Voltage sensing shall be true RMS type and shall be accurate to $\pm 1\%$ of nominal voltage. Frequency sensing shall be accurate to $\pm 0.2\%$. The panel shall be capable of operating over a temperature range of -20 to +60 degrees C and storage from -55 to +85-degrees C.
- C. The controller shall be connected to the ATS by an interconnecting wiring harness. The harness shall include a keyed disconnect plug to enable the controller to be disconnected from the ATS for routine maintenance. Sensing and control logic shall be provided on multi-layer printed circuit boards. Interfacing relays shall be industrial grade plug-in type with dust covers. The panel shall be enclosed with a protective cover and be mounted separately from the ATS unit for safety and ease of maintenance. The protective cover shall include a built-in pocket for storage of the operator's manuals.
- D. The microprocessor controller shall include, but not necessarily be limited to the following:

1. Voltage and frequency sensing monitors. Monitors shall initiate a standby sequence of operation upon complete loss or reduction of any phase-to-phase voltage to an adjustable range of 70% to 95% of rated voltage. The ATS shall transfer to the standby source when its voltage reaches 95% of rated frequency and an adjustable value between 85% and 95% of rated voltage.
2. The ATS shall retransfer to normal when the voltage reaches an adjustable value between 85% and 95% and all-time delays have expired.
3. The standby sequence of operation shall be initiated upon loss or reduction of normal source voltage, after an adjustable time-period of between 0 and 5-seconds. Retransfer to the normal source shall occur after the normal source has been restored for an adjustable time-period of between 0 and 30-minutes. This time delay shall automatically be bypassed if the standby source should fail and the normal source is available. After retransfer to the normal source, the generator(s) shall continue to run for an adjustable time period between 0 and 5 minutes.

E. Accessories:

1. Contact on the main shaft that closes when normal source fails for initiating engine starting, rated 10 amps, 32 volt DC minimum.
2. Contact on the main shaft that opens when normal source fails rated 10 amps, 32 volt DC minimum.
3. Provide indicating panel LEDs to indicate when the ATS is connected to the normal source, when the ATS is connected to the emergency source, which sources are available, and the operating mode of the ATS (e.g. automatic, manual, test, etc.).
4. All LEDs shall be visible without opening the cover. Provide single pushbutton to test all indicating LEDs.
5. Provide two auxiliary contacts that are closed when the ATS is connected to normal and two auxiliary contacts that are closed when the ATS is connected to emergency. Rated 10 amps, 120 volt AC minimum.
6. A test pushbutton switch to momentarily simulate normal source failure. Pushbutton shall be spring maintained in the automatic position. Locate the pushbutton on the outside of the front cover.
7. Commit/No-Commit Transfer Selector: The controller shall include a programmable selector to configure the controller to commit to transferring the load to an alternate source (or not) in the event the preferred source returns prior to the alternate source being ready to accept load.
8. Inhibit Transfer Signals: The controller shall be capable of accepting transfer control inputs that inhibit transfer of the ATS to another source. Provide terminal block for customer external dry contact transfer inhibit signal, which shall prevent the transfer switch from automatically transferring in either direction.
9. Auto/Manual Selector: The controller shall include a programmable function to select either Automatic or Manual operation.
10. Source Priorities: The controlled shall include a programmable function to select the order of source priority.

11. Retransfer Mode Selector: The controller shall include a 3-position key-operated switch or a programmable function to retransfer to preferred source selector switch with the following selections:
 - a. Automatic: When the switch is placed in the AUTO position, the controller will, after a 0 to 120-minute normal power stabilization time delay, automatically direct a transfer of the loads back to the preferred source after the preferred source has been restored.
 - b. Manual: When the switch is placed in the MANUAL position, the controller will not automatically direct a transfer of the loads back to the preferred source unless the alternate source fails and the preferred source is available, or, the switch is placed in the Bypass position.
 - c. Retransfer Bypass: When the switch is placed in the Retransfer Bypass position, the controller will automatically direct a transfer of the loads back to the preferred source and bypass any remaining retransfer time delay, provided the preferred source power is available.
12. Adjustable voltage sensing relays on each phase of normal source set to drop out and start the generator at 85% of normal and restore to utility at 90% of normal rating.
13. Voltage and frequency monitors to prevent transfer to emergency until the emergency source reaches 90% of its voltage and 95% of its frequency rating.
14. Time delay on restoring load to normal after power failure has ended, adjustable 0 to 30-minutes and set at 30-minutes. Any momentary dips in the line will cause the time delay to reset and start its time cycle over. This time delay shall be automatically by-passed if the emergency source fails and the normal source is available.
15. Time delay on stopping of engine after load has been restored to normal source to provide a generator cool down period, adjustable 0 to 30-minutes, set at 5-minutes unless otherwise noted by the Engineer of Record.
16. Time delay, to delay generator-start signal and override momentary normal source outages, adjustable 0.5 to 6-seconds, set at 1-second unless otherwise noted by the Engineer of Record.
17. Time delay on transfer to emergency source after emergency source becomes available, adjustable 0 to 5-minutes, set at 1-minute, unless otherwise noted by the Engineer of Record.
18. Time delay for switching from the off position to the emergency source position, adjustable 0 to 60-seconds, set at 3 seconds for non-VFD loads and 8 seconds for VFD loads unless otherwise noted by the Engineer of Record.
19. Time delay for switching from the off position to the normal source position, adjustable 0 to 60-seconds, set at 3-seconds for non-VFD loads and 8 seconds for VFD loads unless otherwise noted by the Engineer of Record.
20. The above user adjustable devices shall be adjustable without the use of tools, power supplies, meters, etc. The above settings shall be set at the factory.
21. A two position switch, "TEST-NO LOAD/TEST WITH LOAD," such that when in the "TEST-NO LOAD" position and the test switch is activated the generators shall start but the ATS shall remain in the normal position. In the "TEST WITH LOAD" position the ATS will transfer to the emergency source. In either position, the switch shall automatically transfer to the live source in the event of a failure of

the other source. It shall be possible to use this switch to transfer back and forth between sources during a test. Mount switch to front cover.

22. Plant exerciser with 7-day dial to automatically exercise the generating plant. Adjustable type with minimum of 15-minute increments.
23. Equipment grounding bus bar sized for the quantity and size of the ground wires indicated on Drawings.
24. A through-the-door manual operator shall be provided to switch the contacts under full rated load and provide complete operator safety. The manual operator shall provide the same contact-to-contact transfer speed as the electrical operator to prevent a flashover from switching the main contacts slowly.
25. Provide long barrel, 2-hole, high-compression circumference crimp type lugs for the feeder conductors, size as specified on the Drawings. Bussing shall be designed to accommodate the number of crimp type lugs as required by the feeder size indicated in the Drawings.
26. All control wires shall be 600 volt, rated.
27. Provisions to permit load "shedding" by switching the main contacts to the off (open) position via the closing of an external set of dry contacts, rated 120 volt AC, 10 amps. Contacts shall transfer to the normal source position automatically if voltage and frequency are within specified tolerances.
28. Provisions to permit the switching of the main contacts to the emergency position only after the following two occurrences:
 - a. Emergency source voltage and frequency are within specified tolerances.
 - b. Closing of an external set of dry contacts rated 120 volt AC, 10 amps.
29. The control voltage through the contacts specified in the two above accessories, shall originate from the ATS control power transformers.

2.5 ENCLOSURE

- A. Transfer switch shall be freestanding, floor-mounted and non-ventilated NEMA ICS 6, type 1, smooth sheet metal enclosure constructed in accordance with UL 1008.
- B. For service entrance enclosures, the transfer switch shall be furnished in a multi-section switchboard as follows: a service equipment section containing the service (utility source) disconnect circuit breaker, grounding, and bonding provisions; a second non-service section containing the power transfer switch and controls. For circuit breaker requirements, refer to specification section 262816: Overcurrent Protective Devices.

2.6 FINISH

- A. Five step zinc phosphate pre-treatment, one coat of rust inhibiting dichromate primer and one coat baked-on enamel finish, ANSI 61 (light gray).
- B. A seven-step spray wash electroplate primer with final baked-on enamel finish; ANSI 61 (light gray) is an acceptable finish alternative.

2.7 SOURCE QUALITY CONTROL

- A. Factory tests:

1. Transfer switch shall be completely assembled, wired, adjusted, and tested, per ANSI C37.20, at the factory under simulated service conditions to assure the accuracy of the wiring and the functioning of all equipment. The minimum of the following tests shall be performed, and the documentation and measurements shall be included in Operation and Maintenance Manual.
 2. Dielectric test.
 3. Mechanical test.
 4. Grounding of instrument transformers test.
 5. Electrical operation and control wiring test.
 6. Control wiring.
 7. Polarity test.
- B. Submit the certified test reports to the Engineer to confirm that all components have been tested to substantiate designs according to applicable ANSI and NEMA Standards. Tests shall verify the performance of the components as well as the suitability of the enclosure venting, rigidity, and bus bracing.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Contractor shall thoroughly examine Project site conditions for acceptance of transfer switch installation to verify conformance with Manufacturer and Specification tolerances. Do not commence with installation until all conditions are made satisfactory.

3.2 PREPARATION

- A. Ensure all conduit stub-ups for bottom entry into transfer switch are in place and located as required per Shop Drawings.

3.3 INSTALLATION

- A. Install transfer switch(es) in accordance with Manufacturer's written instructions, as indicated on the Drawings and as specified herein.
- B. Transfer switches shall be anchored and braced to withstand seismic forces as calculated per Section 260010: Basic Electrical Requirements.
- C. Tighten electrical connectors and terminals; including screws and bolts, in accordance with equipment Manufacturers published torque-tightening values for equipment connectors. Where Manufacturers torque requirements are not indicated, tighten connectors and terminals to comply with tightening torque specified in NETA Standard Tables.
- D. Mark torque bolt heads using red or pink paint.
- E. Freestanding transfer switches shall be accurately aligned, leveled, and bolted in place on full-length channels securely fastened per the Structural Engineer's calculations.

- F. "Train" interior wiring; bundle and clamp, using specified plastic wire wraps specified under Section 260519: Building Wire and Cable.
- G. Generator control wiring shall be installed and continuously monitored per the requirements of CEC Article 700.10(D)(3).
- H. Replace any panel pieces, doors or trims having dents, bends, warps or poor fit that may impede ready access, security or integrity.
- I. Conduits terminating in concentric, eccentric, or oversized knockouts at transfer switch shall have ground bushings and bonding jumpers installed interconnecting all such conduits and the switch enclosure.

3.4 FIELD QUALITY CONTROL

- A. Manufacturer's field service: Contractor shall arrange and pay for the services of a factory-authorized service representative to supervise the initial start-up, pretesting and adjustment of the transfer switch.
- B. Independent testing: Contractor shall arrange and pay for the services of an independent Testing Agency to perform all quality control electrical testing, calibration and inspection required herein. Testing Agencies objectives shall be to:
 - 1. Assure transfer switch installation conforms to specified requirements and operates within specified tolerances.
 - 2. Field test and inspect to ensure operation in accordance with Manufacturer's recommendations and Specifications.
 - 3. Prepare final test report including results, observations, failures, adjustments, and remedies.
 - 4. Apply label on transfer switch upon satisfactory completion of tests and results.
 - 5. Verify ratings and settings and make final adjustments.
- C. At least three weeks prior to any testing, notify the Engineer so that arrangement can be made for witnessing test, if deemed necessary. All pretesting shall have been tested satisfactorily prior to the Engineer's witnessed test.
- D. The Contractor shall supply a suitable and stable source of electrical power to each test site. The Testing Agency shall specify the specific power requirements.
- E. Testing of overcurrent protective devices shall be done only after all devices are installed and prior to system being energized.
- F. Prefunctional testing:
 - 1. Provide Testing Agency with Contract Documents and Manufacturer instructions for installation and testing.
 - 2. For circuit breaker testing requirements, refer to Specification Section 262816: Overcurrent Protective Devices.
 - 3. Visual and mechanical inspection:
 - a. Inspect for physical damage, defects alignment and fit.
 - b. Perform mechanical operational tests in accordance with Manufacturer's instructions.

- c. Compare nameplate information and connections to Contract Documents.
 - d. Check tightness of all control and power connections.
 - e. Check that all covers, barriers, and doors are secure.
 - f. Perform manual transfer operation.
 - g. Confirm proper lubrication.
 - h. Check switch to ensure positive mechanical interlocks between normal and alternate sources.
4. Electrical tests:
- a. Perform insulation-resistance tests phase-to-phase and phase-to-ground with switch in both source positions. Test voltage shall be 1000 volts DC.
 - b. Perform a contact-resistance test across all main contacts.
 - c. Verify settings and operation of control devices in accordance with the Specifications.
 - d. Calibrate and test all relays and timers including voltage and frequency-sensing relays, in-phase monitor (synchronism check), engine start and cool-down timers, transfer, and retransfer timers, etc.
 - e. Perform ATS tests:
 - 1) Simulate loss of normal power.
 - 2) Return to normal power.
 - 3) Simulate loss of emergency power.
 - 4) Simulate all forms of single-phase conditions.
 - 5) Monitor and verify correct operation and timing of the following simulations:
 - a) Normal voltage sensing relays.
 - b) Engine start sequence.
 - c) Time delay upon transfer.
 - d) Alternate voltage-sensing relays.
 - e) Automatic transfer operation.
 - f) Interlocks and limit switch function.
 - g) Time delay and retransfer upon normal power restoration.
 - h) Engine cool-down and shutdown feature.
- G. In the event that the system fails to function properly during the testing as a result of inadequate pretesting or preparation. The Contractor shall bear all costs incurred by the necessity for retesting including test equipment, transportation, subsistence, and the Engineer's hourly rate.
- H. Contractor shall replace at no costs to the Owner all devices which are found defective or do not operate within factory specified tolerances.
- I. Contractor shall submit the Testing Agency's final report for review prior to Project closeout and final acceptance by the Owner. Test report shall indicate test dates, devices tested, results, observation, deficiencies, and remedies. Test report shall be included in the operation and maintenance manuals.

3.5 CLEANING

- A. Prior to energizing of transfer switch, the Contractor shall thoroughly clean the interior of enclosure of all construction debris, scrap wire, etc. using Manufacturer's approved methods and materials.
- B. Upon completion of Project prior to final acceptance the Contractor shall thoroughly clean both the interior and exterior of transfer switch per Manufacturer's approved methods and materials. Remove paint splatters and other spots, dirt, and debris.
- C. Touch-up paint any marks, blemishes or other finish damage suffered during installation.

3.6 TRAINING

- A. Factory authorized service representative shall conduct a 2-hour training seminar for Owner's Representatives upon completion and acceptance of system. Instructions shall include safe operation, maintenance, and testing of equipment with both classroom training and hands-on instruction.
- B. Contractor shall schedule training with a minimum of 7-days advance notice.

END OF SECTION

SECTION 26 43 13
SURGE PROTECTIVE DEVICES (SPD)

PART 1 - GENERAL

1.1 SUMMARY

- A. Work included: Labor, materials, and equipment necessary to complete the installation required for the item specified under this Division, including but not limited to:
 - 1. Surge protective devices (SPD).
- B. Related Work: Consult all other Sections, determine the extent and character of related Work, and properly coordinate Work specified herein with that specified elsewhere to produce a complete installation.

1.2 REFERENCES

- A. Comply with the latest edition of the following applicable Specifications and standards except as otherwise indicated or specified.
 - 1. American National Standards Institute, Inc. (ANSI)/Institute of Electrical and Electronics Engineers (IEEE):
 - ANSI/IEEE C62.1; Standard for Surge Arresters for Alternating Current Power Circuits.
 - ANSI/IEEE C62.11; Standard for Metal-Oxide Surge Arrestors for AC Power Circuits.
 - ANSI/IEEE C62.41.1; Guide on the Surges Environment in Low-Voltage (1000V and Less) AC Power Circuits.
 - ANSI/IEEE C62.41.2; Recommended Practices on Characterization of Surges in Low-Voltage (1000V and Less) AC Power Circuits.
 - ANSI/IEEE C62.45; Recommended Practice on Surge Testing for Equipment Connected to Low-Voltage (1000V and Less) AC Power Circuits.
 - 2. Underwriters Laboratory, Inc. (UL):
 - UL 50; Enclosures for Electrical Equipment, Non-Environmental Considerations.
 - UL 1283 Electromagnetic Interference Filters. [Type 2 only]
 - UL 1449; Surge Protective Devices, 4th Edition.
 - 3. National Electrical Manufacturers Association (NEMA):
 - NEMA PB 1.1; General Instructions for Proper Installation, Operation, and Maintenance of Panelboards Rated 600 Volts or Less.

1.3 SYSTEM DESCRIPTION

- A. Provide surge protective device (SPD) equipment having the electrical characteristics, ratings, and modifications as specified herein and as shown on the drawings. To maximize performance and reliability and to obtain the lowest possible

let-through voltages, the ac surge protection shall be integrated into electrical distribution equipment such as switchboards and panelboards.

- B. SPD units and all components shall be designed, manufactured, and tested in accordance with the latest applicable UL standard (ANSI/UL 1449 4th Edition).
- C. SPD units shall be furnished in two Types. Type 1 and Type 2 as outlined below:
 - 1. Type 1: Permanently connected SPDs installed on the line or load side of main disconnect device(s), at main switchboard. This type closely relates to the devices previously referred to as secondary surge arrestors. These Type 1 SPDs should be specially suited to conduct the high energy impulses from lightning strikes.
 - 2. Type 2: Permanently connected SPD installed on the load side of the service panel main disconnect device(s). This type most closely relates to devices that were previously classified as Transient Voltage Surge Suppression (TVSS). These Type 2 SPDs are especially suited for distribution boards and panelboard applications.

1.4 SUBMITTALS

- A. Submit in accordance with the requirements of Section 260010: Basic Electrical Requirements, the following items:
 - 1. Data/catalog cuts for each product and component specified herein, listing all physical and electrical characteristics and ratings indicating compliance with all listed standards.
 - 2. Describe system operation, equipment and dimensions and indicate features of each component.
 - 3. Clearly mark on each data sheet the specific item(s) being submitted and the proposed application.
 - 4. Shop Drawings: Include elevations, cabinet dimensions, complete component listing and layout within cabinet, amperage ratings and capacities, system characteristics and wiring diagrams.
 - 5. Furnish structural calculations for equipment anchorage as described in Section 260010: Basic Electrical Requirements.
 - 6. Confirmation in writing of SPD compliance with CEC Article(s) 242 and 700
 - 7. Submit Manufacturer's installation instructions.
 - 8. Complete bill of material listing all components.
 - 9. Warranty.

1.5 OPERATION AND MAINTENANCE MANUAL

- A. Supply operation and maintenance manuals in accordance with the requirements of Section 260010: Basic Electrical Requirements, to include the following.
 - 1. A detailed explanation of the operation of the system.
 - 2. Instruments for routine maintenance.
 - 3. Pictorial parts list and parts number.
 - 4. Telephone numbers for authorized parts and service distributors.

1.6 QUALITY ASSURANCE

- A. All materials, equipment and parts comprising the units specified herein shall be new, unused, and currently under production.
- B. Only products and applications listed in this Section may be used on the Project unless otherwise submitted.

1.7 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Delivery: SPD components shall not be delivered to the Project site until protected storage space is available. Storage outdoors covered by rainproof material is not acceptable. Equipment damaged during shipment shall be replaced and returned to Manufacturer at no cost to Owner.
- B. Storage: Store in a clean, dry, ventilated space free from temperature extremes. Maintain factory wrapping or provide a heavy canvas/plastic cover to protect units from dirt, water, construction debris and traffic. Provide heat where required to prevent condensation.
- C. Handling: Handle in accordance with the Manufacturer's written instructions. Be careful to prevent internal component damage, breakage, denting and scoring. Damaged units shall not be installed. Replace damaged units and return equipment to Manufacturer.

1.8 WARRANTY

- A. Units and components offered under this Section shall be covered by a 5-year parts and labor warranty for malfunctions resulting from defects in materials and workmanship. Warranty shall begin upon acceptance by the Owner.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Products furnished by the following Manufacturers shall be acceptable if in compliance with all features specified herein and indicated on the Drawings.
 - 1. ABB/ General Electric.
 - 2. Eaton.
 - 3. Schneider Electric/ Square D.
 - 4. Siemens.
- B. Substitutions: Under provisions of Section 260010: Basic Electrical Requirements.

2.2 GENERAL

- A. All Specification noted herein apply to the switchboard and panelboard units, unless otherwise noted.
- B. The SPD system utilizes diversion modules to suppress and divert transient voltage and surge currents. The system is designed to provide protection for sensitive electronic devices against the effects of surges, transients, and electrical line noise.

C. Environmental requirements:

1. Operating temperature: -40-degree C to 60-degree C.
2. Relative humidity: 0% to 95%.
3. Operating altitude: 0 to 12,000-feet.
4. Audible noise: Less than 35-dB.

D. Electrical requirements:

1. Unit operating voltage: The SPD system voltage shall be as indicated on the Drawings.
2. Maximum continuous operating voltage "MCOV": The MVOC shall not be less than 125% of the nominal system operating voltage.
3. The suppression system shall incorporate thermally protected metal-oxide varistors "MOVs" as the core surge suppression component for the service entrance and all other distribution levels. The system shall not utilize silicon avalanche diodes, selenium cells, air gaps, or other components that may crowbar the system voltage leading to system upset or create any environmental hazards.
4. Protection modes: The SPD must protect all modes of the electrical system being utilized. The required protection modes are indicated by bullets in the following table:

PROTECTION MODES TABLE				
Configuration	L-N	L-G	L-L	N-G
WYE	•	•	•	•
Delta	N/A	•	•	N/A
Single Split Phase	•	•	•	•
High Leg Delta	•	•	•	•

5. Nominal discharge current (In): All SPDs applied to the distribution system shall have a 20kA In rating regardless of their SPD Type (includes Types 1 and 2) or operating voltage. SPDs having an in less than 20kA shall be rejected.
6. Voltage protection rating (VPR): The maximum ANSI/UL 1449 4th Edition VPR for the device shall not exceed the following:

VOLTAGE PROTECTION RATING TABLE				
System Voltage	L-N	L-G	L-L	N-G
120/208	700V	700V	1200V	700V
277/480	1200V	1200V	2000V	1200V
346/600	1500V	1500V	3000V	1500V

E. SPD design:

1. The SPD shall be maintenance free and shall not require any user intervention throughout its life. SPDs containing items such as replaceable modules, replaceable fuses, or replaceable batteries shall not be accepted. SPDs requiring any maintenance of any sort such as periodic tightening of connections shall not be accepted. SPDs requiring user intervention to test the unit via a diagnostic test kit or similar device shall not be accepted.
2. The surge current shall be equally distributed to all MOV components to ensure equal stressing and maximum performance. The surge suppression platform must provide equal impedance paths to each matched MOV.

3. Each unit shall include a high-performance EMI/RFI noise rejection filter. Noise attenuation for electric line noise shall be up to 50-dB from 10kHz to 100MHz using the MIL-STD-220A insertion loss test method.
4. No plug-in component modules or printed circuit boards shall be used as surge current conductors. All internal components shall be soldered, hardwired with connections utilizing low impedance conductors.
5. SPD shall provide the following integral monitoring options:
 - a. Each unit shall have a green/red solid-state indicator light that reports the status of the protection on each phase:
 - 1) For WYE configured units, the indicator lights must report the status of all protection elements and circuitry in the L-N and L-G modes. WYE configured units shall also contain an additional green/red solid-state indicator light that reports the status of the protection elements and circuitry in the N-G mode.
 - 2) For delta configured units, the indicator lights must report the status of all protection elements and circuitry in the L-G and L-L modes.
 - 3) The absence of a green light and the presence of a red light shall indicate that damage has occurred on the respective phase or mode. All protection status indicators shall indicate the actual status of the protection on each phase or mode. If power is removed from any one phase, the indicator lights shall continue to indicate the status of the protection on all other phases and protection modes.
 - b. The SPD must include Form C dry contacts (one NO and one NC) for remote annunciation of its status. Both the NO and NC contacts shall change state under any fault condition.
 - c. The SPD shall contain an audible alarm that will be activated under any fault condition. There shall also be an audible alarm silence button used to silence the audible alarm after it has been activated.
 - d. Surge counter:
 - 1) The SPD shall be equipped with an LCD display that indicates to the user how many surges have occurred at the location.
 - 2) The surge counter shall trigger each time a surge event with a peak current magnitude of a minimum of 50 amps $\pm$ 20 amps occurs.
 - 3) A reset pushbutton shall also be standard, allowing the surge counter to be zeroed. The reset button shall contain a mechanism to prevent accidental resetting of the counter via a single, short-duration button press. In order to prevent accidental resetting, the surge counter reset button shall be depressed for a minimum of 2-seconds in order to clear the surge count total.
 - 4) The ongoing surge count shall be stored in non-volatile memory. If power to the SPD is completely interrupted, the ongoing count indicated on the surge counter's display prior to the interruption shall be stored in non-volatile memory and displayed after power is restored. The surge counter's memory shall not require a backup battery in order to achieve this functionality.
6. The unit shall contain thermally protected MOVs. These thermally protected MOVs shall have a thermal protection element packaged together with the MOV

in order to achieve overcurrent protection of the MOV. The thermal protection element shall disconnect the MOV(s) from the system in a fail-safe manner should a condition occur that would cause them to enter a thermal runaway condition.

7. All the SPD's components and diagnostics shall be contained within one discrete assembly. SPDs or individual SPD modules that must be ganged together in order to achieve higher surge current ratings or other functionality shall not be accepted.
8. Safety requirements:
 - a. The SPD shall minimize potential arc flash hazards by containing no user serviceable or replaceable parts and shall be maintenance free. SPDs requiring any maintenance of any sort such as periodic tightening of connections shall not be accepted. SPDs requiring user intervention to test the unit via a diagnostic test kit or similar device shall not be accepted.
 - b. SPDs designed to interface with the electrical assembly via conductors shall require no user contact with the inside of the unit. Such units shall have any required conductors be factory installed.

2.3 SYSTEM APPLICATION

- A. The SPD applications covered under this section include switchboards panelboard assemblies. All SPDs shall be tested and demonstrate suitability for application within ANSI/IEEE C62.41 Category C, B, and A environments.
- B. The minimum surge current capacity the device is capable of withstanding shall be as shown in the following table:

MINIMUM SURGE CURRENT CAPACITY TABLE			
Category	Application	Per Phase	Per Mode
C	Service Entrance Locations (Switchboards)	250kA	125kA
B	High Exposure Roof Top Locations (Switchboards and Panelboards)	160kA	80kA
A	Branch Locations (Panelboards)	120kA	60kA

- C. All SPDs installed on the line side of the service entrance disconnect shall be Type 1 SPDs. All SPDs installed on the load side of the service entrance disconnect shall be Type 1 or Type 2 SPDs.

2.4 PANELBOARDS

- A. The SPD application covered under this section includes lighting and outlet panelboards. The SPD units shall be tested and demonstrate suitability for application within ANSI/IEEE C62.41 Category A or B environments.
- B. The SPD shall not limit the use of through-feed lugs, sub-feed lugs, and sub-feed breaker options.
- C. SPDs shall be installed immediately following the load side of the main breaker. SPDs installed in main lug only panelboards shall be installed immediately following the incoming main lugs.
- D. The panelboard shall be capable of re-energizing upon removal of the SPD.

- E. The SPD shall be interfaced to the panelboard via a direct bus bar connection. Alternately, an SPD connected to a 30A circuit breaker for disconnecting purposes may be installed using short lengths of conductors as long as the conductors originate integrally to the SPD. The SPD shall be located directly adjacent to the 30A circuit breaker.
- F. The SPD shall be included and mounted within the panelboard by the manufacturer of the panelboard.
- G. The complete panelboard including the SPD shall be UL67 listed.

2.5 SWITCHBOARDS

- A. The SPD application covered under this section is for switchboard locations. Service entrance located SPDs shall be tested and demonstrate suitability for application within ANSI/IEEE C62.41 Category C environments.
- B. The SPD shall be of the same manufacturer as the switchboard.
- C. The SPD shall be factory installed inside the switchboard at the assembly point by the original equipment manufacturer.
- D. Locate the SPD on the load side of the main disconnect device, as close as possible to the phase conductors and the ground/neutral bar.
- E. The SPD shall be connected through a disconnect (30A circuit breaker). The disconnect shall be located in immediate proximity to the SPD. Connection shall be made via bus, conductors, or other connections originating in the SPD and shall be kept as short as possible.
- F. The SPD shall be integral to switchboard as a factory standardized design.
- G. All monitoring and diagnostic features shall be visible from the front of the equipment.

2.6 ENCLOSURES

- A. All enclosed equipment shall have NEMA 1 general purpose enclosures, unless otherwise noted. Provide enclosures suitable for locations as indicated on the drawings and as described below:
 - 1. NEMA 1: Constructed of a polymer (units integrated within electrical assemblies), intended for indoor use to provide a degree of protection to personal access to hazardous parts and provide a degree of protection against the ingress of solid foreign objects (falling dirt).
 - 2. NEMA 4: Constructed of steel, intended for either indoor or outdoor use, to provide a degree of protection from the following:
 - a. Against access to hazardous parts.
 - b. Of equipment inside the enclosure against ingress of solid foreign objects (dirt and windblown dust).
 - c. With respect to the harmful effects on the equipment due to the ingress of water (rain, sleet, snow, splashing water, and hose directed water).

2.7 SOURCE QUALITY CONTROL

- A. Standard factory tests shall be performed on the equipment under this section. All tests shall be in accordance with the latest version of NEMA and UL standards.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Contractor shall thoroughly examine Project site conditions for acceptance of SPD installation to verify conformance with Manufacturer and Specification tolerances. Do not commence with installation until all conditions are made satisfactory.

3.2 INSTALLATION

- A. Install SPD in accordance with Manufacturer's written instructions, as indicated on the Drawings and as specified herein.
- B. Set cabinets plumb and symmetrical with building lines in conformance with PB1.2. Furnish and install all construction channel bolts, angles, etc., required to mount the equipment furnished under this Section.
- C. As a minimum, provide SPDs on all service entrance switchboards, emergency system switchboards and panelboards, 120/208 volt distribution switchboards and 120/208 volt panelboards, disconnecting means, safety interlock circuits in compliance with CEC Article(s) 242 and 700.
- D. Conductors from the power source to the SPD shall be minimum #4 AWG copper in switchboards and #8 AWG copper in panelboards (when not direct bus connected). Conductors shall be routed without sharp bends and straight and short as possible. The absolute maximum of 7'-0" long for units in switchboards and 1'-0" long for units in panelboards.
- E. Conductors originating from direct bus bar connections shall be individually wrapped with electric tape in half-lapped increments for added protection of the un-protected conductors. Tie-wrap the conductors away from the bus bars without any sharp bends. All holes that the conductors pass through shall be grommets.
- F. Cabinets shall be anchored and braced to withstand seismic forces as calculated per Section 260010: Basic Electrical Requirements.
- G. SPD's protecting disconnecting means (e.g. enclosed circuit breaker or switch) shall be installed per the manufacturer's installation instructions with conductor lengths kept to a minimum (less than 2'-0" long).

3.3 FIELD QUALITY CONTROL

- A. Prefunctional testing:
 - 1. Visual and mechanical inspection:
 - a. Inspect for physical damage, defects, alignment, and fit.
 - b. Compare nameplate information and connections to Contract Documents.
 - c. Check tightness of all control and power connections.
 - d. Prior to energization, verify source neutral is bonded to ground per CEC Articles 250.24(B), 250.28 and 250.30.

END OF SECTION

SECTION 26 50 00

LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

- A. Work included: Labor, materials, and equipment necessary to complete the installation required for the item specified under this Division, including but not limited to:
 - 1. Interior luminaires (lighting fixtures.)
 - 2. Exterior luminaires.
 - 3. Light-emitting diode (LED) assemblies.
 - 4. Drivers and transformers.
 - 5. Optical components; including diffusers, refractors, reflectors, and louvers.
 - 6. Poles and brackets.
- B. Related Work: Consult all other Sections, determine the extent and character of related Work, and properly coordinate Work specified herein with that specified elsewhere to produce a complete installation.
 - 1. Division 03: Concrete; for cast-in place bases for lighting poles and bollards.
 - 2. Division 05: Metals; for fittings, brackets, backing supports, rods, etc. as required for support and bracing of luminaires.
 - 3. Division 09: Finishes; for ceilings, wall assemblies, acoustical treatment, and field painting of luminaires.

1.2 REFERENCES

- A. Comply with the latest edition of the following applicable Specifications and Standards except as otherwise indicated or specified:
 - 1. American National Standards Institute (ANSI):
 - ANSI/IEC 60529; American National Standard for Degrees of Protection Provided by Enclosures (IP Code)
 - C78.54; Electric Lamps – Specification Sheet for Tubular Fluorescent Replacement and Retrofit LED Lamps
 - C81.63; Gauges for Electric Lamp Bases and Lampholders
 - C136.25 Roadway and Area Lighting Equipment—Ingress Protection (Resistance to Dust, Solid Objects and Moisture) for Luminaire Enclosures.
 - C136.37; Solid State Light Sources Used in Roadway and Area Lighting.
 - C137.0 Lighting System Terms and Definitions.
 - C137.1 0-10V Dimming Interface for LED Drivers and Controls
 - 2. Underwriters Laboratories, Inc. (UL):

UL 66;	Fixture Wire.
UL 102.3;	Standard Method of Fire Test of Light Diffusers and Lenses.
UL 153;	Portable Electric Luminaires.
UL 924;	Emergency Lighting and Power Equipment.
UL924a;	Auxiliary Power Supplies (for generator-backed systems.)
UL 1598;	Luminaires.
UL 1993;	Self-Ballasted Lamps and Lamp Adapters.
UL 8750;	Light Emitting Diode (LED) Equipment for Use in Lighting Products.
UL 8754;	Holders, Bases, and Connectors for Solid-State (LED) Light Engines and Arrays.
3. National Electrical Manufacturers Associations (NEMA):
- | | |
|--------|--|
| SSL-1; | Electronic Drivers for LED Devices, Arrays or Systems. |
| LE-4; | Recessed Luminaires, Ceiling Compatibility |
4. Illuminating Engineering Society of North America (IESNA):
- | | |
|---------------|--|
| TM-15; | Luminaire Classification System for Outdoor Luminaires. |
| TM-21; | Projecting Long Term Lumen Maintenance of LED Light Sources. |
| TM-30; | Method for Evaluating Light Source Color Rendition. |
| TM-30-Annex E | Recommendations for Specifying Light Source Color Rendition |
| LM-79; | Electrical and Photometric Measurements of Solid-State Lighting Products. |
| LM-80; | Measuring Luminous Flux and Color Maintenance of LED Packages, Arrays and Modules. |
| LM-84; | Measuring Luminous Flux and Color Maintenance of LED Lamps, Light Engines, and Luminaires. |
| LM-86; | Measuring Luminous Flux and Color Maintenance of Remote Phosphor Components |
5. Restriction of Hazardous Substances (RoHS):
- | | |
|---------|---|
| RoHS 3; | Directive 2015/863 - Cat 5. Lighting: lamps, luminaires, light bulbs. |
|---------|---|

1.3 SYSTEM DESCRIPTION

- A. Provide and install a fully functional and operating lighting system as indicated, complete with light engines, lamps, wiring, and securely attached to support system to meet all seismic code requirements.
- B. Where catalog number and narrative or pictorial descriptions are provided, the written description shall take precedence and prevail.

1.4 SUBSTITUTIONS

- A. Refer to Section 260010: Basic Electrical Requirements for specific Equipment requirements.
- B. Items specified under this Section and Luminaire Schedule are subject to the requirements, with the following qualifications:
 - 1. Items solely specified by Manufacturer name and catalog number, without qualifiers: Provide as specified – No Substitutions.
 - 2. Items specified by multiple Manufacturers, without qualifiers: Provide any listed manufacturer – No Substitutions.
 - 3. Items specified by sole or multiple Manufacturers, followed by “Or Approved Equal” or “Or Approved Equivalent”: Conform to substitution requirements outlined for Equipment.
 - 4. Items specified by sole or multiple Manufacturers, followed by “Or Equal” or “Or Equivalent”: Products that meet the salient requirements are acceptable to provide.
 - a. Equivalency is at the sole judgement of the Architect and Engineer.
 - b. Should a submitted, unspecified product fail to meet the requirements of Equivalency, provide specified products at no additional cost to the Owner.
- C. Equivalency shall be determined by review of the following luminaire characteristics where applicable. Lack of pertinent data on any characteristic shall constitute justification for rejection of the submittal or substitution.
 - 1. Performance:
 - a. Distribution.
 - b. Utilization.
 - c. Luminance distribution (Average brightness / maximum brightness.)
 - d. Spacing to mounting height ratio.
 - e. Overall luminaire efficiency.
 - 2. Construction:
 - a. Engineering.
 - b. Workmanship.
 - c. Rigidity.
 - d. Permanence of materials and finishes.
 - 3. Installation Ease:
 - a. Captive parts and captive hardware.
 - b. Provision for leveling.
 - c. Through-wiring ease.
 - 4. Maintenance:
 - a. Ease of relamping / replacement of LED array.
 - b. Ease of replacement of driver/ballast and lamp sockets.
 - 5. Appearance:
 - a. Architectural integration.

- b. Light tightness.
- c. Styling.
- d. Conformance with design intent.
- e. When requested, furnish a working sample complete with housing, trim, 8' cord and plug, and specified lamp.

1.5 SUBMITTALS

- A. Submit in accordance with the requirements of Section 260010: Basic Electrical Requirements, the following items:
 - 1. Complete bill of material listing (index) of all luminaires. Index shall be organized in the same sequence as the Luminaire Schedule (alphabetical.) Include in the index:
 - a. Type per the Luminaire Schedule.
 - b. Manufacturer.
 - c. Complete catalog number, including all accessories and appurtenances required for the installation.
 - d. Voltage.
 - e. Poles, arms, and brackets, if applicable.
 - f. Lamping, if applicable.
 - 2. Manufacturer's data sheets/catalog cuts for each product and component specified herein, listing all physical and electrical characteristics and ratings indicating compliance with all listed standards.
 - a. Identify luminaire type on each sheet.
 - b. Clearly mark on each data sheet the specific item(s) being submitted. Obfuscate or otherwise delete options on data sheets that are not provided.
 - 3. Driver or transformer and/or lamp data sheets as applicable to submitted item.
 - 4. Manufacturer's installation instructions.
 - 5. Warranty.
 - 6. U.L. labeling information.
 - 7. Photometric Reports consisting of:
 - a. Independent Testing Laboratories, Inc. or equal, photometric test report for each luminaire listed on the Luminaire Schedule. Test reports shall be based on Illuminating Engineering Society published test procedures and shall contain candlepower distribution curves in five lateral planes for luminaires with asymmetric distributions and luminance data for vertical angles above 45 degrees from nadir.
 - b. Coefficient of utilization table.
 - c. Zonal lumen summary including overall luminaire efficiency.
 - 8. Shop Drawings:
 - a. Where noted in the Luminaire Schedule, submit Shop Drawings from Manufacturer detailing modified or custom luminaires indicating dimensions, weights, methods of field assembly, components, features, accessories, methods of support, etc.

1.6 OPERATION AND MAINTENANCE MANUAL

- A. Supply operation and maintenance manuals in accordance with the requirements of Section 260010: Basic Electrical Requirements, to include the following:
 - 1. An updated index per 1.05-A.
 - 2. One complete set of final submittals of actual product installed, including product data and shop drawings.
 - 3. Instructions for routine maintenance.
 - 4. Pictorial parts list and parts number.
 - 5. Telephone numbers for authorized parts and service distributors.

1.7 QUALITY ASSURANCE

- A. All materials, equipment and parts comprising the units specified herein shall be new, unused, and currently under production.
- B. Only products and applications listed in this Section may be used on the Project unless otherwise submitted.

1.8 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Delivery: Luminaires shall not be delivered to the Project site until protected storage space is available. Storage outdoors covered by rainproof material is not acceptable. Equipment damaged during shipment shall be replaced and returned to Manufacturer at no cost to Owner.
- B. Storage: Store in a clean, dry, ventilated space free from temperature extremes. Maintain factory wrapping or provide a heavy canvas/plastic cover to protect units from dirt, water, construction debris and traffic. Provide heat where required to prevent condensation.
- C. Handling: Handle in accordance with Manufacturer's written instructions. Be careful to prevent internal component damage, breakage, denting and scoring. Damaged units shall not be installed. Replace damaged units and return equipment to Manufacturer.

1.9 WARRANTY

- A. Units and components offered under this Section shall be covered by a 1-year parts and labor warranty for malfunctions resulting from defects in materials and workmanship. Warranty shall begin upon acceptance by the Owner.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Products furnished by the following Manufacturers shall be acceptable if in compliance with all features specified herein and indicated on the Drawings.
 - 1. Luminaires, Poles, and Exit Signs: as listed in the Luminaire Schedule.
 - 2. Light-Emitting Diode (LED) Arrays:
 - a. Cree.

- b. Nichia.
 - c. Citizen.
 - d. Lumileds.
 - e. Samsung.
 - f. Lumenetix Araya.
 - g. Xicato.
 - h. Bridgelux.
 - i. LEDs provided by Luminaire Manufacturer listed in the Luminaire Schedule: meeting the technical and warranty requirements of this Section.
3. LED drivers (DC output):
- a. eldoLED.
 - b. Lutron.
 - c. Signify Advance.
 - d. Osram.
 - e. Q-Tran.
 - f. Universal Lighting Technologies.
 - g. Drivers provided by Luminaire Manufacturer listed in the Luminaire Schedule: meeting the technical and warranty requirements of this Section.

B. Substitutions: Under provisions of Section 260010: Basic Electrical Requirements.

2.2 GENERAL

- A. Luminaires new and complete with mounting accessories, junction boxes, trims, and lamps.
- B. Luminaire assemblies U.L. listed appropriate to mounting conditions and application. All labels affixed to the luminaire shall be in a location not visible from normal viewing angles.
- C. Each luminaire family type (downlights, etc.) supplied by only one manufacturer.
- D. Recessed luminaires installed in fire rated ceilings and using a fire rated protective cover shall be thermally protected for this application and shall carry a fire rated listing.
- E. Luminaires installed under canopies, roofs or open areas and similar damp or wet locations shall be UL listed and labeled as suitable for damp or wet locations.
- F. Luminaires shall bear the IP rating appropriate for the application.
- G. Luminaires shall be free of light leaks and shall be designed to provide sufficient ventilation of light engines, including ventilation holes where required.
- H. Directly-controlled luminaires providing emergency illumination shall be individually UL924 listed for use in emergency systems.

2.3 LUMINAIRE CONSTRUCTION

- A. All sheet metal Work shall be free from tool marks and dents and shall have accurate angles bent as sharp as compatible with the gauges of the required metal. 20-gauge (0.7-mm or 0.027-inch) minimum.
 - 1. Finish: Baked white dry polyester powder, unless otherwise specified, with a minimum average reflectance of 85% on all exposed and light reflecting surfaces. Steel components shall be prepared for finishing with a 5-step zinc phosphating process prior to painting.
 - 2. Luminaire (including all painted component parts) shall be painted after fabrication unless specifically noted in the Luminaire Schedule.
- B. Extruded Aluminum Housings: One-piece housing of AA 6063 T5 extruded aluminum with 0.14 minimum thickness smooth and free of tooling lines in one uninterrupted section of 1-foot to 24-foot with the cross sectional dimensions as indicated in the Luminaire Schedule.
- C. Die-Cast Aluminum Housings:
 - 1. Single-piece casting to ensure water tightness.
 - 2. Low copper (<0.7% Cu) aluminum alloy.
 - 3. Minimum Class 4 Consumer Grade per NADCA Standards.
- D. All surfaces shall be cleaned and dressed to eliminate all exposed sharp edges or burrs.
- E. All intersections and joints shall be formed true and of adequate strength and structural rigidity to prevent any distortion after assembly.
- F. End Plates: Die cast end plates shall be mechanically attached without exposed fasteners. End caps shall be minimum 0.125" thick.
- G. All mitered corners or joints shall be accurately aligned with abutting intersecting members. Sheet metal Work shall be properly fabricated so that planes will not deform (i.e. become concave or convex) due to normal expected ambient and operating conditions.
- H. Ferrous mounting hardware and accessories shall be finished using either a galvanic or phosphate primer/baked enamel process to prevent corrosion and discoloration of adjacent materials.
- I. Fasteners shall be manufactured of galvanized steel.
- J. Adjustable Lamp Mechanisms: To have aiming stops which can be permanently set to position lamp vertically and rotationally.
- K. Recessed luminaires: Equip with through-wire junction box. Box, driver, and replaceable components shall be accessible from the ceiling opening of the luminaire.
- L. Finish:
 - 1. All exposed aluminum surfaces shall be treated with an acid wash and clear water rinse prior to painting. The luminaire shall then be electrostatically painted, or powder coated, and oven baked in the color indicated in the Luminaire Schedule.

2. All exposed steel surfaces shall be treated with an acid wash and clear water rinse, then prime coated. The luminaire shall then be electrostatically painted, or powder coated, and oven baked in the color indicated in the Luminaire Schedule.
- M. Door Frames for lensed luminaires: White painted, flat aluminum with mitered corners.

2.4 SUSPENSION

- A. Suspension Devices, type as specified in the Luminaire Schedule:
 1. Aircraft Cable: Stainless steel type - 3/32" nominal diameter, stranded, with positive pressure, field adjustable clamp at luminaire connection.
 2. Rigid Pendant: 1/2" nominal diameter or as specifically shown on drawings. Supplied by luminaire manufacturer when available as standard product. At luminaire end of stems, provide earthquake type swivel fitting to permit 45-degree swing in any direction away from vertical.
- B. Suspension system must permit ± 13 -mm (1/2") minimum vertical adjustment after installation.
- C. Supports:
 1. Provide internal safety cable from luminaire body to stud in outlet box.
 2. Carry luminaire weight to structure and provide horizontal bracing from suspension points to ceiling framing to prevent sideways shifting. Provide diagonal seismic restraint wires per code.
- D. Feed Point:
 1. Flat-plate canopy to cover outlet box, with holes for support cable and power cord, concealed fasteners to permit splice inspection after installation.
 2. At the electrified connection provide straight cord feed.
 3. Power cord: white multi-conductor cord, parallel to support cable (aircraft cable); within pendant (rigid pendant); or flexible conduit (chain hanger).
 4. Where emergency feed is required, a separate feed point shall be provided.
- E. Non-feed Points:
 1. 13-mm (1/2") O.D. polished chrome end sleeve, inside threaded 1/4"-20, with 50-mm (2") diameter. Flat white plate to cover hole in ceiling. Top of cable with ball swaged on end, to fit inside sleeve.
 2. Contractor to provide support above ceiling as required.
- F. Suspension method shall allow adjustment to be made in hanging length to allow for variance in ceiling height.
- G. All exposed paintable suspension components shall have the same finish and color as the luminaire housing.

2.5 LAMP HOLDERS

- A. Of configuration and design to accept standard lamp bases.
- B. Wiring channels and lampholder mountings shall be rigid and accurately constructed.

C. Integral-driver LED:

1. Medium screw base: Unglazed porcelain body or thermoplastic (PET GF) with copper-alloy screw shell. 660 watt, 250 volt rated.
2. Bi-Pin base: Ceramic casing with mica cover plate, copper alloy contact surfaces. Pin distance designed for lamp provided.

2.6 LED ARRAYS

A. Minimum lumen maintenance per LM-80 measurements and TM-21 calculations:
L90 at 60,000 hours.

B. Maximum burnout: B90 at 200,000-hours.

C. Free of mercury and toxic materials; RoHS compliant.

D. Linear LED boards: LED pitch shall be consistent throughout the luminaire and shall remain consistent from the end of one board to the start of the next. LED pitch shall be the same from the endcap of the luminaire to the last LED on the board as the LED pitch throughout the luminaire. Luminaire shall have a continuous luminous appearance – bright or dark spots are not acceptable.

E. White LEDs:

1. TIER 1 (legacy CRI 90)

- a. Informational Note: For applications where color fidelity is critical, such as museums, galleries, high-end residential, etc.
- b. Correlated Color Temperature (CCT); as specified in Luminaire Schedule. Maximum 2-step MacAdam ellipse variation throughout listed life (L70).
- c. Color Rendering Index (CRI); minimum 90 Ra.
- d. R9 value; minimum 80.
- e. TM30 values; Rf >85, 95>Rg>105.

2. TIER 2 (legacy CRI 80)

- a. Informational Note: For applications where color fidelity is important, such as offices, schools, general interior areas, etc.
- b. Minimum efficacy: 75 lumens per watt.
- c. L70 lifetime: minimum 80,000-hours (extrapolated.)
- d. Correlated Color Temperature (CCT); as specified in Luminaire Schedule. Maximum 3-step MacAdam ellipse variation throughout listed life (L70).
- e. Color Rendering Index (CRI); minimum 80 Ra.
- f. R9 value; minimum 30.
- g. TM30 values; Rf >75, 92>Rg>110.

3. TIER 3 (legacy CRI 70)

- a. Informational Note: For applications where color fidelity is not critical, such as exterior parking and area lighting, warehouses, etc.
- b. Minimum efficacy: 100 lumens per watt.
- c. L70 lifetime: minimum 100,000-hours (extrapolated.)

- d. Correlated Color Temperature (CCT); as specified in Luminaire Schedule. Maximum 4-step MacAdam ellipse variation throughout listed life (L70).
- e. Color Rendering Index (CRI); minimum 70 Ra.
- f. R9 value; minimum 20.
- g. TM30 values; $R_f > 70$, $80 > R_g > 120$.

F. Tunable White LEDs:

- 1. CCT range as specified in Luminaire Schedule.
- 2. Color temperature at each "step" shall follow the Planckian Locus (Black Body Curve), $\pm 50K$.
- 3. Color adjustment via separate 0-10 volt input from driver.
- 4. Submit Chromaticity curves for review.

G. RGB Color LEDs:

- 1. As specified in Luminaire Schedule.

2.7 LED DRIVERS:

- A. LED drivers shall be integral to luminaire housing or remotely located, when specified, within 15 feet of diode assembly.
 - 1. Luminaires shall be provided with the UL listed or equivalent driver and low voltage power supply as recommended by Manufacturer to insure proper and consistent lamp and luminaire performance. The number of LEDs per luminaire per power supply shall not be exceeded, and LEDs shall not be wired to a high capacity driver unless recommended by Manufacturer.
 - 2. Light Emitting Diode (LED) control gears shall operate with sustained variations of $\pm 10\%$ in voltage and frequency without damage to the driver and have a power factor not less than 90%. Regulations: $\pm 5\%$ across the listed load range.
 - 3. Driver input current shall have Total Harmonic Distortion (THD) of less than 20%. The Driver shall have a Class A sound rating unless otherwise specified.
 - 4. Control gear shall be rated for 50-degree C ambient temperature.
 - 5. All control gear shall facilitate smooth, flicker-free dimming from 100% to 10%, 1% or 0.1% as noted on the Luminaire Schedule.

2.8 LENSES

A. Acrylic:

- 1. Lenses shall be extruded or injection molded crystal clear 100% virgin acrylic (except as indicated otherwise). For lenses with male pattern of pyramids or cones, specified minimum thickness refers to distance from flat surface to base of pyramids (cones) or thickness of undisturbed material. For lenses with female pattern, specified minimum thickness refers to overall thickness of material.
- 2. Lenses shall fully eliminate lamp images when viewed from all directions within 45 to 90-degree angles from vertical, where the ratio of lamp spacing to the distance from lamp underside to top of lens does not exceed 1.50. Within the viewing angle from 0 to 45-degrees the ratio of maximum brightness (under a lamp) to minimum brightness (between lamps) shall not exceed 3 to 1.

3. Finishes (i.e. sandblasting, etching, polishing) shall be performed as described in the Luminaire Schedule.
4. Plastic electrical light diffusers must meet the requirements of Section 2-5209, CAC, Flame Spread Rating.
5. Prismatic Acrylic:
 - a. Extruded of clear virgin acrylic plastic, 0.125" minimum overall thickness, 0.100" nominal unpenetrated thickness, Pattern 12 with flat sided female prisms running at 45 degrees off panel axis unless otherwise specified in the luminaire schedule. Concave prisms are not acceptable.
6. Opal acrylic:
 - a. Extruded or injection molded of virgin acrylic plastic, 0.080" minimum overall thickness.

2.9 POLES

- A. Wind-load strength: 80 mph and 1.3 gust factor for total support assembly, including pole, base and anchorage, where used, to carry the combined Effective Projected Area (EPA) rating of the luminaire heads, arms, supports, and appurtenances at the indicated heights above grade without deflection or whipping.
- B. Pole shafts:
 1. Round straight, round tapered, square straight, or square tapered as noted on the Luminaire Schedule.
 2. Steel poles: Steel tubing conforming to ASTM A 500, Grade B, carbon steel with a minimum yield of 46,000 psi. Single piece construction up to 40-feet in height.
- C. Arm, bracket and tenon mount materials: Finish to match poles.
- D. Mountings, fastenings, and appurtenances: Corrosion-resistant components compatible with the poles and luminaires that will not cause galvanic action at contact points. Provide mountings that will correctly position the luminaire to provide the indicated light distribution.
- E. Handhole: Provide handhole and cover near base of pole shaft for access to wiring compartment.
- F. Grounding lug: Provide grounding lug for grounding conductor with access through handhole.
- G. Pole bases: Anchor type with galvanized steel hold-down or anchor bolts, leveling nuts and bolt covers.
- H. Anchor bolt covers: Spun or two-piece gravity held unless otherwise specified.
- I. Pole-top tenons: Fabricated to support the luminaire indicated and securely fastened to the pole top.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Contractor shall thoroughly examine Project site conditions for acceptance of luminaire installation to verify conformance with Manufacturer and Specification tolerances. Do not commence with installation until all conditions are made satisfactory.

3.2 PREPARATION

- A. Architectural Plans shall govern exact ceiling construction and mounting conditions for all luminaires. Locate as shown on the architectural elevations and reflected ceiling plan.
- B. Consult Architectural Drawings for details of ceiling construction, finish, and other applicable details.
- C. Contractor shall be responsible for coordination of luminaire mounting and compatibility with ceiling construction.
- D. Luminaires in areas where exposed or concealed pipe and ductwork prevents direct access to the structural ceiling shall be provided with appropriate support system to install luminaire below obstructions to avoid conflicts with same.

3.3 ARCHITECTURAL COORDINATION

- A. Where luminaires are mounted in architectural coves, soffits, valances, or cabinets and are given an overall length, the Contractor shall verify all lengths in the field prior to releasing order.
- B. Where luminaires are surface mounted or suspended to match the length of walls or other architectural elements, the Contractor shall verify all lengths in the field prior to releasing order.
- C. Mounting heights specified on drawings:
 - 1. Wall mounted luminaires: shall be to centerline of luminaire.
 - 2. Pendant mounted luminaires: shall be to bottom of luminaire unless specifically identified in the Luminaire Schedule or on drawings.

3.4 INSTALLATION

- A. Install luminaires in accordance with Manufacturer's written instructions, as indicated on the Drawings and as specified herein.
- B. Contractor shall be responsible for all supports, hangers, and hardware necessary for a complete installation.
- C. Luminaires shall be plumb, level, square, in straight lines and without distortion.
- D. Remedy light leaks that may develop after installation of recessed or enclosed luminaires.
- E. Adjustable luminaires shall be installed with "dead" zone of rotation away from intended aiming point.
- F. Provide equipment grounding conductor in all new wiring serving luminaires and lighting equipment. Existing branch circuit wiring without equipment grounding conductor can to be reused; see CEC 410 Part V, Grounding.

3.5 LUMINAIRE SUPPORTS

A. Physical (gravity) supports:

1. Recessed luminaires in wood framed ceilings shall be supported by 2" x 4" hangers fastened to adjacent ceiling joists.
2. Recessed downlights in wood frame ceilings shall be supported with Manufacturers supplied bar hangers and shall be installed according to the Manufacturer's instructions.
3. Surface mounted luminaires solely supported by recessed boxes in a gypsum board ceiling shall have a 1-1/8" steel bar screwed or welded to the back of the box. This steel bar must be long enough to span two ceiling support channels and shall be attached to the channels by twisting wire around the bar and the support channel. For luminaires weighing over 50-pounds, provide studs in recessed box.
4. Support surface mounted luminaires more than 18" wide at or near each corner or edge, in addition to support from outlet box.
5. Support recessed downlights manufactured with built-in brackets by twisting wire around the bracket and two adjacent ceiling support channel runners on either side of the luminaire.
6. Support outlet boxes as specified in Section 260533: Boxes. Provide all boxes with grounding pigtail.

B. Seismic supports:

1. Recessed luminaires in suspended ceilings shall be supported by connecting two support wires to the luminaire at diagonal opposite corners for luminaires weighing 56 pounds or less. Connect four wires, one at each corner for luminaires weighing more than 56 pounds.
2. Surface mounted luminaires on suspended ceilings shall be attached to the main ceiling runner with at least two positive clamping devices and shall have an additional support wire attached to each clamping device and to the structure above.
3. Recessed downlight luminaires in suspended ceilings shall be supported by connecting one support wire to the luminaire housing.
4. All suspended luminaires shall be able to swing 45-degrees from vertical in any direction without obstruction.
 - a. Furnish suspended rigid pendant luminaires with universal joint type hanger canopy and longitudinal sway adapter at each stem, to permit 45-degree swivel on 360-degree circle at canopy and 45-degree longitudinal movement at sway adapter.
 - b. Submit Drawings of hanger assembly for review prior to ordering.
 - c. If suspended luminaire is not free to swing 45-degrees in any direction, without obstructions, provide seismic restraint to prevent contact in conformance with California Uniform Building Code, Section 2330, Seismic Design.
5. All recessed modular luminaires shall be furnished with earthquake clips where installed in tee bar ceiling.

3.6 INSTALLATION OF POLES

- A. General: Store poles on decay-resistant treated skids at least 1-foot above grade and vegetation. Support pole to prevent distortion and arrange to provide free air circulation.
- B. Metal poles: Retain factory-applied pole wrappings until just before pole installation. For poles with nonmetallic finishes, handle with web fabric straps.
- C. Wood poles: Do not drag treated poles along the ground. Do not handle poles with tongs, cant hooks and other pointed tools capable of producing indentation more than 1/4-inch in depth. Do not apply tools to ground line section of poles.
- D. Pole installation: Use fabric web slings (not chain or cable) to raise and set poles.

3.7 CONCRETE FOUNDATIONS

- A. Construct concrete foundations conforming to Division 03, Section "Cast-In-Place Concrete."
- B. Utilize manufacturer's bolt templates to properly position anchor bolts.
- C. Provide leveling nut to anchor bolt prior to pole base. After pole leveling, pack non-shrink grout between pole base and concrete foundation.
- D. Comply with details and Manufacturer's recommendations for reinforcing, anchor bolts, nuts and washers.

3.8 IDENTIFICATION SYSTEM

- A. All concealed junction box cover plates for the lighting branch circuit system shall be clearly marked with a permanent black ink felt pen identifying the branch circuit (both panel designation and circuit number) contained in the box.

3.9 FIELD QUALITY CONTROL

- A. Visual and mechanical inspection:
 - 1. Inspect for physical damage, defects, alignment and fit.
 - 2. Perform operational test of each luminaire after installed, circuited, and energized.
 - 3. Perform emergency operational test of all luminaires connected to emergency circuiting by simulating normal power source failure.
- B. Contractor shall replace at no cost to the Owner all equipment which is found defective or do not operate within factory specified tolerances.

3.10 ADJUSTING AND AIMING

- A. Aiming will occur at night under the direction of the Owner's Representative and the Architect or Engineer. The Contractor shall be responsible for providing the labor and materials for field aiming. This shall include, but not limited to, special rigging or scaffolding, adjusting luminaires in field, testing of various lenses or louvers, as directed by the Architect or Engineer.
- B. Aim all directional luminaires, including but not limited to luminaires described in the Contract Documents or by the luminaire manufacturer as "aimable," "adjustable," or "asymmetric" as follows:

1. To provide the lighting pattern for which the luminaire is designed.
 2. To provide the lighting pattern as shown on the drawings.
 3. To predetermined aiming points as shown on the drawings.
 4. Where aiming cannot be determined, request, in writing, clarification from the Specifier, indicating luminaires needing clarification.
- C. Re-aim luminaires as determined by Architect during final project walkthrough.
- 3.11 CLEANING
- A. Clean luminaires prior to Project closeout in accordance with Manufacturer's recommended materials and methods.
- B. Remove all debris, fingerprints, and packaging remnants.

END OF SECTION

SECTION 26 61 13

FIRE ALARM SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

- A. Work included: Labor, materials, and equipment necessary to complete the installation required for the item specified under this Division, including but not limited to:
 - 1. Fire alarm control panel(s) 'FACP'
 - 2. Fire alarm annunciators
 - 3. Fire alarm terminal cabinets 'FATC'
 - 4. Initiating devices
 - 5. Notification appliances
 - 6. Auxiliary equipment control and supervision
 - 7. Record Drawings
 - 8. Pretesting and final testing
- B. Work furnish and installed under another Section, but connected under this Section:
 - 1. Fire sprinkler alarm system flow switches, valve monitors and post indicating valves
 - 2. Fire/smoke dampers
- C. Work furnished and connected to alarm system under this Section, but installed and connected to HVAC system under another Section:
 - 1. Duct mounted smoke detectors at supply air HVAC equipment 2000 cfm and larger.
 - 2. In-duct mounted smoke detectors at ducted fire/smoke damper. Except that wiring for damper power, control and monitoring shall be under this contract.
- D. Work furnished and installed under another Section: HVAC shutdown wiring via dry contacts in remote mounted programmable relays.
- E. Related work: Consult all other Sections, determine the extent and character of related Work, and properly coordinate Work specified herein with that specified elsewhere to produce a complete installation.
 - 1. Division 08: Door Hardware
 - 2. Division 23: HVAC System
 - 3. Division 21: Fire Sprinkler System

1.2 REFERENCES

- A. Comply with the latest edition of the following applicable Specifications and standards except as otherwise indicated or specified:
 - 1. American National Standards Institute, Inc. (ANSI):

- ANSI C62.41; Guide for Surge Voltage in Low-Voltage AC Power Circuits
- ANSI/ASME A17.1; Safety Code for Elevators and Escalators
- 2. National Fire Protection Association (NFPA):
 - NFPA 13; Standards for the Installation of Fire Sprinkler Systems
 - NFPA 72; National Fire Alarm Code
 - NFPA 90A; Standard for the Installation of Air Conditioning and Ventilating Systems
 - NFPA 101; Life Safety Code
- 3. Underwriters Laboratories, Inc. (UL):
 - UL 38; Manually Activated Signaling Boxes
 - UL 268; Smoke Detectors for Fire Protective Signaling Systems
 - UL 268A; Smoke Detectors for Duct Applications
 - UL 464; Audible Signal Appliances
 - UL 497B; Protectors for Data Communications and Fire Alarm Circuits
 - UL 864; Control Units for Fire-Protective Signaling Systems
 - UL 1424; Cables for Power-Limited Fire-Alarm Circuits
 - UL 1481; Power Supplies for Fire-Protective Signaling Systems
 - UL 1638 Visual Signaling Appliances Standard
 - UL 1971 Signal Devices for the Hearing Impaired
- 4. Factory Mutual System (FM):
 - FM P7825 Approval Guide

1.3 DEFINITIONS

- A. Addressable device: A fire alarm system initiating, control or monitoring device module component on a signaling line circuit (SLC) with discrete digital identification that can have its status individually identified or that is used to individually control other functions, using site-specific programming at the fire alarm control panel.
- B. Alarm signal: A signal indicating an emergency that requires immediate action, such as a signal indicative of fire.
- C. Annunciator: A unit containing one or more indicator lamps, alphanumeric displays, or other equivalent means in which each indication provides status information about a circuit, condition, or location.
- D. Initiating device: A system component that originates transmission of a change-of-state condition, such as in a smoke detector, manual fire alarm box or supervisory switch.
- E. Initiating device circuit: A circuit to which automatic or manual initiating devices are connected where the signal received does not identify the individual device operated.

- F. Notification appliances: A fire alarm system component such as a bell, horn, speaker, light, or text display that provides audible, tactile, or visible outputs or any combination thereof.
- G. Notification appliance circuit: A circuit or path directly connected to a notification appliance(s).
- H. Signaling line circuit: A circuit or path between any combination of circuit interfaces, control units or transmitters over which multiple system input signals or output signals or both, are carried.
- I. Supervisory signal: A signal indicating the need for action in connection with the supervision of guard tours, the fire suppression systems or equipment or the maintenance features of related systems.
- J. Trouble signal: A signal initiated by the fire alarm system or device indicative of a fault in a monitoring circuit or component.

1.4 SYSTEM DESCRIPTION

- A. The fire alarm system shall be a microprocessor-based direct wired, multi-priority, peer-to-peer networked system. The system shall utilize independently addressed, microprocessor-based smoke detectors, heat detectors, and modules as described in this Specification. It shall be complete with all necessary hardware, software and memory specifically tailored for this installation. It shall be possible to permanently modify the software on site by using a plug-in programmer.
- B. It shall be 24Vdc closed circuit, electronically supervised, common signaling, device indicating, and automatic alarm type. The system shall include all wiring, raceways, pullboxes, terminal cabinets, outlet and mounting boxes, control equipment, alarm and supervisory signal initiating devices, alarm notification appliances and all other accessories required for a complete operating system.
- C. Provide system with the following circuit and pathway performance:
 - 1. Initiating devices circuits (IDCs): Class B.
 - 2. Signaling line circuits (SLCs): Class B
 - 3. Notification appliance circuits (NACs): Class B.
- D. Standby power: The standby power supply shall be an electrical battery with capacity to operate the system under maximum supervisory load for twenty 24-hours and capable of operating the system for 5-minutes of evacuation alarm on all devices, operating at maximum load. The system shall include a charging circuit to automatically maintain the electrical charge of the battery. The system shall automatically adjust the charging of the battery to compensate for temperature.
- E. Voltage drop:
 - 1. Under all operating conditions, the voltage on the NAC must be sufficient to operate all the notification appliances so that they deliver the proper signal intensity. The worst-case operating condition shall be calculated from when the control unit primary power supply has failed and the battery capacity is at its lowest point. An end of useful battery life starting value of 20.4volts shall be used at the starting voltage unless the manufacturer's instructions indicate that a

higher or lower value should be used. The current draw of an appliance at the minimum listed operating voltage (16volts) should be used.

2. The point-to-point Ohm's Law voltage drop calculations of all alarm system circuits shall not exceed 10%.
- F. Auxiliary equipment requiring control and monitoring:
1. Flow switches, tamper switches and PIV monitoring
 2. Emergency generator monitoring
 3. Elevator recall and monitoring
 4. Interface and provide fan shutdown control for all supply fans over 2000cfm
 5. Interface and provide fire/smoke damper (FSD) control and monitoring
 6. Door hold/open release device power and control

1.5 SEQUENCE OF OPERATION

- A. General alarm operation: Upon alarm activation of any area smoke detector, duct smoke detector, heat detector, manual pull station, sprinkler waterflow, etc., the following functions shall automatically occur:
1. The internal audible device shall sound at the control panel and annunciator.
 2. The LCD Display shall indicate all applicable information associated with the alarm condition including zone, device type, device location and time/date.
 3. Any remote or local annunciator LCD/LED's associated with the alarm zone shall be illuminated.
 4. The following notification signals and actions shall occur simultaneously:
 - a. Horns shall sound throughout the building.
 - b. Activate visual strobes throughout the building.
 5. Transmit signal to the central station with point identification.
 6. All self-closing fire/smoke doors held open shall be released.
 7. All automatic events programmed to the alarm point shall be executed and the associated outputs activated.
- B. Supervisory operation: Upon supervisory activation of any sprinkler valve supervisory switch, fire pump off-normal, etc., the following functions shall automatically occur:
1. The internal audible device shall sound at the control panel and annunciator.
 2. The LCD display shall indicate all applicable information associated with the supervisory condition including zone, device type, device location and time/date.
 3. Any remote or local annunciator LCD/LED's associated with the supervisory zone shall be illuminated.
 4. Transmit signal to the central station with point identification.
- C. Trouble operation: Upon activation of a trouble condition or signal from any device on the system, the following functions shall automatically occur:
1. The internal audible device shall sound at the control panel and annunciator.

2. The LCD keypad display shall indicate all applicable information associated with the trouble condition including zone, device type, device location and time/date.
 3. Any remote or local annunciator LCD/LED's associated with the trouble zone shall be illuminated.
 4. Transmit signal to the central station with point identification.
- D. Monitor activation: Upon activation of any device connected to a monitor circuit (fire pump, emergency generator status, etc.), the following functions shall automatically occur:
1. The LCD display shall indicate all applicable information associated with the status condition including zone, device type, device location and time/date.
 2. Any remote or local annunciator LCD/LED's associated with the status zone shall be illuminated.
- E. In addition to the above sequence of operation, the FACP shall perform the following functions:
1. Identify every addressable device by location, priority, and device type.
 2. Read and display at FACP the sensitivity of addressable smoke and heat detection devices.
 3. Remain 100% operational and capable of responding to an alarm condition while in the routine maintenance mode.
 4. Be capable of supporting non-addressable as well as addressable devices.
 5. Allow individual programmable control of each connected remote or panel-mounted relay.
 6. Provide the user with the field programmability to add or change addressable device types and custom messages on-site.
 7. Display up to 127 alarms and/or up to 127 trouble indications, one at a time, as a list on the system printer/terminal.
 8. Change the status of configured circuits (arming or disarming) and change status of relays.
 9. Generate an addressable detector sensitivity report providing a chamber voltage listing (device testing) for each detector.

1.6 SUBMITTALS

- A. Submit in accordance with the requirements of Section 280010: Basic Electronic Safety and Security Requirements, the following items:
1. Data/catalog cuts for each product and component specified herein, listing all physical and electrical characteristics and ratings indicating compliance with all listed standards.
 2. Describe system operation, equipment and dimensions and indicate features of each component.
 3. Clearly mark on each data sheet the specific item(s) being submitted and the proposed application.
 4. Shop Drawings. A complete set of shop drawings shall be supplied. The shop drawings shall be reproduced electronically in digital format. This package shall include but not be limited to:

- a. All drawings and diagrams shall include the contractor's title block, complete with drawing title, contractor's name, address, date including revisions, and preparer's and reviewer's initials.
- b. Detailed system operational description. Any Specification differences and deviations shall be clearly noted and marked.
- c. A riser diagram that individually depicts all control panels, annunciators, addressable devices, and notification appliances. Field addressable devices and notification appliances may be grouped together by specific type per loop or circuit.
- d. Complete 1/8" = 1'-0 scale floor plan drawing locating all system devices and elevation of all equipment. Floor plans shall indicate accurate locations for all control and peripheral devices as well as raceway size and routing, junction boxes, and conductor size, and quantity in each raceway. All notification appliances shall be provided with a candela rating and circuit address that corresponds to that depicted on the Riser Diagram. If individual floors need to be segmented to accommodate the 1/8" scale requirements, KEY PLANS and BREAK-LINES shall be provided on the plans in an orderly and professional manner. End-of-line resistors (and values) shall be depicted.
- e. Control panel wiring and interconnection schematics. The drawing(s) shall depict internal component placement and all internal and field termination points. Drawing shall provide a detail indicating where conduit penetrations shall be made, so as to avoid conflicts with internally mounted batteries. For each additional data-gathering panel, a separate control panel drawing shall be provided, which clearly indicated the designation, service, and location of the control enclosure.
- f. Complete calculations shall clearly indicate the quantity of devices, the device part numbers, the supervisory current draw, the alarm current draw, totals for all categories, and the calculated battery requirements. Battery calculations shall also reflect all control panel component, remote annunciator, and auxiliary relay current draws.
- g. System (Load & Battery) calculations shall be provided for each system power supply, each notification appliance circuit and each auxiliary control circuit that draws power from any system power supply.
- h. Additionally, Drawings shall include:
 - 1) Symbols legend.
 - 2) Equipment list showing quantity, make, model and CSFM listing number for each device.
 - 3) Wire and cable schedule.
 - 4) Scope of Work with overall system description.
 - 5) Sequence of operation matrix with system inputs signals and output functions.
 - 6) Code summary and Building type.
 - 7) Assignment of Class and/or Style designation for device circuits.
 - 8) Elevation indicating mounting heights for manual pull stations, audible and visual devices, and combination audible/visual devices.
 - 9) Rated penetration details.

- 10) Typical wiring diagram details of field devices.
- 11) Detector mounting details at HVAC ducts.
- 12) Voltage drop calculations for system wiring circuits.
- 5. Furnish structural calculations for equipment anchorage as described in Section 280010: Basic Electronic Safety and Security Requirements.
- 6. Submit Manufacturer's installation instructions.
- 7. Complete bill of materials listing all components.
- 8. Warranty.

B. Contractor shall submit approved Shop Drawings for review by Local Fire Marshal prior to the purchase and installation of equipment. Provide quantities of Drawing sets as required by jurisdiction. Drawings shall be wet stamped and signed by a registered professional Engineer.

C. Record Drawings:

- 1. Furnish Record Drawings as described in Section 280010: Basic Electronic Safety and Security Requirements, utilizing Shop-Drawing submissions with updated field conditions. These Drawings shall include but not be limited to the following:
 - a. Plot plans and building floor plans, showing point-to-point wiring location of and conduit routing to all devices.
 - b. Block Diagram/Riser Diagram showing the FACP, system components and all conduit and wire type/sizes between each.
- 2. Drawings shall be incorporated into the Record Drawing submission.
- 3. Final acceptance will not be made until the Engineer has approved the Record Drawings.

1.7 OPERATION AND MAINTENANCE MANUAL

- A. Supply operation and maintenance manuals in accordance with the requirements of Section 280010: Basic Electronic Safety and Security Requirements, to include the following:
 - 1. A detailed explanation of the operation of the system.
 - 2. Instructions for routine maintenance.
 - 3. Pictorial parts list and part numbers.
 - 4. Schematic Drawings of wiring system, including all initiation and annunciation devices, control panel, annunciators, etc.
 - 5. Telephone numbers for the authorized parts and service distributors.
 - 6. Final testing reports.

1.8 QUALITY ASSURANCE

- A. All materials, equipment and parts comprising the units specified herein shall be new, unused, and currently under production.
- B. Only products and applications listed in this Section may be used on the Project unless otherwise submitted.

1.9 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Delivery: Fire alarm system components shall not be delivered to the Project site until protected storage space is available. Storage outdoors covered by rainproof material is not acceptable. Equipment damaged during shipment shall be replaced and returned to Manufacturer at no cost to Owner.
- B. Storage: Store in a clean, dry, ventilated space free from temperature extremes. Maintain factory wrapping or provide a heavy canvas/plastic cover to protect units from dirt, water, construction debris and traffic. Provide heat where required to prevent condensation.
- C. Handling: Handle in accordance with Manufacturer's written instructions. Be careful to prevent internal component damage, breakage, denting and scoring. Damaged units shall not be installed. Replace damaged units and return equipment to Manufacturer.

1.10 WARRANTY

- A. Units and components offered under this Section shall be covered by a 1-year parts and labor warranty for malfunctions resulting from defects in materials and workmanship. Warranty shall begin upon acceptance by the Owner.
- B. The warranty package shall include, but not be limited to the following:
 - 1. Emergency maintenance service.
 - 2. Service by factory trained service representative of system Manufacturer.
 - 3. Replacement of any defective components.

1.11 SYSTEM START-UP

- A. Upon completion of installation, a factory trained dealer service representative shall perform initial start-up of the fire alarm system. Sufficient time shall be allowed to properly check the system out and perform required minor adjustments before the Engineer's witnessed test shall begin.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Products furnished by the following Manufacturers shall be acceptable if in compliance with all features specified herein and indicated on the Drawings.
 - 1. EST.
 - 2. Gamewell/FCI (Fire Control Instruments).
 - 3. Notifier.
 - 4. Siemens.
- B. Substitutions: Under provisions of Section 280010: Basic Electronic Safety and Security Requirements.

2.2 CONTROL PANEL 'FACP'

- A. General:

1. The control panel shall comply with applicable requirements of UL864 and shall provide power, annunciation, supervision, and control for the complete fire alarm system. The panel shall be installed in a surface mounted steel cabinet, containing all modules necessary to operate as indicated herein. The operating controls shall be located behind hinged, locked door with viewing window. All control modules shall be labeled, and all zone locations shall be identified.
2. The panel shall be supervised, site programmable, and of modular design supporting up to 64 network nodes. The peer-to-peer network shall contain multiple nodes consisting of the command center, main controller, remote control panels, and annunciation nodes. Each node is an equal, active functional node of the network, which is capable of making all local decisions and generating network tasks to other nodes in the event of node failure or communications failure between nodes. When utilizing a network and multiple wiring faults occur, the network shall re-configure into many sub-networks and continue to respond to alarm events from every panel that can transmit and receive network messages.
3. The panel module shall control and monitor all local or remote peripherals. It shall support a large 168-character LCD, power supply, remote LCD and zone display annunciators, printers, etc.
4. The programmer shall be able to download all network applications from the configuration computer to all the network panels from a single location on the system.
5. The panels shall have the ability to add an operator interface control/display at each node that shall annunciate, command and control system functions.
6. The system shall store all basic system functionality and job specific data in non-volatile memory. All site specific and operating data shall survive a complete power failure intact.
7. The control panel shall contain a standby power supply that automatically supplies electrical energy to the system upon primary power supply failure. The system shall include a charging circuit to automatically maintain the electrical charge of the battery.
8. All addressable devices shall be individually identified by the system and any quantity of addressable devices may be in alarm at any time up to the total number connected to the system.
9. Dynamic supervision of system electronics, wiring, initiating devices and software shall be provided by the control system. Failure of system hardware or wiring shall be indicated by type and location on the alphanumeric annunciator. Software and processor operation shall be monitored by an independent hardware watchdog, which will indicate their failure. The panel shall provide failsafe operation, i.e. all incoming alarms shall override all other modes of operation.
10. Provide a service mode to permit the arming and disarming of individual initiating or output devices as well as manually operating output devices. Status of these devices shall be displayed upon command from the control panel. The panel shall automatically return to the normal mode in the event the panel remains unattended in the service mode.
11. The panel shall be capable of measuring and adjusting the sensitivity of addressable detectors upon request. An alphanumeric display shall be provided

to display custom messages and give readings of detector sensitivity detector by detector. Each device on an addressable initiating circuit shall be checked continuously to include the following:

- a. Sensitivity.
 - b. Response.
 - c. Opens.
 - d. Shorts.
 - e. Ground faults.
 - f. Functionality.
 - g. Status.
12. The panel shall monitor the addressable smoke detectors in such a manner that if the detectors become dirty and reach and maintain 80% of alarm threshold for 5-consecutive hours, a trouble condition indicating exactly which device needs service shall be automatically annunciated. If the device becomes too insensitive for a period of 10-seconds, the trouble indication will read: "Input device response too low".
 13. The panel shall report, by specific device number, any device removed from an addressable initiating circuit and all other devices shall continue to function.
 14. The panel shall automatically indicate the total quantity of alarms and troubles, which have occurred prior to reset at the control unit.
 15. No alarm or trouble indication shall be resettable until it has been acknowledged. It shall not be possible to reset the system until all alarms have been acknowledged.
 16. The panel shall be capable of:
 - a. Counting the number of addressable devices within a designated area or "zone" which are in alarm.
 - b. Counting "zones" which are in alarm.
 - c. Counting the number of addressable devices, which are in alarm on the system.
 - d. Differentiating among types of addressable devices such as smoke detectors, manual stations, waterflow switches, heat detectors, etc.
 - e. Assigning priorities to types of devices, zones, or groups of devices.
 - f. Cross-Zoning.
 17. Each addressable device shall report its condition to the panel control unit every 3-seconds in a manner such that failure of the connections to or internal electronics of the device will result in a trouble signal that identifies the specific device involved.

B. Signaling line circuits (SLC):

1. The control panel shall be supervised, site programmable, and of modular design supporting up to 125-detectors and 125-remote modules per addressable SLC. The panel shall support up to 10-SLC's per panel for a total system capacity of 2500-intelligent addressable points. The system shall be designed with peer-to-peer networking capability for enhanced survivability, with support for up to 64 nodes, each with up to 2500-points and an overall capacity of 160,000-points.

2. The system shall provide electronic addressing of analog/addressable devices.
 3. The system shall have built-in automatic system programming to automatically address and map all system devices attached to the main controller.
 4. The system shall use full digital communications to supervise all addressable loop devices for placement, correct location, and operation. It shall allow swapping of "same type" devices without the need of addressing and impose the "location" parameters on replacement device. It shall initiate and maintain a trouble if a device is added to a loop and clear the trouble when the new device is mapped and defined into the system.
 5. The system shall have a UL Listed detector sensitivity test feature, which will be a function of the smoke detectors and performed automatically every 4-hours.
- C. Digital alarm communicator transmitter (DACT):
1. The system shall provide DACT for off premise communications capability, transmitting system events to single or multiple Central Monitoring Station (CMS) receivers.
 2. The system shall be capable of providing the CMS with point identification of system events using Contact ID or SIA DCS protocols.
 3. In the event of a panel CPU failure during a fire alarm condition, the DACT degrade mode shall transmit a general fire alarm signal to the CMS.
- D. Internal Modular Power Supply:
1. System power supply(s) shall provide multiple power limited 24volt DC output circuits as required by the panel.
 2. Upon failure of normal (AC) power, the affected portion(s) of the system shall automatically switch over to secondary power without losing any system functions.
 3. Each system power supply shall be individually supervised. Power supply trouble signals shall identify the specific supply and the nature of the trouble condition.
 4. All standby batteries shall be continuously monitored by the power supply. Low battery and disconnection of battery power supply conditions shall immediately annunciate as battery trouble and identify the specific power supply affected.
 5. All system power supplies shall be capable of recharging up to 260AH batteries, from a fully discharged condition to a capacity sufficient to allow the system to perform consistent with the requirements of this section, in 48 hours maximum.
 6. Power supply shall be adequate to supply all system components of the fire alarm system, including FACP modules, initiating devices, notification appliances, remote control and monitoring devices, annunciators, etc. All power connections whether AC or DC shall be separately fused within panel.
- E. Storage batteries: Shall be provided and shall be the sealed, lead-calcium types. The batteries shall have ample capacity, with primary power disconnected, to operate the fire alarm system for a period of 24-hours. Following this period of operation via batteries, the batteries shall have ample capacity to operate all components of the system, including all alarm annunciating devices in the total alarm mode for a period of 5-minutes. Batteries shall be sized to deliver 50 percent more

ampere/hours than required for the calculated capacities. Battery cabinet shall be a separate compartment within the control panel.

- F. Battery charger: Shall be completely automatic, with high/low charging rate, capable of restoring the batteries from full discharge to full charge within 8-hours. A separate ammeter shall be provided for indicating rate of charge. A separate voltmeter shall be provided to indicate the state of the battery charge. Pilot light shall indicate when batteries are manually placed on a high rate of charge as part of the unit assembly if a high-rate switch is provided. Charger shall be located in control panel.

G. Reports:

1. The system shall provide the operator with system reports that give detailed description of the status of system parameters for corrective action, or for preventative maintenance programs. The system shall provide these reports via the main LCD and shall be capable of being printed on any system printer.
2. The system shall provide a report that gives a sensitivity listing of all detectors that have less than 75% environmental compensation remaining. The system shall provide a report that provides a sensitivity (% Obscuration per foot) listing of any detector.
3. The system shall provide a report that gives a listing of the sensitivity of all the detectors on any given panel in the system, or any given analog/addressable device loop within any given panel.
4. The system shall provide a report to determine the carbon monoxide detectors end-of-life.
5. The system shall provide a report that gives a chronological listing of up to the last 1740 system events.
6. The system shall provide a listing of all the firmware revision listings for all the installed network components in the system.

2.3 ANNUNCIATORS

A. Main control and annunciator panel:

1. Main annunciator shall be located with the FACP.
2. The main display shall be a large 168-character LCD with normal, alarm, trouble, supervisory, disabled point, and ground fault indicators.
3. The main display shall show the first and most recent highest priority system events without any operator intervention. All system events shall be directed to one of four message queues. Messages of different types shall never inter-mixed to eliminate operator confusion. A "Details" switch shall provide additional information about any device highlighted by the operator.
4. Receipt of alarm, trouble, and supervisory signals shall activate integral audible devices at the control panel(s) and at each remote annunciation device. The integral audible devices shall produce a sound output upon activation of not less than 85-dBA at 10-feet.
5. The internal audible signal shall have different programmable patterns to distinguish between alarm, supervisory, trouble and monitor conditions.
6. The annunciator shall contain the following controls:
 - a. System reset switch with indicator

- b. System alarm silence switch with indicator
 - c. System panel silence switch with indicator
 - d. Programmable switch with indicator
 - e. Details switch
 - f. System message queue scroll switches.
 - g. 10-Digit keypad to enable/disable system and functions.
 - 7. An authorized operator shall have the ability to operate or modify system functions like system time, date, passwords, holiday dates, restart the system and clear control panel event history file.
 - 8. An authorized operator shall be capable of performing test functions within the installed system.
- B. Fireman's remote annunciator panel (FRAP):
- 1. Remote LCD network alphanumeric annunciators shall display each point in the system.
 - 2. Network alphanumeric annunciators shall be located as indicated on the plans. This annunciator shall be an integral part of the peer-to-peer network for survivability.
 - 3. Annunciator shall contain a supervised, back-lit, liquid crystal display with a minimum of 8-lines and 21-characters per line. The annunciator shall support full ability to serve as the operating interface to the system and shall include the following features:
 - a. Matched appearance with other system displays
 - b. LCD display shall be configurable to show the status of any or all the following functions anywhere in the system:
 - 1) Alarm
 - 2) Supervisory
 - 3) Trouble
 - 4) Monitor
 - 4. Annunciator must be capable of supporting custom messages as well as system event annunciation. It must be possible to filter unwanted annunciation of trouble, alarm, or supervisory functions on a by point or by geographic area. The annunciators shall be mounted in stand-alone enclosures at location as indicated on the plans.

2.4 INTELLIGENT ADDRESSABLE DETECTORS

A. General:

- 1. Each detector device shall have a microprocessor with non-volatile memory to support its functionality and serviceability. Devices shall store as required for its functionality the following data: device serial number, device address, device type, personality code, date of manufacture, hours in use, time and date of last alarm, amount of environmental compensation left/used, last maintenance date, job/project number, current detector sensitivity values, diagnostic information (trouble codes) and algorithms required to process sensor data and perform communications with the loop controller.

2. Each device shall be capable of electronic addressing, either automatically or application programmed assigned, to support physical/electrical mapping and supervision by location. Setting a device's address by physical means shall not be necessary.
 3. The intelligent detectors shall be capable of full digital communications using both broadcast and polling protocol. Each detector shall be capable of performing independent fire detection algorithms. The fire detection algorithm shall measure sensor signal dimensions, time patterns, and combine different fire parameters to increase reliability and distinguish real fire conditions from unwanted deceptive nuisance alarms. Signal patterns that are not typical of fires shall be eliminated by digital filters. Devices not capable of combining different fire parameters or employing digital filters shall not be acceptable.
 4. Each detector shall be capable of making alarm decisions based on fire parameter information stored in the detector head. Distributed intelligence shall improve response time by decreasing the data flow between detector and analog loop controller. Maximum total analog loop response time for detectors changing state shall be 0.75-seconds. The integral microprocessor shall dynamically examine values from the sensor and initiate an alarm based on the analysis of data.
 5. The detector shall continually monitor any changes in sensitivity due to the environmental effects of dirt, smoke, temperature, aging, and humidity.
 6. Each detector shall have a separate means of displaying communication and alarm status. A green/red LED shall flash to confirm communication with the analog loop controller and display alarm status.
 7. The detector shall be capable of identifying up to 32-diagnostic codes. This information shall be available for system maintenance. The diagnostic code shall be stored at the detector.
 8. Each smoke detector shall be capable of transmitting pre-alarm and alarm signals in addition to the normal, trouble and need cleaning information. It shall be possible to program control panel activity to each level. Each smoke detector may be individually programmed to operate at any one of 5-sensitivity settings.
 9. Each device microprocessor shall contain an environmental compensation algorithm, which identifies and sets ambient "Environmental Thresholds" approximately six times an hour. The microprocessor shall continually monitor the environmental impact of temperature, humidity, other contaminants as well as detector aging. The process shall employ digital compensation to adapt the detector to both 24-hour long-term and 4-hour short-term environmental changes. The microprocessor shall monitor the environmental compensation value and alert the system operator when the detector approaches 80% and 100% of the allowable environmental compensation value. Differential sensing algorithms shall maintain a constant differential between selected detector sensitivity and the "learned" base line sensitivity. The base line sensitivity information shall be updated and permanently stored at the detector approximately once every hour.
- B. Photoelectric smoke detector:
1. Provide intelligent analog photoelectric detector shall utilize a light scattering type photoelectric smoke sensor to sense changes in air samples from its surroundings.

2. Each unit shall have a field-replaceable smoke chamber.
 3. The photo detector shall be rated for ceiling installation at a minimum of 30-foot centers and be suitable for wall mount applications.
 4. The photoelectric smoke detector shall be suitable for direct insertion into air ducts up to 3-feet high and 3-feet wide with air velocities up to 5,000-feet/minute.
 5. The percent smoke obscuration per foot alarm set point shall be field selectable to any of five sensitivity settings ranging from 1.0% to 3.5%. The photoelectric detector shall be suitable for operation in the following environment:
 - a. Temperature: 32-degree F to 120-degree F (0-degree C to 49-degree C)
 - b. Humidity: 0-93% RH, non-condensing
 - c. Installation attitude: no limit
- C. Photoelectric smoke/carbon monoxide detector:
1. Provide intelligent photoelectric smoke and carbon monoxide detectors with analog photoelectric detector that utilizes a light scattering type photoelectric smoke sensor to sense changes in air samples from its surroundings. The integral electrochemical carbon monoxide cell shall be provided.
 2. Each unit shall have a field-replaceable smoke chamber
 3. Each unit shall be provided with a field-replaceable carbon monoxide sensor module.
 4. The carbon monoxide sensor module shall have a end of life at 6-years. End of life status shall be continuously monitored and reported by the control panel.
 5. Each unit shall provide split sensor programming such that the combination device shall only require one software address while still providing two distinct inputs. This capability will allow for separate actions to be initiated independently from the two separate elements (smoke & CO) without requiring a separate software address on the loop.
 6. The photoelectric detector shall be rated for ceiling installation at a minimum of 30-foot centers and be suitable for wall mount applications.
 7. The percent smoke obscuration per foot alarm set point shall be field selectable to any of five sensitivity settings ranging from 1.0% to 3.5%. The photoelectric detector shall be suitable for operation in the following environment:
 - a. Temperature: 32-degree F to 120-degree F (0-degree C to 49-degree C)
 - b. Humidity: 0-93% RH, non-condensing
 - c. Installation Attitude: no limit
- D. Standard detector bases:
1. Provide standard detector mounting bases suitable for mounting on a standard 4" octagon or square box. The base shall contain no electronics and support all intelligent detector types.
 2. Removal of the respective detector shall not affect communications with other detectors.
 3. Terminal connections shall be made on the room side of the base.
- E. Relay detector bases:

1. Provide standard detector mounting bases suitable for mounting on a standard 4" octagon or square box. The base shall support all intelligent detector types.
2. Removal of the respective detector shall not affect communications with other detectors.
3. Terminal connections shall be made on the room side of the base. Bases, which must be removed to gain access to the terminals, shall not be acceptable.
4. The relay shall be a bi-stable type and selectable for normally open or normally closed operation.
5. The position of the contact shall be supervised.
6. The relay shall automatically de-energize when a detector is removed.
7. The operation of the relay base shall be controlled by its respective detector processor. Detectors operating standalone mode shall operate the relay upon changing to alarm state. Relay bases not controlled by the detector microprocessor shall not be acceptable.
8. Form "C" relay contacts shall have a minimum rating of 1amp at 30volt DC and be listed for pilot duty.

F. Duct detector:

1. Provide intelligent addressable analog photoelectric duct smoke detectors that utilize a light scattering type photoelectric smoke sensor to sense changes in air samples from its surroundings. The integral microprocessor shall dynamically examine values from the sensor and initiate an alarm based on the analysis of data. Systems using central intelligence for alarm decisions shall not be acceptable. The detector shall continually monitor any changes in sensitivity due to the environmental effects of dirt, smoke, temperature, aging, and humidity.
2. The percent smoke obscuration per foot alarm set point shall be field selectable to any of five sensitivity settings ranging from 0.79% to 2.46%. The duct detector shall be suitable for operation in the following environment:
 - a. Temperature: -20-degree F to 158-degree F (-29-degree C to 70-degree C)
 - b. Humidity: 0% to 93% RH, non-condensing
 - c. Air velocity: 100 to 4000-feet/minimum
3. Provide an air exhaust tube and an air sampling inlet tube, which extends into the duct air stream up to ten feet. The sampling tube can be installed with or without the cover in place and can be rotated in 45-degree increments to ensure proper alignment with the duct airflow.
4. Status LEDs shall remain visible through a clear assembly cover.
5. The unit shall contain a magnet-activated test switch.
6. One integral Form C auxiliary alarm relay shall be provided. The relay contact shall be capable of being individually programmed from the control panel. The contact shall be rated for 2.0amp at 30volt DC.

2.5 INTELLIGENT ADDRESSABLE MODULES

A. General:

1. Each remote device shall have a microprocessor with non-volatile memory to support its functionality and serviceability. Devices shall store as required for its

functionality the following data: device serial number, device address, device type, personality code, date of manufacture, hours in use, time and date of last alarm, amount of environmental compensation left/used, last maintenance date, job/project number, current detector sensitivity values, diagnostic information (trouble codes) and algorithms required to process sensor data and perform communications with the loop controller.

2. Each device shall be capable of electronic addressing, either automatically or application programmed assigned, to support physical/electrical mapping and supervision by location.
 3. The module shall be suitable for operation in the following environment:
 - a. Temperature: 32°F to 120°F (0°C to 49°C)
 - b. Humidity: 0-93% RH, non-condensing
- B. Single input module:
1. Provide intelligent signal input modules for monitoring of PIV's, tamper switches, flow switches, fan & damper status, or any other sets of dry contacts required to be monitored.
 2. The single input module shall provide one (1) supervised Class B input circuit capable of a minimum of 4 personalities, each with a distinct operation.
 3. The module shall be suitable for mounting on a standard 4" square box with 1-gang ring.
 4. The single input module shall support the following circuit types:
 - a. Normally Open Alarm Latching (Manual Stations, Heat Detectors, etc.)
 - b. Normally Open Alarm Delayed Latching (Waterflow Switches)
 - c. Normally Open Active Non-Latching (Monitor, Fans, Dampers, Doors, etc.)
 - d. Normally Open Active Latching (Supervisory, Tamper Switches)
- C. Dual input module:
1. Provide intelligent dual input modules for monitoring of sets of PIV's, tamper switches, flow switches, fan & damper status, or any other sets of dry contacts required to be monitored.
 2. The dual input module shall provide two (2) supervised Class B input circuits each capable of a minimum of 4 personalities, each with a distinct operation.
 3. The module shall be suitable for mounting on a standard 4" square box with 1-gang ring.
 4. The dual input module shall support the following circuit types:
 - a. Normally open alarm latching
 - b. Normally open alarm delayed latching
 - c. Normally open active non-latching
 - d. Normally open active latching
- D. Signal module:
1. Provide intelligent single input signal modules for activation of booster power supplies, audible/visual circuits.

2. The single input signal module shall provide 1-supervised Class B output circuit capable of a minimum of 2-personalities, each with a distinct operation.
 3. The module shall be suitable for mounting on a standard 4" square box with 2-gang ring.
 4. The single input signal module shall support audible/visible signal power selector (polarized 24volt DC at 2amps, 25Vrms at 50watt or 70Vrms at 35watt of audio)
- E. Synchronized signal module:
1. Provide intelligent single input signal modules for activation of booster power supplies and/or audible/visual circuits that require synchronization.
 2. The single input signal module shall provide one (1) supervised Class B output circuit capable of a minimum of 2 personalities, each with a distinct operation.
 3. The module shall be suitable for mounting on a standard 4" square box with 2-gang ring.
 4. The single input signal module shall support audible/visible signal power selector (polarized 24volt DC at 2amp, 25Vrms at 50watt or 70Vrms at 35watt of audio)
 5. Provides UL1971 auto-sync output for synchronizing multiple notification appliance circuits
- F. Control relay module:
1. Provide intelligent control relay modules for activation and/or shutdown of fans, dampers, door holder circuits, door locks, shunt trip, elevator recall or any other fail-safe system requiring control or activation.
 2. The control relay module shall provide one Form R dry relay contact rated at 2amps at 24volt DC to control external appliances or equipment shutdown.
 3. The control relay shall be rated for pilot duty and releasing systems.
 4. The control relay module shall be suitable for mounting on a standard 4" square box with 1-gang ring.
- G. Manual pull station:
1. Provide intelligent single action, single stage fire alarm pull stations. The fire alarm pull station shall be of metal construction with an internal toggle switch. Provide a locked test feature. Finish the station in red with silver "PULL IN CASE OF FIRE" lettering.
 2. The manual station shall be suitable for mounting on a standard 4" square box with 1-gang ring.
 3. Provide compatible surface mount red box at all surface mount locations.

2.6 NOTIFICATION APPLIANCES

A. Horns:

1. Horns shall be a low-profile design, finished in red with white lettering and shall not protrude more than 1" off the finished wall surface. In-out screw terminals shall be provided for wiring.
2. Horns shall be provided with a switch selectable audible output of at least two decibel levels. Maximum 84-dBA output at 10-feet when measured in reverberation room per UL 464.

3. Horns shall have two selectable tone options of temporal or non-temporal continuous pattern.
4. Horns shall be suitable for wall mounting and shall mount in a standard 4" square x 2 1/8" deep electrical box. All mounting hardware shall be captive and there shall be no mounting screws visible after the device is installed.
5. Horns shall also be suitable for ceiling mounting and shall mount in a standard 4" square x 2-1/8" deep electrical box. All mounting hardware shall be captive and there shall be no mounting screws visible after the device is installed.
6. Where surface mounted horns are installed a skirt enclosure or manufacturer's color-matched surface mount box, shall be installed to conceal the electrical box to which the strobe lights are mounted. The correct surface box shall be used to ensure the skirt fits properly and is flush with the wall or ceiling.

B. Strobe lights:

1. Strobes shall be a low-profile design, finished in red with white lettering and shall not protrude more than 1" off the finished wall surface. In-out screw terminals shall be provided for wiring.
2. Strobes shall provide synchronized flash outputs at maximum pulse duration of 0.2-seconds. The light output shall be an even pattern with no hot spots. Strobes appliances shall be comprised of a Xenon flashtube with a clear lens and be entirely solid state.
3. The strobe shall have selectable 15, 30, 75 or 110 cd settings for wall or standard ceiling height mounting.
4. The strobe shall have selectable 95, 115, 150 or 177 cd settings for high ceilings.
5. It shall be possible to change the strobe setting without removing the device from the wall or ceiling.
6. Strobes shall be suitable for wall mounting and shall mount in a standard 4" square x 1-1/2" deep electrical box. All mounting hardware shall be captive and there shall be no mounting screws visible after the device is installed.
7. Strobes shall also be suitable for ceiling mounting and shall mount in a standard 4" square x 1-1/2" deep electrical box. All mounting hardware shall be captive and there shall be no mounting screws visible after the device is installed.
8. Where surface mounted strobe lights are installed a skirt enclosure or manufacturer's color-matched surface mount box, shall be installed to conceal the electrical box to which the strobe lights are mounted. The correct surface box shall be used to ensure the skirt fits properly and is flush with the wall or ceiling.

C. Combination horn/strobe lights:

1. Horns shall be a low-profile design, finished in red with white lettering and shall not protrude more than 1" off the finished wall surface. In-out screw terminals shall be provided for wiring.
2. Horns shall be provided with a switch selectable audible output of at least two decibel levels.
3. Horns shall have two selectable tone options of temporal or non-temporal continuous pattern.

4. Strobes shall provide synchronized flash outputs at maximum pulse duration of 0.2-seconds. The light output shall be an even pattern with no hot spots. Strobes appliances shall be comprised of a Xenon flashtube with a clear lens and be entirely solid state.
 5. It shall be possible to flash the strobe at a temporal flash rate to match the horn.
 6. The strobe shall have selectable 15, 30, 75 or 110 cd settings for wall or standard ceiling height mounting.
 7. The strobe shall have selectable 95, 115, 150 or 177 cd settings for high ceilings.
 8. It shall be possible to change the strobe setting without removing the device from the wall or ceiling.
 9. Horn/strobes shall be suitable for wall mounting and shall mount in a standard 4" square x 1-1/2" deep electrical box. All mounting hardware shall be captive and there shall be no mounting screws visible after the device is installed.
 10. Horn/strobes shall also be suitable for ceiling mounting and shall mount in a standard 4" square x 1-1/2" deep electrical box. All mounting hardware shall be captive and there shall be no mounting screws visible after the device is installed.
 11. Where surface mounted horn/strobe lights are installed a skirt enclosure or manufacturer's color-matched surface mount box, shall be installed to conceal the electrical box to which the strobe lights are mounted. The correct surface box shall be used to ensure the skirt fits properly and is flush with the wall or ceiling.
- D. Weatherproof horns and strobes and/or combination appliances:
1. Appliances shall be a semi-flush design, finished in red with white lettering. In-out screw terminals shall be provided for wiring.
 2. Horns shall be provided with a switch selectable audible output of at least three decibel levels of 99, 95, and 90-dBA.
 3. Horns shall have two selectable tone options of temporal or non-temporal continuous pattern.
 4. Strobes shall provide synchronized flash outputs at maximum pulse duration of 0.2 seconds. The light output shall be an even pattern with no hot spots. Strobes appliances shall be comprised of a Xenon flashtube with a clear lens and be entirely solid state.
 5. The strobe shall have a 75 cd setting for wall or standard ceiling height mounting.
 6. Strobe shall operate over an extended temperature range of -31-degree F to 150-degree F. All inputs shall be polarized for compatibility with standard reverse polarity supervision of circuit wiring.
 7. Appliance backbox shall be weatherproof and vandal resistant.
- E. Vibrating bell:
1. Provide 10" surface weatherproof vibrating bell.
 2. The bell shall be 24volt DC.
 3. Bell shall have heavy-duty cast housing with Red finish.
 4. Weatherproof boxes shall be provided for outdoor mounting.
- F. Remote booster power supplies:

1. Unit shall be a self-contained with 24volt DC power supply and batteries housed in its own locked enclosure. Keys provided shall be identical to the keys provided for all other fire alarm equipment provided.
2. Power supply shall be available in both 10amp or 6.5amp models and 120volt AC.
3. On board LED indicators for each NAC, battery supervision, ground fault and AC power.
4. The power supply shall provide four (4) independent 3amp NACs. Each circuit can be configurable as an auxiliary output.
5. Configurable for any one of three signaling rates: 120SPM; 3-3-3 temporal; or, continuous.
6. Two independent and configurable inputs switch selectable to allow correlation of the two (2) inputs and the four (4) outputs.
7. NACs shall be configurable for either four Class B or two Class A circuits.
8. The unit shall be compatible with SIGA-CC1S for synchronization of multiple power supplies without inter-connect wiring.
9. Brackets shall be provided inside the enclosure to allow mounting the signaling modules. All signaling modules shall be listed to be located inside the booster power supply enclosure.
10. A selectable dip switch shall enable built in synchronization for horns and strobes which may be used to synchronize downstream devices, as well as other boosters and their connected devices.

2.7 AUXILIARY EQUIPMENT CONTROL AND SUPERVISION

- A. Fire sprinkler system components: Include single or dual input modules at waterflow and/or tamper switch on each floor of building, fire pump room, etc., for monitoring status:
 1. Each waterflow switch will initiate an alarm signal.
 2. Each tamper switch will initiate a trouble signal.
 3. Each post indicating valve (PIV) will initiate a trouble signal.
- B. Emergency generator status: Include single or dual input modules at generator for monitoring the following conditions:
 1. Generator running to initiate a trouble signal.
 2. Generate malfunction to initiate a trouble signal.
 3. Generator output circuit breaker(s) open.
- C. Supply fan/air handler shutdown: All supply air fan, 2000cfm and greater, shall be furnished with a duct-mounted smoke detector and addressable control relay for shutdown purposes. Upon smoke detection, the fan shall be automatically controlled to the "OFF" position.
- D. Fire/smoke dampers (FSDs):
 1. FSDs for return air systems: Include spot smoke detector(s) over the openings of all return air FSDs for "OPEN/CLOSE" control upon detection of smoke.

Provide one detector if open is 36" wide or less, two if opening is 72" wide or less and three if opening is 108" wide or less.

2. FSDs for supply air systems: Include in-duct smoke detector(s) within ducts adjacent to supply air FSDs for "OPEN/CLOSE" control upon detection of smoke. Provide one detector if open is 36" wide or less, two if opening is 72" wide or less and three if opening is 108"
- E. Door hold-open/closure devices: Provide an addressable control relay for doors with magnetic hold-open/closure devices as well as a 24volt DC power circuit from fire alarm system to release doors when system is in alarm.
- F. Roll-down fire doors and shutters: Provide an addressable control relay for fire roll-down doors or shutters for interconnection with fire-fly release devices on doors for closure when system is in alarm.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Contractor shall thoroughly examine Project site conditions for acceptance of fire alarm system installation to verify conformance with Manufacturer and Specification tolerances. Do not commence with installation until all conditions are made satisfactory.

3.2 INSTALLATION

A. General:

1. Install fire alarm system in accordance with Manufacturer's written instructions, as indicated on the Drawings and as specified herein.
2. The 120volt, 2-wire, 60-cycles AC two-20amp circuits supply required to power the system shall be connected as indicated on the Drawings. Connect to red colored circuit breaker(s) in panelboard. Identify circuit as "Fire Alarm Circuit Control."

B. Conductors:

1. Refer to Section 280513: Electronic Safety and Security Conductors and Cables.
2. All circuits shall be rated power limited in accordance with CEC Article 760.
3. All system conductors shall be of the type(s) specified herein.
 - a. All initiating circuit, signaling line circuit, AC power conductors, shield drain conductors and grounding conductors, shall be solid copper, stranded or bunch tinned (bonded) stranded copper.
 - b. All wiring shall be color-coded throughout.
 - c. Signaling line circuits: Shall be #18 AWG minimum multi-conductor jacketed twisted cable or as per manufacturer's requirements.
 - d. Initiating device circuits: 24volt DC circuits shall be #18 AWG minimum or per manufacturer's requirements.
 - e. Notification appliance circuits:
 - 1) Horn-strobe or strobe: Non-twisted pair, not less than #14 AWG or as recommended by the manufacturer.

f. 120Vac circuits:

- 1) Minimum #10 AWG for panel power circuits.
- 2) Minimum #12 AWG for all other circuits.
- 3) Each circuit shall have its own dedicated neutral conductor.

C. Conduit raceway:

1. All system components listed to UL864 Control Units for Fire Protective Signaling Systems shall be installed within a common conduit raceway system, in accordance with the manufacture's recommendations. System components not listed to the UL864 standard shall utilize a separate conduit raceway system for each of the sub-systems.
2. All system conduits shall be EMT, 1/2-inch minimum, except for flexible metallic conduit used for whips to devices only, maximum length 6 feet, 1/2-inch diameter, minimum.
3. Conduits shall be sized according to the conductors contained therein. Cross sectional area percentage fill for system conduits shall not exceed 40%.
4. All fire alarm conduit systems shall be routed and installed to minimize the potential for physical, mechanical or by fire damage, and so as not to interfere with other building systems, facilities or equipment, and to facilitate service and minimize maintenance.
5. All system conduits, junction boxes, pull boxes, terminal cabinets, electrical enclosures, and device back boxes shall be readily accessible for inspection, testing, service and maintenance.
6. All penetration of floor slabs and firewalls shall be sleeved (1" conduit minimum) fire stopped in accordance with all local fire codes.
7. All junction box covers shall be painted red.

D. Equipment:

1. All devices and appliances shall be mounted to flush mounted boxes where areas are finished. Exceptions being above suspended ceiling, exposed ceiling areas, or equipment rooms to facilitate connections to other equipment.
2. All pull stations shall be mounted 48-inches above the finished floor, as measured on handle.
3. All audio/visual devices shall be mounted at a minimum of 80-inches and no more than 96-inches above the finished floor, as measured on strobe center. Devices shall be mounted no less than 6-inches from the ceiling.
4. No area smoke detectors shall be mounted within 36-inches of any HVAC supply, return air register or luminaire.
5. No area smoke or heat detector shall be mounted within 12-inches of any wall.
6. All fire alarm devices shall be accessible for periodic maintenance.
7. End-of-line resistors shall be furnished as required for mounting as directed by the manufacturer. Devices containing end-of-line resistors shall be appropriately labeled. Devices should be labeled so removal of the device is not required to identify the EOL device.
8. All addressable modules shall be mounted within 36-inches of the monitored or controlled point of termination. This shall include, but is not necessarily limited

to, fan shutdown, elevator recall, shunt trip, sprinkler status points, or door release. Label all addressable modules as to their function.

9. Power-limited/non-power-limited CEC wiring standards shall be observed.
10. Relays shall be appropriately labeled on the exterior to indicate "FIRE ALARM SYSTEM" and their specific function (i.e. FAN SHUTDOWN).

3.3 FIELD QUALITY CONTROL

- A. Manufacturer's field service: Contractor shall arrange and pay for the services of a factory-authorized service representative to supervise the initial start-up, pretesting, and adjustment of the fire alarm system.
- B. Independent testing: Contractor shall arrange and pay for the services of an independent Testing Agency to perform all quality control testing, calibration and inspection required herein. Testing Agencies objectives shall be to:
 1. Assure fire alarm system installation conforms to specified requirements and operates within specified tolerances.
 2. Field test and inspect to ensure operation in accordance with Manufacturer's recommendations and Specifications.
 3. Prepare final test report including results, observations, failures, adjustments, and remedies.
 4. Apply label on fire alarm system control panel upon satisfactory completion of tests and results.
 5. Verify settings and make final adjustments.
- C. At least three weeks prior to any testing, notify the Engineer so that arrangement can be made for witnessing test, if deemed necessary. All pretesting shall have been tested satisfactorily prior to the Engineer's witnessed test.
- D. Prefunctional testing:
 1. Provide Testing Agency with Contract Documents and Manufacturer instructions for installation and testing.
 2. Visual and mechanical inspection:
 - a. Inspect for physical damage, defects alignment and fit.
 - b. Perform mechanical operational tests in accordance with Manufacturer's instructions.
 - c. Compare nameplate information and connections to Contract Documents.
 - d. Check tightness of all control and power connections.
 - e. Check that all covers, barriers, and doors are secure.
 3. Fire alarm system tests:
 - a. The system shall be completely tested prior to final acceptance testing. All points shall be tested from point of initiation to the final point or points of annunciation. All circuits shall be tested for continuity and ability to transmit the required signal correctly to the FACP. Any problem due to wrong wire type, wire twist, impedance, mismatches, noise filtering or shielding shall be completely corrected during pretesting and prior to any final acceptance tests.

- b. Testing shall include each device in the system. Coordinate with other trades as necessary for testing.
 - 1) Sprinkler flow switches: Record time delay from water flow to alarm and adjust as necessary for a 30 to 50-second delay.
 - 2) Tamper switches: Verify "trouble" signal is received and alarmed on closing of each valve.
 - 3) Smoke detectors, in-duct smoke detectors and duct mounted smoke detectors: Test with actual or approved artificial smoke. Verify that reset does not occur when devices are cleared of smoke. Verify supervisory circuit function. Perform pressure differential test on all duct mounted smoke detectors.
 - 4) Door release: Verify that proper alarm activates every held-open door, roll-down doors, and shutters, that doors close completely to the closed position.
 - 5) Elevator recall: Verify that elevators recall to designated floor by testing elevator lobby detectors with smoke. This is necessary on the ground floor and one other only.
 - 6) Audible/visual notification: Activate by means of an alarm-initiating device that audible and visual devices are clearly audible and/or visual throughout.
 - 7) Central station notification: Verify that one set of conductors in the terminal cabinet becomes a short circuit on any "trouble" condition and that the other set becomes a short circuit on any "alarm" condition. Verify that the conductor groups are labeled properly.
- c. Test report:
 - 1) Provide a complete report listing every device, the date it was tested, the results and the date retested (if failure occurred during the previous test). The test report shall indicate that every device tested successfully.
 - 2) Submit two typed copies of the test report in a neatly bound folder for review and approval. Failure to comply with this will result in a delay of final testing and acceptance.

E. Functional performance testing:

- 1. After the approval of the test report, provide a schedule of final testing to be done in the presence of the Fire Marshal and Owner's Representative. The schedule must be received by the Engineer a minimum of 2 weeks prior to the Final Test Date and must list the dates and time slots in which the various systems can be tested.
- 2. Coordination of the Final Test dates with all parties (General Contractor, Mechanical Contractor, Elevator Contractor, Engineer, Owner, and others) shall be the sole responsibility of the Contractor. If a party is required to be present during any phase of testing to activate a device, ensure that the party or a qualified representative of the party is present throughout that phase of the testing.

F. In the event that the system fails to function properly during the testing, as a result of inadequate pretesting or preparation, the Contractor shall bear all costs incurred by

the necessity for retesting including test equipment, transportation, subsistence and the Engineer's hourly rate.

- G. Contractor shall replace at no costs to the Owner all devices which are found defective or do not operate within factory specified tolerances.
- H. Contractor shall submit the Testing Agency's final report for review prior to Project closeout and final acceptance by the Owner. Test report shall indicate test dates, devices tested, results, observation, deficiencies, and remedies. Test report shall be included in the operation and maintenance manuals.

3.4 TRAINING

- A. Factory authorized service representative shall conduct a 2-hour training seminar for Owner's Representatives upon completion and acceptance of system. Instructions shall include safe operation, maintenance, and testing of equipment with both classroom training and hands-on instruction.
- B. Contractor shall schedule training with a minimum of 7-days advance notice.

END OF SECTION

SECTION 27 00 10

BASIC COMMUNICATION REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Table of Contents, Division 27 - Communications:

<u>SECTION NO.</u>	<u>SECTION TITLE</u>
270010	BASIC COMMUNICATION REQUIREMENTS
270526	COMMUNICATION GROUNDING AND BONDING
270529	COMMUNICATION HANGERS AND SUPPORTS
270528	COMMUNICATION PATHWAYS
270536	COMMUNICATION CABLE RUNWAYS AND TRAYS
270553	COMMUNICATION IDENTIFICATION
271100	COMMUNICATION EQUIPMENT ROOMS
271500	COMMUNICATION HORIZONTAL CABLING

B. Work included: This Section includes general administrative and procedural requirements for Division 27. The following administrative and procedural requirements are included in this Section to supplement the requirements specified in Division 01.

1. Quality assurance.
2. Definition of terms.
3. Submittals.
4. Coordination.
5. Record documents.
6. Operation and maintenance manuals.
7. Excavation
8. Rough-in.
9. Communication installation.
10. Cutting, patching, painting, and sealing.
11. Field quality control.
12. Cleaning.
13. Project closeout.

C. Related Work: Consult all other Sections, determine the extent and character of related Work, and properly coordinate Work specified herein with that specified elsewhere to produce a complete and operable installation.

1. General and supplementary conditions: Drawings and general provisions of Contract and Division 01 of the Specifications, apply to all Division 27 Sections.
2. Earthwork: Include trenching, backfilling, boring and soil compaction as required for the installation of underground conduit, in-grade pull boxes, vaults, etc. Refer to Division 31, Earthwork.

3. Concrete Work: Include forming, steel bar reinforcing, cast-in- place concrete, finishing and grouting as required for underground conduit encasement, pull box slabs, vaults, etc. Refer to Division 03, Concrete.
 4. Miscellaneous metal Work: Include fittings, brackets, backing, supports, rods, welding and pipe as required for support and bracing of raceways, cable trays, racks, etc. Refer to Division 05, Miscellaneous Metals.
 5. Miscellaneous lumber and framing Work: Include wood grounds, nailers, blocking, fasteners and anchorage for support of communications materials and equipment. Refer to Division 06, Rough Carpentry.
 6. Moisture protection and smoke barrier penetrations: Include membrane clamps, sheet metal flashing, counter flashing, caulking and sealant as required for waterproofing of conduit penetrations and sealing penetrations in or through fire walls, floors, ceiling slabs and foundation walls. All penetrations through vapor barriers at slabs on grade shall be taped and made vaportight. Refer to Division 07, Thermal and Moisture Protection.
 7. Access panels and doors: Required in walls, ceilings, and floors to provide access to communications devices and equipment. Refer to Division 08, Access Doors also, Division 05, Metals.
 8. Painting: Include surface preparation, priming and finish coating as required for exposed conduit, pull and junction boxes, etc. where indicated as field painted in this Division. Refer to Division 09, Painting.
- D. Work furnished and installed under another Division requiring connections under this Division includes but is not limited to:
1. Fire alarm control panel.
 2. Lighting control panels.
 3. Security alarm control panel(s)

1.2 QUALITY ASSURANCE

- A. Reference to Codes, Standards, Specifications and recommendations of technical societies, trade organizations and governmental agencies shall mean that latest edition of such publications adopted and published prior to submittal of the bid. Such codes or standards shall be considered a part of this Specification as though fully repeated herein.
- B. When codes, standards, regulations, etc. allow Work of lesser quality or extent than is specified under this Division, nothing in said codes shall be construed or inferred authority for reducing the quality, requirements, or extent of the Contract Documents. The Contract Documents address the minimum requirements for construction.
- C. Work shall be performed in accordance with all applicable requirements of the latest edition of all governing codes, rules and regulations including but not limited to the following minimum standards, whether statutory or not:
 1. California Electrical Code (CEC).
 2. California Building Code (CBC).
 3. California Fire Code (CFC).
 4. California Mechanical Code (CMC).

- D. Standards: Equipment and materials specified under this Division shall conform to the following standards where applicable:

ACI	American Concrete Institute
ANSI	American National Standards Institute
ASTM	American Society for Testing Materials
BICSI	Building Industry Consulting Service International, Inc
EIA	Electronics Industries Alliance
FCC	Federal Communications Commission
ICEA	Insulated Cable Engineers Association
IEEE	Institute of Electrical and Electronics Engineers, Inc
NEMA	National Electrical Manufacturer's Association
NFPA	National Fire Protection Association
TIA	Telecommunication Industry Association
UL	Underwriters' Laboratories

1.3 DEFINITIONS

- A. The following list of terms as used in the Division 27 documents shall be defined as follows:

1. Adapter: Shall mean a connecting device joining two fiber connectors, either like or unlike.
2. Administration: The methodology defining the documentation requirements of a cabling system and its containment, the labeling of functional elements and the process by which moves, additions, and changes are recorded.
3. Attenuation: The decrease in magnitude of transmission signal strength between points, expressed in dB as the ratio of output to input signal level.
4. Attenuation-to-crosstalk ratio (ACR): The ratio obtained by subtracting insertion loss (attenuation dB) from near-end crosstalk (dB). ACR is normally stated at a given frequency.
5. Auditory assistance device: An intentional radiator used to provide auditory assistance to a handicapped person or persons. Such a device may be used for auricular training in an educational institution, for auditory assistance at places of public gatherings, such as a church, theater, or auditorium, and for auditory assistance to handicapped individuals, only, in other locations.
6. Backboard: Backboard generally refers to the 3/4" A-C grade plywood sheeting, lining the walls of the telecommunications room. Plywood shall be void-free, with two coats of fire-retardant paint matching the painted interior walls covering both sides.
7. Backbone: A facility (e.g., pathway, cable, or conductors) between any of the following spaces: telecommunications rooms, common telecommunications rooms, floor-serving terminals, entrance facilities, equipment rooms, and common equipment rooms.
8. Basic link test configuration: Horizontal cable of up to 295 feet plus up to 6.5 feet of test equipment cord from the main unit of the tester to the local connection, and up to 6.5 feet of test equipment cord from the remote connection to the remote unit of the tester. Maximum length is 308 feet.
9. Bonding Conductor (BC): A conductor used specifically for the purpose of bonding.
10. Cable Labeling System:

- a. The scheme employed when identifying cable or its associated hardware.
 - b. Scheme adapted for labeling cables to identify them based on ANSI/TIA/ EIA-606-A, Administration Standard for Commercial Telecommunications Infrastructure.
11. Cable Runway: Hardware designed and manufactured for horizontal pathway distribution of cable and inside wiring inside the MC, IC, or TR rooms.
 12. Cabling: A system comprised of cables, wires, cords, and connecting hardware.
 13. Ceiling Distribution System: A distribution system that utilizes the space between a suspended or false ceiling and the structural surface above.
 14. Channel: End-to-end transmission path, i.e. the entire portion of the horizontal cabling to each outlet consisting of the Permanent Link, line cord (at the workstation), patch cord, and, if a full cross-connection is implemented, the cross-connect termination/connecting apparatus and equipment cord.
 15. Connect: To install required patch cords, equipment cords, cross-connect wires, etc. to complete an electrical or optical circuit.
 16. Cord: Shall mean length of cordage having connectors at each end. The term "cord" is synonymous with the term "jumper" and "lead."
 17. Entrance Conduit: Conduit that connects the campus underground infrastructure with the building's Telecommunications Room.
 18. Fire Retardant: Any substance added to delay the start or ignition of fire or slow the spread of the flame of any material.
 19. Firestopping: The process of installing (specialty) listed fire-rated materials into penetrations of fire-rated barriers to reestablish the fire-resistance rating of the barrier.
 20. Firestopping Location: A penetration through a fire-rated wall with a sleeve.
 21. Firestop System: A specific installation consisting of the material(s) (firestop penetration seals) that fill the opening in the wall or floor assembly, and around and between any items that penetrate the wall or floor (e.g., cables, cable trays, conduit, ducts, pipes), and any termination devices (e.g., electrical outlet boxes) along with their means of support.
 22. Horizontal Cabling: The part of the cabling system that extends from the work area telecommunications outlet to the horizontal cross-connect in the telecommunications room.
 23. Hybrid Cable: An assembly of two or more cables, of the same or different types or categories, covered by one overall sheath.
 24. Identifier: A unique code assigned to an element of the communication infrastructure that links it to its corresponding record.
 25. Infrastructure (Telecommunications): A collection of those telecommunications components, excluding equipment, that together provide the basic support for the distribution of all information within a building or campus.
 26. Loose Tube: A type of optical fiber cable construction where one or more fibers are laid loosely in a tube. Also called loose tube fiber.
 27. Passive link segment: Shall mean the cable, connectors, couplings, and splices between two fiber optic termination units.

28. Permanent link: Test configuration for a horizontal cabling link excluding test cords, connections at the ends of the test cords, patch cords, equipment cords, line cords, etc. The “permanent” portion of the horizontal cabling to each outlet consisting of cable, consolidation point (if used), termination/connecting apparatus in equipment rooms, and the connectors at outlets.
 29. Telecommunications Entrance Facility: Utility Partnerships/Alternate Carrier Minimum Point of Entry that is usually located within the Main Cross-connect Room (MC).
- B. Abbreviations:
1. AFF: Above Finish Floor. Standard mounting height (e.g. 18” AFF) for a device using the center line of the device as the measurement point.
 2. BEP: Building Entrance Protection. For termination of OSP twisted pair cabling.
 3. CAT: Category. Used when identifying the performance characteristics of twisted pair cabling.
 4. CMP: Communication Media Plenum. Rating applied to ISP twisted pair cable. Cable shall be listed as being suitable for use in ducts, plenums, and other spaces used for environmental air and shall also be listed as having adequate fire-resistant and low smoke-producing characteristics. Cables must pass required test for fire and smoke characteristics of wires and cables, NFPA 262 or UL 910.
 5. CMR: Communication Media Riser. Rating applied to ISP twisted pair cable. Cable shall be listed as being suitable for use in a vertical run in a shaft or from floor-to-floor and shall also be listed as having fire-resistant characteristics capable of preventing the carrying of fire from floor to floor. Cables must pass requirements for flame propagation.
 6. CCTV: Closed-Circuit Television. A private television system, typically used for security purposes, in which the signal is transmitted to a limited number of receivers.
 7. EMI: Electromagnetic Interference. Radiated or conducted electromagnetic energy that has an undesirable effect on electronic equipment or signal transmissions.
 8. IC: Intermediate Cross-Connect. The cross-connect points between a backbone cable that extends from the main cross-connect and the backbone cable from the horizontal cross-connect.
 9. IDF: Intermediate Distribution Facilities. Telecommunication equipment rooms housing network equipment and containing termination fields for backbone cabling from MDF and horizontal cabling from outlet devices.
 10. IR: Intermediate Cross-Connect Room. Telecommunication equipment rooms housing network equipment and containing termination fields for backbone cabling from MDF and horizontal cabling from outlet devices.
 11. ISP: Inside Plant. Cable installation within building.
 12. NAM: Metropolitan Area Network. A data communications network that covers an area larger than a campus area and smaller than a wide area network. Typically interconnects two or more LANs and usually covers an entire metropolitan area.

13. MC: Main Cross-Connect. The cross-connect normally located in the MDF room for cross-connection and interconnection of entrance cables, first-level backbone cables, and equipment cables.
14. MDF: Main Distribution Facilities. Telecommunication equipment room housing possible service entrance facilities for interbuilding backbone cabling, network equipment, house voice system equipment headend, backbone cabling distribution headend, termination fields for backbone and horizontal cabling.
15. MMF: Multimode Fiber Cable. An optical fiber that carries many paths of light or an optical waveguide that allows many bound modes to propagate.
16. MPOE: Minimum Point of Entry. For serving communications utility terminations. House's service provider's termination field(s) and interfaces between utility's facilities and premises facilities.
17. NAM: Network Access Module. Workstations.
18. OFN: Optical Fiber Non-Conductive. General purpose indoor non-plenum rated.
19. OFNP: Optical Fiber Non-Conductive Plenum. Plenum rated cable.
20. OFNR: Optical Fiber Non-Conductive Riser. Non-plenum rated riser cable.
21. OSP: Outside Plant. Cable installation outside of building.
22. PIC: Plastic Insulated Conductors.
23. PVC: Polyvinyl Chloride.
24. SMF: Singlemode Fiber Cable. An optical fiber, usually step-index grade, which supports only one mode of light propagation. This does not necessarily imply single wavelength operation. The light source is normally a laser.
25. STR: Strand. A single unit of optical fiber within a cable (e.g., a 12-strand fiber cable has 12 individual optical fibers within the cable sheath).
26. TMGB: Telecommunications Main Grounding Busbar. A grounding busbar, located in the MDF room, connected to the power system main building ground bus by a continuous #1/0 THHN wire.
27. TGB: Telecommunication Grounding Busbar. A grounding busbar, located in the IDF and MPOE rooms, connected to the telecommunication main ground bus at ground or second floor, and as a riser to all stacked IDF rooms by a continuous #1/0 THHN wire.
28. TER: Telecommunications Equipment Room. A centralized space that provides space and maintains a suitable operating environment for the termination of backbone and campus cabling and house centralized communications and/ or computer equipment (such as Core Switches and Servers). Note: An equipment room is considered distinct from a telecommunications closet because of the nature or complexity of the equipment housed by the equipment room.
29. TR: Telecommunications Room. A room dedicated to housing a group of telecommunications connectors (e.g., patch panel or punch-down block) that allows equipment and backbone cabling to be cross connected with patch cords or jumpers.
30. UTP: Unshielded Twisted Pair. Copper cable type.

1.4 SUBMITTALS

- A. Format: Furnish submittal data in electronic format for each Specification Section with a table of contents listing materials by Section and paragraph number.
- B. Submittals shall consist of detailed Shop Drawings, Specifications, block wiring diagrams, "catalog cuts" and data sheets containing physical and dimensional information, performance data, electrical characteristics, materials used in fabrication and material finish. Clearly indicate by arrows or brackets precisely what is being submitted on and those optional accessories which are included and those which are excluded. Furnish quantities of each submittal as noted in Division 01.
- C. Each submittal shall be labeled with the Specification Section Number and shall be accompanied by a cover letter or shall bear a stamp stating that the submittal has been thoroughly reviewed by the Contractor and is in full compliance with the requirements of the Contract Documents or provide a Specification Section line-by-line compliance response statement with detailed exception/ deviation response statements for all applicable provisions for the applicable Specification Section. Any Specification Section lines without a detailed exception/ deviation response statement shall be treated as the Contractor or Vendor is submitting in full compliance with the applicable Specification Section requirements. Cover letters shall list in full the items and data submitted. Failure to comply with this requirement shall constitute grounds for rejection of data.
- D. The Contractor shall submit detailed Drawings of all communications equipment rooms and closets if the proposed installation layout differs from the construction documents. Physical size of communications equipment indicated on the Drawings shall match those of the communications equipment that is being submitted for review, i.e.: equipment racks, cable ladder, fuse protectors, ground bars, etc. Minimum scale: 1/4" = 1'- 0". Revised communications equipment layouts must be approved prior to release of order for equipment and prior to installation.
- E. As part of the equipment submittals, the Contractor shall provide anchorage calculations for floor and wall mounted communication equipment, conduits, and raceways, in conformance with the latest edition of the California Building Code (CBC) and ASCE 7. Use the Occupancy Category, Ground Accelerations, Site Class, Seismic Design Category, and Seismic Importance Factor as noted in the structural drawings. For components required for Life Safety or containing hazardous materials use $I_p=1.5$. Structural Calculations shall be prepared, stamped, and signed by a California Registered Structural Engineer. Specify proof loads for drilled-in anchors, if used.
- F. The Manufacturer shall recommend the method of anchoring the equipment to the mounting surface and shall provide the Contractor with the assembly dimensions, weights, and approximate centers of gravity.
- G. Review of submittals is for general conformance to design concept and general compliance with the Specification Sections. Submittal Review Comments do not imply waiver of Specifications Section requirements unless specifically noted.
- H. All re-submittals shall include a cover letter that lists the action taken and revisions made to each Drawing and equipment data sheet in response to Submittal Review Comments. Re-submittal packages will not be reviewed unless accompanied by this cover letter. Failure to include this cover letter will constitute rejection of the re-submittal package.

I. Substitutions:

1. All requests for substitutions shall conform to the general requirements and procedure outlined in Division 01.
2. Where items are noted as "or equal," a product of equal design, construction and performance will be considered. Contractor must submit to the Engineer all pertinent test data, catalog cuts and product information required substantiating that the product is in fact equal to that specified. Only one substitution will be considered for each product specified.
3. Manufacturers' names and model numbers used in conjunction with materials, processes or equipment included in the Contract Documents are used to establish standards of quality, utility, and appearance. Materials, processes, or equipment, which in the opinion of the Engineer is equal in quality, utility and appearance will be approved as substitutions to that specified.
4. Whenever any material, process or equipment is specified in accordance with a Federal specification, an ASTM standard, an ANSI specification, UL rating or other association standard, the Contractor shall present an affidavit from the Manufacturer certifying that the product complies with the particular standard specification. When requested by the Engineer, support test data to substantiate compliance shall be submitted by the Contractor at no additional cost.
5. Substitutions shall be equal, in the opinion of the Architect/Engineer, to the specified product. The burden of proof of such shall rest with the Contractor. When the Architect/Engineer in writing accepts a substitution, it is with the understanding that the Contractor guaranteed the substituted article or material to be equal to the one specified and dimensioned to fit within the construction. Approved substitutions shall not relieve the Contractor of responsibilities for the proper execution of the Work or from any provisions of the Specifications.
6. The Contractor shall be responsible for all expenses in connection with the substitution materials, processes, and equipment, including the effect of the substitution on the Contractor, Subcontractor's, or other Contractor's Work. No substitution of material, processes or equipment shall be permitted without written authorization of the Architect/Engineer. Any assumptions on the acceptability of a proposed substitution prior to acceptance by the Engineer are at the sole risk of the Contractor.

1.5 COORDINATION

A. Discrepancies:

1. In the event of discrepancies within the Contract Documents, the Engineer shall be so notified, within sufficient time, as delineated in Division 01, prior to the Bid Opening to allow the issuance of an Addendum.
2. If, in the event that time does not permit notification or clarification of discrepancies prior to the Bid Opening, the following shall apply: The Drawings govern in matters of quantity and the Specifications govern in matters of quality. In the event of conflict within the Drawings involving quantities or within the Specifications involving quantities or within the Specifications involving quality, the greater quantity and higher quality shall apply. Such discrepancies shall be noted and clarified in the Contractor's Bid. No additional allowances will be made because of errors, ambiguities or omissions that reasonably should have been discovered during the preparation of the Bid.

B. Project conditions:

1. Examination of Project site: The Contractor shall visit the Project site and thoroughly review the locale, working conditions, conflicting utilities, and the conditions in which the communications Work will take place. Verify all existing conditions in the field. No allowances will be made subsequently for any costs that may be incurred because of any error or omission due to failure to examine the Project site and to notify the Engineer of any discrepancies between Contract Documents and actual Project site conditions.
2. Protection: Keep conduits, junction boxes, outlet boxes and other openings closed to prevent entry of foreign matter. Cover equipment, devices, and apparatus and protect them against dirt, paint, water, chemical or mechanical damage, before and during construction period. Prior to final acceptance, restore to original condition any fixture, apparatus or equipment damaged including restoration of damaged factory applied painted finishes. Protect bright finished surfaces and similar items until in service. No rust or damage will be permitted.
3. Supervision: Contractor shall personally or through an authorized and competent representative constantly supervise the Work from beginning to completion and, within reason, keep the same foreman and workmen on the Project throughout the Project duration.

C. Preparation:

1. Drawings:
 - a. Layout: General layout indicated on the Drawings shall be followed except where other Work may conflict with the Drawings.
 - b. Accuracy: Drawings for the Work under this Section are essentially diagrammatic within the constraints of the symbology applied.

1.6 RECORD DOCUMENTS

A. Provide Project Record Drawings as described herein:

1. Drawings shall fully represent installed conditions including actual locations of telecom outlets, patch panels, termination blocks, security panels, security devices, fiber panels, fire alarm panels, intercom systems, clock system, video system, labeling of all components and systems, correct conduit and cabling as well as routing, revised fire alarm schedule listing Manufacturers and products actually installed. Contractor shall record all changes in the Work during the course of construction on black line prints. These prints shall be made subject of monthly review by the Owner's Representative to ascertain that they are current. If not, current monthly payments may be withheld.
2. Record Drawings shall be the transfer of information on these prints to the construction documents via information modeling (Revit) process. A set of Revit files of the communication construction documents will be provided to the Contractor by the Engineer.
3. Record drawing submissions shall be provided to the Engineer to review upon the completion of the following phases of Work:
 - a. All underground installation.
 - b. Building communications rough-in.
 - c. Final communications installation.

4. A single set of half size prints of the Record Drawings shall be submitted for review. Upon receipt of the Engineer's review comments, corrections shall be made, and the Contractor shall provide the following:
 - a. Two sets of full-size prints.
 - b. Four sets of half size prints.
 - c. One electronic file of Revit
 - d. One electronic set in pdf.

1.7 OPERATION AND MAINTENANCE MANUALS

- A. Prior to Project closeout furnish to the Owner, six (6) hard back 3-ring binders containing all bulletins, operation and maintenance instructions, part lists, service telephone numbers and other pertinent information as noted in each Section all equipment furnished under Division 27. Binders shall be indexed into Division Sections and labeled for easy reference. Bulletins containing more information than the equipment concerned shall be properly stripped and assembled.

PART 2 - PRODUCTS (NOT APPLICABLE)

PART 3 - EXECUTION

3.1 EXCAVATION

- A. General: Cutting and digging shall be under the direct supervision of the General Contractor and included as necessary for the Work of this Section.
- B. Excavation for underground vaults and electrical structures: Conform to elevations and dimensions indicated within a tolerance of plus or minus 0.10-feet; plus, a sufficient distance to permit placing and removal of concrete formwork, installation or services, other construction and for inspection.
 1. Excavate, by hand, areas within dripline of large trees. Protect the root system for damage and dry-out. Maintain moist conditions for root system and over exposed roots with burlap. Paint root cuts of 1 inch in diameter and larger with emulsified asphalt tree paint.
 2. Take care not to disturb bottom of excavation. Excavate by hand to final grade just before concrete reinforcement is placed.
- C. Trenching: Excavate trenches for electrical installation as follows:
 1. Excavate trenches to the uniform width, sufficiently wide to provide ample working room and a minimum of 6 to 9 inches clearances on both side of raceways and equipment.
 2. Excavate trenches to depth indicated or required.
 3. Limit the length of open trench to that in which installations can be made and the trench backfilled within the same day.
 4. Where rock is encountered, carry excavation below required elevation and backfill with a layer of crushed stone or gravel prior to installation of raceways and equipment. Provide a minimum of 6 inches of stone or gravel cushion between rock bearing surface and electrical installations.

- D. Backfilling: Place soil materials in layers to required subgrade elevations for each area classification, using materials and methods specified in Division 31, Earthwork.
 - 1. Under building slabs, use drainage fill materials.

3.2 ROUGH-IN

- A. Contractor shall verify lines, levels and dimensions indicated on the Drawings and shall be responsible for the accuracy of the setting out of Work and for its strict conformance with existing conditions at the Project site.
- B. Verify final locations for rough-in with field measurements and with the requirements for the actual equipment to be connected.

3.3 COMMUNICATIONS INSTALLATION

- A. Preparation, sequencing, handling, and installation shall be in accordance with Manufacturer's written instructions and technical data particular to the product specified and/or accepted equal except as otherwise specified. Comply with the following requirements:
 - 1. Shop Drawings prepared by Manufacturer.
 - 2. Verify all dimensions by field measurements.
 - 3. Arrange for chases, slots, and openings in other building components during progress of construction, to allow for communications installations.
 - 4. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components, as they are constructed.
 - 5. Sequence, coordinate and integrate installations of communications materials and equipment for efficient flow of the Work. Give attention to large equipment requiring positioning prior to closing in the building.
 - 6. Where mounting height is not detailed or dimensioned, contact the Architect for direction prior to proceeding with rough-in.
 - 7. Install systems, materials, and equipment to conform with approved submittal data, including coordination Drawings, to greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that portions of the Work are indicated only in diagrammatic form. Where coordination requirements conflict with individual system requirements, refer conflict to the Architect.
 - 8. Install systems, materials, and equipment level and plumb, parallel, and perpendicular to other building systems and components, where installed exposed in finished spaces.
 - 9. Install communications equipment to facilitate servicing, maintenance and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations.
 - 10. Coordinate communications systems, equipment, and materials installations with other building components.
 - 11. Provide access panel or doors where devices or equipment are concealed behind finished surfaces. Furnish and install access doors per the requirements of Division 08.

12. Install systems, materials and equipment giving right-of-way priority to other systems that are required to maintain a specified slope.
13. Conform to the National communications Contractor's Association "Standard of Installation" for general installation practice.

3.4 CUTTING, PATCHING, PAINTING AND SEALING

- A. Structural members shall in no case be drilled, bored, or notched in such a manner that will impair their structural value. Cutting of holes, if required, shall be done with core drill and only with the approval of the Architect and Structural Engineer.
- B. Protection of Installed Work: During cutting and patching operations, protect adjacent installations.
- C. Provide and maintain temporary partitions or dust barriers adequate to prevent the spread of dust and dirt to adjacent areas.
- D. Patch existing surfaces and building components using experienced installers and new materials matching existing materials and the original installation. For installers' qualifications refer to the materials and methods required for the surface and building components being patched.
- E. Application of joint sealers:
 1. General: Comply with joint sealer Manufacturers' printed application instructions applicable to products and applications indicated, except where more stringent requirements apply.
 2. Installation of fire-stopping sealant: Install sealant, including forming, packing and other accessory materials, to fill openings around communications services penetrating floors and walls, to provide fire-stops and fire-resistance ratings indicated for floor or wall assembly in which penetration occurs. Comply with installation requirements established by testing and inspecting agency.

3.5 FIELD QUALITY CONTROL

- A. General testing requirements:
 1. The purpose of testing is to ensure that all tested communications equipment, both Contractor and Owner supplied, is operational and within industry and Manufacturer's tolerances and is installed in accordance with design Specifications.
 2. Tests and inspections shall determine suitability for energization.
 3. Perform tests in presence of the Owner's Representative and furnish test equipment, facilities and technical personnel required to perform tests.
 4. Tests shall be conducted during the construction period and at completion to determine conformity with applicable codes and with these Specifications.
- B. Tests: In addition to specific system test described elsewhere, tests shall include:
 1. Equipment operations: Test All systems for proper operation
 2. Circuit numbering verification: Select on a random basis various patch panel ports and wire test to verify compliance of the port labeling with actual field wiring.

- C. Contractor shall perform testing on fiber strands with an OTDR and Power Meter.
- D. Contractor shall perform testing on each cable of the Structured Cabling system with test equipment that will provide a full test of the EIA/TIA requirements for the installed category cable and provide test results of each cable under test.
- E. Testing safety and precautions:
 - 1. Safety practices shall include the following requirements:
 - a. Applicable State and Local safety operating procedures.
 - b. OSHA.
 - c. NSC.
 - d. NFPA 70E.
- F. Calibration of test equipment:
 - 1. Testing Agency shall have calibration program that assures test instruments are maintained within rated accuracy.
 - 2. Instruments shall be calibrated in accordance with the following frequency schedule:
 - a. Field instruments: Analog, 6-month maximum; Digital, 12-months maximum.
 - b. Laboratory instruments: 12-months.
 - c. Leased specialty equipment: 12-months where accuracy is guaranteed by lessor.
 - 3. Dated calibration labels shall be visible on test equipment.
 - 4. Records, which show date and results of instruments calibrated or tested, must be kept up to date.
 - 5. Up-to-date instrument calibration instructions and procedures shall be maintained for test instrument.
 - 6. Calibration standards shall be of higher accuracy than instrument tested.
 - 7. Equipment used for field testing shall be more accurate than instrument being tested.
- G. Coordinate with General Contractor regarding testing schedule and availability of equipment ready for testing.
- H. Notify Owner and Engineer one week in advance of any testing.
- I. Any products which fail during the tests or are ruled unsatisfactory by the Owner's Representative shall be replaced, repaired, or corrected as prescribed by the Owner's Representative at the expense of the Contractor. Tests shall be performed after repairs, replacements or corrections until satisfactory performance is demonstrated.
- J. Testing Agency shall maintain written record of tests and shall assemble and certify final test report.
- K. Include all test results in the maintenance manuals.

3.6 CLEANING

- A. Prior to acceptance of communications systems, the Contractor shall thoroughly clean communications rooms from construction debris, scrap wire, etc. using Manufacturer's approved methods and materials.
- B. Upon completion of Project, prior to final acceptance, the Contractor shall thoroughly clean both the interior and exterior of all communications equipment per Manufacturers approved methods and materials. Remove paint splatters and other spots, dirt, and debris.
- C. Touch-up paint any marks, blemishes or other finish damage suffered during installation.

3.7 PROJECT CLOSEOUT

- A. Training: At the time of completion, a period of not less than 2-hours shall be allotted by the Contractor for instruction of building operating and maintenance personnel in the use of all systems. This 2-hours training is in addition to any instruction time called out in the Specifications for specific systems. All personnel shall be instructed at one time, the Contractor making all necessary arrangements with Manufacturer's Representative. The equipment Manufacturer shall be requested to provide product literature and application guides for the users' reference. Costs, if any, for the above services shall be paid by the Contractor.
- B. Special tools: Provide one of each tool required for proper operation and maintenance of the equipment provided under this Section. All tools shall be delivered to the Owner at the Project completion.
- C. Keying: Provide two keys for each lock furnished under this Section and turn over to Owner.

END OF SECTION

SECTION 27 05 26

COMMUNICATION GROUNDING AND BONDING

PART 1 - GENERAL

1.1 SUMMARY

- A. Work included: Labor, materials, and equipment necessary to complete the installation required for the item specified under this Division, including but not limited to:
 - 1. Communication system grounding.
 - 2. Communication equipment and raceway grounding and bonding.
- B. Related Work: Consult all other Sections, determine the extent and character of related Work, and properly coordinate Work specified herein with that specified elsewhere to produce a complete installation.
 - 1. Division 05: Building Steel.
 - 2. Division 26: Grounding and Bonding

1.2 REFERENCES

- A. Comply with the latest edition of the following applicable Specifications and standards except as otherwise indicated or specified:
 - 1. American National Standards Institute, Inc. (ANSI) / Telecommunications Industry Association (TIA):
ANSI/TIA-607-C-1; Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises.
 - 2. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
IEEE No. 142; Recommended Practice for Grounding of industrial and Commercial Power Systems.
 - 3. Underwriters Laboratories, Inc. (UL):
UL 467; Grounding and Bonding Equipment.

1.3 SYSTEM DESCRIPTION

- A. Provide communications system grounding conductor and bus bars as described herein and indicated on the Drawings.
- B. Except as otherwise indicated, the complete communication installation including metallic conduits and raceways, cable trays, boxes, racks, cabinets, and equipment shall be completely and effectively grounded and bonded, whether or not such connections are specifically indicated or specified.

1.4 SUBMITTALS

- A. Submit in accordance with the requirements of Section 270010: Basic Communications Requirements, the following items:

1. Data/catalog cuts for each product and component specified herein, listing all physical and electrical characteristics and ratings indicating compliance with all listed standards.
2. Clearly mark on each data sheet the specific item(s) being submitted and the proposed application.
3. Submit Manufacturer's installation instructions.

1.5 QUALITY ASSURANCE

- A. All materials, equipment and parts comprising the units specified herein shall be new, unused, and currently under production.
- B. Only products and applications listed in this Section may be used on the Project unless otherwise submitted.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Products furnished by the following Manufacturers shall be acceptable if in compliance with all features specified herein and indicated on the Drawings.
 1. Bonding strap:
 - a. Chatsworth Product Inc. (CPI).
 - b. Cooper/B-Line Systems, Inc.
 - c. Thomas & Betts.
 2. Bonding connectors and lugs:
 - a. Chatsworth Product Inc. (CPI).
 - b. Cooper/B-Line Systems, Inc.
 - c. Panduit.
 - d. Thomas & Betts.
 - e. O-Z/Gedney.
 3. Ground Bus Bar, Ground Straps, Ground Lugs:
 - a. Chatsworth Product Inc. (CPI).
 - b. Cooper/B-Line Systems, Inc.
 - c. Panduit.
- B. Substitutions: Under provisions of Section 270010: Basic Communications Requirements.

2.2 COMMUNICATION SYSTEM GROUND BUS REQUIREMENTS:

- A. Telecommunication Main Ground Bus (TMGB): Provide one 20" wide x 4" high x 1/4" thick copper bus bar as a minimum. Mount on wall in MDF room utilizing insulating stand-offs at 6" below bottom of cable ladder.
- B. Telecommunication Ground Bus (TGB): Provide one 12" wide x 4" high x 1/4" thick copper bus bar as a minimum. Mount on wall in each IDF room and in the MPOE room utilizing insulating stand-offs at 6" below cable ladder.

- C. Furnish complete with cast copper alloy body lugs for connecting grounding system conductors. Attach lugs to bus with appropriate size cadmium bronze bolt, flat washer, and Belleville washer. Torque all lug connections.
- D. All holes shall be drilled and tapped for single-hole lugs. Provide 3-spare lugs and lug spaces.

2.3 GROUND CONDUCTORS

- A. Refer to Specification Section 260519: Building Wire and Cable for conductor specifications.
- B. Conductor material:
 - 1. Provide annealed copper for all wire, conductor, and cable, unless otherwise indicated.
 - 2. Copper wire AWG #8 and larger shall be stranded, unless otherwise indicated.
 - 3. Copper wire AWG #10 and smaller may be solid or stranded as best suited for the installation.

2.4 EQUIPMENT BONDING

- A. General:
 - 1. Provide a complete grounding and bonding system as shown on the drawings in Riser Diagram format. It includes grounding bus bars, grounding riser conductors, connections to main service ground system, ground lugs and clamps, etc.
 - 2. The work outlined in this Section covers the bonding of all telecommunication equipment and apparatus in the equipment rooms to the telecommunication system grounding backbone.
- B. Bonding conductor:
 - 1. Conductor: #6 AWG (or larger), copper, stranded.
 - 2. Insulation: THHN/THWN, green in color.
- C. Cable runway bonding straps: Flexible braided copper strap with factory installed termination connectors.
- D. Connectors and lugs:
 - 1. Conductor to conductor connector: C-type copper compression tap, heavy-wall, for tapping into unbroken continuous conductors as a splice, wire joint, "T" tap, or making parallel wire connections. Connector can be used with stranded or solid conductors.
 - 2. Conductor to busbar, racks, cabinets, conduit, cable shields, copper fuse protectors, building steel or other equipment/component connector: Two-hole, copper, compression type lugs for #6 AWG conductors.
 - 3. Conductor to cable runway connector: Cable tray ground clamp, Extruded aluminum/tin-plated, mechanical type connector with set screws for tightening both tray and bonding conductor.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Contractor shall thoroughly examine Project site conditions for acceptance of installed equipment to verify conformance with Manufacturer and Specification tolerances. Do not commence with installation until all conditions are made satisfactory.

3.2 COMMUNICATION SYSTEM GROUNDING:

- A. In addition to grounding noted on the Drawings for the power systems, provide a telecommunication system ground riser for interconnecting the MDF, MPOE and all the IDF rooms in the building.
- B. Riser shall consist of the following:
 - 1. Provide a telecommunication main ground bus (TMGB) wall mounted in the MDF room at the ground floor of building.
 - 2. Provide telecommunication ground bus (TGB) wall mounted in each IDF room and at MPOE room.
 - 3. From the TMGB provide one #1/0 THHN in 1-1/4" conduit to the main electrical room and terminate conductor at the power system main building ground bus.
 - 4. Additionally, from the TMGB provide one #1/0 THHN in 1-1/4" conduit to the MPOE room and terminate conductor at the TGB.
 - 5. If IDF rooms exist on the ground floor of building, provide one #1/0 THHN in 1-1/4" conduit from the TGB in each room to the TMGB in the MDF room. If there are no IDF rooms at ground floor, provide one #1/0 THHN in 1-1/4" conduit from the TGB in each IDF room at second floor and route to the TMGB in the MDF room at ground floor.
 - 6. From each of the TGBs at the IDF rooms on ground or second floor, route one #1/0 THHN in 1-1/4" conduit as a riser up the building to intertie all the TGBs in each IDF room that are stacked above.

3.3 INSTALLATION

- A. Equipment bonding:
 - 1. Provide telecommunication bonding conductor and appropriate hardware between the telecommunication system grounding backbone bus in each equipment room and the equipment racks/rack bays, overhead cable support, vertical cable support, telecommunication conduits, primary pathways that exit/enter the rooms (if applicable), and all other metallic telecommunication infrastructure components.
 - 2. Telecommunication bonding conductor:
 - a. The minimum size for the bonding conductor shall be #6 THHN/THWN.
 - b. Install the bonding conductors in a manner that will protect them from physical and mechanical damage.
 - c. Route the bonding conductors in the shortest possible path, using right angles for turns and routed parallel to building lines.
 - d. Utilize a minimum of 1'-0" bending radius.
 - e. At the backbone ground busbar:

- 1) Thoroughly clean the busbar prior to attaching connectors and terminating conductors.
 - 2) Attach connectors to the busbar with appropriate size cadmium bronze bolt, flat washer, and Belleville washer.
 - 3) Torque all connectors.
3. Rack bays:
- a. Bond equipment racks, frames, frame bays, cabinets, server racks, and all other similar support systems located within the same equipment room or space to the backbone ground busbar in same room.
 - b. Rack bays may be bonded in series using either of the following configurations:
 - 1) Provide a bonding conductor from the backbone busbar to the closest rack and route through ground lug connected to rack, extending the conductor the full length of the rack bay. Each individual rack shall have a ground lug attached that the bonding conductor passes through. Insulation on bonding conductor, where it passes through the lug, shall be removed prior to tightening connection around conductor.
 - 2) Provide a bonding conductor from the backbone busbar to the closest rack and then along the entire length of rack bay. "T" tap a pigtail, sized the same as the bonding conductor, from the bonding conductor to each individual rack and terminate on ground lug connected to rack.
4. Overhead and vertical cable runway support:
- a. Bond cable runway located within the same equipment room or space to the backbone ground busbar in same room.
 - b. Provide a "ground kit" (straps and connectors) to bond sections of the runway for ground continuity. This requirement applies to runway sections and junctions within the same equipment room.

3.4 FIELD QUALITY CONTROL

- A. At least three weeks prior to any testing, notify the Engineer so that arrangement can be made for witnessing test, if deemed necessary. All pretesting shall have been tested satisfactorily prior to the Engineer's witnessed test.
- B. Prefunctional testing:
 1. Visual and mechanical inspection:
 2. Cable tests:
 3. Test values:
- C. In the event that the system fails to function properly during the testing as a result of inadequate pretesting or preparation, the Contractor shall bear all costs incurred by the necessity for retesting including test equipment, transportation, subsistence and the Engineer's hourly rate.
- D. Contractor shall replace at no costs to the Owner all cables, equipment and devices which are found defective or do not operate within factory specified tolerances.
- E. Contractor shall submit final report for review prior to Project closeout and final acceptance by the Owner. Test report shall indicate test dates, devices tested,

results, observation, deficiencies, and remedies. Test report shall be included in the operation and maintenance manuals.

3.5 CLEANING

- A. Upon completion of Project prior to final acceptance the Contractor shall thoroughly clean all equipment per Manufacturers approved methods and materials. Remove paint splatters and other spots, dirt and debris.
- B. Touch-up paint for any marks, blemishes or other finish damage suffered during installation.

END OF SECTION

SECTION 27 05 28
COMMUNICATION PATHWAYS

PART 1 - GENERAL

1.1 SUMMARY

- A. Work included: Labor, materials, and equipment necessary to complete the installation required for the item specified under this Division, including but not limited to:
 - 1. Conduit and fittings.
 - 2. Fire-rated wall and floor through-penetration.
 - 3. Boxes
 - 4. J-Hooks.
- B. Related Work: Consult all other Sections, determine the extent and character of related Work, and properly coordinate Work specified herein with that specified elsewhere to produce a complete installation.
 - 1. Division 01: Cutting and patching.
 - 2. Division 03: Cast-in-place concrete. Protective envelope for underground conduit installations.
 - 3. Division 07: Sheet metal flashing and trim.
 - 4. Division 08: Access doors. Wall and ceiling access doors.
 - 5. Division 09: Painting. Exposed conduit and other devices.
 - 6. Division 31: Earthwork. Excavation and backfill for conduit and utilities on Project site.

1.2 REFERENCES

- A. Comply with the latest edition of the following applicable Specifications and standards except as otherwise indicated or specified:
 - 1. American National Standards Institute (ANSI)/National Electrical Manufacturer Association (NEMA):
 - ANSI C80.3; Electrical Metallic Tubing, Zinc Coated.
 - ANSI/NEMA OS-1; Sheet-Steel Outlet Boxes, Device Boxes, Covers and Box Supports.
 - NEMA 250; Enclosures for Electrical Equipment (1000 volts maximum).
 - 2. American Society for Testing and Materials (ASTM):
 - ASTM E84; Surface Burning Characteristics of Building Materials
 - ASTM E119; Fire Tests of Building Construction and Materials
 - ASTM E814; Fire Tests of Penetration Fire Stops
 - ASTM E1725; Standard Test Methods for Fire Tests of Fire Resistive Barrier Systems for Electrical System Components
 - 3. Underwriters Laboratories, Inc. (UL):

UL 50;	Enclosures for Electrical Equipment, Non-Environmental Considerations.
UL 263;	Fire Tests of Building Construction and Materials
UL 514A;	Metallic Outlet Boxes.
UL 514B;	Conduit, Tubing and Cable Fittings.
UL 635;	Insulating Bushings.
UL 651;	Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings.
UL 651A;	Schedule 40 and 80 High Density Polyethylene (HDPE) Conduit.
UL 723;	Surface Burning Characteristics of Building Materials
UL 797;	Electrical Metallic Tubing - Steel.
UL 1479;	Fire Tests of Through Penetration Firestops
UL 1773;	Termination Boxes.
UL 2239;	Hardware for the Support of Conduit, Tubing, and Cable
4. National Electrical Manufacturer Association (NEMA):
- | | |
|------------|--|
| NEMA TC 2; | Electrical Plastic Tubing and Conduit. |
| NEMA TC 3; | PVC Fittings for use with Rigid PVC Conduit. |
| NEMA TC 6; | PVC Plastic Utilities Duct (EB and DB Type) |
| NEMA TC 9; | Fittings for PVC Plastic Utilities Duct (EB and DB Type) |

1.3 SYSTEM DESCRIPTION

- A. Conduits supported from structure and within stud walls for the continuous routing of communication cables, where non-accessible concealed Work is indicated and where required by Code and/or shown on the Drawings. Conduits shall be sized for a 40-percent maximum cable fill ratio.
- B. Assemblies supported from structure for the continuous routing of communication cables, where exposed Work is indicated on the Drawings.
- C. J-Hooks supported from structure, above suspended ceiling, for the routing of communication cables, where accessible through ceiling and where shown on the Drawings. J-hooks shall be sized for a 40-percent maximum cable fill ratio.
- D. Where exposed cable routing is indicated, provide conduit sleeves through walls, above suspended ceilings or at cable routing elevation, with insulated bushings on both ends, for access into enclosed spaces, i.e., offices, workrooms, conference rooms, etc. Sleeves shall be 2" minimum and 4" maximum conduits and shall be sized for a 40-percent maximum cable fill ratio.
- E. Provide UL listed fire-rated sleeves for passing through 1 and 2-hour rated walls and/or floors assemblies.

1.4 SUBMITTALS

- A. Submit in accordance with the requirements of Section 270010: Basic Communications Requirements, the following items:

1. Data/catalog cuts for each product and component specified herein, listing all physical and electrical characteristics and ratings indicating compliance with all listed standards.
 2. Clearly mark on each data sheet the specific item(s) being submitted and the proposed application.
 3. Furnish structural calculations for equipment anchorage as described in Section 270010: Basic Communications Requirements.
 4. Submit Manufacturer's installation instructions.
 5. Complete Bill of Material listing all components.
- B. Dimensions and configurations of equipment shall conform to the space allocated on the Drawings. The Contractor shall submit a revised layout if equipment furnished varies in size from that indicated on Drawings for the Engineer's approval.

1.5 QUALITY ASSURANCE

- A. All materials, equipment and parts comprising the units specified herein shall be new, unused, and currently under production.
- B. Only products and applications listed in this Section may be used on the Project unless otherwise submitted.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Products furnished by the following Manufacturers shall be acceptable if in compliance with all features specified herein and indicated on the Drawings.
1. Conduit:
 - a. Metal conduit:
 - 1) Allied Tube and Conduit Co.
 - 2) Triangle PWC, Inc.
 - 3) Western Tube and Conduit Corp.
 - b. Nonmetallic conduit:
 - 1) Prime Conduit.
 - 2) JM Eagle.
 - 3) Cantex.
 - c. Fittings:
 - 1) Appleton Electric Co.
 - 2) OZ/Gedney.
 - 3) Thomas & Betts Corp.
 - 4) Carlon.
 2. Fire-rated penetration assemblies:
 - a. EZ-Path, STI Firestop.
 - b. Hilti

- c. 3M
 - d. Lowry's, Inc.
 - 3. Boxes:
 - a. Outlet and junction boxes:
 - 1) Spring City Electrical Manufacturing Co.
 - 2) Thomas & Betts Corp.
 - 3) Racor, Inc.
 - b. Cast boxes:
 - 1) Appleton Electric Co.
 - 2) Crouse-Hinds.
 - c. Floor boxes:
 - 1) Hubbell Inc.
 - 2) Walker.
 - 3) Wiremold/Legrand.
 - d. Pullboxes:
 - 1) Circle AW Products.
 - 2) Hoffman Engineering Co.
 - 4. Precast concrete vaults:
 - a. Oldcastle Enclosure Solutions.
 - b. Jensen Precast.
 - 5. J-Hooks Systems:
 - a. Erico nVent Caddy HP.
 - b. B-Line.
 - c. Panduit.
 - d. Mono-Systems, Inc.
- B. Substitutions: Under provisions of Section 270010: Basic Communications Requirements.

2.2 CONDUIT

- A. Electrical metallic tubing (EMT):
 - 1. Conduit: Shall be formed of cold rolled strip steel, electrical resistance welded continuously along the longitudinal seam and hot dip galvanized after fabrication. Conduit shall conform to ANSI C80.3 Specifications and shall meet UL requirements.
 - 2. Set screw type couplings: Hot dip galvanized, steel or cast malleable iron, UL listed concrete tight. Use set screw type couplings with four setscrews each of conduit sizes over 2-inches. Setscrews shall be of case-hardened steel with hex-head and cup point to firmly seat in wall of conduit for positive grounding.

3. Set screw type connectors: Hot dip galvanized, steel or cast malleable iron UL listed concrete tight with male hub and insulated plastic throat, 150-degree C temperature rated. Setscrew shall be same as for couplings.
 4. Raintight couplings: Hot dip galvanized, steel or cast malleable iron; UL listed raintight and concrete tight, using gland and ring compression type construction.
 5. Raintight connectors: Hot dip galvanized, steel or cast malleable iron, UL listed raintight and concrete tight, with insulated throat, using gland and ring compression type construction.
- B. Rigid non-metallic conduit (PVC)
1. Conduit:
 - a. Rigid polyvinyl chloride, Schedule 40 or 80 conforming to NEMA TC1 and UL 651, latest edition. UL listed for exposed and direct-burial applications and for 90-degrees C conductor insulation. Conduit shall include an integral bell fitting at one end.
 - b. Rigid polyvinyl chloride, Type EB or DB conforming to NEMA TC 6 and UL 651, latest edition. UL listed for concrete encased burial and direct burial applications and for 90 degrees C conductor insulation. Conduit shall include an integral bell fitting at one end.
 2. Fittings: Couplings, adaptors, transition fittings, etc., shall be molded PVC, slip on, solvent weld type conforming to NEMA TC3 for Schedule 40 or 80 and NEMA TC 9 for type EB or DB.
- C. Miscellaneous conduit fittings and products:
1. Watertight conduit entrance seals: Steel or cast malleable iron bodies and pressure clamps with PVC sleeve, neoprene sealing grommets and PVC coated steel pressure rings. Fittings shall be supplied with neoprene sealing rings between the body and PVC sleeve.
 2. Watertight cable sealing bushings: One piece, compression molded sealing ring with PVC coated steel pressure disks, stainless steel sealing screws and zinc plated cast malleable iron locking collar.
 3. Expansion fittings: Multi-piece unit comprised of a hot dip galvanized malleable iron or steel body and outside pressure bussing designed to allow a maximum of 4" conduit movement (2" in either direction). Furnish with external braid tinned copper bonding jumper. Unit shall be UL listed for wet or dry locations.
 4. Expansion/deflection couplings: Multi-piece unit comprised of a neoprene sleeve with internal flexible tinned copper braid attached to bronze end couplings with stainless steel bands. Coupling shall accommodate 0.75-inch deflection, expansion or contraction in any direction and allow 30-degree angular deflections. Flexible, corrosion-resistant, watertight, moisture and heat resistant molded rubber jacket and stainless-steel jacket clamps. Unit shall comply with UL467 and UL514. Manufacturer shall be OZ/Gedney Type DX, Steel City Type EDF or equal.
 5. Standard products not herein specified:
 - a. Provide listing of standard electrical conduit hardware and fittings not herein specified for approval prior to use or installation, i.e. locknuts, bushings, etc.
 - b. Listing shall include Manufacturers name, part numbers and a written description of the item indicating type of material and construction.

- c. Miscellaneous components shall be equal in quality, material and construction to similar items herein specified.

2.3 FIRE-RATED WALL AND FLOOR THROUGH-PENETRATION

A. General:

1. Through-penetration firestop system shall have been tested for specific fire resistance rated construction conditions or acoustical and smoke related requirements conforming to construction assembly type, penetrating item type, annular space requirements, and rating involved for each separate instance.
2. Firestop rating shall match that of the wall or floor construction being penetrated.
3. Firestop systems shall be as outlined below:
 - a. Firestop putty.
 - b. Firestop putty pads.
 - c. Fire-rated cable pathways.

B. Firestop putty:

1. Intumescent, non-hardening, water resistant putties containing no solvents, inorganic fibers, or silicone compounds.
2. Putty shall be used to seal openings around conduit penetrations through rated walls or floors, to maintain the construction rating.

C. Firestop putty pads:

1. Intumescent, non-hardening, pliable putty pads designed to seal both through and membrane penetrations against the spread of fire and smoke around outlet boxes in rated construction.
2. The pads are 6" x 8" x 0.125" thick.
3. Pads are rated for up to 4-hour rated wall assemblies.

D. Fire-rated cable pathway penetrations:

1. Cable pathway penetrations shall be used in fire-rated construction for low-voltage cabling, where cables pass through fire-rated wall or floor construction.
2. Cable pathways shall consist of an enclosed heavy-gauge galvanized steel housing lined with intumescent material engineered for rapid expansion when exposed to fire or high temperatures, quickly sealing the pathway, and preventing the passage of flames and smoke. The pathway shall be approximately 4" square x 14" long.
3. Cable pathways shall meet the hourly fire-rating of fire rated wall and/or floor penetrated.
4. Cable pathways shall be tested for the surrounding construction and cable types involved.
5. Pathways shall be UL Systems permitting cable loads from 0 to 100-percent fill. This requirement eliminates need for fill-ratio calculations to be made by cable technicians to ensure cable load is within maximum allowed by UL System.
6. Pathway shall be maintenance-free, having a corresponding Evaluation Services Report from a Nationally Recognized Third-Party Laboratory. Maintenance-free

is defined as no action required by cabling technician to open and/or close pathway for cable moves, adds or changes, such as, but not limited to:

- a. Opening or closing of doors.
 - b. Spinning rings to open or close fabric liner.
 - c. Removal and or replacement of any material such as, but not limited to, firestop caulk, putty, pillows, bags, foam muffins, foam, foam plugs, foam blocks, or foam closures of any sort.
 - d. Evaluation Services Report (ESR) from an accredited Nationally Recognized Third-party Laboratory certifying compliance with this definition of "Maintenance-Free" and all relevant codes and standards.
7. Pathways shall be engineered such that two or more devices may be ganged together for larger cable capacities.
 8. Pathways shall be engineered to be re-enterable so they can be retrofitted and removed from around existing cables without cutting and re-splicing them.
 9. Affix adhesive wall label immediately adjacent to devices to communicate to future cable technicians, authorities having jurisdiction and others the manufacturer of the device and the corresponding UL System number installed.

2.4 OUTLET BOXES

A. Standard outlet box:

1. Provide galvanized, one-piece die formed or drawn steel or welded, knockout type box of size and configuration best suited to the application indicated on the Drawings.
2. 4.687-inch square by 2.125-inch deep shall be minimum box size.
3. ANSI/NEMA OS 1.

B. Concrete box:

1. Provide galvanized steel, 4-inch octagon rings with mounting lugs, backplate and adapter ring as required.
2. Select height as necessary to position knockouts above concrete reinforcing steel.
3. ANSI/NEMA OS 1.

C. Pull and junction boxes:

1. Sheet metal pull and junction box:
 - a. Provide standard outlet or concrete ring boxes wherever possible; otherwise use minimum 16-gauge galvanized sheet metal, NEMA 1 boxes, sized to Code requirements with covers secured by cadmium plated machine screws located 6 inches on centers.
 - b. ANSI/NEMA OS 1.
2. Cast metal pull and junction box: Provide standard cast malleable iron outlet or device boxes wherever possible; otherwise use cadmium plated, cast malleable iron boxes with bolt-on, interchangeable conduit hub plates with neoprene gaskets.

3. Flush mounted pullboxes and junction boxes: Provide overlapping covers with flush head cover retaining screws, prime coated.

2.5 J-HOOK "NON-CONTINUOUS" CABLE SUPPORT SYSTEM

A. General:

1. J-hooks shall provide a bearing surface of sufficient width to comply with required bend radii of high-performance cables per ANSI/TIA 568.0-D.
2. J-hooks shall have flared edges to prevent damage while installing cables.
3. J-hook shall have a cable retainer wire form to provide containment of cables within the hanger. The cable retainer shall be removable and reusable.
4. J-hook shall have a hot-dipped galvanized or G60 finish and shall be rated for indoor use in non-corrosive environments.
5. J-hook shall be made using a metal thickness of 0.052" and in a finish and hardness.
6. Attaching J-hooks and assemblies to ceiling support wires is not allowed per the CEC.

B. Multi-tiered field assemblies:

1. Multi-tiered J-hook assemblies shall be used where separate cabling compartments are required. Assemblies may be created by joining the J-hook with snap-on tree-mounting brackets. Assemblies can be made single-sided for wall-mount applications or single/double sided for ceiling/beam/threaded rod suspended applications. The assembly is rated for indoor use in non-corrosive environments.
2. For installation on threaded rod, a snap-on angle bracket must be added on top of the assembly.
3. If required, the multi-tier J-hook assembly can be attached to snap-on angle or straight brackets riveted to beam clamps, flange clips, angle brackets, etc.

C. Factory assembled multi-tier J-hook assemblies: The assemblies shall be used where separate cabling compartments are required. These assemblies are assembled by the factory. Multi-tier assemblies are available for specific applications including wall mount, ceiling mount, threaded rod mount, and beam/flange mount. The beam/flange mount assembly shall include a beam clamp rated to hold the weight of any of the multi-tier configurations. Assemblies shall be available in 1, 2, 3, & 4 tier double-sided and 2, 3, & 4 tier in single-sided configurations. The assembly shall be rated for indoor use in non-corrosive environments.

D. J-hook assemblies shall be furnished with appropriate fittings and add-on devices to allow for supports in multiple applications. Support fittings and add-on devices include beam or flange fasteners, threaded rod fasteners, support wire fasteners, construction channel support fasteners, wall or concrete or joist fasteners, raised access floor pedestal supports, etc.

E. Finishes: ASTM B633 Standard Specification for Electro-Deposited Coatings of Zinc on Iron and Steel, or ASTM A924/A924M Standard Specification for General Requirements for Steel Sheet, Metallic Coated by the Hot Dip Process

- F. Material: Base material of the J-hooks shall be metal (at least a 0.052" thickness). Any fasteners used to affix the J-hooks shall also be metal and shall be fastened to the metal of the J-hook support.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Contractor shall thoroughly examine Project site conditions for acceptance of pathway installation to verify conformance with Manufacturer and Specification tolerances. Do not commence with installation until all conditions are made satisfactory.

3.2 CONDUIT APPLICATION

- A. Electrical metallic tubing (EMT): Shall be used exposed or concealed for interior communication conduits 4" and smaller, where run above suspended ceilings, in concrete slabs and walls not in contact with earth; in stud walls, furred spaces and crawl spaces. EMT shall not be installed exposed below 6 feet above the finish floor except within communication rooms or closets.
- B. Rigid non-metallic conduit (PVC): Shall be used in the following applications:
1. Direct burial ducts: Schedule 40, minimum 24-inches below finished grade.
 2. Concrete encased ducts: Type DB, minimum 30-inches below finished grade.
 3. Below building slab-on-grade: Schedule 40, minimum 4-inches below bottom of slab except that bends and penetrates through floor slab shall be insulated galvanized rigid steel conduit.
 4. Below roads and paved surfaces:
 - a. Schedule 80, minimum 36-inches below finished grade.
 - b. Concrete encased type EB or DB, minimum 30-inches below finished grade.
 5. Utility pole riser: Schedule 80.
 6. Penetrations of building and equipment slabs: Schedule 80 conduit.
 7. Slope duct to drain towards vaults and away from building and equipment entrances. Pitch not less than 4-inches per 100-feet.
 8. Curved sections in duct lines shall consist of long sweep bends with a minimum radius of 25-feet in the horizontal and vertical directions. The use of manufactured bends is limited to building entrances and equipment stub-ups.
 9. For communications conduits, do not exceed a combined bend radius of greater than 180-degrees between pull points.
 10. Underground conduit stub-ups to inside of building and exterior equipment shall be Schedule 80 conduit.
 11. Make joints in ducts and fittings watertight according to Manufacturer's instructions. Stagger couplings so those of adjacent ducts do not lie in the same plane.
 12. Terminate duct lines at vaults with end bells spaced 10-inches on center for 5-inch ducts and varied proportionately for other duct sizes. Change from regular

spacing to end-bell spacing 10-feet from the end bell without reducing duct line slope and without forming trap in the line. Grout end bells into manhole walls from both sides to provide watertight entrance.

13. Separation between direct buried duct lines shall be 3-inches minimum for like systems and 12-inches minimum between power and communication ducts.
14. Concrete encased ducts:
 - a. Duct lines shall consist of single or multiple duct assemblies encased in concrete. Ducts material throughout the installation.
 - b. Rigid PVC spacers shall securely support and maintain uniform spacing of the duct assembly a minimum of 3-inches above bottom of trench during the concrete pour. Spacer spacing shall not exceed 5-feet.
 - c. Provide non-ferrous tie wires to prevent displacement of the ducts during pouring of concrete.
 - d. Separate ducts 3-inches for like systems and 6-inches between power and signal ducts.
15. For direct burial installations install continuous warning strip of heavy gage plastic imprinted "communication ducts below", approximately 12-inch wide at 12-inches above ducts.
16. Mandrel all ducts upon completion of installation and prior to pulling cables.

3.3 PREPARATION

A. Conduit:

1. Locations of conduit runs shall be planned in advance of the installation and coordinated with ductwork, plumbing, ceiling and wall construction in the same areas and shall not unnecessarily cross other conduits or pipe, nor prevent removal of ceiling tiles or panels, nor block access to mechanical or electrical equipment.
2. Where practical, install conduits in groups in parallel vertical or horizontal runs and at elevations that avoid unnecessary offsets.
3. All conduits shall be run parallel or at right angles to the centerlines of columns and beams, whether routed exposed, concealed above suspended ceiling or in concrete slabs.
4. Communications conduits shall not be placed closer than 12-inches to power, a flue, parallel hot water, steam line or other heat producing source or three inches from such lines when crossing perpendicular to the runs.
5. Exposed conduit installation shall not encroach into the ceiling height headroom of walkways or doorways. Where possible, install horizontal raceway runs above water and below steam piping.
6. The largest trade size conduits in concrete floor and wall slabs shall not exceed 1/3 the floor or wall thickness and conduits shall be spaced a minimum of three conduit diameters apart unless otherwise noted on the Drawings. All conduits shall be installed in the center of concrete slabs or wall and shall not be placed between reinforcing steel and the bottom of floor slabs.
7. In long runs of conduit, provide sufficient pull boxes inside buildings to facilitate pulling wires and cables, with spacing not to exceed 150-feet. Support pull

boxes from structure independent of conduit supports. These pull boxes are not indicated on the Drawings.

8. Communication conduit bends shall not exceed 180-degrees within any single run of conduit.
9. Provide all reasonably inferred standard conduits fitting and products required to complete conduit installation to meet the intended application whether noted, indicated, or specified in the Contract Documents or not.

B. Boxes:

1. Install all outlet boxes flush with building walls, ceilings, and floors.
2. Locate pullboxes and junction boxes in concealed locations above removable ceilings or exposed in electrical rooms, utility rooms or storage areas.
3. Install outlet boxes at the locations and elevations indicated on the Drawings or specified herein. Adjust locations as required by structural conditions and to suit coordination requirements of other trades.
4. Do not install outlet boxes back-to-back, separate boxes by at least 6". In fire-rated walls separate boxes by at least 24" and wall stud.
5. Adjust position of outlet boxes in finished masonry walls to suit masonry course lines. Coordinate cutting of masonry walls to achieve neat openings for boxes.

C. J-hooks:

1. Location of J-hooks shall be planned in advance of the installation and coordinated with ductwork, plumbing, ceiling and wall construction in the same areas and shall not unnecessarily cross other conduits or pipe, nor prevent removal of ceiling tiles or panels, nor block access to mechanical or electrical equipment.
2. J-hooks shall not be placed closer than 12-inches to a flue, parallel hot water, steam line or other heat producing source or three inches from such lines when crossing perpendicular to the runs.
3. J-hooks shall not be placed closer than 3-inches to any branch circuit power raceway.

3.4 INSTALLATION

A. Conduit:

1. Install conduit in accordance with Manufacturer's written instructions, as indicated on Drawings and as specified herein.
2. Minimum communication conduit size: Unless otherwise noted herein or on Drawings, minimum conduit size shall be 1-1/4" for interior applications and 2" for exterior and underground applications.
3. All communication conduit sizes indicated on the Drawings are sized for 40-percent fill or less for category 6 or 6A cable. If cable type or size is changed the Contractor shall be responsible for resizing conduits upward to meet a maximum 40-percent fill.
4. In general, all conduit work shall be concealed where possible. Exceptions shall be communication rooms, exposed ceiling areas, and parking garages.
5. Install conduits in complete runs before pulling in cables or wires.

6. Install conduit free from dented, bruises or deformations. Remove and replace any damaged conduits with new undamaged material.
 7. Conduits shall be well protected and tightly covered during construction using metallic bushings and bushing "pennies" to seal open ends.
 8. Clean any conduit in which moisture or any foreign matter has collected before pulling in conductors. Paint all field-threaded joints to prevent corrosion.
 9. In all empty conduits or ducts, install a "True Tape" conduit measuring tape line to provide overall conduit length for determining length of cables/conductors for future use.
 10. Metallic conduit shall not be in contact with other dissimilar metal pipes (i.e. plumbing).
 11. Make bends with standard conduit bending hand tool or machines. The use of any item not specifically designed for the bending of electrical conduit is strictly prohibited.
 12. A run of communications conduit between terminations at wire pulling points shall not contain more than the equivalent of two-quarter bends (180-degrees, total).
- B. Fire-rated cable pathways:
1. Install cable pathways in accordance with Manufacturer's written instructions, as indicated on Drawings and as specified herein.
 2. Install pathways using mounting plates and gasketing that comes with equipment for the application of each installation.
 3. Where multi-gang pathway penetrations occur, use framing hardware brackets recommended by manufacturer for specific applications. Pathways shall be furnished with insert hooks and eye windows to connect units together and align them for multi-gang installations.
- C. Boxes:
1. Install boxes in accordance with Manufacturer's written instructions, as indicated on Drawings and as specified herein.
 2. Locate electrical boxes as indicated on Drawings.
 3. Install junction or pullboxes where required to limit bends in conduit runs to not more than 180-degrees or where pulling tension achieved would exceed the maximum allowable for the cable to be installed. Note that these boxes are not indicated on the Drawings.
 4. Install raised covers (plaster rings) on all outlet boxes in stud walls or in furred, suspended, or exposed concrete ceilings. Covers shall be of a depth to suit the wall or ceiling finish.
 5. Leave no unused openings in any box. Install close-up plugs as required to seal openings.
 6. Provide cast metal boxes with gasketed cast metal cover plates where boxes are exposed in damp or wet locations.
 7. Welded outlet boxes shall only be used in concealed interior installations.
 8. Provide an access panel in permanent ceiling or wall where boxes are installed and will be inaccessible.

9. For boxes mounted in exterior walls, make sure that there is insulation behind outlet boxes to prevent condensation in boxes.
10. For outlets mounted above counters, benches or backsplashes, coordinate location and mounting heights with built-in units. Adjust mounting height to agree with required location for equipment served.

D. J-hooks:

1. Install J-hooks in accordance with Manufacturer's written instructions, as indicated on Drawings and as specified herein.
2. Support J-hooks every 48-inches or less throughout the cable pathway.
3. J-hook support shall consist of 1/4" to 3/8" threaded rods supported from structure above, to structural wall studs with #10 wood or Tek screws or to #12 ceiling wire (independent of ceiling support) to structure.

3.5 PENETRATIONS

A. Conduit:

1. Locate penetrations and holes in advance where they are proposed in the structural sections such as footings, beams, wall, etc. Penetrations are acceptable only when the following occurs:
 - a. Where indicated on the Structural Drawings.
 - b. As approved by the Structural Engineer prior to construction and after submittal of Drawing showing location, size, and position of each penetration.
2. Cutting or holes:
 - a. Cut holes through concrete, masonry block or brick floors and floors of structure with a diamond core drill or concrete saw. Pneumatic hammer, impact electric, hand or manual hammer type drills are not allowed, except where permitted by the Structural Engineer as required by limited working space. Obtain the approval of the Structural Engineer prior to drilling through structural sections.
 - b. Provide sleeves or "can outs" for cast-in-place concrete floors and walls. Following conduit installation, seal all penetrations using non-iron bearing, chloride free, non-shrinking, dry-pack grouting compounds; or fire rated penetration-sealing materials.
 - c. Cut holes for conduit penetrations through non-concrete and non-masonry walls, partitions, or floors with a hole saw. The hole shall be only as large as required to accommodate the size of the conduit.
 - d. Provide single piece escutcheon plates around all exposed conduit penetrations in public places.
3. Sealing:
 - a. Non-rated penetrations: Pack opening around conduits with non-flammable insulating material and seal with gypsum wallboard taping compound.
 - b. Firestop: Where conduits and other communication raceways pass through fire-rated partitions, walls, smoke partitions or floor; install a UL classified fire-stop material to provide an effective barrier against the spread of fire, smoke, and gases. Completely fill and seal clearances between raceways and openings with the fire-stop material.

4. Waterproofing: At floor, exterior wall, and roof conduit penetrations, completely seal clearances around the conduit and make watertight as specified in Division 07: Sealants and Caulking.
 - a. Install specified watertight conduit entrance seals at all below grade wall and floor penetrations. Conduits penetrating exterior building walls and building floor slab shall be Schedule 80 PVC conduit.
 - b. For roof penetrations furnish and install roof flashing, counter flashing and pitch-pockets as specified under Roofing and Sheet Metal Sections of the Specifications.
 - c. Provide membrane clamps and cable sealing fittings for any conduit that horizontally penetrates the waterproof membrane.
 - d. Conduits that horizontally penetrate a waterproof membrane shall fall away from and below the penetration on the exterior side a minimum of two times the conduit diameters.

3.6 CONDUIT CONCEALED IN CONCRETE

- A. Install conduits approximately in the center of the slab so that there will be a minimum of 1-inch of concrete around the conduits.
- B. Installation of conduit in structural concrete that is less than three inches thick is prohibited. Topping slabs, maintenance pads and curbs are exempted.
- C. Tie conduits to reinforcing rods or otherwise secure them to prevent sagging or shifting during concrete placement. Run conduit larger than 1-inch trade size, parallel with or at right angles to the main reinforcement; where at right angles to the reinforcement, the conduit shall be close to one of the supports of the slab.
- D. Where nonmetallic conduit or tubing is used, raceways must be converted to EMT conduit before rising above floor.
- E. Make couplings and connections watertight.
- F. Protect stub-ups from damage where conduits rise from floor slabs. Arrange so curved portion of bends is not visible above the finished slab.

3.7 UNDERGROUND CONDUIT INSTALLATION

- A. Perform trenching, backfilling and compaction operations as specified in Division 31: Trenching.
- B. Install service utility company underground conduits in strict conformance to each utility company's requirements. Obtain a copy of each utility company's installation guidelines prior to commencing Work.
- C. Tops of conduits shall be as follows unless otherwise noted:
- D. Not less than 18-inches below finished grade.
- E. Not less than 30-inches below roadways, paved parking lots, driveways or any surface subject to vehicular traffic.
- F. Not less than 4-inches below building floor slab for branch circuits. Major feeders and large signal conduits (2" and greater) at not less than 18-inches.

- G. Depth of service utility conduits shall conform to utility company requirements.
- H. Furnish and install specified underground conduit marker 12" above conduits in trenches with all buried conduits.

3.8 CONDUIT TERMINATIONS AND JOINTS

- A. Use raceway fittings that are of types compatible with the associated raceway and suitable for the use and location.
- B. Raceways shall be joined using specified couplings or transition couplings where dissimilar raceway systems are joined.
- C. Stub-up connections: Extend conduits through concrete minimum of 3" and terminate with insulated bushing.
- D. Install specified cable sealing bushings on all conduits originating outside the building walls and terminating inside the building. Install cable sealing bushings or raceway seal for conduit terminations in all grade level or below grade exterior pull, junction, or outlet boxes.
- E. Install expansion couplings where any conduit crosses a building separation or expansion joint as follows:
 - 1. Conduits three inches and larger, shall be rigidly secured to the building structure on opposite sides of a building expansion joint and provided with expansion or deflection couplings. Install the couplings in accordance with the Manufacturer's recommendations.
 - 2. Conduits smaller than three inches shall be rigidly secured to the building structure on opposite sides of a building expansion joint with junction boxes on both sides of the joint. Connect conduits to junction boxes with 15-inches of slack flexible conduit. Flexible conduit shall have a green copper ground-bonding jumper installed. For concrete embedded conduit, use expansion and deflection couplings as specified above for three inches and larger conduits.

3.9 SUPPORTS

- A. Conduit:
 - 1. Provide supports for raceways as specified in Section 270529: Communication Hangers and Supports.
 - 2. All raceways systems shall be secured to building structures using specified fasteners, clamps and hangers spaced according to the CEC.
 - 3. Support single runs of conduit using one-hole pipe straps. Where run horizontally on walls in damp or wet locations, install "clamp backs" to space conduit off the surface.
 - 4. Multiple conduit runs shall be supported using "trapeze" hangers fabricated from specified construction channel, mounted to 3/8-inch diameter, threaded steel rods secured to building structures. Fasten conduit to construction channel with standard one-hole pipe clamps or the equivalent. Provide lateral seismic bracing for hangers.
 - 5. Fasteners and supports in solid masonry and concrete:

- a. Use steel or malleable iron concrete inserts set in place prior to placing the concrete.
 - b. After concrete installation:
 - 1) Steel expansion anchors not less than ¼ inch bolt size and not less than 1-1/8" embedment.
 - 2) Power set fasteners not less than ¼-inch diameter with depth of penetration not less than 3-inches.
 - 3) Use vibration and shock resistant anchors and fasteners for attaching to concrete ceilings.
 6. Hollow masonry: Toggle bolts are permitted. Bolts supported only by masonry block are not acceptable.
 7. Metal structures: Use machine screw fasteners or other devices specifically designed and approved for the application.
- B. Boxes:
1. Provide boxes installed in metal stud walls with brackets designed for attaching directly to the studs or mount boxes on specified box supports.
 2. Mount boxes, installed in suspended ceilings of gypsum board or lath and plaster construction, to 16-gauge metal channel bars attached to main ceiling runners.
 3. Support boxes independently of conduit system.
 4. Support boxes, installed in suspended ceilings supporting acoustical tiles or panels, directly from the structure above wherever pendant mounted luminaires are to be installed from the box.
 5. Support boxes mounted above suspended acoustical tile ceilings, directly from the structure above.

3.10 CLEANING

- A. Upon completion of Project prior to final acceptance the Contractor shall thoroughly clean all equipment per Manufacturers approved methods and materials. Remove paint splatters and other spots, dirt, and debris.
- B. Touch-up paint for any marks, blemishes or other finish damage suffered during installation.

END OF SECTION

SECTION 27 05 29

COMMUNICATION HANGERS AND SUPPORTS

PART 1 - GENERAL

1.1 SUMMARY

- A. Work included: Labor, materials, and equipment necessary to complete the installation required for the item specified under this Division, including but not limited to:
 - 1. Conduit supports.
 - 2. Equipment supports.
 - 3. Fastening hardware.
- B. Related Work: Consult all other Sections, determine the extent and character of related Work, and properly coordinate Work specified herein with that specified elsewhere to produce a complete installation.
 - 1. Division 05: Miscellaneous metals. Hangers for communication equipment.
 - 2. Division 09: Ceiling suspension systems. Slack support wires.

1.2 REFERENCES

- A. Comply with the latest edition of the following applicable Specifications and standards except as otherwise indicated or specified:
 - 1. Underwriters Laboratories, Inc. (UL):
 - UL 2239; Hardware for the Supports of Conduit, Tubing and Cable.

1.3 SYSTEM DESCRIPTION

- A. Provide devices specified in this Section and related Sections for support of communication equipment furnished and installed under Division 27.
- B. Provide support systems that are adequate for the weight of equipment, conduit and wiring to be supported.

1.4 SUBMITTALS

- A. Submit in accordance with the requirements of Section 270010: Basic Communications Requirements, the following items:
 - 1. Data/catalog cuts for each product and component specified herein.
 - 2. Clearly mark on each data sheet the specific item(s) being submitted and the proposed application.
 - 3. Submit Manufacturer's installation instructions.

1.5 QUALITY ASSURANCE

- A. All materials, equipment and parts comprising the units specified herein shall be new, unused, and currently under production.

- B. Only products and applications listed in this Section may be used on the Project unless otherwise submitted.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Products furnished by the following Manufacturers shall be acceptable if in compliance with all features specified herein and indicated on the Drawings.
 - 1. Concrete fasteners:
 - a. Phillips "Red-Head".
 - b. Remington.
 - c. Ramset.
 - 2. Concrete inserts and construction channel:
 - a. Unistrut Corp.
 - b. GS Metals "Globe Strut."
 - c. Thomas & Betts "Kindorf" Corp.
 - 3. Conduit straps:
 - a. O-Z/Gedney.
 - b. Erico "Caddy" Fastening Products.
 - c. Thomas & Betts "Kindorf" Corp.
- B. Substitutions: Under provisions of Section 270010: Basic Communications Requirements.

2.2 CONCRETE FASTENERS

- A. Provide expansion-shield type concrete anchors.
- B. Provide powder driven concrete fasteners with washers. Obtain approval by Architect and Structural Engineer prior to use.

2.3 CONCRETE INSERTS

- A. Provide pressed galvanized steel, concrete spot insert, with oval slot capable of accepting square or rectangular support nuts of 1/4" to 1/2" diameter thread for rod support.

2.4 THREADED ROD

- A. Provide steel threaded rod, sized for the load unless otherwise noted on the Drawings or in the Specifications.

2.5 CONSTRUCTION CHANNEL

- A. Provide 1.5-inch by 1.5-inch (nominal), 12-gauge galvanized steel channel with 17/32-inch diameter bolt holes and 1.5-inch on center in the base of the channel.

2.6 CONDUIT STRAPS

- A. One-hole strap, steel, or malleable iron, with malleable iron clamp-back spacer for surface mounted wall and ceiling applications.
 - 1. Use malleable strap with spacers for exterior and wet locations.
 - 2. Use steel strap without spacers for interior locations.
- B. Steel channel conduit strap for support from construction channel.
- C. Steel conduit hanger for pendant support with threaded rod
- D. Steel wire conduit support strap for support from independent #12-gauge hanger wires.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Contractor shall thoroughly examine Project site conditions for acceptance of supporting device installation to verify conformance with Manufacturer and Specification tolerances. Do not commence with installation until all conditions are made satisfactory.

3.2 PREPARATION

- A. Coordinate size, shape, and location of concrete pads with Division 03, Cast-in-place concrete.
- B. Layout support devices to maintain headroom, neat mechanical appearance and to support the equipment loads.

3.3 INSTALLATION

- A. Furnish and install supporting devices as noted throughout Division 27.
- B. Telecommunication devices and conduit supports shall be independent of all other system supports that are not structural elements of the building, unless otherwise noted.
- C. Fasten hanger rods, conduit clamps, outlets, and junction boxes to building structure using precast inserts, expansion anchors, preset inserts, or beam clamps.
- D. Use toggle bolts or hollow wall fasteners in hollow masonry, plaster or gypsum board partitions and walls.
- E. Use expansion anchors or preset inserts in solid masonry walls.
- F. Use self-drilling anchors, expansion anchor or preset inserts on concrete surfaces.
- G. Use sheet metal screws in sheet metal studs and wood screws in wood construction.
- H. Do not fasten supports to piping, ductwork, mechanical equipment, conduit, or acoustical ceiling suspension wires.
- I. Do not drill structural steel members unless first approved in writing by the Architect or Structural Engineer.

- J. Fabricate supports from structural steel or steel channel, rigidly welded, or bolted to present a neat appearance. Use hexagon head bolts with spring lock washers under all nuts.
- K. Install surface-mounted cabinets with minimum of four anchors. Provide additional support backing in stud walls prior to sheet rocking as required to adequately support cabinets and panels.
- L. Bridge studs top and bottom with channels to support flush mounted cabinets in stud walls.

3.4 ERECTION OF METAL SUPPORTS

- A. Cut, fit, and place miscellaneous metal fabrications accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
- B. Field Welding: Comply with AWS "Structural Welding Code."

3.5 WOOD SUPPORTS

- A. Cut, fit, and place wood nailers, blocking and anchorage accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

3.6 ANCHORAGE

- A. All floor mounted, free standing telecommunications equipment such as racks and cabinets etc., shall be securely fastened to the floor structure.
- B. Anchorage of communication equipment shall comply with the seismic requirements as outlined in Section 270010: Basic Communication Requirements.

END OF SECTION

SECTION 27 05 36

COMMUNICATION CABLE RUNWAYS AND TRAYS

PART 1 - GENERAL

1.1 SUMMARY

- A. Work included: Labor, materials, and equipment necessary to complete the installation required for the item specified under this Division, including but not limited to:
 - 1. Cable runways.
 - 2. Cable trays.
 - 3. Cable tray accessories.
 - 4. Wire basket cable support system and accessories.
- B. Related Work: Consult all other Sections, determine the extent and character of related Work, and properly coordinate Work specified herein with that specified elsewhere to produce a complete installation.

1.2 REFERENCES

- A. Comply with the latest edition of the following applicable Specifications and standards except as otherwise indicated or specified.
 - 1. National Electrical Manufacturer Association (NEMA):
 - NEMA VE 1; Cable Tray Systems
 - 2. American Society for Testing Materials (ASTM):
 - ASTM A123 Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
 - ASTM A510 General Requirements for Wire Rods and Coarse Round Wire, Carbon Steel
 - ASTM A633 Electrodeposited Coatings of Zinc and Steel

1.3 SYSTEM DESCRIPTION

- A. Cable tray shall be installed above accessible ceiling to convey cable from the telecommunication rooms to the workstation. They shall be routed as shown on the drawings.
- B. Cable runways shall be placed in telecommunication rooms around the perimeter of the room and over equipment racks.

1.4 SUBMITTALS

- A. Submit in accordance with the requirements of Section 270010: Basic Communication Requirements, the following items:
 - 1. Data/catalog cuts for each product and component specified herein, listing, and physical and electrical characteristics and ratings indicating compliance with all listed standards.

2. Clearly mark on each data sheet the specific item(s) being submitted and the proposed application.
3. Submit Manufacturer's installation instruction: Provide written instructions for cable tray and runway products special installation techniques.
4. Complete bill of material listing all components.
5. Shop Drawings: Indicate layout, dimensions, support locations and mounting details.
6. Furnish structural calculations for equipment support as described in Section 270010: Basic Communication Requirements.

1.5 OPERATION AND MAINTENANCE MANUAL

- A. Supply operation and maintenance manuals in accordance with the requirements of Section 270010: Basic Communications Requirements, to include the following.
 1. Instructions for routine maintenance to include bolt-tightening procedures.
 2. Pictorial parts list and part numbers.
 3. Telephone numbers for the authorized parts and service distributors.

1.6 QUALITY ASSURANCE

- A. All materials, equipment and parts comprising the units specified herein shall be new, unused, and currently under production.
- B. Only products and applications listed in this Section may be used on the Project unless otherwise submitted.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Products furnished by the following Manufacturers shall be acceptable if in compliance with all features specified herein and indicated on the Drawings.
 1. Cable Runway:
 - a. Chatsworth Product Inc. (CPI).
 - b. Cooper/B-Line Systems, Inc.
 - c. Belden cable
 - d. Panduit
 - e. Mono-Systems, Inc.
 2. Cable Tray:
 - a. GS Metals Corp. (Globetray).
 - b. Cooper/B-Line Systems, Inc.
 - c. Chalfant.
 - d. MP Husky Corp.
 - e. PW Industries, Inc.
 - f. Mono-Systems, Inc.

g. Cablofil EZ Tray

- B. Substitutions: Under provisions of Section 270010: Basic Communications Requirements.

2.2 CABLE RUNWAY SYSTEM

- A. Cable runway shall be used to convey cable within the telecommunication rooms, above equipment racks, plywood backboards at room perimeter, and vertically on walls above conduit sleeves for cable routing to overhead.
- B. Cable runway shall be ladder type and consist of two longitudinal members (stringers) with transverse members (rungs) welded to the stringers. Rungs shall be spaced 9-inches on center. Rung spacing in radius fittings shall be 9-inches measured at the center of the runway width. Rungs shall have a minimum cable bearing surface of 1-inch with rounded edges. No portion of the rungs shall protrude below the bottom plane of the side rails.
- C. Straight cable runway sections shall have side rails fabricated as tubular steel channels. All straight sections shall be supplied in standard 10-foot lengths, except where shorter lengths are permitted to facilitate cable runway assembly lengths as shown on drawings.
- D. Cable runway widths shall be 12, 18, or 24-inches as indicated on drawings.
- E. Splice plates shall be the bolted type. The resistance of fixed splice connections between an adjacent section of cable runway shall not exceed .00033ohm. Splice plate construction shall be such that a splice may be located anywhere within the support span without diminishing the cable runway rated loading capacity.
- F. All splice materials shall be made of ASTM A570 structural steel using carriage bolts and serrated flange locknuts. Hardware shall be powder coated black.
- G. Cable runway supports shall be placed so that the support spans do not exceed a maximum span of 5-feet. Supports shall be constructed from formed shape channel members 1-5/8" by 1-5/8" with necessary hardware such as trapeze support kits, ceiling support kits, triangular support brackets, wall angle support kits, cable drop outs, etc., as provided by the same manufacturer.
- H. Trapeze hangers shall be supported by 5/8" (minimum) diameter all thread rods. All thread rods shall be equipped with threaded rod covers to protect cable from damage during installation.
- I. Accessories shall be furnished as required to protect, support, and install cable runway systems. Accessories shall consist of but are not limited to; section splice plates, expansion plates, blind-end plates, specially designed runway drop-outs, barriers, etc.
- J. All cable runway, splice hardware, and support hardware shall be powder coated black.
- K. Loading capacities shall meet NEMA class designations 8A.
- L. Ground bonding:

1. All cable runway shall be bonded with a #6 copper wire with a green jacket to the ground bus bar in room.
2. All sections of the runway shall be bonded with #6 ground straps.

2.3 WIRE BASKET SYSTEM SECTIONS AND COMPONENTS

- A. General: Provide wire basket of type and sizes indicated; with connector assemblies, clamp assemblies, connector plates, splice plates and splice bars. Construct units with round edges and smooth surfaces, in compliance with applicable standards and with the following additional construction features.
- B. Construction:
1. Wire basket system shall be made of high strength steel wires and formed into a standard 2" x 4" wire mesh pattern with intersecting wires welded together. All wire ends along system sides shall be rounded during fabrication.
 2. All straight section longitudinal wires shall be straight, with no bends.
 3. Wire basket size shall be 2" deep by 12" or 18" or 24" wide by 118" long.
 4. Wire diameter: 0.177 inches, minimum.
 5. All fitting shall be field formed as needed to accommodate layout as indicated.
 6. All splicing assemblies shall be the bolted type using serrated flange locknuts.
 7. Hardware, including splice connectors and support components shall all be furnished by Manufacturer.
- C. Materials and finishes:
1. Hot dip galvanized after fabrication:
 - a. Straight sections shall be made from steel meeting the minimum mechanical properties of ASTM A510 and shall be coated after the wire basket system has been fabricated in accordance with ASTM A123 (CSA Type 1).
 - b. All hot dip galvanized after fabrication sections must be returned to the point of manufacture after coating for inspection and removal of all icicles and excess zinc.
 2. Electro-galvanized zinc: Support accessories and miscellaneous threaded hardware shall be coated in accordance with ASTM B633 SC3. All threaded components shall be coated in accordance with ASTM B633 SC1.
- D. Support system:
1. Wire basket shall be pendant hung via threaded rods and expansion anchors to form a trapeze system with construction channel.
 2. No hardware required to mount basket to bracket. Simply bend tabs of bracket down around wires.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Contractor shall thoroughly examine Project site conditions for acceptance of cable runway and tray installation to verify conformance with Manufacturer and

Specification tolerances. Do not commence with installation until all conditions are made satisfactory.

3.2 PREPARATION

- A. Location of cable runway and tray shall be planned in advance of the installation and coordinated with ductwork, plumbing, electrical, ceiling and wall construction in the same areas and shall not unnecessarily cross other conduits or pipe, nor prevent removal of ceiling tiles or panels, nor block access to mechanical or electrical equipment. Provide offsets as required to avoid obstruction of cable tray with other trades.
- B. Exposed cable runways and trays shall be run parallel or at right angles to the centerlines of columns and beams.
- C. Cable runways and trays shall not be placed closer than 12-inches to a flue, parallel hot water, steam line or other heat producing source or three inches from such lines when crossing perpendicular to the runs.
- D. Cable runway and tray shall not be placed closer than 3-inches to any branch circuit power raceway.

3.3 INSTALLATION

- A. Install cable runway and tray in accordance with Manufacturer's written instructions, as indicated on Drawings and as specified herein.
- B. Installation shall conform to NEMA VE 1 requirements.
- C. Cable runway:
 - 1. All cable runways will be installed in the telecommunication rooms only.
 - 2. Install cable runway in compliance with requirements of CEC, and applicable portions of NFPA 70B and NECA's "Standards of Installation" pertaining to general communication installation practices.
 - 3. All cable runway shall be supported from the structure and at top of cabinets. Horizontal runway shall not be supported from the wall.
 - 4. Provide dimensional structural restraints around the cable runway for transverse and longitudinal bracing.
 - 5. Coordinate cable runway with other work as necessary to properly interface installation of cable runway work with other trades.
 - 6. Provide sufficient space encompassing cable runways to permit access for installing and maintaining cables.
 - 7. Ground all cable runway to the communications room ground bus bar. Use ground straps between each section of runway installed or where splice plates are used to join sections. Scrape paint away from cable runway at points of connection to each section of runway by the ground strap.
- D. Cable Tray
 - 1. Support cable tray at each connection point, at the end of each run and at other points to maintain spacing between supports of 8-feet maximum.

2. Cable tray support shall be a wall mounted bracket and/or trapeze type hanger system.
 - a. Wall brackets shall be supported to wall studs every 48" with manufacturer's trapeze style bracket. Size bracket shall be the next size greater than the size of the tray. Secure brackets to wall studs with #12 wood or STS screws appropriate for the material securing to. Wall brackets hanger shall have tab slots for the bottom of the tray to slide into. Crimp tab around tray per manufacturer's instructions.
 - b. Trapeze supports shall be consisting of two (2) 3/8" threaded rods, supported from structure above, supporting the tray manufacturer's trapeze style bracket. Size bracket shall be the next size greater than the size of the tray. Trapeze hanger shall have tab slots for the bottom of the tray to slide into. Crimp tab around tray per manufacturer's instructions.
3. Provide lateral bracing support along cable tray spaced at a maximum of 30-feet on center with tray manufacturer's seismic cable kit. Bracing kit shall consist of 4 each, 10-foot cables with mounting eyelets, 2 each metal support brackets, 4 each cable clamp collars and 4 each concrete bolts. Provide additional components as required to secure seismic kit to structure.
4. Provide bonding continuity between cable tray sections and fittings and ground per manufacturer's instructions and CEC.

END OF SECTION

SECTION 27 05 53

COMMUNICATION IDENTIFICATION

PART 1 - GENERAL

1.1 SUMMARY

- A. Work included: Labor, materials, and equipment necessary to complete the installation required for the item specified under this Division, including but not limited to:
 - 1. Equipment rack and cabinet nameplates.
 - 2. Fuse protector labels.
 - 3. Vertical and horizontal wire management labeling.
- B. Related Work: Consult all other Sections, determine the extent and character of related Work, and properly coordinate Work specified herein with that specified elsewhere to produce a complete installation.

1.2 REFERENCES

- A. Comply with the latest edition of the following applicable Specifications and standards except as otherwise indicated or specified:
 - 1. American National Standards Institute, Inc. (ANSI) / Telecommunications Industry Association (TIA):
 - ANSI/TIA-606-C; Administration Standard for Telecommunications Infrastructure
 - 2. Electronics Industries Alliance (EIA):
 - EIA 230; Color Marking of Thermoplastic Wire.
 - 3. Telecommunications Industry Association (TIA) / Electronics Industries Alliance (EIA):
 - TIA/EIA-606-A; Administration Standard for Commercial Telecommunications Infrastructure

1.3 SUBMITTALS

- A. Submit in accordance with the requirements of Section 270010: Basic Communication Requirements, the following items:
 - 1. Data/catalog cuts for each product and component specified herein.
 - 2. Schedules for nameplates to be furnished.

1.4 QUALITY ASSURANCE

- A. All materials, equipment and parts comprising the units specified herein shall be new, unused, and currently under production.
- B. Only products and applications listed in this Section may be used on the Project unless otherwise submitted.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Products furnished by the following Manufacturers shall be acceptable if in compliance with all features specified herein and indicated on the Drawings.
 - 1. Equipment rack and cabinet nameplates:
 - a. Chatsworth Product Inc. (CPI).
 - b. Cooper/B-Line Systems, Inc.
 - c. Great Lakes.
 - d. Panduit.
 - e. Ortronics.
 - 2. Vertical and horizontal wire management labeling:
 - a. Chatsworth Product Inc. (CPI).
 - b. Cooper/B-Line Systems, Inc.
 - c. Panduit.
- B. Substitutions: Under provisions of Section 270010: Basic Communications Requirements.

2.2 NAMEPLATES FOR EQUIPMENT AND RACKS

- A. Engraved, plastic laminated labels, signs, and instruction plates. Engrave stock melamine plastic laminate 1/16-inch minimum thickness for signs up to 20 square inches or 6-inches in length and 1/8-inch thick for larger sizes. Engraved nameplates shall have white letters and be punched for mechanical fasteners.
- B. Color and letter height as specified in Part 3: Execution.

2.3 BACKBONE COPPER CABLING

- A. Labels type shall be durable plastic (PE or equal) tags, suitable for indoor and/or outdoor use, and shall contain UV inhibitors.
- B. Tags shall attach to the cable via an integrated tie or via a separate steel or plastic tie wrap.
- C. Machine printable with laser printer. Area shall be 1.50" by 2.62", minimum.
- D. Color: Gray tags with white tie-wraps for indoor locations and black tie-wraps for outdoor locations.

2.4 VERTICAL AND HORIZONTAL CABLE LABELS

- A. Fiber optic, twisted pair, and coaxial cables.
- B. Self-laminating adhesive laser labels.
- C. Machine printable with laser printer.
- D. Color: White with black lettering

2.5 OUTLET DEVICE COVERPLATES

- A. Self-laminating, type-on-tape, adhesive labels.
- B. Imprinted or thermal transfer characters onto tape lettering system.
- C. Tape trimmer.
- D. Matte finish spray-on clear coating.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Contractor shall thoroughly examine Project site conditions for acceptance of identification device installation to verify conformance with Manufacturer and Specification tolerances. Do not commence with installation until all conditions are made satisfactory.

3.2 NAMEPLATES

- A. Installation:
 - 1. Degrease and clean surfaces to receive nameplates.
 - 2. Install nameplates parallel to equipment lines.
 - 3. Secure nameplates to equipment fronts using machine screws.
- B. Provide type 'NP' color coded nameplates that present, as applicable, the system and equipment designations.
- C. Nameplates for telecommunication systems equipment and devices are to be black.

3.3 BACKBONE CABLING

- A. General requirements:
 - 1. Labeling, label colors, and identifier assignments shall conform to ANSI/EIA-606-C and TIA/EIA-606-A Administration Standards and as approved by the Owner.
 - 2. Provide permanent and machine-generated labels.
- B. Backbone cable labeling:
 - 1. Cables:
 - a. Text color shall be black with #10 font size.
 - b. Identifier assignment:
 - 1) First field: Type of cable.
 - 2) Second field: Total number of pairs.
 - 3) Third field: Cable number.
 - 4) Fourth field: Active cable count and "dead" pairs.
 - 5) Fifth field: Source and destination.
 - 6) Sixth field: Terminal number (MPOE, MDF, IDF).
 - c. Label installation:

- 1) Provide labels on both ends of cables.
- 2) Install such that they are visible by a technician from normal stance.
- 3) Fully wrap label around the cable jacket (self-lamination).
- 4) Provide one label within 12" of the termination apparatus.
- 5) Provide one label at the point where the cable enters/exits the equipment room.
- 6) Provide one label at the approximate mid-point between where the cable enters/exits the room and the termination apparatus.

2. BEP terminals:

- a. Text color shall be black with #10 font size.
- b. Identifier assignment:
 - 1) First field: Building identifier.
 - 2) Second field: Building zone identifier.
 - 3) Third field: Incoming cable pair identifier.
 - 4) Fourth field: Outgoing cable pair identifier.
- c. Label installation:
 - 1) Install labels such that they are visible by technician from normal stance.
 - 2) Provide one label on the terminal cover or housing.

3. Fiber patch panels:

- a. Text color shall be black, #10 font size.
- b. Label installation:
 - 1) Provide labels at each port.
 - 2) Install labels into label window.

4. Label installation in manholes/vaults/pullboxes:

- a. Provide at least one label within the manholes/vaults/pullboxes.
- b. Install labels such that they are visible by technician from above grade.

5. Label installation at splice points:

- a. Provide one label on each side of splice case.
- b. Install labels such that they are visible by technician from above grade.

3.4 EQUIPMENT RACKS AND CABINETS

- A. Labeling and identifier assignments shall conform to the TIA-606 Standard and as approved by the Owner before installation.
- B. Provide two label nameplates per rack. Permanently affix label nameplates centered on the rack's front top angle and back top angle.
- C. Provide two label nameplates per cabinet. Permanently affix label nameplates centered at the top of cabinet's front door and back door.

3.5 CABLING AND INSCRIBED DEVICE COVERPLATE

A. General:

1. Lettering type: Helvetica, 12-point or 1/8" high.
2. Color of characters shall be black.
3. Locate the top of the inscription 1/2" below the top edge of the coverplate.
4. Inscription shall be centered and square with coverplate.

B. Application:

1. Provide inscribed coverplates for devices as outlined below:
 - a. Telecommunication outlets.
2. Type-on-tape inscriptions shall be provided for the following devices:
 - a. Telecommunication outlets.
3. Type-on-tape installation:
 - a. Tape shall be trimmed to the height of the letters.
 - b. Trim tape length to 1/4 inch back from each edge of coverplate.
 - c. Contractor hands shall be clean or covered with surgical type glove prior to application of tape. Tape installations with visible fingerprints or smudges will not be acceptable.

3.6 CLEANING

- A. Upon completion of Project prior to final acceptance the Contractor shall thoroughly clean all equipment per Manufacturers approved methods and materials. Remove paint splatters and other spots, dirt, and debris.
- B. Touch-up paint for any marks, blemishes or other finish damage suffered during installation.

END OF SECTION

SECTION 27 11 00

COMMUNICATION EQUIPMENT ROOMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Work included: Labor, materials, and equipment necessary to complete the installation required for the item specified under this Division, including but not limited to:
 - 1. Equipment racks.
 - 2. PDU power strips.
 - 3. Vertical cable management.
 - 4. Horizontal cable management.
 - 5. Plywood Backboards
- B. Related Work: Consult all other Sections, determine the extent and character of related Work, and properly coordinate Work specified herein with that specified elsewhere to produce a complete installation.

1.2 REFERENCES

- A. Comply with the latest edition of the following applicable Specifications and standards except as otherwise indicated or specified:
 - 1. American National Standards Institute, Inc. (ANSI) / Telecommunications Industry Association (TIA):
ANSI/TIA-569-D; Telecommunications Pathways and Spaces.
 - 2. American Society for Testing and Materials (ASTM):
ASTM E84; Surface Burning Characteristics of Building Materials
 - 3. Electronics Industries Alliance (EIA) / Electronic Components, Assemblies & Materials Association (ECA):
EIA/ECA-310-E; Cabinet, Racks, Panels, and Associated Equipment.

1.3 SYSTEM DESCRIPTION

- A. The work under this Section covers the materials, accessories, fasteners, etc., and all labor and services required to buildout the telecommunication equipment rooms per the Drawings and per these Specifications.
- B. Installation includes equipment racks, cabinets, cabling, cable management, cable terminations, plywood backboards, cable runways, and termination hardware to support communications equipment. Although, not all the aforementioned equipment is specified under this Section, but covered elsewhere within Division 27.
- C. Also, the grounding system for bonding of equipment racks, cable runway, entrance conduits, riser conduits, etc. within the communication equipment room is included, but specified under Section 270526: Communication Grounding and Bonding.

1.4 SUBMITTALS

- A. Submit in accordance with the requirements of Section 270010: Basic Communications Requirements, the following items:
 - 1. Data/catalog cuts for each product and component specified herein, listing all physical and electrical characteristics and ratings indicating compliance with all listed standards.
 - 2. Shop Drawings to include:
 - a. Enlarged equipment room plans of the racks, cabinets, overhead cable runway, and conduit stubs into adjoining spaces.
 - b. Wall and rack elevations with scaled components.
 - 3. Furnish structural calculations for equipment anchorage as described in Section 270010: Basic Communications Requirements.
 - 4. Submit Manufacturer's installation instructions.
 - 5. Complete Bill of Material listing all components.
 - 6. Final test results.
 - 7. Warranty.
- B. Dimensions and configurations of equipment shall conform to the space allocated on the Drawings. The Contractor shall submit a revised layout if equipment furnished varies in size from that indicated on Drawings for the Engineer's approval.

1.5 OPERATION AND MAINTENANCE MANUALS

- A. Supply operation and maintenance manuals in accordance with the requirements of Section 270010: Basic Communications Requirements, to include the following:
 - 1. A detailed explanation of the operation of the system.
 - 2. Instructions for routine maintenance.
 - 3. Pictorial parts list and part numbers.
 - 4. Pictorial and schematic Electrical Drawings of wiring systems, including operating and safety devices, control panels, instrumentation, and annunciators.
 - 5. Telephone numbers for the authorized parts and service distributors.
 - 6. Include all service bulletins and torque Specifications for all terminations.
 - 7. Final testing report.

1.6 QUALITY ASSURANCE

- A. All materials, equipment and parts comprising the units specified herein shall be new, unused, and currently under production.
- B. Only products and applications listed in this section may be used on the Project unless otherwise submitted.
- C. Manufacturer qualifications: Manufacturer must have a minimum 5 continuous years of experience in design and manufacturing of the materials and equipment specified herein.
- D. Installer's qualifications:

1. Installer must have a minimum 5 continuous years of experience in satisfactory completion for Projects similar in scope and cost. Provide backup information on 5 such Projects.
2. Installer shall possess a current, active, and valid C7 California State Contractors License.
3. All conduit and power shall be performed by a valid C10 California State Contractors License

1.7 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Delivery: Equipment components shall not be delivered to the Project site until protected storage space is available. Storage outdoors covered by rainproof material is not acceptable. Equipment damaged during shipment shall be replaced and returned to manufacturer at no cost to Owner. Components shall be properly packaged in factory-fabricated containers and mounted on shipping skids.
- B. Storage: Store in a clean, dry, ventilated space free from temperature extremes. Maintain factory wrapping or provide a heavy canvas/plastic cover to protect units from dirt, water, construction debris and traffic. Provide heat where required to prevent condensation.
- C. Handling: Handle in accordance with manufacturer's written instructions. Be careful to prevent internal component damage, breakage, denting and scoring. Damaged units shall not be installed. Replace damaged units and return equipment per Manufacturer's

1.8 WARRANTY

- A. Units and components offered under this Section shall be covered by a 1-year parts and labor warranty for malfunctions resulting from defects in materials and workmanship. Warranty shall begin upon acceptance by the Owner.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Products furnished by the following Manufacturers shall be acceptable if in compliance with all features specified herein and indicated on the Drawings.
 1. Equipment Racks:
 - a. Legrand: Middle Atlantic SR Series Pivoting Rack
 2. Power distribution unit (PDU) power strip:
 - a. APC Series #AP7532, Rack PDU
 - b. Chatsworth Product Inc. (CPI), Rack Unit.
 - c. Tripp-Lite, Rack Unit.
 3. Vertical management sections:
 - a. Chatsworth Product Inc. (CPI).
 - b. Panduit.
 - c. Belden.

- 4. Horizontal management panels:
 - a. Chatsworth Product Inc. (CPI).
 - b. Panduit.
 - c. Belden.
 - B. Substitutions: Under provisions of Section 270010: Basic Communications Requirements.
- 2.2 EQUIPMENT RACKS:
- A. Application: Suitable for the support of termination apparatus, cable and cord management apparatus, network equipment, and other similar equipment within a telecommunication room.
 - B. Material: High-strength, lightweight, #6061-T6 extruded aluminum construction
 - C. Channel:
 - 1. Size: 3" deep with flanges on each side (double sided).
 - 2. Flange: 1.265" wide by 0.25" thick with mounting holes.
 - 3. Mounting holes: Threaded mounting holes at #12-24 rolled and spaced 5/8", 5/8", 1/2" compatible with ANSI/EIA-310-D.
 - 4. RMU markings: The RMU markings shall be permanently stamped on the outside of both flanges on both channels.
 - D. Assembled rack: All equipment racks shall be 4-post, complete with twomounting channels, two base angles (3.5" high by 6" deep by 0.375" thick), four top angles (1.5" high by 1.5" deep by 0.375" thick. Rack shall be 7'-0" high (overall) by 19" mounting width (20.25" width overall and shall contain 45 EIA mounting spaces (1.75" on center).
 - E. Load rating: 1000-lbs, when evenly distributed for the height of rack.
 - F. Finish: Powder coat, black.
 - G. Accessories: Include required accessories, such as floor installation kits, seismic gusset kits, mounting hardware, etc. for a complete installation.
- 2.3 PDU POWER STRIP
- A. Provide two PDU power strips per rack. PDUs shall be rated at 30 amps, 120 volt, 1-phase, 2-wire plus ground.
 - B. PDU input shall be NEMA L5-30P cord and plug, with #10awg stranded wire and maximum cord length of 4'-0".
 - C. PDU shall contain twenty-four NEMA 5-20R receptacles all per wired.
 - D. Overall length of power strip shall be 5'-3".
- 2.4 VERTICAL MANAGEMENT SECTION:
- A. Suitable for cable routing (back), cord routing, and cord slack storage (front) vertically within a rack bay, from bottom of rack to the top.

- B. The vertical management sections shall be double-sided having covered cable guides on the front and flip-retainers on the rear.
- C. Size and capacity between racks: 7'-0" high by 10" wide by 16.15" deep minimum.
- D. Size and capacity at end of racks: 7'-0" high by 6" wide by 16.15" deep.
- E. The vertical management sections shall have matching bolt holes for attachment to equipment rack.
- F. Finish: Black, guide and cover.

2.5 HORIZONTAL MANAGEMENT PANEL

- A. Suitable for installation into equipment rack for horizontal cord management. The horizontal management panel shall match (and fully integrate with) the vertical management sections.
- B. The horizontal management panel shall be double-sided.
- C. Size: 1U, 2U, or 3U high by 19" mounting.
- D. Finish: Black, guide and cover.

2.6 PLYWOOD BACKBOARDS

- A. Plywood backboards shall be placed on all walls of the telecommunications equipment room to 8'-4"AFF. Bottom of plywood shall be 6"AFF. The plywood will support wall mounted equipment, termination blocks, cable runways, etc.
- B. Plywood backboards shall be A-C grade, fire treated, 3/4" thick by 8' high by 4' wide, void free and sanded one side.
- C. Paint plywood with 2 coats of fire-retardant paint on both sides and edges. Color to match painted interior. Leave one fire rated stamp visible on each plywood board.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Contractor shall thoroughly examine Project site conditions for acceptance of equipment installation to verify conformance with Manufacturer and Specification tolerances. Do not commence with installation until all conditions are made satisfactory.

3.2 APPLICATION

- A. Provide support equipment in telecommunications equipment rooms to support cable infrastructure, network equipment, horizontal cabling, patch cords and entrance cable.

3.3 EQUIPMENT RACKS AND WALL-MOUNTED ENCLOSURES

- A. Installation
 - 1. Equipment racks shall be mounted to the floor using drop-in type anchors.

2. Mount equipment racks per dimensions stated on the construction drawings to allow proper clearances and preserve future growth.
3. Equipment racks shall be mounted square and level.
4. Equipment racks shall be supported laterally by the cable runway which is mounted to the equipment room wall.
5. Each equipment rack shall be grounded to the Telecommunication Grounding Busbar with a dedicated #6 AWG wire. Daisy-chaining racks are not allowed.
6. Wall-mounted enclosures shall be mounted to the wall studs at six places minimum. Pre-drill plywood backboards prior to mounting to assure proper stud anchoring.
7. Wall-mounted enclosures shall be mounted level and mounting rails installed with 6" of clearance to the front of enclosure door.
8. Wall-mounted enclosures shall be mounted so they can swing open with proper clearances. Cables shall maintain proper slack to allow opening of enclosures.
9. Wall-mounted enclosures shall be grounded to an electrical panel ground bus with a #6 AWG wire.

3.4 PDU POWER STRIPS

- A. Install vertical power strips as shown on Drawings or as specified herein. There shall be two vertical power strips per rack or cabinet, located on the back side, one on each side. Install fasteners and parts as required, per manufacturers instructions, as required for proper supports.
- B. Route the input cords within designated cable management and provide cord fasteners to prevent movement of the input cords. Plug the input cords into the receptacle the designated for the purpose.

3.5 CABLE MANAGEMENT

- A. Vertical Managers
 1. All equipment racks shall contain vertical managers between racks and on each end of racks.
 2. Attach managers securely to equipment racks.
 3. Provide cable protection with radius drops or plastic inserts into managers that allow cables to be free of kinks or cuts.
- B. Horizontal Managers
 1. All equipment racks shall contain horizontal managers between all patch panels and equipment.
 2. Secure managers with at least four rack screws.
 3. Utilize managers on the backs of all premises cable equipment racks to properly dress cable terminations.

3.6 PLYWOOD BACKBOARDS

- A. Plywood shall be 4' by 8' by 3/4" fire-treated with one side sanded.

- B. Plywood shall be installed 4" above finished floor with stamped and sanded side out. Install around all walls of Telecommunications room.
- C. Secure plywood in backing or studs with #12 flat head screws (Wood or STS) as required.
- D. Secure within 2" from edge and 12" on center.

3.7 MISCELLANEOUS EQUIPMENT

- A. For the complete installation of Communication Equipment Rooms, the following equipment would also be required, but are each covered elsewhere in this Division of Work:
 - 1. Communication cabling.
 - 2. Communication termination blocks and accessory hardware.
 - 3. Communication cable runways.
 - 4. Communication grounding and bonding.
- B. Refer to other Sections of this Division for specific requirements for the installation of the above equipment.

3.8 FIELD QUALITY CONTROL

- A. At least three weeks prior to any testing, notify the Owner's Representative so that arrangement can be made for witnessing test, if deemed necessary. All pretesting shall have been tested satisfactorily prior to the Owner's Representative's witnessed test.
- B. Test equipment racks to ensure electrical continuity of bonding and grounding connections, and to demonstrate compliance with specified maximum grounding resistance. Refer to NFPA70B, Chapter 18, for testing and test methods.
- C. Visual and mechanical inspection:
 - 1. Visually inspect all rack support hardware and structural supports for loose bolts, nuts and other connection hardware that could cause the mechanical failure of cable support systems.
 - 2. Inspect ground connections to conduits, cable runway, equipment racks, BEP's, backbone cables and bus bars for mechanical integrity of the bond between ground cable and grounded equipment.
 - 3. Inspect the ground bus between electrical ground and each bus bar in system.
- D. In the event that the system fails to function properly during the testing as a result of inadequate pretesting or preparation, the Contractor shall bear all costs incurred by the necessity for retesting including test equipment, transportation, subsistence and the Owner's Representative's hourly rate.
- E. Contractor shall replace at no costs to the Owner, all equipment and devices which are found defective or do not operate within factory specified tolerances.
- F. Contractor shall submit final report for review prior to Project closeout and final acceptance by the Owner. Test report shall indicate test dates, devices tested,

results, observation, deficiencies, and remedies. Test report shall be included in the operation and maintenance manuals.

3.9 CLEANING

- A. Upon completion of Project prior to final acceptance the Contractor shall thoroughly clean all equipment per Manufacturers approved methods and materials. Remove paint splatters and other spots, dirt, and debris.
- B. Touch-up paint for any marks, blemishes or other finish damage suffered during installation.

END OF SECTION

SECTION 27 15 00

COMMUNICATIONS HORIZONTAL CABLING

PART 1 - GENERAL

1.1 SUMMARY

- A. Work included: Labor, materials, and equipment necessary to complete the installation required for the item specified under this Division, including but not limited to:
 - 1. Horizontal twisted pair cabling.
 - 2. Horizontal cable terminations.
 - 3. Cable testing equipment.
- B. Related Work: Consult all other Sections, determine the extent and character of related Work, and properly coordinate Work specified herein with that specified elsewhere to produce a complete installation.

1.2 REFERENCES

- A. Comply with the latest edition of the following applicable Specifications and standards except as otherwise indicated or specified:
 - 1. Federal Communications Commission (FCC) Regulations:
 - FCC Part 15; Radio Frequency Devices & Radiation Limits.
 - FCC Part 68; Connection of Terminal Equipment to the Telephone Network.
 - 2. Electronics Industries Alliance (EIA):
 - EIA 230; Color Marking of Thermoplastic Wire.
 - 3. American National Standards Institute, Inc. (ANSI) / Telecommunications Industry Association (TIA) / Electronics Industries Alliance (EIA):
 - ANSI/TIA/EIA-568-C; Commercial Building Telecommunications Cabling Standards, including the following:
 - Part 1: General Requirements.
 - Part 2: Balanced Twisted-Pair Cabling Components.
 - Part 2, Addendum 1: Transmission Performance Specifications for 4-Pair 100 Ohm Category 6A Cable.
 - TIA SP 3-4426 (12/28/06 or latest version): Transmission Performance Specifications for 4-Pair 100 Ohm Augmented Category 6A Cable (to be published as TIA-568-C.2-10).
 - ANSI/TIA/EIA-569-A; Commercial Building Standard for Telecommunications Pathways and Spaces, including the following:
 - TIA/EIA-569-A-1: Perimeter Pathway Addendum.
 - TIA/EIA-569-A-2: Furniture Pathway Fill Addendum.
 - TIA/EIA-569-A-3: Access Floors.

- TIA/EIA-569-A-4: Poke-Thru Devices.
- TIA/EIA-569-A-6: Multi-Tenant Pathway and Spaces.
- TIA/EIA-569-A-7: Cable Trays and Wireways.
- ANSI/TIA/EIA-606-C; Administration Standard for Commercial Telecommunications Infrastructure.
- TIA TSB-155; Guidelines for the Assessment and Mitigation of Installed Category 6A Cabling to Support 10GBase-T.
- 4. Building Industry Consulting Service International, Inc. (BICSI):
 - BICSI (TDMM); Telecommunication Distribution Methods Manual.
 - BICSI (WDRM); Wireless Design Reference Manual.
 - BICSI (NDRM); Network Design Reference Manual.
- 5. Underwriters Laboratories, Inc. (UL):
 - UL 444; Communication Cables.
 - UL 1690; Data-Processing Cable.
 - UL 1963; Communications-Circuit Accessories.

1.3 SYSTEM DESCRIPTION

- A. Provide a complete telecommunication cabling system installation as specified herein and as shown on the Drawings. In general, system shall include, but not be limited to, the following:
 - 1. Workstation horizontal twisted pair cabling:
 - a. Horizontal twisted pair cables shall route between the IDF/TR and workstation outlets, and shall consist of Category 6A, 4-pair, UTP, plenum rated copper cables.
 - b. Category 6A horizontal twisted pair cable will support communication devices such as, but not limited to, the following:
 - 1) Data workstations
 - 2) Wireless access points
 - 3) Telephones (VoIP)
 - 4) Emergency phones
 - 5) Fax machines
 - 6) AV equipment
 - 7) HVAC controls
 - 8) Security cameras
 - 9) Security alarm panels
 - 10) Fire alarm system panels
 - 11) Elevator equipment
 - 12) Electrical utility meters
 - c. Category 6A horizontal twisted pair cables for data system applications shall terminate on Category 6A, patch panels for interface with routers/switches.

- d. Horizontal twisted pair security cables (surveillance cameras, security intercom, security panels) shall terminate on Category 6A, 19" wide patch panels (24- or 48-ports) with modular 8-pin connector front for interface with Owner furnished routers/switches via Category 6A or RJ45-RJ45 patch cords. Patch panels shall have 110 type terminations at rear for horizontal cable terminations.
 - e. Horizontal wire management shall be provided above and below each patch panel with 2 RU wire managers.
 - f. Copper jack standard is Category 6A, RJ-45 connectors at patch panels and workstation outlets.
- B. Workstation wall outlets:
- 1. Standard telecommunication outlets shall consist of the following, unless otherwise noted on the Drawings:
 - a. Two horizontal twisted pair cables per outlet. Cables shall be blue in color.
 - b. Single-gang coverplate with 4-ports.
 - c. RJ-45 connector jacks for twisted pair terminations, T568B.
 - d. Blanks as required.
 - 2. All data outlets shall be located within 12" from a 120 volt duplex power outlet.
- C. Workstation furniture outlets:
- 1. Furniture telecommunication outlets shall consist of the following, unless otherwise noted on the Drawings:
 - a. Two horizontal twisted pair cables per outlet. Cables shall be blue in color.
 - b. Furniture base cover plate with 4-ports.
 - c. Two RJ-45 connector jacks for twisted pair terminations, T568B.
 - d. Blanks as required.
 - 2. All data outlets shall be located within 12" from a 120 volt duplex power outlet.
- D. Wireless access point outlets shall consist of the following, unless otherwise noted on the Drawings:
- 1. Two horizontal twisted pair cables per outlet. Cables shall be blue in color.
 - 2. Two-gang cover plate with 2-ports when wall mounted.
 - 3. 4-11/16" square surface mount box for above ceiling attached to #12 AWG steel wire or wall.
 - 4. Two Category 6A, RJ-45 connector jack for twisted pair terminations, T568B.
 - 5. Blanks as required.
- E. Surveillance camera outlets, above ceiling, shall consist of the following, unless otherwise noted on the Drawings:
- 1. One horizontal twisted pair cable per outlet. Cable shall be blue in color.
 - 2. 4-11/16" square surface mount box for above ceiling attached to #12 AWG steel wire or wall.
 - 3. One RJ-45 connector jack for twisted pair terminations, T568B.

4. Blanks as required.
- F. Wall mounted telephone shall consist of the following, unless otherwise noted on the Drawings:
 1. One horizontal twisted pair cable per outlet. Cable shall be blue in color.
 2. Single-gang metal coverplate with 1-port and two support studs.
 3. One RJ-45 connector jack for twisted pair terminations, T568B. Color to match cable.
- G. Specialty analog telephone (fire alarm system panel, security panel, elevator phones, etc.) outlets shall consist of the following, unless otherwise noted on the Drawings:
 1. Two horizontal twisted pair cable per outlet. Cable shall be blue in color.
 2. Two port surface mount box (SMB) mounted in enclosure.
 3. Two RJ-45 connector jacks for twisted pair terminations, T568A.
- H. Refer to Drawings for complete documentation of above requirements and all additional requirements.

1.4 SUBMITTALS

- A. Submit in accordance with the requirements of Section 270010: Basic Communications Requirements, the following items:
 1. Data/catalog cuts for each product and component specified herein, listing all physical and electrical characteristics and ratings indicating compliance with all listed standards.
 2. Describe system operation, equipment, dimensions and indicate features of each component.
 3. Clearly mark on each data sheet the specific item(s) being submitted and the proposed application.
 4. Shop Drawings prepare in Revit, to include the following:
 - a. Building floor plans showing location of all outlets, raceways, cable trays, conduits, and cable routing to each device at same scale as construction documents.
 - b. Provide 1/4" scale plans of equipment layout in MPOE, ER, MDF, BDF, and IDF/TR rooms.
 - c. Provide wall elevations of MPOE, ER, MDF, BDF, and IDF/TR rooms at 1/4" scale.
 - d. Provide equipment rack elevations at 1/4" scale.
 - e. Use identical symbols as those used in construction documents.
 - f. Text shall be a minimum of 3/32" high when plotted at full scale.
 - g. Screen all background information.
 5. Furnish structural calculations for equipment anchorage as described in Section 270010: Basic Communications Requirements.
 6. Submit Manufacturer's installation instructions.
 7. Complete bill of materials listing all components.

- 8. Final test results.
- 9. Warranty.
- B. Dimensions and configurations of equipment shall conform to the space allocated on the Drawings. The Contractor shall submit a revised layout, if equipment furnished varies in size from that indicated on Drawings, for approval.

1.5 OPERATION AND MAINTENANCE MANUAL

- A. Supply operation and maintenance manuals in accordance with the requirements of Section 270010: Basic Communications Requirements, to include the following:
 - 1. A detailed explanation of the operation of the system.
 - 2. Instructions for routine maintenance.
 - 3. Pictorial parts list and part numbers.
 - 4. Schematic wiring diagrams.
 - 5. Telephone numbers for the authorized parts and service distributor.
 - 6. Include all service bulletins and torque Specifications for all terminations.
 - 7. Final testing reports.

1.6 QUALITY ASSURANCE

- A. All materials, equipment and parts comprising the units specified herein shall be new, unused, and currently under production.
- B. Only products and applications listed in this section may be used on the Project unless otherwise submitted.
- C. Manufacturer qualifications: Manufacturer must have a minimum 5 continuous years of experience in design and manufacturing of the materials and equipment specified herein.
- D. Installer's qualifications:
 - 1. Installer must have a minimum 5 continuous years of experience in satisfactory completion for Projects similar in scope and cost. Provide backup information on 5 such Projects.
 - 2. Installer shall possess a current, active, and valid C7 California State Contractors License.
 - 3. Conduit contractor shall possess a current, active, and valid C10 California State Contractors License.
 - 4. The installer shall be the Manufacturer's certified reseller/installer of the telecommunication equipment/cable system provided. The certification shall have been completed 60 days prior to project bid date. Provide evidence of this certification.

1.7 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Delivery: Telecommunication system components shall not be delivered to the Project site until protected storage space is available. Storage outdoors covered by rainproof material is not acceptable. Equipment damaged during shipping shall be replaced and returned to Manufacturer at no cost to Owner.

- B. Storage: Store in clean, dry, ventilated space free from temperature extremes. Maintain factory wrapping or provide a heavy canvas/plastic cover to protect units from dirt, water, construction debris and traffic.
- C. Handling: Handle in accordance with Manufacturer's written instructions. Be careful to prevent internal components damage, breakage, denting and scoring. Damaged units shall not be installed. Replace damaged units and return equipment to Manufacturer.

1.8 WARRANTY

- A. Units and components offered under this Section shall be covered by a minimum 25-year product and application warranty for malfunctions resulting from defects in materials and workmanship. Warranty shall be provided from the component manufacturer and shall name the owner on the warranty certificate. Warranty shall begin upon acceptance by the Owner.
- B. Contractor shall provide required drawings, test results, application and any other items required by the manufacturer to produce the required warranty.

1.9 MAINTENANCE

- A. Maintenance services:
 - 1. Distributor of the major system components shall maintain a replacement parts department and provide testing equipment when needed. A complete parts department shall be located close enough to supply replacement parts within a 4-hour period.
 - 2. Service must be rendered within 4-hours of system failure notification.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Products furnished by the following Manufacturers shall be acceptable if in compliance with all features specified herein and indicated on the Drawings.
 - 1. Category 6A horizontal structured cable systems:
 - a. Belden Cabling System
 - b. BerkTek Cable
 - c. CommScope
 - d. General Cable
 - e. Superior Essex Cable
 - 2. Category 6A twisted pair patch cord cable:
 - a. Belden Cabling System
 - b. CommScope
 - c. Leviton
 - d. Ortronics
 - e. Panduit
 - 3. Cable test equipment:

- a. Fluke Networks.
- b. Agilent Technologies WireScope 350 Test Set.
- c. Tektronix.

B. Substitutions: Under provisions of Section 270010: Basic Communication Requirements.

2.2 HORIZONTAL TWISTED PAIR CABLING

A. Horizontal cables:

1. Application:

- a. Suitable for indoor installations, exposed within equipment rooms, above suspended ceilings and below raised floors in cable trays, hangers or on deck, or within walls. If space is used as an air plenum, cable shall either be plenum rated or installed in EMT conduit.
- b. Each cable run shall be continuous single cable, homogenous in nature, without splices.
- c. Cables shall meet 6A performance criteria.
- d. Cables shall be CMR or CMP rated as required for rating of space.

2. Conductors:

- a. Eight #23 AWG, solid copper wire insulated with FEP for plenum applications or thermoplastic polyethylene or high-density polyolefin for non-plenum rated applications.
- b. Two insulated conductors twisted together to form a pair and four such paired cables to form a unit with individually color-coded pairs to conform to industry standards (ANSI/ICEA Publication S-80-576-1994 and EIA-230).

3. Cable sheath:

- a. Seamless outer jacket, flame-retardant PVC, applied to and completely covering the internal components (twisted pairs).
- b. CMP flame rating according to CEC Chapter 8, tested to NFPA 262 and UL Listed as such.

4. Electrical performance: Meet or exceed TIA/EIA-568-C.2 for Category 6A, UTP cabling.

5. Color: Cable shall be blue in color.

2.3 HORIZONTAL CABLE TERMINATIONS

A. Category 6A data system patch panels:

- 1. Terminations of horizontal distribution cable for data and telephone systems shall be made at Category 6A, 2U, 48 port panels.
- 2. Terminations of horizontal distribution cable for data WAP locations shall be made at Category 6A, 2U, 48 port panels.

B. Workstation jacks and coverplates:

- 1. Outlet coverplates shall be suitable for indoor installations to standard single-gang flush wall mounted outlet box plaster rings and floor boxes.

2. Outlets:

- a. Data jacks shall be 8-pin, IDC termination and rated Category 6A.
 - 1) Voice/Data Jack: Blue
 - 2) Security Camera Jack: Green
- b. WAP data jacks shall be 8-pin, IDC termination and rated Category 6A.
 - 1) WAP jack: Yellow
- c. Standard wall mounted coverplates:
 - 1) Coverplate shall be single-gang, flush mounted with 4-ports and shall include required accessories.
 - 2) Coverplate shall be white ABS plastic with an ID label window at the top and bottom of the plate.
- d. Partition furniture mounted coverplates:
 - 1) Coverplates shall have 4-ports and shall include required accessories, such as icons, blank inserts, label windows, and labels.
 - 2) Furniture plate shall match the type furniture installed for a seamless snap in fit to the base knock out of the installed furniture.
 - 3) Coverplates shall match the color of the furniture base.

2.4 MISCELLANEOUS COMPONENTS:

A. Velcro cable ties:

- 1. Width: 0.75".
- 2. Color: Velcro cable ties the same color as the cable to which it is applied.

B. Plenum cable ties:

- 1. Suitable for use in plenums or air handling spaces.
- 2. Color: Maroon or other distinctive non-white color.

2.5 CABLE TESTING EQUIPMENT

- A. Equipment shall meet TIA/EIA-568-D requirements for Level III accuracy, as applicable for cable type specified herein.
- B. Test standards: ISO/IEC 11801 Class C and D; ISO/IEC 11801-2000 Class C and D, 1000Base-Y, 100Base-TX; IEEE 802.3 10Base-T; ANSI TP-PMD; IEEE 802.5.
- C. Areas of test measurement (minimum):
 - 1. Wire Map.
 - 2. Length.
 - 3. Insertion Loss.
 - 4. The following at both master unit and remote unit:
 - a. Near End Crosstalk (NEXT) loss.
 - b. Power Sum NEXT (PSNEXT) loss.
 - c. Equal Level Far End Crosstalk (ELFEXT).

- d. Power Sum ELFEXT.
- e. Return Loss (RL).
- f. Attenuation-to-Crosstalk Ratio (ACR).
- g. Power Sum ACR (PSACR).
- 5. Propagation Delay and Delay Skew.
- 6. Characteristic Impedance.
- 7. DC Loop Resistance.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Contractor shall thoroughly examine Project site conditions for acceptance of the telecommunication cabling system installation to verify conformance with manufacturer and specification tolerances. Do not commence with installation until all conditions are made satisfactory.
- B. Verify that pathways and supporting devices are properly and completely installed prior to cable installation.
- C. Verify dimensions of pathways to include length, i.e. "true tape" conduit runs.
- D. Prior to installation, verify that equipment rooms are ready to accept cables and terminations.

3.2 INSTALLATION

- A. Horizontal management panels:
 - 1. Provide the horizontal management panels mounted to racks with one above and one below each patch panel.
 - 2. Provide fasteners and parts required to complete the installation.
- B. Accessories: Provide all accessories as required for a complete installation. Include one bag of rack mounting screws, as come packaged with rack product. Attach the screws directly to the rack, which shall constitute turn-over to the Owner.
- C. Horizontal twisted pair cabling:
 - 1. Horizontal cable installation and routing:
 - a. Cable runs shall have continuous sheath continuity, homogenous in nature with no splicing.
 - b. Cabling shall not exceed a cable length of 295' (90m) from the termination point at the Telecom room to the termination at the workstation outlet, including service slack, when measured using test equipment. The cable length shall be determined by the contractor prior to installing cable with a true tape. Cable lengths exceeding the 295-foot maximum length, shall be brought to the attention of the engineer of record (EOR).
 - c. Place cables within the designated pathways, such as cable tray or basket tray, cable runway, cable hangers, etc. Do not fasten, support or attach cables to other building infrastructures (i.e. ducts, pipes, conduits, etc.), other

systems (i.e. ceiling support wires, wall studs, etc.), or to the outside of conduits, cable trays and non-approved pathway systems.

- d. Place and suspend cables during installation and termination in a manner to protect them from physical damage or interference. Place cables with no kinks, twists, or impact damage to the sheath. Replace cables damaged during installation or termination at no additional cost.
 - e. Route cables at 90-degree angles, allowing for bending radius.
 - f. Do not exceed pulling tension of 25-lbs.
 - g. Do not use cable-pulling compounds.
 - h. Do not exceed a minimum bend radius of 6 times the cable diameter during and after installation.
 - i. Route cables beneath other building infrastructures (i.e. ducts, pipes, conduits, etc.) in above ceiling applications. Do not route cables over building infrastructure/s. The installation shall result in easy accessibility to the cables in the future.
 - j. Place cables 6" minimum away from power sources to reduce interference from EMI.
 - k. Do not set 360-degree service loops in place for slack storage. Instead, set slack as forward-and-back or as figure eights.
 - l. Place a pull string along with cables where run in conduits and spare capacity in conduit remains. Tie off ends of the pull string to prevent the string from falling onto the conduit.
 - m. When exiting the primary pathway, such as cable or basket tray, to the workstation outlets, exit via the top of the pathway. Secure the cables to the pathway using an approved Velcro cable tie.
2. Cable routing and dressing within telecommunications rooms:
- a. Within rooms, only use Velcro type straps on bundles.
 - b. Individual bindles of cable shall not exceed 48 cables to minimize heating of cables that use PoE. Bundles of cables shall be per 48-port patch panel.
 - c. Place cables within the overhead cable support system. When routing vertically on walls, fasten the cables onto vertical supports every 24" on center.
 - d. Provide 12" minimum sheath cable slack, length not to exceed permanent link maximum length requirement. Place the slack in the overhead cable support system.
 - e. At the rack bay, route, and neatly dress cables from the overhead cable support system into the back of the vertical management sections. Divide the cables equally between both sides of an equipment rack such that a cable does not travel past the midpoint of the rack prior to termination. Fasten the cables to the cable support bar at the back of the patch panel using approved ties.
3. Termination in the telecommunications rooms:
- a. Provide termination apparatus and accessories required for a complete installation. Install and assemble termination apparatus, accessories, and

associated management apparatus according to the manufacturer's instructions.

- b. Properly relieve strain from the cables to and at termination points per manufacturer's instructions. Provide a strain relief bar at the back of the modular patch panels for proper strain relief.
- c. Terminate cables and twisted pairs in accordance with manufacturer's latest installation requirements and TIA/EIA-568-R standard installation practices. Terminate cable pairs onto the termination apparatus compliant to T568B wiring.
- d. Modular patch panels and horizontal management panels:
 - 1) Provide quantity of patch panels to support the terminations of cables served from respective Telecom Room.
 - 2) Install and assemble patch panels and wire management panels according to the manufacturer's instructions.
 - 3) Install the termination hardware and cable management as shown on the Drawings.
 - 4) Terminate cables in sequential order using the link's identifier starting at the top left and completing a block before moving to the next block below.
 - 5) Terminate all WAP cables on its own patch panel.
- 4. Cable routing and dressing at workstations:
 - a. Provide 18" cable slack at each workstation outlet, length not to exceed permanent link maximum length requirement. Place the slack within ceiling space neatly on a cable hanger or other approved cable support device.
 - b. Route to partition furniture mounted faceplates:
 - 1) Route cables from primary or secondary pathway within ceiling through the furniture partition feed pathway (stub from wall or floor box) into opening at bottom of furniture system. Exercise caution to prevent scraping, cutting or other damage to cable jacket.
 - 2) Provide spiral wrap around cables from furniture-feed pathway to point where cables enter furniture.
- 5. Termination at the workstation outlets:
 - a. Provide device components, connectors, and accessories required for a complete installation. Install and assemble connectors, jacks, adapters, termination apparatus, accessories, and associated management apparatus according to the manufacturer's instructions.
 - b. Provide blue connectors for data links, yellow connectors for wireless data, and green connectors for cameras.
 - c. Wall mounted standard devices:
 - 1) Install devices at heights indicated on drawings.
 - 2) Mount faceplates plumb, square and at the same level as adjacent power receptacles.
 - 3) Patch gaps around faceplates so that faceplate covers the entire wall opening.
 - d. Partition furniture mounted devices:

- 1) Coordinate installation of the faceplate adapters with the furniture contractor, including color.
- 2) Mount faceplate adapters into the designated openings for horizontal cables.
- e. Terminate cables and twisted pairs in accordance with the manufacturer's latest installation requirements and TIA/EIA-568-D standard installation practices. Terminate cable pairs onto the connector compliant to T568B wiring.
6. Patching and cross connecting:
 - a. In equipment rooms, provide one modular patch cord for each connector jack in each workstation outlet. Install from the horizontal termination field to the network switches/equipment. Neatly dress patch cords within the horizontal and vertical cable management components. Cords lengths shall be coordinated with the Owners IT representative.
 - b. At workstations, provide one modular patch cord for each cable jack installed in each workstation outlet. Cord lengths shall be 10' and each shall be labeled.
- D. General requirements:
 1. Labeling, label colors, and identifier assignments shall conform to EIA/EIA-606-C Administration Standards and as approved by the Owner.
 2. Provide permanent and machine-generated labels. Handwritten labels will not be accepted.
- E. Horizontal twisted pair labeling:
 1. Labeling shall be per the Owners standards in lieu of the following requirements. Coordinate with the Owners IT representative prior to the labeling phase of the cable installation to determine the Owners labeling requirements.
 2. Cables:
 - a. Text color shall be black, #10 font size.
 - b. Label installation:
 - 1) Provide labels on both ends of cable.
 - 2) Install labels such that they are visible by technician from a normal stance.
 - 3) Fully wrap label around the cable jacket (self-lamination).
 - 4) Provide one label within 4" of the termination apparatus.
 3. Modular patch panels:
 - a. Text color shall be black, #10 font size.
 - b. Label installation: Provide a Letter designation for each panel (A, B, C etc.). Patch Panel port number will match the cable designation at the station end.
 4. Outlets:
 - a. Text color shall be black, #10 font size.
 - b. Label installation:
 - 1) At faceplates, provide labels above and below jacks.

- 2) At surface boxes, provide labels on the top of the box.

3.3 FIELD QUALITY CONTROL AND TESTING

A. General:

1. Calibrate test sets and associated equipment per the manufacturer's instructions at the beginning of each day's testing and after each battery charge. Fully charge the test sets prior to each day's testing to ensure proper operation.
2. Ensure test equipment and test cords are clean and undamaged during testing activities. Per the Engineer's discretion, halt testing activity and clean testing equipment, test cords and related apparatus.
3. Permanently record test results electronically within test equipment at the time of testing.

B. Twisted pair testing:

1. Test for UTP cabling as follows:

TESTS FOR CATEGORY 6 CABLING TABLE				
Subsystem	Type	Test	Configuration	Notes
Horizontal	Category 6A	Category 6A	Permanent Link	Per TIA/EIA-568-C.2

2. Precautions:

- a. Adhere to the equipment manufacturer's instructions during all testing.
- b. Prior to any testing activity or any measurements taken, ensure the test equipment is at room temperature, approximately 70-degrees F.
- c. Fully charge power sources before each day's testing activity.

3. Horizontal twisted pair testing:

a. Test equipment set-up:

- 1) Set-up the tester to perform a full Category 6A test, as a Permanent Link configuration.
- 2) If the tester has the capability, set the cable type as product specific setting. If not, set as generic Category 6A cable.
- 3) Set the tester to save the full test results (all test points, graphs, etc.).
- 4) Save the test results with associated cable link identifier.
- 5) Calibrate the test set per the manufacturer's instructions.

b. Acceptable test results measurements:

- 1) Overall test results:

- a) Links which report a Fail, Fail or Pass for any of the individual tests shall result in an overall link Fail. All individual test results must result in a Pass to achieve an overall Pass.
- b) Any reconfiguration of link components required because of a test Fail, must be re-tested for conformance.

- c) Remove and replace any cabling links failing to meet the criteria described in this Specification, at no cost to the Owner, with cables that prove to meet the minimum requirements.
- 2) Wire map: Provide continuous pairs and terminate all the cabling links correctly at both ends, no exceptions taken.
- 3) Length: One hundred meters (328 feet) is the maximum acceptable electrical length measurements for any cabling link measured under a Permanent Link configuration, including test cords.
- 4) Insertion loss: The acceptable insertion loss measurements for any horizontal cabling link is that which is no greater than that listed in TIA/EIA-568-C.2.
- 5) Worst pair-to-pair near end crosstalk (NEXT) loss: The acceptable worst pair-to-pair NEXT loss for any horizontal cable is that which is no greater than that listed in TIA/EIA-568-C.2.
- 6) Power sum NEXT loss: The acceptable power sum PS-NEXT loss for any horizontal cable is that which is no greater than that listed in TIA/EIA-568-C.2.
- 7) Worst pair-to-pair ELFEXT and FEXT loss: The acceptable worst pair-to-pair ELFEXT and FEXT loss for any horizontal cable is that which is no greater than that listed in TIA/EIA-568-C.2.
- 8) Power sum ELFEXT and FEXT loss: The acceptable PS-ELFEXT and PS-FEXT loss for any horizontal cable is that which is no greater than that listed in TIA/EIA-568-C.2.
- 9) Return loss: The acceptable return loss measurements for any horizontal cabling link is that which is no greater than that listed in TIA/EIA-568-C.2.
- 10) Propagation delay and delay skew: The acceptable propagation delay and delay skew measurements for any horizontal cabling link is that which is no greater than that listed in TIA/EIA-568-C.2.

C. Record documents:

1. Permanently record all test results.
2. Export test results' numerical values to a single Microsoft Excel spreadsheet.
3. Submit test results in a format acceptable to the Owner, Owner's Representative, and the Engineer before system acceptance.
4. Cable and pair identifiers of the test reports shall match the identifiers as labeled in the field, i.e. use the same ID on the cable/termination label as what appears on the test report.
5. Measurements shall carry a precision through one significant decimal place, minimum.
6. Use feet for the units for measurements shown on the print of the test measurements.
7. Print report such that fiber strands of a given cabling link have matching axis scales. The "X" and the "Y" axis shall be the same from report-to-report.
8. The trace of the printed test report shall show the launch cord.
9. For each cabling link, include either a schematic graphic or a brief narrative accurately describing the test set-up. The description shall include test/launch

cord (with length), expected events (connectors, slices, etc.) with expected distances, etc. This information will eliminate many questions the Engineer will have while reviewing the reports.

10. For each twisted pair horizontal cable test, report shall contain the following information:

- a. Project name and address.
- b. Test company's and Operator's name.
- c. Date measurements were taken.
- d. Test equipment type to include model and serial numbers.
- e. Cable identification number and pair number.
- f. Measurement results.
- g. Pass/Fail

3.4 INSPECTION AND ADJUSTMENTS

- A. Contractor shall inspect all installed Work in conjunction with the General Contractor and develop a "punchlist" for all items needing correction. Provide punchlist to the Engineer prior to their final walk of Project.
- B. Punchlist work and the required remediation shall be performed prior to system final acceptance.
- C. Replace or repair work completed by others that was defaced or destroyed during the installation of the telecommunication cabling system by this contractor.
- D. Make changes to adjust the system to optimum operation for final use. Contractor is responsible for making changes to the system such that any defects in workmanship are correct and all cables and the associated termination hardware passes the minimum test requirements.

3.5 CLEANING

- A. Remove all unused, excess, and left-over products, to include debris, spills, and installation equipment.
- B. Leave finished work and adjacent surfaces in neat, clean conditions with no evidence of damage.
- C. Legally dispose of debris.
- D. Clean installed products in accordance with manufacturer's instructions prior to final punch list.

3.6 TRAINING

- A. At the completion of all Work, a period of not less than 4-hours shall be allocated by the Contractor for instruction and training for the Owner's Representative. The Cabling Contractor will need to describe how the cable from each cover plate is separated between different patch panels and 110 blocks, how cross-connects are made and other basic cable plant management skills.
- B. Contractor shall schedule training with a minimum of 7-days advance notice.

END OF SECTION

SECTION 28 00 10

BASIC ELECTRONIC SAFETY AND SECURITY REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Table of Contents, Division 28 – Electronic Safety and Security:

SECTION NO.	SECTION TITLE
280010	BASIC ELECTRONIC SAFETY & SECURITY REQUIREMENTS
280513	ELECTRONIC SAFETY & SECURITY CONDUCTORS & CABLES
280528	ELECTRONIC SAFETY & SECURITY PATHWAYS
280529	ELECTRONIC SAFETY & SECURITY HANGERS & SUPPORTS
281300	SECURITY ACCESS CONTROL SYSTEM

B. Work included: This Section includes general administrative and procedural requirements for Division 28. The following administrative and procedural requirements are included in this Section to supplement the requirements specified in Division 01.

1. Quality assurance.
2. Definition of terms.
3. Submittals.
4. Coordination.
5. Record documents.
6. Operation and maintenance manuals.
7. Excavation
8. Rough-in.
9. Installation.
10. Cutting, patching, painting, and sealing.
11. Field quality control.
12. Cleaning.
13. Project closeout.

C. Related Work: Consult all other Sections, determine the extent and character of related Work, and properly coordinate Work specified herein with that specified elsewhere to produce a complete and operable installation.

1. General and supplementary conditions: Drawings and general provisions of Contract and Division 01 of the Specifications, apply to all Division 28 Sections.
2. Earthwork: Include trenching, backfilling, boring and soil compaction as required for the installation of underground conduit, in-grade pull boxes, vaults, etc. Refer to Division 31, Earthwork.
3. Concrete Work: Include forming, steel bar reinforcing, cast-in- place concrete, finishing and grouting as required for underground conduit encasement, pull box slabs, vaults, etc. Refer to Division 03, Concrete.

4. Miscellaneous metal Work: Include fittings, brackets, backing, supports, rods, welding and pipe as required for support and bracing of raceways, cable trays, racks, etc. Refer to Division 05, Miscellaneous Metals.
 5. Miscellaneous lumber and framing Work: Include wood grounds, nailers, blocking, fasteners and anchorage for support of electronic safety and security materials and equipment. Refer to Division 06, Rough Carpentry.
 6. Moisture protection and smoke barrier penetrations: Include membrane clamps, sheet metal flashing, counter flashing, caulking and sealant as required for waterproofing of conduit penetrations and sealing penetrations in or through fire walls, floors, ceiling slabs and foundation walls. All penetrations through vapor barriers at slabs on grade shall be taped and made vaportight. Refer to Division 07, Thermal and Moisture Protection.
 7. Access panels and doors: Required in walls, ceilings, and floors to provide access to electronic safety and security devices and equipment. Refer to Division 08, Access Doors also, Division 05, Metals.
 8. Painting: Include surface preparation, priming and finish coating as required for exposed conduit, pull and junction boxes, etc. where indicated as field painted in this Division. Refer to Division 09, Painting.
- D. Work furnished and installed under another Division requiring connections or interface under this Division includes but is not limited to:
1. Mechanical BAS control panel
 2. Communication system

1.2 QUALITY ASSURANCE

- A. Reference to Codes, Standards, Specifications and recommendations of technical societies, trade organizations and governmental agencies shall mean that latest edition of such publications adopted and published prior to submittal of the bid. Such codes or standards shall be considered a part of this Specification as though fully repeated herein.
- B. When codes, standards, regulations, etc. allow Work of lesser quality or extent than is specified under this Division, nothing in said codes shall be construed or inferred authority for reducing the quality, requirements, or extent of the Contract Documents. The Contract Documents address the minimum requirements for construction.
- C. Work shall be performed in accordance with all applicable requirements of the latest edition of all governing codes, rules and regulations including but not limited to the following minimum standards, whether statutory or not:
1. California Electrical Code (CEC).
 2. California Building Code (CBC).
 3. California Fire Code (CFC).
 4. California Mechanical Code (CMC).
 5. FCC Regulations, Part 15 – Radio Frequency Devices & Radiation Limits.
- D. Standards: Equipment and materials specified under this Division shall conform to the following standards where applicable:
- ACI American Concrete Institute

ANSI	American National Standards Institute
ASTM	American Society for Testing Materials
BICSI	Building Industry Consulting Service International, Inc
EIA	Electronics Industries Alliance
FCC	Federal Communications Commission
ICEA	Insulated Cable Engineers Association
IEEE	Institute of Electrical and Electronics Engineers, Inc
NEMA	National Electrical Manufacturer's Association
NFPA	National Fire Protection Association
TIA	Telecommunication Industry Association
UL	Underwriters' Laboratories

1.3 DEFINITIONS

- A. The definitions of Division 01 shall apply to this Division of Work.
- B. In addition to those definitions of Division 01, the following list of terms as used in this specification shall be defined as follows:
 - 1. Furnish: To purchase, procure, acquire, and deliver complete with related accessories.
 - 2. Install: To set in place, join, unite, fasten, link, attach, set up or otherwise connect, and test before turning over to the Owner, all parts, items, or equipment supplied by contractor. Installation shall be complete and ready for regular operation.
 - 3. Provide: To furnish, transport, install, erect, connect, test, and turn over to the Owner, complete and ready for regular operation.
 - 4. Connect: To install all required patch cords, equipment cords, cross-connect wire, device, and appliance wiring, etc. to complete system conductivity.
 - 5. As directed: As instructed by the Owner, or their authorized representative.
 - 6. Cabling: A combination of all cables, wire, cords, and connecting hardware, e.g., cables, conductor terminations, connectors, outlets, patch panels, blocks, and labeling.
- C. Abbreviations:
 - 1. ACS: Access Control System
 - 2. AFF: Above Finish Floor. Standard mounting height (e.g. 18" AFF) for a device using the center line of the device as the measurement point.
 - 3. CCTV: Closed-Circuit Television. A private television system, typically used for security purposes, in which the signal is transmitted to a limited number of receivers.
 - 4. VSS: Video Surveillance System

1.4 SUBMITTALS

- A. Format: Furnish submittal data in electronic format for each Specification Section with a table of contents listing materials by Section and paragraph number.
- B. Submittals shall consist of detailed Shop Drawings, Specifications, block wiring diagrams, "catalog cuts" and data sheets containing physical and dimensional information, performance data, electrical characteristics, materials used in fabrication

- and material finish. Clearly indicate by arrows or brackets precisely what is being submitted on and those optional accessories which are included and those which are excluded. Furnish quantities of each submittal as noted in Division 01.
- C. Each submittal shall be labeled with the Specification Section Number and shall be accompanied by a cover letter or shall bear a stamp stating that the submittal has been thoroughly reviewed by the Contractor and is in full compliance with the requirements of the Contract Documents or provide a Specification Section line-by-line compliance response statement with detailed exception/ deviation response statements for all applicable provisions for the applicable Specification Section. Any Specification Section lines without a detailed exception/ deviation response statement shall be treated as the Contractor or Vendor is submitting in full compliance with the applicable Specification Section requirements. Cover letters shall list in full the items and data submitted. Failure to comply with this requirement shall constitute grounds for rejection of data.
 - D. The Contractor shall submit detailed Drawings of all electronic safety and security equipment rooms and closets if the proposed installation layout differs from the construction documents. Physical size of electronic safety and security equipment indicated on the Drawings shall match those of the electronic safety and security equipment that is being submitted for review, i.e.: equipment racks, cabinets, etc. Minimum scale: 1/4" = 1'- 0". Revised electronic safety and security equipment layouts must be approved prior to release of order for equipment and prior to installation.
 - E. As part of the equipment submittals, the Contractor shall provide anchorage calculations for floor and wall mounted electronic safety and security equipment, conduits, and raceways, in conformance with the latest edition of the California Building Code (CBC) and ASCE 7. Use the Occupancy Category, Ground Accelerations, Site Class, Seismic Design Category, and Seismic Importance Factor as noted in the structural drawings. For components required for Life Safety or containing hazardous materials use $I_p=1.5$. Structural Calculations shall be prepared, stamped, and signed by a California Registered Structural Engineer. Specify proof loads for drilled-in anchors, if used.
 - F. The Manufacturer shall recommend the method of anchoring the equipment to the mounting surface and shall provide the Contractor with the assembly dimensions, weights, and approximate centers of gravity.
 - G. Review of submittals is for general conformance to design concept and general compliance with the Specification Sections. Submittal Review Comments do not imply waiver of Specifications Section requirements unless specifically noted.
 - H. All re-submittals shall include a cover letter that lists the action taken and revisions made to each Drawing and equipment data sheet in response to Submittal Review Comments. Re-submittal packages will not be reviewed unless accompanied by this cover letter. Failure to include this cover letter will constitute rejection of the re-submittal package.
 - I. Substitutions:
 - 1. All requests for substitutions shall conform to the general requirements and procedure outlined in Division 01.

2. Where items are noted as "or equal," a product of equal design, construction and performance will be considered. Contractor must submit to the Engineer all pertinent test data, catalog cuts and product information required substantiating that the product is in fact equal to that specified. Only one substitution will be considered for each product specified.
3. Manufacturers' names and model numbers used in conjunction with materials, processes or equipment included in the Contract Documents are used to establish standards of quality, utility, and appearance. Materials, processes, or equipment, which in the opinion of the Engineer is equal in quality, utility and appearance will be approved as substitutions to that specified.
4. Whenever any material, process or equipment is specified in accordance with a ASTM standard, an ANSI specification, UL rating or other association standard, the Contractor shall present an affidavit from the Manufacturer certifying that the product complies with the particular standard specification. When requested by the Engineer, support test data to substantiate compliance shall be submitted by the Contractor at no additional cost.
5. Substitutions shall be equal, in the opinion of the Architect/Engineer, to the specified product. The burden of proof of such shall rest with the Contractor. When the Architect/Engineer in writing accepts a substitution, it is with the understanding that the Contractor guaranteed the substituted article or material to be equal to the one specified and dimensioned to fit within the construction. Approved substitutions shall not relieve the Contractor of responsibilities for the proper execution of the Work or from any provisions of the Specifications.
6. The Contractor shall be responsible for all expenses in connection with the substitution materials, processes, and equipment, including the effect of the substitution on the Contractor, Subcontractor's, or other Contractor's Work. No substitution of material, processes or equipment shall be permitted without written authorization of the Architect/Engineer. Any assumptions on the acceptability of a proposed substitution prior to acceptance by the Engineer are at the sole risk of the Contractor.

1.5 COORDINATION

A. Discrepancies:

1. In the event of discrepancies within the Contract Documents, the Engineer shall be so notified, within sufficient time, as delineated in Division 01, prior to the Bid Opening to allow the issuance of an Addendum.
2. If, in the event that time does not permit notification or clarification of discrepancies prior to the Bid Opening, the following shall apply: The Drawings govern in matters of quantity and the Specifications govern in matters of quality. In the event of conflict within the Drawings involving quantities or within the Specifications involving quantities or within the Specifications involving quality, the greater quantity and higher quality shall apply. Such discrepancies shall be noted and clarified in the Contractor's Bid. No additional allowances will be made because of errors, ambiguities or omissions that reasonably should have been discovered during the preparation of the Bid.

B. Project conditions:

1. Examination of Project site: The Contractor shall visit the Project site and thoroughly review the locale, working conditions, conflicting utilities, and the

conditions in which the electronic safety and security Work will take place. Verify all existing conditions in the field. No allowances will be made subsequently for any costs that may be incurred because of any error or omission due to failure to examine the Project site and to notify the Engineer of any discrepancies between Contract Documents and actual Project site conditions.

2. Protection: Keep conduits, junction boxes, outlet boxes and other openings closed to prevent entry of foreign matter. Cover equipment, devices, and apparatus and protect them against dirt, paint, water, chemical or mechanical damage, before and during construction period. Prior to final acceptance, restore to original condition any fixture, apparatus or equipment damaged including restoration of damaged factory applied painted finishes. Protect bright finished surfaces and similar items until in service. No rust or damage will be permitted.
3. Supervision: Contractor shall personally or through an authorized and competent representative constantly supervise the Work from beginning to completion and, within reason, keep the same foreman and workmen on the Project throughout the Project duration.

C. Drawing preparation:

1. Layout: General layout indicated on the Drawings shall be followed except where other Work may conflict with the Drawings.
2. Accuracy: Drawings for the Work under this Section are essentially diagrammatic within the constraints of the symbology applied.
3. The Drawings do not fully represent the entire installation required for the electronic safety and security systems. Drawings indicate the layout and locations of major equipment components, as well as field devices and appliances, but do not show all conduits between equipment, components, devices, and appliances.

1.6 RECORD DOCUMENTS

A. Provide Project Record Drawings as described herein:

1. Drawings shall fully represent installed conditions including actual locations of electronic safety and security equipment, labeling of all components and systems, correct conduit and cabling as well as routing, revised schedule listing Manufacturers and products installed. Contractor shall record all changes in the Work during the course of construction on black line prints. These prints shall be made subject of monthly review by the Owner's Representative to ascertain that they are current. If not, current monthly payments may be withheld.
2. Record Drawings shall be the transfer of information on these prints to the construction documents via building information modeling (Revit) process. A set of Revit files of the electronic safety and security construction documents will be provided to the Contractor by the Engineer. For the BIM/clash detection process, a Revit file of the electronic safety and security construction documents will be provided to the Contractor by the Engineer, which will represent a LOD of 300 design level. The Contractor is responsible for updating the model with changes as well as taking the model to a LOD of 500 design level.
3. Record drawing submissions shall be provided to the Engineer to review upon the completion of the following phases of Work:
 - a. All underground installation.

- b. Building electronic safety and security rough-in.
- c. Final electronic safety and security installation.
- 4. A single set of half size prints of the Record Drawings shall be submitted for review. Upon receipt of the Engineer's review comments, corrections shall be made, and the Contractor shall provide the following:
 - a. Two sets of full-size prints.
 - b. Four sets of half size prints.
 - c. One electronic file of Revit
 - d. One electronic set in pdf.

1.7 OPERATION AND MAINTENANCE MANUALS

- A. Prior to Project closeout furnish to the Owner, six (6) hard back 3-ring binders containing all bulletins, operation and maintenance instructions, part lists, service telephone numbers and other pertinent information as noted in each Section all equipment furnished under Division 28. Binders shall be indexed into Division Sections and labeled for easy reference. Bulletins containing more information than the equipment concerned shall be properly stripped and assembled.

PART 2 - PRODUCTS (NOT APPLICABLE)

PART 3 - EXECUTION

3.1 EXCAVATION

- A. General: Cutting and digging shall be under the direct supervision of the General Contractor and included as necessary for the Work of this Section.
- B. Excavation for underground vaults and structures: Conform to elevations and dimensions indicated within a tolerance of plus or minus 0.10-feet; plus, a sufficient distance to permit placing and removal of concrete formwork, installation or services, other construction and for inspection.
 - 1. Excavate, by hand, areas within dripline of large trees. Protect the root system for damage and dry-out. Maintain moist conditions for root system and over exposed roots with burlap. Paint root cuts of 1 inch in diameter and larger with emulsified asphalt tree paint.
 - 2. Take care not to disturb bottom of excavation. Excavate by hand to final grade just before concrete reinforcement is placed.
- C. Trenching: Excavate trenches for electronic safety and security installation as follows:
 - 1. Excavate trenches to the uniform width, sufficiently wide to provide ample working room and a minimum of 6 to 9-inches clearances on both side of raceways and equipment.
 - 2. Excavate trenches to depth indicated or required.
 - 3. Limit the length of open trench to that in which installations can be made and the trench backfilled within the same day.

4. Where rock is encountered, carry excavation below required elevation and backfill with a layer of crushed stone or gravel prior to installation of raceways and equipment. Provide a minimum of 6-inches of stone or gravel cushion between rock bearing surface and electronic safety and security installations.
- D. Backfilling: Place soil materials in layers to required subgrade elevations for each area classification, using materials and methods specified in Division 31, Earthwork.
 1. Under building slabs, use drainage fill materials.

3.2 ROUGH-IN

- A. Contractor shall verify lines, levels and dimensions indicated on the Drawings and shall be responsible for the accuracy of the setting out of Work and for its strict conformance with existing conditions at the Project site.
- B. Verify final locations for rough-in with field measurements and with the requirements for the actual equipment to be connected.

3.3 INSTALLATION

- A. Preparation, sequencing, handling, and installation shall be in accordance with Manufacturer's written instructions and technical data particular to the product specified and/or accepted equal, except as otherwise specified. Refer to Shop Drawings prepared by Manufacturer.
- B. Verify all dimensions by field measurements.
- C. Arrange for chases, slots, and openings in other building components during progress of construction, to allow for electronic safety and security installations.
- D. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components, as they are constructed.
- E. Sequence, coordinate and integrate installations of electronic safety and security materials and equipment for efficient flow of the Work. Give attention to large equipment requiring positioning prior to closing in the building.
- F. Where mounting height is not detailed or dimensioned, contact the Architect for direction prior to proceeding with rough-in.
- G. Coordinate connection of electronic safety and security systems with exterior underground utilities and services. Comply with requirements of governing regulations and controlling agencies. Provide required connection for each service.
- H. Install systems, materials, and equipment to conform with approved submittal data, including coordination Drawings, to greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that portions of the Work are indicated only in diagrammatic form. Where coordination requirements conflict with individual system requirements, refer conflict to the Architect.
- I. Install systems, materials, and equipment level and plumb, parallel, and perpendicular to other building systems and components, where installed exposed in finished spaces.

- J. Install electronic safety and security equipment to facilitate servicing, maintenance and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations.
- K. Coordinate electronic safety and security systems, equipment, and materials installations with other building components.
- L. Provide access panel or doors where devices or equipment are concealed behind finished surfaces. Furnish and install access doors per the requirements of Division 08.
- M. Install systems, materials and equipment giving right-of-way priority to other systems that are required to maintain a specified slope.

3.4 CUTTING, PATCHING, PAINTING AND SEALING

- A. Structural members shall in no case be drilled, bored, or notched in such a manner that will impair their structural value. Cutting of holes, if required, shall be done with core drill and only with the approval of the Architect and Structural Engineer.
- B. Protection of Installed Work: During cutting and patching operations, protect adjacent installations.
- C. Provide and maintain temporary partitions or dust barriers adequate to prevent the spread of dust and dirt to adjacent areas.
- D. Patch existing surfaces and building components using experienced installers and new materials matching existing materials and the original installation. For installers' qualifications refer to the materials and methods required for the surface and building components being patched.
- E. Application of joint sealers:
 - 1. General: Comply with joint sealer Manufacturers' printed application instructions applicable to products and applications indicated, except where more stringent requirements apply.
 - 2. Installation of fire-stopping sealant: Install sealant, including forming, packing and other accessory materials, to fill openings around electronic safety and security penetrating floors and walls, to provide firestop and fire-resistance ratings indicated for floor or wall assembly in which penetration occurs. Comply with installation requirements established by testing and inspecting agency.

3.5 FIELD QUALITY CONTROL

- A. General testing requirements:
 - 1. The purpose of testing is to ensure that all tested electronic safety and security equipment, both Contractor and Owner supplied, is operational and within industry and Manufacturer's tolerances and is installed in accordance with design Specifications.
 - 2. Tests and inspections shall determine suitability for energization.
 - 3. Perform tests in presence of the Owner's Representative and furnish test equipment, facilities and technical personnel required to perform tests.

4. Tests shall be conducted during the construction period and at completion to determine conformity with applicable codes and with these Specifications.
- B. Testing safety and precautions shall include the following requirements:
 1. Applicable State and Local safety operating procedures.
 2. OSHA.
 3. NSC.
 4. NFPA 70E.
- C. Coordinate with General Contractor regarding testing schedule and availability of equipment ready for testing.
- D. Notify Owner and Engineer one week in advance of any testing.
- E. Any products which fail during the tests or are ruled unsatisfactory by the Owner's Representative shall be replaced, repaired, or corrected as prescribed by the Owner's Representative at the expense of the Contractor. Tests shall be performed after repairs, replacements or corrections until satisfactory performance is demonstrated.
- F. Testing Agency shall maintain written record of tests and shall assemble and certify final test report.
- G. Include all test results in the maintenance manuals.

3.6 CLEANING

- A. Prior to acceptance of electronic safety and security systems, the Contractor shall thoroughly clean electronic safety and security rooms from construction debris, scrap wire, etc. using Manufacturer's approved methods and materials.
- B. Upon completion of Project, prior to final acceptance, the Contractor shall thoroughly clean both the interior and exterior of all electronic safety and security equipment per Manufacturers approved methods and materials. Remove paint splatters and other spots, dirt, and debris.
- C. Touch-up paint any marks, blemishes or other finish damage suffered during installation.

3.7 PROJECT CLOSEOUT

- A. Training: At the time of completion, a period of not less than 2-hours shall be allotted by the Contractor for instruction of building operating and maintenance personnel in the use of all systems. This 2-hours training is in addition to any instruction time called out in the Specifications for specific systems. All personnel shall be instructed at one time, the Contractor making all necessary arrangements with Manufacturer's Representative. The equipment Manufacturer shall be requested to provide product literature and application guides for the users' reference. Costs, if any, for the above services shall be paid by the Contractor.
- B. Special tools: Provide one of each tool required for proper operation and maintenance of the equipment provided under this Section. All tools shall be delivered to the Owner at the Project completion.

- C. Keying: Provide two keys for each lock furnished under this Section and turn over to Owner.

END OF SECTION

SECTION 28 05 13

ELECTRONIC SAFETY & SECURITY CONDUCTORS & CABLES

PART 1 - GENERAL

1.01 SUMMARY

- A. Work included: Labor, materials, and equipment necessary to complete the installation required for the item specified under this Division, including but not limited to:
 - 1. Conductors.
 - 2. Cables.
 - 3. Wiring connections and terminations.
- B. Related Work: Consult all other Sections, determine the extent and character of related Work, and properly coordinate Work specified herein with that specified elsewhere to produce a complete installation.

1.02 REFERENCES

- A. Comply with the latest edition of the following applicable Specifications and standards except as otherwise indicated or specified:
 - 1. American National Standards Institute, Inc. (ANSI) / Telecommunications Industry Association (TIA) / Electronics Industries Alliance (EIA):
 - ANSI/TIA/EIA-568-C; Commercial Building Telecommunications Cabling Standards, including the following:
 - Part 1: General Requirements.
 - Part 2: Balanced Twisted-Pair Cabling Components.
 - Part 2, Addendum 1: Transmission Performance Specifications for 4-Pair 100 Ohm Category 6A Cable.
 - TIA SP 3-4426 (12/28/06 or latest version): Transmission Performance Specifications for 4-Pair 100 Ohm Augmented Category 6A Cable (to be published as TIA-568-C.2-10).
 - ANSI/TIA/EIA-606-C; Administration Standard for Commercial Telecommunications Infrastructure.
 - TIA TSB-155; Guidelines for the Assessment and Mitigation of Installed Category 6 Cabling to Support 10GBase-T.
 - 2. Institute of Electrical and Electronic Engineers (IEEE):
 - IEEE 82; Test Procedure for Impulse Voltage Tests on Insulated Conductors.
 - IEEE 576; Recommended Practice for Installation, Termination, and Testing of Insulated Power Cable as Used in Industrial and Commercial Applications.
 - 3. National Electrical Manufacturer Association (NEMA):

NEMA WC-5; Thermoplastic Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.

NEMA WC-7; Cross-Linked Thermosetting Polyethylene Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.

4. Underwriters Laboratories, Inc. (UL):

UL 44; Thermoset-Insulated Wires and Cables.

UL 83; Thermoplastic-Insulated Wires and Cables.

UL 310; Electrical Quick-Connect Terminals.

UL 444; Communication Cables.

UL 486A & B; Wire Connectors.

UL 486C; Splicing Wire Connectors.

UL 486D; Insulated Wire Connector Systems for Underground Use or in Damp or Wet Locations.

UL 493; Thermoplastic-Insulated Underground Feeder and Branch Circuit Cables.

UL 1581; Reference Standard for Electrical Wires, Cables and Flexible Cords.

UL 1690; Data-Processing Cable.

UL 1963; Communications-Circuit Accessories.

UL 2196; Standard for Tests of Fire Resistive Cables.

1.03 SYSTEM DESCRIPTION

A. Provide a complete electronic safety and security conductor and cable system installation as specified herein and as shown on the Drawings. In general, system shall include, but not be limited to, the following:

1. Provide all required conductor and cable supports for complete installation as specified.
2. Provide required conductor and cable sizes to allow for voltage drop on long runs.
3. Provide for effective shielding to allow the routing of 12 to 24 volt power and video conductors and cables in the same conduit without interference or signal noise.
4. Conductors and cables installed outdoors and in underground conduits, shall meet all CEC requirements and be rated for exterior applications.
5. Cables installed indoors, not in conduit, shall require a plenum-rated jacket (type CMP).

B. Conductor and cable sizing:

1. 24 volt DC or AC locks: 2-conductor, #18 AWG, stranded, unshielded.
2. Motion detector: 2-twisted pair, #22 AWG, stranded, unshielded.
3. Glass break detector: 2-twisted pair, #22 AWG, stranded, unshielded.
4. Door alarm contact: 2-twisted pair, #18 AWG, stranded, unshielded.

5. Card reader: 8-conductor, #18 AWG, stranded, unshielded.
6. Ethernet network: Category 6A.
7. Camera (PoE): Category 6A.
8. Cabinet hook-up: 600 volt MTW (TFF or AWM), #18 AWG, stranded, unshielded.

1.04 SUBMITTALS

- A. Submit in accordance with the requirements of Section 280010: Basic Electronic Safety & Security Requirements, the following items:
 1. Data/catalog cuts for each product and component specified herein, listing all physical and electrical characteristics and ratings indicating compliance with all listed standards.
 2. Clearly mark on each data sheet the specific item(s) being submitted and the proposed application.
 3. Shop Drawings prepare in Revit, to include the following:
 - a. Building floor plans showing location of all equipment, devices, appliances, raceways, conduits, and cable routing to each device at same scale as construction documents.
 - b. Provide 1/4" scale plans of equipment layouts.
 - c. Provide wall elevations of equipment layouts at 1/4" scale.
 - d. Provide equipment rack elevations at 1/4" scale.
 - e. Use identical symbols as those used in construction documents.
 - f. Text shall be a minimum of 3/32" high when plotted at full scale.
 - g. Screen all background information.
 4. Furnish structural calculations for equipment anchorage as described in Section 280010: Basic Electronic Safety & Security Requirements.
 5. Submit Manufacturer's installation instructions.
 6. Complete bill of materials listing all components.
 7. Final test results.
 8. Warranty.
- B. Dimensions and configurations of equipment shall conform to the space allocated on the Drawings. The Contractor shall submit a revised layout, if equipment furnished varies in size from that indicated on Drawings, for approval.

1.05 QUALITY ASSURANCE

- A. All materials, equipment and parts comprising the units specified herein shall be new, unused, and currently under production.
- B. Only products and applications listed in this Section may be used on the Project unless otherwise submitted.
- C. Independent Testing Agency qualifications: Refer to Section 280010: Basic Electronic Safety & Security Requirements.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Products furnished by the following Manufacturers shall be acceptable if in compliance with all features specified herein and indicated on the Drawings.
 - 1. Building wire:
 - a. Belden Cabling System.
 - b. General Cable
 - c. West Penn
 - 2. Category 6A horizontal structured cable systems and patch cord cables:
 - a. Belden Cabling System
 - b. BerkTek Cable
 - c. CommScope
 - d. General Cable
 - e. Superior Essex Cable
 - 3. Wiring connectors and terminations:
 - a. 3M Company.
 - b. Ideal.
 - c. Blackburn-Holub.
 - d. Burndy.
 - e. Thomas & Betts Corp.
 - f. Beau Barrier.
- B. Substitutions: Under provisions of Section 280010: Basic Electronic Safety & Security Requirements.

2.02 CONDUCTORS

- A. Conductor material:
 - 1. Provide annealed copper for all conductors.
 - 2. Copper wire AWG #12 and smaller may be solid or stranded as best suited for the installation or as specified herein.
- B. Insulation material:
 - 1. All insulated wire, conductor and cable shall be 600 volt rated, unless otherwise noted on the Drawings.
 - 2. Thermoplastic-insulated building wire: NEMA WC 5.
 - 3. Copper conductors #8 AWG and smaller: Type TW, THW, XHHW or dual rated THHN/THWN.
 - 4. Hook-up conductors #8 AWG and smaller: Type MTW, TFF or AWM.
 - 5. Identify system conductors as to voltage and phase connections by means of color-impregnated insulation.

2.03 CABLES

A. Horizontal twisted-pair cables:

1. Application:
 - a. Suitable for indoor installations in conduit and above suspended ceilings via hangers or on deck, or within walls. If space is used as an air plenum, cable shall either be plenum rated or installed in EMT conduit.
 - b. Each cable run shall be continuous single cable, homogenous in nature, without splices.
 - c. Cables shall meet 6A performance criteria.
 - d. Cables shall be CMR or CMP rated as required for rating of space.
2. Conductors:
 - a. Eight #23 AWG, solid copper wire insulated with FEP for plenum applications or thermoplastic polyethylene or high-density polyolefin for non-plenum rated applications.
 - b. Two insulated conductors twisted together to form a pair and four such paired cables to form a unit with individually color-coded pairs to conform to industry standards (ANSI/ICEA Publication S-80-576-1994 and EIA-230).
3. Cable sheath:
 - a. Seamless outer jacket, flame-retardant PVC, applied to and completely covering the internal components (twisted pairs).
 - b. CMP flame rating according to CEC Chapter 8, tested to NFPA 262 and UL Listed as such.
4. Electrical performance: Meet or exceed TIA/EIA-568-C.2 for Category 6A, UTP cabling.
5. Color: Cable shall be blue in color.

B. Twisted-pair patch cords:

1. Application: Suitable for indoor installations within equipment room environments.
2. Cords assembled from a single, continuous length of cordage, homogenous in nature and terminated at both ends via 8-position modular plugs. Splices are not permitted anywhere.
3. Cordage:
 - a. Eight #23 AWG, solid copper wire insulated with thermoplastic polyethylene or high-density polyolefin for non-plenum rated applications.
 - b. Two insulated conductors twisted together to form a pair and four such paired cables to form a unit with individually color-coded pairs to conform to industry standards (ANSI/ICEA Publication S-80-576-1994 and EIA-230).
4. Cable sheath:
 - a. Seamless outer jacket, flame-retardant PVC, applied to and completely covering the internal components (twisted pairs).
 - b. CM flame rated according to CEC Chapter 8, tested to UL listed as such.

5. Electrical performance: Meet or exceed TIA/EIA-568-C.2 for Category 6A, UTP cabling.

2.04 CONDUCTOR CONNECTIONS AND TERMINATIONS

A. Electrical spring wire connectors:

1. Provide multi-part construction incorporating a non-restricted, zinc coated square cross-section steel spring enclosed in a steel sheet with an outer jacket of plastic and insulating skirt.
2. Self-striping pigtail and tap U-contact connectors shall not be used.

B. Push-in wire connectors:

1. Multi-port push-in wire connectors for a maximum of 8-wires, as required for specific application. Connectors are manufactured to accommodate a wide range of sizes with either solid or stranded conductors, up to a maximum wire size of #10 AWG. Low insertion force required for ease of installation.
2. Housing shall be 105-degrees C and transparent for visual connection verification.
3. 600 volt maximum rating with copper contacts.
4. UL Listed to 486C and UL 467 Listed for grounding and bonding applications.

C. Splicing and insulating tape: Provide black, ultraviolet proof, self-extinguishing, 7-mil thick vinyl general purpose electrical tape with a dielectric strength of 10,000 volts suitable for temperatures from minus 18-degrees C to 105-degrees C.

D. Cable ties: Provide harnessing and point-to-point wire bundling with nylon cable ties. All cable ties shall be installed using tool supplied by Manufacturer of ties.

2.05 HORIZONTAL CABLE TERMINATIONS

A. Category 6A data system patch panels:

1. Terminations of horizontal distribution cable for data and telephone systems shall be made at Category 6A, 2U, 48 port panels.
2. Terminations of horizontal distribution cable for data WAP locations shall be made at Category 6A, 2U, 48 port panels.

B. Velcro cable ties:

1. Width: 0.75".
2. Color: Velcro cable ties the same color as the cable to which it is applied.

C. Plenum cable ties:

1. Suitable for use in plenums or air handling spaces.
2. Color: Maroon or other distinctive non-white color.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Contractor shall thoroughly examine Project site conditions for acceptance of conductor and cable installation to verify conformance with Manufacturer and Specification tolerances. Do not commence with installation until all conditions are made satisfactory.

3.02 APPLICATION

- A. All conductor and cable with their respective connectors, fittings and supports shall be UL listed for the installed application and ambient condition.

3.03 INSTALLATION METHODS

- A. Install wires and cables in accordance with manufacturer's written instructions, as indicated on Drawings and as specified herein.
- B. Provide adequate length of conductors within enclosures and train the conductors to terminal points with no excess. Make terminations so there is no bare conductor at the terminal.
- C. Splice conductors only in outlet boxes, junction boxes, pull boxes, manholes or handholes. Group and bundle with tie wrap each neutral with its associated phase conductor where more than one neutral is present in a conduit.
- D. Neatly form, train, and tie the cables in bundles for cabinets, runways, surface raceways, and equipment assemblies.

3.04 CONDUCTOR INSTALLATION

- A. In Raceway:
 - 1. Install wire in raceway in accordance with manufacturer's written instructions, as indicated on the Drawings and as specified herein after interior of building has been physically protected from the weather and all mechanical Work likely to injure conductors has been completed. Pull all conductors into a raceway at the same time. Exercise care in pulling conductors so that insulation is not damaged. Use UL listed, non-petroleum base and insulating type pulling compound as needed.
 - 2. Completely mandrel all underground or concrete encased conduits prior to installing conductors.
 - 3. Completely and thoroughly swab raceway system before installing conductors.
 - 4. Do not use block and tackle, power driven winch or other mechanical means for pulling conductors.
 - 5. Wire pulling:
 - a. Provide installation equipment that will prevent the cutting or abrasion of insulation during pulling of cables.
 - b. Pull in together multiple conductors or cables in a single conduit.
 - c. Pulling tensions and sidewall pressures shall not exceed 60% of the manufacturer's recommended maximum values. Pulling tension shall be continuously monitored during the pull by a calibrated dynamometer. If pulling tension is exceeded during the pull, immediately notify the engineer to determine if the cables will be considered damaged and require contractor replacement.

6. Install and test all cables in accordance with manufacturer's instructions and warranty.
- B. Conductor splices, joints, and terminations:
1. Join and terminate conductors in accordance with UL 486A & C, CEC and manufacturer's instructions.
 2. Thoroughly clean wires before installing connectors.
 3. Make splices, taps and terminations to carry full ampacity of conductors without perceptible temperature rise.
 4. Splices and terminations shall be made mechanically and electrically secure.
 5. Where it is determined that unsatisfactory splice or terminations have been installed, remove the devices and install approved devices at no addition cost.
 6. Insulate spare conductors with electrical tape and leave sufficient length to terminate anywhere in the enclosure or cabinet.
 7. Install cable ties and maintain harnessing.
 8. Encapsulate splices in exterior devices, pull boxes and junction boxes using specified insulating resin kits. Make all splices watertight for exterior equipment and equipment in pump rooms.
 9. Make up all splices and taps in accessible junction or device boxes with connectors as specified herein. Pigtails and taps shall be the same color as the feed conductor. Form conductor prior to cutting and provide at least 6-inches of tail and neatly packed in box after splice is made up.

3.05 HORIZONTAL CABLE INSTALLATION

- A. Horizontal management panels:
1. Provide the horizontal management panels mounted to racks with one above and one below each patch panel.
 2. Provide fasteners and parts required to complete the installation.
- B. Accessories: Provide all accessories as required for a complete installation. Include one bag of rack mounting screws, as come packaged with rack product. Attach the screws directly to the rack, which shall constitute turn-over to the Owner.
- C. Horizontal twisted-pair cabling:
1. Horizontal cable installation and routing:
 - a. Cable runs shall have continuous sheath continuity, homogenous in nature with no splicing.
 - b. Cabling shall not exceed a cable length of 295' (90m) from the termination point at the Telecom room to the termination at the workstation outlet, including service slack, when measured using test equipment. The cable length shall be determined by the contractor prior to installing cable with a true tape. Cable lengths exceeding the 295-foot maximum length, shall be brought to the attention of the engineer of record (EOR).
 - c. Place cables within the designated pathways, such as cable tray or basket tray, cable runway, cable hangers, conduit. etc. Do not fasten, support, or attach cables to other building infrastructures (i.e., ducts, pipes, conduits,

etc.), other systems (i.e., ceiling support wires, wall studs, etc.), or to the outside of conduits, cable trays and non-approved pathway systems.

- d. Place and suspend cables during installation and termination in a manner to protect them from physical damage or interference. Place cables with no kinks, twists, or impact damage to the sheath. Replace cables damaged during installation or termination at no additional cost.
 - e. Route cables at 90-degree angles, allowing for bending radius.
 - f. Do not exceed pulling tension of 25-lbs.
 - g. Do not use cable-pulling compounds.
 - h. Do not exceed a minimum bend radius of 6 times the cable diameter during and after installation.
 - i. Route cables beneath other building infrastructures (i.e. ducts, pipes, conduits, etc.) in above ceiling applications. Do not route cables over building infrastructure/s. The installation shall result in easy accessibility to the cables in the future.
 - j. Place cables 6" minimum away from power sources to reduce interference from EMI.
 - k. Do not set 360-degree service loops in place for slack storage. Instead, set slack as forward-and-back or as figure eights.
 - l. Place a pull string along with cables where run in conduits and spare capacity in conduit remains. Tie off ends of the pull string to prevent the string from falling onto the conduit.
 - m. When exiting the primary pathway, such as cable or basket tray, to the devices, exit via the top of the pathway. Secure the cables to the pathway using an approved Velcro cable tie.
2. Cable routing and dressing within equipment rooms:
- a. Within rooms, only use Velcro type straps on bundles.
 - b. Individual bindles of cable shall not exceed 48 cables to minimize heating of cables that use PoE. Bundles of cables shall be per 48-port patch panel.
 - c. Place cables within the overhead cable support system. When routing vertically on walls, fasten the cables onto vertical supports every 24" on center.
 - d. Provide 12" minimum sheath cable slack, length not to exceed permanent link maximum length requirement. Place the slack in the overhead cable support system.
 - e. At the rack bay, route, and neatly dress cables from the overhead cable support system into the back of the vertical management sections. Divide the cables equally between both sides of an equipment rack such that a cable does not travel past the midpoint of the rack prior to termination. Fasten the cables to the cable support bar at the back of the patch panel using approved ties.
3. Termination in the equipment rooms:
- a. Provide termination apparatus and accessories required for a complete installation. Install and assemble termination apparatus, accessories, and

associated management apparatus according to the manufacturer's instructions.

- b. Properly relieve strain from the cables to and at termination points per manufacturer's instructions. Provide a strain relief bar at the back of the modular patch panels for proper strain relief.
 - c. Terminate cables and twisted pairs in accordance with manufacturer's latest installation requirements and TIA/EIA-568-R standard installation practices. Terminate cable pairs onto the termination apparatus compliant to T568B wiring.
 - d. Modular patch panels and horizontal management panels:
 - 1) Provide quantity of patch panels to support the terminations of cables served from respective equipment room.
 - 2) Install and assemble patch panels and wire management panels according to the manufacturer's instructions.
 - 3) Install the termination hardware and cable management as shown on the Drawings.
 - 4) Terminate cables in sequential order using the link's identifier starting at the top left and completing a block before moving to the next block below.
4. Cable routing and dressing at device connection:
- a. Provide 18" cable slack at each device, length not to exceed permanent link maximum length requirement. Place the slack within ceiling space neatly on a cable hanger or other approved cable support device.
 - b. Terminate cables and twisted pairs in accordance with the manufacturer's latest installation requirements and TIA/EIA-568-D standard installation practices. Terminate cable pairs onto the connector compliant to T568B wiring.
5. Patching and cross connecting: In equipment rooms, provide one modular patch cord for each device connection. Install from the horizontal termination field to the network switches/equipment. Neatly dress patch cords within the horizontal and vertical cable management components. Cords lengths shall be coordinated with the Owners IT representative.
- D. General requirements:
- 1. Labeling, label colors, and identifier assignments shall conform to EIA/EIA-606-C Administration Standards and as approved by the Owner.
 - 2. Provide permanent and machine-generated labels. Handwritten labels will not be accepted.

3.06 IDENTIFICATION

- A. Refer to Section 280553: Electronic Safety & Security Identification for additional requirements.
- B. Conductors:
 - 1. Securely tag all conductors. Mark conductors with specified vinyl wrap-around markers. Where more than two conductors run through a single outlet, mark each conductor with the corresponding circuit number.

2. Provide all terminal strips with each individual terminal identified using specified vinyl markers.
- C. Horizontal twisted-pair cables:
 1. Labeling shall be per the Owners standards in lieu of the following requirements. Coordinate with the Owners IT representative prior to the labeling phase of the cable installation to determine the Owners labeling requirements.
 2. Cables:
 - a. Text color shall be black, #10 font size.
 - b. Label installation:
 - 1) Provide labels on both ends of cable.
 - 2) Install labels such that they are visible by technician from a normal stance.
 - 3) Fully wrap label around the cable jacket (self-lamination).
 - 4) Provide one label within 4" of the termination apparatus.
 3. Modular patch panels:
 - a. Text color shall be black, #10 font size.
 - b. Label installation: Provide a Letter designation for each panel (A, B, C etc.). Patch Panel port number will match the cable designation at the station end.

3.07 FIELD QUALITY CONTROL

- A. Independent testing: Contractor shall arrange and pay for the services of an independent Testing Agency to perform all quality control electrical testing required herein. Independent Testing Agency shall meet the requirements as outlined in Section 280010: Basic Electronic Safety & Security Requirements.
- B. Prefunctional testing:
 1. Visual and mechanical inspection:
 - a. Compare cable data with Contract Documents.
 - b. Inspect exposed sections of wires and cables for physical damage and proper connections.
 - c. Inspect compression applied connectors for correct cable match and indentation.
 - d. Verify visible cable bend meet or exceed ICEA and Manufacturer's minimum allowable bending radius.
 - e. Ensure conductor and cable identification has been installed as specified herein.
- C. Conductors:
 1. Electrical testing:
 - a. Contractor shall perform circuit insulation test after installation and prior to connection to utilization devices such as door hardware, cabinets, or appliances. 10% of all circuits shall be tested.
 - b. Perform insulation-resistance test using megohm meter with applied potential of 1000 volt DC for a continuous duration of 60-seconds. Test conductors'

phase-to-phase and phase-to-ground. Conductors shall test free from short-circuit and ground faults.

- c. Perform continuity test of all circuits to ensure correct connections. Test all neutrals for improper grounds.
 - d. Contractor shall furnish instruments, materials, and labor for these tests.
2. Test values: Investigate resistance values less than 50-megohms.
 3. Furnish test results in typewritten report form for review and inclusion in the operation and maintenance manuals.

D. Twisted-pair cables:

1. General:
 - a. Calibrate test sets and associated equipment per the manufacturer's instructions at the beginning of each day's testing and after each battery charge. Fully charge the test sets prior to each day's testing to ensure proper operation.
 - b. Ensure test equipment and test cords are clean and undamaged during testing activities. Per the Engineer's discretion, halt testing activity and clean testing equipment, test cords and related apparatus.
 - c. Permanently record test results electronically within test equipment at the time of testing.

2. Twisted-pair testing:

- a. Test for UTP cabling as follows:

TESTS FOR CATEGORY 6 CABLING TABLE				
Subsystem	Type	Test	Configuration	Notes
Horizontal	Category 6A	Category 6A	Permanent Link	Per TIA/EIA-568-C.2

- b. Precautions:
 - 1) Adhere to the equipment manufacturer's instructions during all testing.
 - 2) Prior to any testing activity or any measurements taken, ensure the test equipment is at room temperature, approximately 70-degrees F.
 - 3) Fully charge power sources before each day's testing activity.
- c. Horizontal twisted pair testing:
 - 1) Test equipment set-up:
 - a) Set-up the tester to perform a full Category 6A test, as a Permanent Link configuration.
 - b) If the tester has the capability, set the cable type as product specific setting. If not, set as generic Category 6A cable.
 - c) Set the tester to save the full test results (all test points, graphs, etc.).
 - d) Save the test results with associated cable link identifier.
 - e) Calibrate the test set per the manufacturer's instructions.
 - 2) Acceptable test results measurements:
 - a) Overall test results:

- (1) Links which report a Fail, Fail or Pass for any of the individual tests shall result in an overall link Fail. All individual test results must result in a Pass to achieve an overall Pass.
 - (2) Any reconfiguration of link components required because of a test Fail, must be re-tested for conformance.
 - (3) Remove and replace any cabling links failing to meet the criteria described in this Specification, at no cost to the Owner, with cables that prove to meet the minimum requirements.
- b) Wire map: Provide continuous pairs and terminate all the cabling links correctly at both ends, no exceptions taken.
 - c) Length: One hundred meters (328 feet) is the maximum acceptable electrical length measurements for any cabling link measured under a Permanent Link configuration, including test cords.
 - d) Insertion loss: The acceptable insertion loss measurements for any horizontal cabling link is that which is no greater than that listed in TIA/EIA-568-C.2.
 - e) Worst pair-to-pair near end crosstalk (NEXT) loss: The acceptable worst pair-to-pair NEXT loss for any horizontal cable is that which is no greater than that listed in TIA/EIA-568-C.2.
 - f) Power sum NEXT loss: The acceptable power sum PS-NEXT loss for any horizontal cable is that which is no greater than that listed in TIA/EIA-568-C.2.
 - g) Worst pair-to-pair ELFEXT and FEXT loss: The acceptable worst pair-to-pair ELFEXT and FEXT loss for any horizontal cable is that which is no greater than that listed in TIA/EIA-568-C.2.
 - h) Power sum ELFEXT and FEXT loss: The acceptable PS-ELFEXT and PS-FEXT loss for any horizontal cable is that which is no greater than that listed in TIA/EIA-568-C.2.
 - i) Return loss: The acceptable return loss measurements for any horizontal cabling link is that which is no greater than that listed in TIA/EIA-568-C.2.
 - j) Propagation delay and delay skew: The acceptable propagation delay and delay skew measurements for any horizontal cabling link is that which is no greater than that listed in TIA/EIA-568-C.2.
3. Record documents:
- a. Permanently record all test results.
 - b. Export test results' numerical values to a single Microsoft Excel spreadsheet.
 - c. Submit test results in a format acceptable to the Owner, Owner's Representative, and the Engineer before system acceptance.
 - d. Cable and pair identifiers of the test reports shall match the identifiers as labeled in the field, i.e. use the same ID on the cable/termination label as what appears on the test report.
 - e. Measurements shall carry a precision through one significant decimal place, minimum.

- f. Use feet for the units for measurements shown on the print of the test measurements.
- g. Print report such that fiber strands of a given cabling link have matching axis scales. The "X" and the "Y" axis shall be the same from report-to-report.
- h. The trace of the printed test report shall show the launch cord.
- i. For each cabling link, include either a schematic graphic or a brief narrative accurately describing the test set-up. The description shall include test/launch cord (with length), expected events (connectors, slices, etc.) with expected distances, etc. This information will eliminate many questions the Engineer will have while reviewing the reports.
- j. For each twisted pair horizontal cable test, report shall contain the following information:
 - 1) Project name and address.
 - 2) Test company's and Operator's name.
 - 3) Date measurements were taken.
 - 4) Test equipment type to include model and serial numbers.
 - 5) Cable identification number and pair number.
 - 6) Measurement results.

3.08 INSPECTION AND ADJUSTMENTS

- A. Contractor shall inspect all installed Work in conjunction with the General Contractor and develop a "punchlist" for all items needing correction. Provide punchlist to the Engineer prior to their final walk of Project.
- B. Punchlist work and the required remediation shall be performed prior to system final acceptance.
- C. Replace or repair work completed by others that was defaced or destroyed during the installation of the electronic safety and security conductor and cable system by this contractor.
- D. Make changes to adjust the system to optimum operation for final use. Contractor is responsible for making changes to the system such that any defects in workmanship are correct and all cables and the associated termination hardware passes the minimum test requirements.

3.09 CLEANING

- A. Remove all unused, excess, and left-over products, to include debris, spills, and installation equipment.
- B. Leave finished work and adjacent surfaces in neat, clean conditions with no evidence of damage.
- C. Legally dispose of debris.
- D. Clean installed products in accordance with manufacturer's instructions prior to final punch list.

END OF SECTION

SECTION 28 05 28

ELECTRONIC SAFETY & SECURITY PATHWAYS

PART 1 - GENERAL

1.1 SUMMARY

- A. Work included: Labor, materials, and equipment necessary to complete the installation required for the item specified under this Division, including but not limited to:
 - 1. Conduit and fittings.
 - 2. Fire-rated wall and floor through-penetration.
 - 3. Boxes
 - 4. Vaults
 - 5. J-Hooks.
- B. Related Work: Consult all other Sections, determine the extent and character of related Work, and properly coordinate Work specified herein with that specified elsewhere to produce a complete installation.
 - 1. Division 01: Cutting and patching.
 - 2. Division 31: Earthwork. Excavation and backfill for conduit and utilities on Project site.
 - 3. Division 03: Cast-in-place concrete. Protective envelope for underground conduit installations.
 - 4. Division 07: Sheet metal flashing and trim.
 - 5. Division 09: Painting. Exposed conduit and other devices.
 - 6. Division 08: Access doors. Wall and ceiling access doors.

1.2 REFERENCES

- A. Comply with the latest edition of the following applicable Specifications and standards except as otherwise indicated or specified:
 - 1. American National Standards Institute (ANSI)/National Electrical Manufacturer Association (NEMA):
 - ANSI C80.3; Electrical Metallic Tubing, Zinc Coated.
 - ANSI/NEMA OS-1; Sheet-Steel Outlet Boxes, Device Boxes, Covers and Box Supports.
 - NEMA 250; Enclosures for Electrical Equipment (1000 volts maximum).
 - 2. American Society for Testing and Materials (ASTM):
 - ASTM E84; Surface Burning Characteristics of Building Materials
 - ASTM E119; Fire Tests of Building Construction and Materials
 - ASTM E814; Fire Tests of Penetration Fire Stops
 - ASTM E1725; Standard Test Methods for Fire Tests of Fire Resistive Barrier Systems for Electrical System Components

3. Underwriters Laboratories, Inc. (UL):
 - UL 50; Enclosures for Electrical Equipment, Non-Environmental Considerations.
 - UL 263; Fire Tests of Building Construction and Materials
 - UL 514A; Metallic Outlet Boxes.
 - UL 514B; Conduit, Tubing and Cable Fittings.
 - UL 635; Insulating Bushings.
 - UL 651; Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings.
 - UL 651A; Schedule 40 and 80 High Density Polyethylene (HDPE) Conduit.
 - UL 723; Surface Burning Characteristics of Building Materials
 - UL 797; Electrical Metallic Tubing - Steel.
 - UL 1479; Fire Tests of Through Penetration Firestops
 - UL 1773; Termination Boxes.
 - UL 2239; Hardware for the Support of Conduit, Tubing, and Cable
4. National Electrical Manufacturer Association (NEMA):
 - NEMA TC 2; Electrical Plastic Tubing and Conduit.
 - NEMA TC 3; PVC Fittings for use with Rigid PVC Conduit.
 - NEMA TC 6; PVC Plastic Utilities Duct (EB and DB Type)
 - NEMA TC 9; Fittings for PVC Plastic Utilities Duct (EB and DB Type)

1.3 SYSTEM DESCRIPTION

- A. Conduits supported from structure and within stud walls for the continuous routing of electronic safety and security conductors and cables, where non-accessible concealed Work is indicated and where required by Code and/or shown on the Drawings. Conduits shall be sized for a 40-percent maximum cable fill ratio.
- B. Assemblies supported from structure for the continuous routing of electronic safety and security conductors and cables, where exposed Work is indicated on the Drawings.
- C. J-Hooks supported from structure, above suspended ceiling, for the routing of electronic safety and security conductors and cables, where accessible through ceiling and where shown on the Drawings. J-hooks shall be sized for a 40-percent maximum cable fill ratio.
- D. Where exposed cable routing is indicated, provide conduit sleeves through walls, above suspended ceilings or at cable routing elevation, with insulated bushings on both ends, for access into enclosed spaces, i.e., offices, workrooms, conference rooms, etc. Sleeves shall be 2" minimum and 4" maximum conduits and shall be sized for a 40-percent maximum cable fill ratio.
- E. Provide UL listed fire-rated sleeves for passing through 1 and 2-hour rated walls and/or floors assemblies.

1.4 SUBMITTALS

- A. Submit in accordance with the requirements of Section 280010: Basic Electronic Safety & Security Requirements, the following items:
 - 1. Data/catalog cuts for each product and component specified herein, listing all physical and electrical characteristics and ratings indicating compliance with all listed standards.
 - 2. Clearly mark on each data sheet the specific item(s) being submitted and the proposed application.
 - 3. Furnish structural calculations for equipment anchorage as described in Section 280010: Basic Electronic Safety & Security Requirements.
 - 4. Submit Manufacturer's installation instructions.
 - 5. Complete Bill of Material listing all components.

1.5 QUALITY ASSURANCE

- A. All materials, equipment and parts comprising the units specified herein shall be new, unused, and currently under production.
- B. Only products and applications listed in this Section may be used on the Project unless otherwise submitted.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Products furnished by the following Manufacturers shall be acceptable if in compliance with all features specified herein and indicated on the Drawings.
 - 1. Conduit:
 - a. Metal conduit:
 - 1) Allied Tube and Conduit Co.
 - 2) Triangle PWC, Inc.
 - 3) Western Tube and Conduit Corp.
 - b. Nonmetallic conduit:
 - 1) Prime Conduit.
 - 2) JM Eagle.
 - 3) Cantex.
 - c. Fittings:
 - 1) Appleton Electric Co.
 - 2) OZ/Gedney.
 - 3) Thomas & Betts Corp.
 - 4) Carlon.
 - 2. Fire-rated penetration assemblies:
 - a. EZ-Path, STI Firestop.

- b. Hilti
 - c. 3M
 - d. Lowry's, Inc.
 - 3. Boxes:
 - a. Outlet and junction boxes:
 - 1) Spring City Electrical Manufacturing Co.
 - 2) Thomas & Betts Corp.
 - 3) Raco, Inc.
 - b. Cast boxes:
 - 1) Appleton Electric Co.
 - 2) Crouse-Hinds.
 - c. Floor boxes:
 - 1) Hubbell Inc.
 - 2) Walker.
 - 3) Wiremold/Legrand.
 - d. Pullboxes:
 - 1) Circle AW Products.
 - 2) Hoffman Engineering Co.
 - 4. J-Hooks Systems:
 - a. Erico nVent Caddy HP.
 - b. B-Line.
 - c. Panduit.
- B. Substitutions: Under provisions of Section 280010: Basic Electronic Safety & Security Requirements.

2.2 CONDUIT

- A. Electrical metallic tubing (EMT):
- 1. Conduit: Shall be formed of cold rolled strip steel, electrical resistance welded continuously along the longitudinal seam and hot dip galvanized after fabrication. Conduit shall conform to ANSI C80.3 Specifications and shall meet UL requirements.
 - 2. Set screw type couplings: Hot dip galvanized, steel or cast malleable iron, UL listed concrete tight. Use set screw type couplings with four setscrews each of conduit sizes over 2-inches. Setscrews shall be of case-hardened steel with hex-head and cup point to firmly seat in wall of conduit for positive grounding.
 - 3. Set screw type connectors: Hot dip galvanized, steel or cast malleable iron UL listed concrete tight with male hub and insulated plastic throat, 150-degree C temperature rated. Setscrew shall be same as for couplings.
 - 4. Raintight couplings: Hot dip galvanized, steel or cast malleable iron; UL listed raintight and concrete tight, using gland and ring compression type construction.

5. Raintight connectors: Hot dip galvanized, steel or cast malleable iron, UL listed raintight and concrete tight, with insulated throat, using gland and ring compression type construction.
- B. Rigid non-metallic conduit (PVC)
1. Conduit:
 - a. Rigid polyvinyl chloride, Schedule 40 or 80 conforming to NEMA TC1 and UL 651, latest edition. UL listed for exposed and direct-burial applications and for 90 degrees C conductor insulation. Conduit shall include an integral bell fitting at one end.
 - b. Rigid polyvinyl chloride, Type EB or DB conforming to NEMA TC 6 and UL 651, latest edition. UL listed for concrete encased burial and direct burial applications and for 90 degrees C conductor insulation. Conduit shall include an integral bell fitting at one end.
 2. Fittings: Couplings, adaptors, transition fittings, etc., shall be molded PVC, slip on, solvent weld type conforming to NEMA TC3 for Schedule 40 or 80 and NEMA TC 9 for type EB or DB.
- C. Miscellaneous conduit fittings and products:
1. Watertight conduit entrance seals: Steel or cast malleable iron bodies and pressure clamps with PVC sleeve, neoprene sealing grommets and PVC coated steel pressure rings. Fittings shall be supplied with neoprene sealing rings between the body and PVC sleeve.
 2. Watertight cable sealing bushings: One piece, compression molded sealing ring with PVC coated steel pressure disks, stainless steel sealing screws and zinc plated cast malleable iron locking collar.
 3. Expansion fittings: Multi-piece unit comprised of a hot dip galvanized malleable iron or steel body and outside pressure bussing designed to allow a maximum of 4" conduit movement (2" in either direction). Furnish with external braid tinned copper bonding jumper. Unit shall be UL listed for wet or dry locations.
 4. Expansion/deflection couplings: Multi-piece unit comprised of a neoprene sleeve with internal flexible tinned copper braid attached to bronze end couplings with stainless steel bands. Coupling shall accommodate 0.75-inch deflection, expansion or contraction in any direction and allow 30-degree angular deflections. Flexible, corrosion-resistant, watertight, moisture and heat resistant molded rubber jacket and stainless-steel jacket clamps. Unit shall comply with UL467 and UL514. Manufacturer shall be OZ/Gedney Type DX, Steel City Type EDF or equal.
 5. Standard products not herein specified:
 - a. Provide listing of standard electrical conduit hardware and fittings not herein specified for approval prior to use or installation, i.e. locknuts, bushings, etc.
 - b. Listing shall include Manufacturers name, part numbers and a written description of the item indicating type of material and construction.
 - c. Miscellaneous components shall be equal in quality, material and construction to similar items herein specified.

2.3 FIRE-RATED WALL AND FLOOR THROUGH-PENETRATION

A. General:

1. Through-penetration firestop system shall have been tested for specific fire resistance rated construction conditions or acoustical and smoke related requirements conforming to construction assembly type, penetrating item type, annular space requirements, and rating involved for each separate instance.
 2. Firestop rating shall match that of the wall or floor construction being penetrated.
 3. Firestop systems shall be as outlined below:
 - a. Firestop putty.
 - b. Firestop putty pads.
 - c. Fire-rated cable pathways.
- B. Firestop putty:
1. Intumescent, non-hardening, water resistant putties containing no solvents, inorganic fibers, or silicone compounds.
 2. Putty shall be used to seal openings around conduit penetrations through rated walls or floors, to maintain the construction rating.
- C. Firestop putty pads:
1. Intumescent, non-hardening, pliable putty pads designed to seal both through and membrane penetrations against the spread of fire and smoke around outlet boxes in rated construction.
 2. The pads are 6" x 8" x 0.125" thick.
 3. Pads are rated for up to 4-hour rated wall assemblies.
- D. Fire-rated pathway penetrations:
1. Pathway penetrations shall be used in fire-rated construction for low-voltage conductors and cabling, where they pass through fire-rated wall or floor construction.
 2. Pathways shall consist of an enclosed heavy-gauge galvanized steel housing lined with intumescent material engineered for rapid expansion when exposed to fire or high temperatures, quickly sealing the pathway, and preventing the passage of flames and smoke. The pathway shall be approximately 4" square x 14" long.
 3. Pathways shall meet the hourly fire-rating of fire rated wall and/or floor penetrated.
 4. Pathways shall be tested for the surrounding construction and cable types involved.
 5. Pathways shall be UL Systems permitting cable loads from 0 to 100-percent fill. This requirement eliminates need for fill-ratio calculations to be made by cable technicians to ensure cable load is within maximum allowed by UL System.
 6. Pathway shall be maintenance-free, having a corresponding Evaluation Services Report from a Nationally Recognized Third-Party Laboratory. Maintenance-free is defined as no action required by cabling technician to open and/or close pathway for cable moves, adds or changes, such as, but not limited to:
 - a. Opening or closing of doors.
 - b. Spinning rings to open or close fabric liner.

- c. Removal and or replacement of any material such as, but not limited to, firestop caulk, putty, pillows, bags, foam muffins, foam, foam plugs, foam blocks, or foam closures of any sort.
 - d. Evaluation Services Report (ESR) from an accredited Nationally Recognized Third-party Laboratory certifying compliance with this definition of "Maintenance-Free" and all relevant codes and standards.
- 7. Pathways shall be engineered such that two or more devices may be ganged together for larger cable capacities.
 - 8. Pathways shall be engineered to be re-enterable so they can be retrofitted and removed from around existing cables without cutting and re-splicing them.
 - 9. Affix adhesive wall label immediately adjacent to devices to communicate to future cable technicians, authorities having jurisdiction and others the manufacturer of the device and the corresponding UL System number installed.

2.4 OUTLET BOXES

A. Standard outlet box:

- 1. Provide galvanized, one-piece die formed or drawn steel or welded, knockout type box of size and configuration best suited to the application indicated on the Drawings.
- 2. 4.687-inch square by 2.125-inch deep shall be minimum box size.
- 3. ANSI/NEMA OS 1.

B. Concrete box:

- 1. Provide galvanized steel, 4-inch octagon rings with mounting lugs, backplate and adapter ring as required.
- 2. Select height as necessary to position knockouts above concrete reinforcing steel.
- 3. ANSI/NEMA OS 1.

C. Pull and junction boxes:

- 1. Sheet metal pull and junction box:
 - a. Provide standard outlet or concrete ring boxes wherever possible; otherwise use minimum 16-gauge galvanized sheet metal, NEMA 1 boxes, sized to Code requirements with covers secured by cadmium plated machine screws located 6 inches on centers.
 - b. ANSI/NEMA OS 1.
- 2. Cast metal pull and junction box: Provide standard cast malleable iron outlet or device boxes wherever possible; otherwise use cadmium plated, cast malleable iron boxes with bolt-on, interchangeable conduit hub plates with neoprene gaskets.
- 3. Flush mounted pullboxes and junction boxes: Provide overlapping covers with flush head cover retaining screws, prime coated.

2.5 VAULTS

- A. Precast concrete: Concrete mix and reinforcing placement shall be in accordance with ACI 318. Design tops and wall structures for AASHTO H20 highway loading,

with 30 percent loading added for impact. Walls shall withstand all soil pressures, taking into consideration the soil encountered and ground water level present at the Project site. Assume ground water level three feet below ground surface unless a higher water table is indicated in soils report.

B. Construction:

1. Monolithic or modular assembled sections.
2. Assembled sections shall have mating edges with tongue and groove joints. Joints shall firmly interlock adjoining components and provide waterproof junctions. Seal joints watertight using preformed plastic strip.
3. Provide lifting devices cast into units for proper handling of units.
4. Identify all structures with Manufacturer's name embedded in or otherwise permanently attached to an interior wall face.
5. Include concrete knockout panels for conduit entrance and sleeve for ground rod.

C. Size and dimensions: As indicated on Drawings.

D. Accessories:

1. Frames and covers: Cast iron with cast-in legend "SECURITY" or "LOW-VOLTAGE" as appropriate. Machine cover-to-frame bearing surfaces.
2. Pulling eyes in walls: Eyebolt with reinforcing bar fastening insert. 2-inch diameter eye, 1-inch by 4-inch bolt. Working load embedded in 6-inch, 4000-PSI concrete: 13,000 pounds minimum tension.
3. Pulling and lifting irons in floor: 7/8-inch diameter, hot-dipped galvanized, bent steel rod, stress relieved after forming and fastened to reinforced rod. Exposed triangular opening. Ultimate yield strength: 40,000 pounds shear and 60,000 pounds tension.
4. Bolting inserts for cable stanchions: Flared, threaded inserts of non-corrosive, chemical resistant, nonconductive thermoplastic material; 1/2-inch internal diameter by 2.75-inch deep, flared to 1.24-inch minimum at base. Tested ultimate pull-out strength at 12,000 pounds minimum.
5. Expansion anchors for installation after concrete is cast: Zinc-plated carbon steel wedge type with stainless-steel expander cup 1/2-inch bolt size, 5,300 pound rated pull-out strength and 6800 pound rated shear strength minimum.
6. Cable stanchions: Hot-rolled, hot-dipped, galvanized "T" section steel, two 1/4-inches size, punched with 14-holes on 1.5-inch centers for cable arm attachment.
7. Cable arms: 3/16-inch thick hot-rolled, hot-dipped galvanized sheet steel pressed to channel shape, approximately two 12-inches wide by 14-inches long and arranged for secure mounting in horizontal position at any position on cable stanchions.
8. Cable support insulators: High glaze, wet-process porcelain arranged for mounting on cable arms.
9. Ground rods: Solid copper, 3/4-inch diameter by 10-feet length (minimum).
10. Ground wire: Stranded bare copper conductor, #6 AWG (minimum). Size in accordance with CEC Article 250.
11. Steps: Cast iron, suitable for shape and construction.

2.6 J-HOOK "NON-CONTINUOUS" CABLE SUPPORT SYSTEM

A. General:

1. J-hooks shall provide a bearing surface of sufficient width to comply with required bend radii of high-performance cables per ANSI/TIA 568.0-D.
2. J-hooks shall have flared edges to prevent damage while installing cables.
3. J-hook shall have a cable retainer wire form to provide containment of cables within the hanger. The cable retainer shall be removable and reusable.
4. J-hook shall have a hot-dipped galvanized or G60 finish and shall be rated for indoor use in non-corrosive environments.
5. J-hook shall be made using a metal thickness of 0.052" and in a finish and hardness.
6. Attaching J-hooks and assemblies to ceiling support wires is not allowed per the CEC.

B. Multi-tiered field assemblies:

1. Multi-tiered J-hook assemblies shall be used where separate cabling compartments are required. Assemblies may be created by joining the J-hook with snap-on tree-mounting brackets. Assemblies can be made single-sided for wall-mount applications or single/double sided for ceiling/beam/threaded rod suspended applications. The assembly is rated for indoor use in non-corrosive environments.
2. For installation on threaded rod, a snap-on angle bracket must be added on top of the assembly.
3. If required, the multi-tier J-hook assembly can be attached to snap-on angle or straight brackets riveted to beam clamps, flange clips, angle brackets, etc.

C. Factory assembled multi-tier J-hook assemblies: The assemblies shall be used where separate cabling compartments are required. These assemblies are assembled by the factory. Multi-tier assemblies are available for specific applications including wall mount, ceiling mount, threaded rod mount, and beam/flange mount. The beam/flange mount assembly shall include a beam clamp rated to hold the weight of any of the multi-tier configurations. Assemblies shall be available in 1, 2, 3, & 4 tier double-sided and 2, 3, & 4 tier in single-sided configurations. The assembly shall be rated for indoor use in non-corrosive environments.

D. J-hook assemblies shall be furnished with appropriate fittings and add-on devices to allow for supports in multiple applications. Support fittings and add-on devices include beam or flange fasteners, threaded rod fasteners, support wire fasteners, construction channel support fasteners, wall or concrete or joist fasteners, raised access floor pedestal supports, etc.

E. Finishes: ASTM B633 Standard Specification for Electro-Deposited Coatings of Zinc on Iron and Steel, or ASTM A924/A924M Standard Specification for General Requirements for Steel Sheet, Metallic Coated by the Hot Dip Process

F. Material: Base material of the J-hooks shall be metal (at least a 0.052" thickness). Any fasteners used to affix the J-hooks shall also be metal and shall be fastened to the metal of the J-hook support.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Contractor shall thoroughly examine Project site conditions for acceptance of pathway installation to verify conformance with Manufacturer and Specification tolerances. Do not commence with installation until all conditions are made satisfactory.

3.2 CONDUIT APPLICATION

- A. Electrical metallic tubing (EMT): Shall be used exposed or concealed for interior electronic safety and security conduits 4" and smaller, where run above suspended ceilings, in concrete slabs and walls not in contact with earth; in stud walls, furred spaces and crawl spaces. EMT shall not be installed exposed below 6 feet above the finish floor except within equipment rooms or closets.
- B. Rigid non-metallic conduit (PVC): Shall be used in the following applications:
 - 1. Direct burial ducts: Schedule 40 minimum 24-inches below finished grade.
 - 2. Concrete encased ducts: Type EB or DB, minimum 30 inches below finished grade.
 - 3. Below building slab-on-grade: Schedule 40, minimum 4-inches below bottom of slab except that bends and penetrates through floor slab shall be insulated galvanized rigid steel conduit.
 - 4. Below roads and paved surfaces:
 - a. Schedule 80, minimum 36-inches below finished grade.
 - b. Concrete encased type EB or DB, minimum 30 inches below finished grade.
 - 5. Penetrations of building and equipment slabs: Schedule 80 conduit.
 - 6. Slope duct to drain towards vaults and away from building and equipment entrances. Pitch not less than 4-inches per 100-feet.
 - 7. Curved sections in duct lines shall consist of long sweep bends with a minimum radius of 25-feet in the horizontal and vertical directions. The use of manufactured bends is limited to building entrances and equipment stub-ups.
 - 8. For electronic safety and security conduits, do not exceed a combined bend radius of greater than 270 degrees between pull points.
 - 9. Underground conduit stub-ups to inside of building and exterior equipment shall be Schedule 80 conduit.
 - 10. Make joints in ducts and fittings watertight according to Manufacturer's instructions. Stagger couplings so those of adjacent ducts do not lie in the same plane.
 - 11. Terminate duct lines at vaults with end bells spaced 10-inches on center for 5-inch ducts and varied proportionately for other duct sizes. Change from regular spacing to end-bell spacing 10-feet from the end bell without reducing duct line slope and without forming trap in the line. Grout end bells into manhole walls from both sides to provide watertight entrance.
 - 12. Separation between direct buried duct lines shall be 3-inches minimum for like systems and 12-inches minimum between power and communication ducts.
 - 13. Concrete encased ducts:

- a. Duct lines shall consist of single or multiple duct assemblies encased in concrete. Ducts material throughout the installation.
 - b. Rigid PVC spacers shall securely support and maintain uniform spacing of the duct assembly a minimum of 3-inches above bottom of trench during the concrete pour. Spacer spacing shall not exceed 5-feet.
 - c. Provide non-ferrous tie wires to prevent displacement of the ducts during pouring of concrete.
 - d. Separate ducts 3-inches for like systems and 6-inches between power and signal ducts.
14. For direct burial installations install continuous warning strip of heavy gage plastic imprinted "low-voltage ducts below", approximately 12-inch wide at 12-inches above ducts.
15. Mandrel all ducts upon completion of installation and prior to pulling cables.

3.3 PREPARATION

A. Conduit:

1. Locations of conduit runs shall be planned in advance of the installation and coordinated with ductwork, plumbing, ceiling and wall construction in the same areas and shall not unnecessarily cross other conduits or pipe, nor prevent removal of ceiling tiles or panels, nor block access to mechanical or electrical equipment.
2. Where practical, install conduits in groups in parallel vertical or horizontal runs and at elevations that avoid unnecessary offsets.
3. All conduits shall be run parallel or at right angles to the centerlines of columns and beams, whether routed exposed, concealed above suspended ceiling or in concrete slabs.
4. Electronic safety and security conduits shall not be placed closer than 12-inches to power, a flue, parallel hot water, steam line or other heat producing source or three inches from such lines when crossing perpendicular to the runs.
5. Exposed conduit installation shall not encroach into the ceiling height headroom of walkways or doorways. Where possible, install horizontal raceway runs above water and below steam piping.
6. The largest trade size conduits in concrete floor and wall slabs shall not exceed 1/3 the floor or wall thickness and conduits shall be spaced a minimum of three conduit diameters apart unless otherwise noted on the Drawings. All conduits shall be installed in the center of concrete slabs or wall and shall not be placed between reinforcing steel and the bottom of floor slabs.
7. In long runs of conduit, provide sufficient pull boxes inside buildings to facilitate pulling wires and cables, with spacing not to exceed 150-feet. Support pull boxes from structure independent of conduit supports. These pull boxes are not indicated on the Drawings.
8. Electronic safety and security conduit bends shall not exceed 270-degrees within any single run of conduit.
9. Provide all reasonably inferred standard conduits fitting and products required to complete conduit installation to meet the intended application whether noted, indicated, or specified in the Contract Documents or not.

B. Boxes:

1. Install all outlet boxes flush with building walls, ceilings, and floors.
2. Locate pullboxes and junction boxes in concealed locations above removable ceilings or exposed in electrical rooms, utility rooms or storage areas.
3. Install outlet boxes at the locations and elevations indicated on the Drawings or specified herein. Adjust locations as required by structural conditions and to suit coordination requirements of other trades.
4. Do not install outlet boxes back-to-back, separate boxes by at least 6". In fire-rated walls separate boxes by at least 24" and wall stud.
5. Adjust position of outlet boxes in finished masonry walls to suit masonry course lines. Coordinate cutting of masonry walls to achieve neat openings for boxes.

C. J-hooks:

1. Location of J-hooks shall be planned in advance of the installation and coordinated with ductwork, plumbing, ceiling and wall construction in the same areas and shall not unnecessarily cross other conduits or pipe, nor prevent removal of ceiling tiles or panels, nor block access to mechanical or electrical equipment.
2. J-hooks shall not be placed closer than 12-inches to a flue, parallel hot water, steam line or other heat producing source or three inches from such lines when crossing perpendicular to the runs.
3. J-hooks shall not be placed closer than 3-inches to any branch circuit power raceway.

3.4 INSTALLATION

A. Conduit:

1. Install conduit in accordance with Manufacturer's written instructions, as indicated on Drawings and as specified herein.
2. Minimum electronic safety and security conduit size: Unless otherwise noted herein or on Drawings, minimum conduit size shall be 1" for interior applications and 2" for exterior and underground applications.
3. All electronic safety and security conduit sizes indicated on the Drawings are sized for 40-percent fill or less. If cable type or size is changed the Contractor shall be responsible for resizing conduits upward to meet a maximum 40-percent fill.
4. In general, all conduit work shall be concealed where possible. Exceptions shall be equipment rooms, exposed ceiling areas, and parking garages.
5. Install conduits in complete runs before pulling in cables or wires.
6. Install conduit free from dented, bruises or deformations. Remove and replace any damaged conduits with new undamaged material.
7. Conduits shall be well protected and tightly covered during construction using metallic bushings and bushing "pennies" to seal open ends.
8. Clean any conduit in which moisture or any foreign matter has collected before pulling in conductors. Paint all field-threaded joints to prevent corrosion.

9. In all empty conduits or ducts, install a "True Tape" conduit measuring tape line to provide overall conduit length for determining length of cables/conductors for future use.
10. Metallic conduit shall not be in contact with other dissimilar metal pipes (i.e. plumbing).
11. Make bends with standard conduit bending hand tool or machines. The use of any item not specifically designed for the bending of electrical conduit is strictly prohibited.
12. A run of electronic safety and security conduit between terminations at wire pulling points shall not contain more than the equivalent of three-quarter bends (270-degrees, total).

B. Fire-rated cable pathways:

1. Install cable pathways in accordance with Manufacturer's written instructions, as indicated on Drawings and as specified herein.
2. Install pathways using mounting plates and gasketing that comes with equipment for the application of each installation.
3. Where multi-gang pathway penetrations occur, use framing hardware brackets recommended by manufacturer for specific applications. Pathways shall be furnished with insert hooks and eye windows to connect units together and align them for multi-gang installations.

C. Boxes:

1. Install boxes in accordance with Manufacturer's written instructions, as indicated on Drawings and as specified herein.
2. Locate electrical boxes as indicated on Drawings.
3. Install junction or pullboxes where required to limit bends in conduit runs to not more than 270-degrees or where pulling tension achieved would exceed the maximum allowable for the cable to be installed. Note that these boxes are not indicated on the Drawings.
4. Install raised covers (plaster rings) on all outlet boxes in stud walls or in furred, suspended, or exposed concrete ceilings. Covers shall be of a depth to suit the wall or ceiling finish.
5. Leave no unused openings in any box. Install close-up plugs as required to seal openings.
6. Provide cast metal boxes with gasketed cast metal cover plates where boxes are exposed in damp or wet locations.
7. Welded outlet boxes shall only be used in concealed interior installations.
8. Provide an access panel in permanent ceiling or wall where boxes are installed and will be inaccessible.
9. For boxes mounted in exterior walls, make sure that there is insulation behind outlet boxes to prevent condensation in boxes.
10. For outlets mounted above counters, benches or backsplashes, coordinate location and mounting heights with built-in units. Adjust mounting height to agree with required location for equipment served.

D. Vaults:

1. Install precast assembly in accordance with Manufacturer's written instructions, as indicated on Drawings and as specified herein.
2. Install cast iron frame and cover. Set frames in paved areas and traffic ways flush with finished grade. Set other frames 1-inch above finished grade.
3. Units shall be installed on a level 12-inch bed of well-tamped gravel or crushed stone.
4. Install drains in bottom of units where indicated.
5. Install removable hardware, including pulling eyes, cable stanchions, cable arms and insulators, as required for installation and support of cable and conductors and as indicated.
6. Do not drill deeper than 3-7/8" for anchor bolts installed in the field. Use a minimum of 2 anchors for each cable stanchion.

E. J-hooks:

1. Install J-hooks in accordance with Manufacturer's written instructions, as indicated on Drawings and as specified herein.
2. Support J-hooks every 48-inches or less throughout the cable pathway.
3. J-hook support shall consist of 1/4" to 3/8" threaded rods supported from structure above, to structural wall studs with #10 wood or Tek screws or to #12 ceiling wire (independent of ceiling support) to structure.

3.5 PENETRATIONS

A. Conduit:

1. Locate penetrations and holes in advance where they are proposed in the structural sections such as footings, beams, wall, etc. Penetrations are acceptable only when the following occurs:
 - a. Where indicated on the Structural Drawings.
 - b. As approved by the Structural Engineer prior to construction and after submittal of Drawing showing location, size, and position of each penetration.
2. Cutting or holes:
 - a. Cut holes through concrete, masonry block or brick floors and floors of structure with a diamond core drill or concrete saw. Pneumatic hammer, impact electric, hand or manual hammer type drills are not allowed, except where permitted by the Structural Engineer as required by limited working space. Obtain the approval of the Structural Engineer prior to drilling through structural sections.
 - b. Provide sleeves or "can outs" for cast-in-place concrete floors and walls. Following conduit installation, seal all penetrations using non-iron bearing, chloride free, non-shrinking, dry-pack grouting compounds; or fire rated penetration-sealing materials.
 - c. Cut holes for conduit penetrations through non-concrete and non-masonry walls, partitions, or floors with a hole saw. The hole shall be only as large as required to accommodate the size of the conduit.
 - d. Provide single piece escutcheon plates around all exposed conduit penetrations in public places.

3. Sealing:

- a. Non-rated penetrations: Pack opening around conduits with non-flammable insulating material and seal with gypsum wallboard taping compound.
 - b. Firestop: Where conduits and other electronic safety and security raceways pass through fire-rated partitions, walls, smoke partitions or floor; install a UL classified fire-stop material to provide an effective barrier against the spread of fire, smoke, and gases. Completely fill and seal clearances between raceways and openings with the fire-stop material.
4. Waterproofing: At floor, exterior wall, and roof conduit penetrations, completely seal clearances around the conduit and make watertight as specified in Division 07: Sealants and Caulking.
- a. Install specified watertight conduit entrance seals at all below grade wall and floor penetrations. Conduits penetrating exterior building walls and building floor slab shall be Schedule 80 PVC conduit.
 - b. For roof penetrations furnish and install roof flashing, counter flashing and pitch-pockets as specified under Roofing and Sheet Metal Sections of the Specifications.
 - c. Provide membrane clamps and cable sealing fittings for any conduit that horizontally penetrates the waterproof membrane.
 - d. Conduits that horizontally penetrate a waterproof membrane shall fall away from and below the penetration on the exterior side a minimum of two times the conduit diameters.

3.6 CONDUIT CONCEALED IN CONCRETE

- A. Install conduits approximately in the center of the slab so that there will be a minimum of 1-inch of concrete around the conduits.
- B. Installation of conduit in structural concrete that is less than three inches thick is prohibited. Topping slabs, maintenance pads and curbs are exempted.
- C. Tie conduits to reinforcing rods or otherwise secure them to prevent sagging or shifting during concrete placement. Run conduit larger than 1-inch trade size, parallel with or at right angles to the main reinforcement; where at right angles to the reinforcement, the conduit shall be close to one of the supports of the slab.
- D. Where nonmetallic conduit or tubing is used, raceways must be converted to EMT conduit before rising above floor.
- E. Make couplings and connections watertight.
- F. Protect stub-ups from damage where conduits rise from floor slabs. Arrange so curved portion of bends is not visible above the finished slab.

3.7 UNDERGROUND CONDUIT INSTALLATION

- A. Perform trenching, backfilling and compaction operations as specified in Division 31: Trenching.
- B. Tops of conduits shall be as follows unless otherwise noted:
- C. Not less than 18-inches below finished grade.

- D. Not less than 30-inches below roadways, paved parking lots, driveways or any surface subject to vehicular traffic.
- E. Not less than 4-inches below building floor slab for branch circuits. Major feeders and large signal conduits (2" and greater) at not less than 18-inches.
- F. Furnish and install specified underground conduit marker 12" above conduits in trenches with all buried conduits.

3.8 CONDUIT TERMINATIONS AND JOINTS

- A. Use raceway fittings that are of types compatible with the associated raceway and suitable for the use and location.
- B. Raceways shall be joined using specified couplings or transition couplings where dissimilar raceway systems are joined.
- C. Stub-up connections: Extend conduits through concrete minimum of 3" and terminate with insulated bushing.
- D. Install specified cable sealing bushings on all conduits originating outside the building walls and terminating inside the building. Install cable sealing bushings or raceway seal for conduit terminations in all grade level or below grade exterior pull, junction, or outlet boxes.
- E. Install expansion couplings where any conduit crosses a building separation or expansion joint as follows:
 - 1. Conduits three inches and larger, shall be rigidly secured to the building structure on opposite sides of a building expansion joint and provided with expansion or deflection couplings. Install the couplings in accordance with the Manufacturer's recommendations.
 - 2. Conduits smaller than three inches shall be rigidly secured to the building structure on opposite sides of a building expansion joint with junction boxes on both sides of the joint. Connect conduits to junction boxes with 15-inches of slack flexible conduit. Flexible conduit shall have a green copper ground-bonding jumper installed. For concrete embedded conduit, use expansion and deflection couplings as specified above for three inches and larger conduits.

3.9 SUPPORTS

- A. Conduit:
 - 1. Provide supports for raceways as specified in Section 280529: Electronic Safety & Security Hangers and Supports.
 - 2. All raceways systems shall be secured to building structures using specified fasteners, clamps and hangers spaced according to the CEC.
 - 3. Support single runs of conduit using one-hole pipe straps. Where run horizontally on walls in damp or wet locations, install "clamp backs" to space conduit off the surface.
 - 4. Multiple conduit runs shall be supported using "trapeze" hangers fabricated from specified construction channel, mounted to 3/8-inch diameter, threaded steel rods secured to building structures. Fasten conduit to construction channel with

standard one-hole pipe clamps or the equivalent. Provide lateral seismic bracing for hangers.

5. Fasteners and supports in solid masonry and concrete:
 - a. Use steel or malleable iron concrete inserts set in place prior to placing the concrete.
 - b. After concrete installation:
 - 1) Steel expansion anchors not less than ¼ inch bolt size and not less than 1-1/8" embedment.
 - 2) Power set fasteners not less than ¼-inch diameter with depth of penetration not less than 3-inches.
 - 3) Use vibration and shock resistant anchors and fasteners for attaching to concrete ceilings.
 6. Hollow masonry: Toggle bolts are permitted. Bolts supported only by masonry block are not acceptable.
 7. Metal structures: Use machine screw fasteners or other devices specifically designed and approved for the application.
- B. Boxes:
1. Provide boxes installed in metal stud walls with brackets designed for attaching directly to the studs or mount boxes on specified box supports.
 2. Mount boxes, installed in suspended ceilings of gypsum board or lath and plaster construction, to 16-gauge metal channel bars attached to main ceiling runners.
 3. Support boxes independently of conduit system.
 4. Support boxes, installed in suspended ceilings supporting acoustical tiles or panels, directly from the structure above wherever pendant mounted luminaires are to be installed from the box.
 5. Support boxes mounted above suspended acoustical tile ceilings, directly from the structure above.

3.10 CLEANING

- A. Upon completion of Project prior to final acceptance the Contractor shall thoroughly clean all equipment per Manufacturers approved methods and materials. Remove paint splatters and other spots, dirt, and debris.
- B. Touch-up paint any marks, blemishes or other finish damage suffered during installation.

END OF SECTION

SECTION 28 05 29

ELECTRONIC SAFETY & SECURITY HANGERS & SUPPORTS

PART 1 - GENERAL

1.1 SUMMARY

- A. Work included: Labor, materials, and equipment necessary to complete the installation required for the item specified under this Division, including but not limited to:
 - 1. Conduit supports.
 - 2. Equipment supports.
 - 3. Fastening hardware.
- B. Related Work: Consult all other Sections, determine the extent and character of related Work, and properly coordinate Work specified herein with that specified elsewhere to produce a complete installation.
 - 1. Division 05: Miscellaneous metals. Hangers for electronic safety and security equipment.
 - 2. Division 09: Ceiling suspension systems. Slack support wires.

1.2 REFERENCES

- A. Comply with the latest edition of the following applicable Specifications and standards except as otherwise indicated or specified:
 - 1. Underwriters Laboratories, Inc. (UL):
 - UL 2239; Hardware for the Supports of Conduit, Tubing and Cable.

1.3 SYSTEM DESCRIPTION

- A. Provide devices specified in this Section and related Sections for support of electronic safety and security equipment furnished and installed under Division 28.
- B. Provide support systems that are adequate for the weight of equipment, conduit and wiring to be supported.

1.4 SUBMITTALS

- A. Submit in accordance with the requirements of Section 280010: Basic Electronic Safety & Security Requirements, the following items:
 - 1. Data/catalog cuts for each product and component specified herein.
 - 2. Clearly mark on each data sheet the specific item(s) being submitted and the proposed application.
 - 3. Submit Manufacturer's installation instructions.

1.5 QUALITY ASSURANCE

- A. All materials, equipment and parts comprising the units specified herein shall be new, unused, and currently under production.

- B. Only products and applications listed in this Section may be used on the Project unless otherwise submitted.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Products furnished by the following Manufacturers shall be acceptable if in compliance with all features specified herein and indicated on the Drawings.
 - 1. Concrete fasteners:
 - a. Phillips "Red-Head".
 - b. Remington.
 - c. Ramset.
 - 2. Concrete inserts and construction channel:
 - a. Unistrut Corp.
 - b. GS Metals "Globe Strut."
 - c. Thomas & Betts "Kindorf" Corp.
 - 3. Conduit straps:
 - a. O-Z/Gedney.
 - b. Erico "Caddy" Fastening Products.
 - c. Thomas & Betts "Kindorf" Corp.
- B. Substitutions: Under provisions of Section 280010: Basic Electronic Safety & Security Requirements.

2.2 CONCRETE FASTENERS

- A. Provide expansion-shield type concrete anchors.
- B. Provide powder driven concrete fasteners with washers. Obtain approval by Architect and Structural Engineer prior to use.

2.3 CONCRETE INSERTS

- A. Provide pressed galvanized steel, concrete spot insert, with oval slot capable of accepting square or rectangular support nuts of 1/4" to 1/2" diameter thread for rod support.

2.4 THREADED ROD

- A. Provide steel threaded rod, sized for the load unless otherwise noted on the Drawings or in the Specifications.

2.5 CONSTRUCTION CHANNEL

- A. Provide 1.5-inch by 1.5-inch (nominal), 12-gauge galvanized steel channel with 17/32-inch diameter bolt holes and 1.5-inch on center in the base of the channel.

2.6 CONDUIT STRAPS

- A. One-hole strap, steel, or malleable iron, with malleable iron clamp-back spacer for surface mounted wall and ceiling applications.
 - 1. Use malleable strap with spacers for exterior and wet locations.
 - 2. Use steel strap without spacers for interior locations.
- B. Steel channel conduit strap for support from construction channel.
- C. Steel conduit hanger for pendant support with threaded rod
- D. Steel wire conduit support strap for support from independent #12-gauge hanger wires.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Contractor shall thoroughly examine Project site conditions for acceptance of supporting device installation to verify conformance with Manufacturer and Specification tolerances. Do not commence with installation until all conditions are made satisfactory.

3.2 PREPARATION

- A. Coordinate size, shape, and location of concrete pads with Division 03, Cast-in-place concrete.
- B. Layout support devices to maintain headroom, neat mechanical appearance and to support the equipment loads.

3.3 INSTALLATION

- A. Furnish and install supporting devices as noted throughout Division 28.
- B. Electronic safety and security devices and conduit support shall be independent of all other system supports that are not structural elements of the building, unless otherwise noted.
- C. Fasten hanger rods, conduit clamps, outlets, and junction boxes to building structure using precast inserts, expansion anchors, preset inserts, or beam clamps.
- D. Use toggle bolts or hollow wall fasteners in hollow masonry, plaster or gypsum board partitions and walls.
- E. Use expansion anchors or preset inserts in solid masonry walls.
- F. Use self-drilling anchors, expansion anchor or preset inserts on concrete surfaces.
- G. Use sheet metal screws in sheet metal studs and wood screws in wood construction.
- H. Do not fasten supports to piping, ductwork, mechanical equipment, conduit, or acoustical ceiling suspension wires.
- I. Do not drill structural steel members unless first approved in writing by the Architect or Structural Engineer.

- J. Fabricate supports from structural steel or steel channel, rigidly welded, or bolted to present a neat appearance. Use hexagon head bolts with spring lock washers under all nuts.
- K. Install surface-mounted cabinets with minimum of four anchors. Provide additional support backing in stud walls prior to sheet rocking as required to adequately support cabinets and panels.
- L. Bridge studs top and bottom with channels to support flush mounted cabinets in stud walls.

3.4 ERECTION OF METAL SUPPORTS

- A. Cut, fit, and place miscellaneous metal fabrications accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
- B. Field Welding: Comply with AWS "Structural Welding Code."

3.5 WOOD SUPPORTS

- A. Cut, fit, and place wood nailers, blocking and anchorage accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

3.6 ANCHORAGE

- A. All floor mounted, free standing electronic safety and security equipment such as racks and cabinets etc., shall be securely fastened to the floor structure.
- B. Anchorage of electronic safety and security equipment shall comply with the seismic requirements as outlined in Section 280010: Basic Electronic Safety & Security Requirements.

END OF SECTION

SECTION 281300

SECURITY ACCESS CONTROL SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

- A. Work included: Labor, materials, and equipment necessary to complete the installation required for the item specified under this Division, including but not limited to:
 - 1. Access control system server hardware
 - 2. Access control system server software.
 - 3. Intelligent controller.
 - 4. Two door controller modules.
 - 5. In/out modules.
 - 6. Proximity card readers.
 - 7. Door monitoring switches.
 - 8. Access control cards.
 - 9. Request to exit modules.
 - 10. Power supplies and accessories.
- B. Related Work: Consult all other Sections, determine the extent and character of related Work and properly coordinate Work specified herein with that specified elsewhere to produce a complete installation.
 - 1. Division 08: Door Hardware
 - 2. Division 26: Electrical

1.2 REFERENCES

- A. Comply with the latest edition of the following applicable Specifications and standards except as otherwise indicated or specified:
 - 1. Underwriters Laboratories, Inc. (UL):
 - UL 13; Power-Limited Circuit Cables.
 - UL 294; Access Control System Units.
 - UL 603; Power Supplies for Use with Burglar-Alarm Systems.
 - UL 639; Intrusion-Detection Units.
 - UL 1076: Proprietary Burglar Alarm Units and Systems.
 - 2. Electronics Industries Alliance (EIA):
 - EIA: Testing standards.

1.3 SYSTEM DESCRIPTION

- A. General requirements:
 - 1. Provide a complete access control system

2. The system shall be comprised of all necessary supervision, processing, display, and printout circuitry and/or devices. It shall also have redundant circuitry to ensure that no single independent failure of any component or component group shall cause consequential failure of the system.
 3. The system shall include door readers, door monitoring contacts, input/output modules, ethernet interface modules, door controller modules, system software, power supplies, batteries, proximity cards, ID Card encoder software and printer, and other any other devices required for a fully operational system.
- B. Overview:
1. A centralized computer shall monitor door readers, door monitoring contacts, and other security devices located as shown on the Drawings. The system shall be expandable and have a minimum capacity of 3,500 active cards.
 2. Contractor shall program the system to permit card holders access to entry doors as authorized by location, time zone, and other parameters as determined by Owner.
 3. The access control system shall control electric door locks, strikes, and other devices as shown on the Drawings.
 4. All system activity shall be displayed on a video control terminal located as determined by the Owner, as well as logged on the computer hard-disk drive. Specific events shall also be recorded on the system printer, if determined by the Owner.
 5. The video terminal shall display a custom English-Language description of the location and type of device reporting activity, as well as the date and time. Routine (authorized) access entries shall be logged on the disk-drive, but not displayed on the terminal.
 6. It shall be possible to manually lock or unlock any door electric locking devices connected to the access control system by means of keyboard commands.
 7. Display alarm signals and provide control interface to custom monitoring stations, as specified and shown on the Drawings. Provide inputs and outputs to the control panel and to field devices.

1.4 SUBMITTALS

- A. Submit in accordance with the requirements of Section 280010: Basic Electronic Safety & Security Requirements, the following items:
1. Data/catalog cuts for each product and component specified herein, listing all physical and electrical characteristics and ratings indicating compliance with all listed standards.
 2. Describe system operation, equipment and dimensions and indicate features of each component.
 3. Clearly mark on each data sheet the specific item(s) being submitted and the proposed application.
 - a. Plot plans and building floor plans, showing location of and conduit routing to all devices.
 - b. Point-to-point wiring diagram in block or riser formats showing all components, conduit and wire types and sizes with cable legend.

- c. Include elevations of control panel and remote terminal cabinet(s).
4. Furnish structural calculations for equipment anchorage as described in Section 280010: Basic Electronic Safety & Security Requirements.
5. Submit Manufacturer's installation instructions.
6. Complete bill of materials listing all components.
7. Warranty.

1.5 OPERATION AND MAINTENANCE MANUAL

- A. Supply operation and maintenance manuals in accordance with the requirements of Section 280010: Basic Electronic Safety & Security Requirements, to include the following:
 1. A detailed explanation of the operation of the system.
 2. Instructions for routine maintenance.
 3. Pictorial parts list and part numbers.
 4. Schematic Drawings of wiring system, including all devices, control panel, terminal cabinets, etc.
 5. Telephone numbers for the authorized parts and service distributors.
 6. Final testing reports.

1.6 QUALITY ASSURANCE

- A. All materials, equipment and parts comprising the units specified herein shall be new, unused, and currently under production.
- B. Only products and applications listed in this Section may be used on the Project unless otherwise submitted.

1.7 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Delivery: Security monitoring and control system components shall not be delivered to the Project site until protected storage space is available. Storage outdoors covered by rainproof material is not acceptable. Equipment damaged during shipment shall be replaced and returned to Manufacturer at no cost to Owner.
- B. Storage: Store in a clean, dry, ventilated space free from temperature extremes. Maintain factory wrapping or provide a heavy canvas/plastic cover to protect units from dirt, water, construction debris and traffic. Provide heat where required to prevent condensation.
- C. Handling: Handle in accordance with Manufacturer's written instructions. Be careful to prevent internal component damage, breakage, denting and scoring. Damaged units shall not be installed. Replace damaged units and return equipment to Manufacturer.

1.8 WARRANTY

- A. Units and components offered under this Section shall be covered by a 3-year parts and labor warranty for malfunctions resulting from defects in materials and workmanship. Warranty shall begin upon acceptance by the Owner.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Products furnished by the following Manufacturers shall be acceptable if in compliance with all features specified herein and indicated on the Drawings.
1. Access control system (ACS):
 - a. Manufacturer shall be Hirsch Secure Systems by Identiv
 2. ACS server
 - a. Hirsch Velocity Cirrus
 - 1) Cloud-Based ACaaS Solution
 - 2) VEC-8DR (Velocity Cirrus ACaaS 8-Door License)
 3. Licensing:
 - a. Base License (Doors 1-2)
 - 1) VEC-BASE-1-2dr-MTH
 - 2) QTY: 24
 - 3) This will license doors 1&2 for a period of 12 months
 - b. Door License (Doors 3-12)
 - 1) VEC-3-12DR-MTH
 - 2) QTY : 72
 - 3) This will license doors 3-8 for a period of 12 months
 4. **The 8 door controller will require license of unused door ports.Door Controllers:
 - a. MX-8 (8-door controller by Hirsch)
 - 1) Description: Access control hardware controller provides power and control for standalone doors.
 - 2) Technical Specifications
 - a) Power Supply:
 - (1) 110-240 VAC, 50/60, fused
 - b) Standby Batteries
 - (1) 7.2, 8 or 9 Ah
 - b. Inputs:
 - 1) 8 door relays
 - 2) 8 alarm inputs (requires line modules)
 5. Proximity card readers:
 - a. Manufacturer shall be Identiv's uTrust TS Reader Family
 - 1) TS Migration Keypad (dual frequency keypad readers)
 - 2) model number #8210ABP0000
 - 3) Mounting: keypad
 - b. Wiring output
 - 1) Wiegand or RS-485 (2-wire)

- a) 1x 12VDC @ 110mA/ RS-485 ports 1x 12VDC @ 115mA @ 110mA
1x wiegand ports
- 2) Cable Distance: Wiegand 152m/500ft (22 AWG wire), RS-485
1200m/4000ft (24 AWG shielded twisted pair)
- 3) Door position contact switches:
 - a) Doors:
 - (1) Honeywell #947-45.
 - (2) Magnasphere #HSS-L2C.
 - (3) SECO #SM-4105.
 - (4) Sentrol #1076D.
 - (5) Or approved equal
- 6. Access control cards:
 - 1) HID Seos/ iCLASS/Prox 520X smart cards.
 - 2) Or approved equal
- 7. Request to exit modules
 - a. Bosch #DS160 with TP160 trim.
 - b. Or approved equal
- 8. Power supplies and battery chargers:
 - a. LifeSafety Power part number: FPO150/250-C8PD8PE2
- B. Substitutions: Under provisions of Section 280010: Basic Electronic Safety & Security Requirements.

2.2 ACCESS CONTROL SYSTEM (ACS) SERVER OVERVIEW

- A. System description:
 - 1. The ACS server shall be IT standards compliant and fully featured solution.
 - 2. The ACS shall be available in hardware and software bundled as a true network, so that all applications are pre-installed, enabling the system to run almost immediately with minimal configuration required.
 - 3. The ACS server shall be built on a hardened Linux network using LDAP compliant directory structure.
 - 4. The ACS shall support updates for:
 - a. Software maintenance of operating system service packs.
 - b. License seats.
 - c. Virus control.
 - 5. The ACS server shall utilize industry standard TCP/IP network infrastructures to communicate including, but not limited to:
 - a. All ACS field devices.
 - b. Intelligent field hardware controllers.
 - c. Browser based workstation.

6. The ACS server shall be comprised of industry standard pre-installed components including:
 - a. An embedded Linux operating system utilizing an open source kernel.
 - b. An open LDAP directory structure for identifying data storage.
 - c. A NGINX web server.
 - d. ACS software.
7. All setup, maintenance, and interaction with the system shall be accomplished with no interaction with the operating system or directory structure.
8. The ACS server shall act as the central repository for all system configuration and activity.
 - a. Interfacing with the ACS server shall be via a web browser only.
 - b. A separate database server with a unique operating system or a database server shall not be acceptable.
9. The ACS server shall provide browser-based accessibility to all applications, without the mandated requirement of a dedicated client workstation. The following industry standard web browsers shall be supported:
 - a. Mozilla Firefox.
 - b. Google Chrome.
 - c. Apple Safari.
 - d. Microsoft Edge.
10. The ACS server shall support industry standard field hardware platforms, including but not limited to:
 - a. Mercury Security's access control product line.
 - b. HID control product line.
 - c. Wired Locks.
11. The ACS server shall be hardened to safely secure all communications and data.
 - a. Data communicated over the network to and from the ACS server, and the web browser workstations, shall be secured via SSL 128-bit encryption.
 - b. ACS server backups shall be encrypted using AES encryption.
 - c. ACS server shall back up to:
 - 1) USB storage device.
 - 2) Windows shared directory or network shared folder.
 - 3) Secured SCP servers.
 - d. All passwords required to log in to the ACS server shall be encrypted within the open LDAP directory structure.
12. The ACS server architecture shall enable distributed decision-making at the intelligent field hardware controllers.
 - a. The ACS server architecture shall enable complete functionality during periods where communication is lost between an servers and its associated intelligent field hardware controllers.

- b. During downtime, the intelligent field hardware controllers shall maintain an audit log of all activity that occurred and shall upload this data to the ACS server once normal communications are restored.
- 13. The ACS server architecture shall provide scalability to support the addition of:
 - a. Card readers and/or input/output points.
 - b. Additional ACS controllers.
 - c. Intelligent field hardware controllers.
- 14. When multiple ACS servers are deployed, the ACS shall support automated grid-based replication of the ACS directory. The replication architecture shall:
 - a. Be peer-to-peer.
 - b. Not require a dedicated central database server.
 - c. Enable replication of identities and configuration across ACS servers.
- 15. The ACS shall support a hot standby, auto-failover architecture. Should a primary ACS server fail to function, a second ACS server, assigned to act as the backup to the primary, shall automatically detect a problem and assume system control.
- 16. The ACS shall support integration with 3rd party subsystems through use of its collaboration interface. These systems shall include, but not be limited to:
 - a. Integrated access management (IAM) systems.
 - b. Security information and event management (SIEM) systems.
 - c. 3rd party IT and business systems, including but not limited to:
 - 1) Systems that utilize Oracle RDBMS as their data engine.
 - 2) Systems that utilize Microsoft SQL Server as their data engine.
 - d. The ACS shall be able to pull information into its directory structure and push events out to third-party systems.
- 17. The ACS shall provide single software-based license key that resides on each ACS server to control licensed features and/or components.
 - a. Software licenses shall be upgradable and/or amendable via email or download from manufacturer secured web site.
 - b. The ACS server shall support a minimum of 50 concurrent client connections. Individual license keys for traditional client workstations and/or physical hardware license keys shall not be acceptable.
- 18. The ACS server shall support seamless, forward compatible upgrades of the ACS application software.
 - a. All systems of the same generation shall be upward compatible.
 - b. Access control field hardware devices shall not have to be replaced as the system grows to larger levels.

2.3 ACCESS CONTROL SYSTEM (ACS) SERVER HARDWARE

A. ACS server:

- 1. The hardware platform shall consist of a 1U, short depth, rack-mount unit meeting the following minimum specifications:

- a. CPU: Intel Quad Core 3.1 GHz 8M Cache
- b. Memory: 4GB, 1600Mhz
- c. Network interface: Minimum of 2 x 1GbE per port
- d. OS compatibility: Linux Hardened Virtual Server
- e. 1TB: 7200 RPM disc for OS/server and storage
- 2. ACS server capacities:
 - a. Doors: 2048.
 - b. Alarm input points: 5,060.
 - c. Relay output points: 5060.
 - d. Card holder identities: 500,000.
 - e. Concurrent WEB client connections: 50.
 - f. On-line event history log: 150,000,000.
- 3. Rack drawer:
 - a. The rack drawer shall be an integrated system including keyboard, mouse, monitor, 1x switch, and connecting cords, all in a 1U slide-out drawer package.
 - b. Keyboard: 104-key with separate numeric keypad.
 - c. Mouse: 2-button Trackball mouse.
 - d. Monitor: 19" TFT/LCD high resolution (1280 x 1024, minimum) monitor, VGA or DVI.
 - e. Integrated DVI/USB/audio 1x8 switch.

2.4 ACCESS CONTROL SYSTEM (ACS) SERVER SOFTWARE

A. Alarm monitoring functionality:

- 1. Alarm and event attributes shall allow administrators to configure how each alarm and event is communicated in the alarm monitors:
 - a. The event listing window shall list all alarms and events with their associated event type and the source object that is responsible for generating the alarm or event.
 - b. Upon logging in and accessing the alarm monitor, all queued alarms and events shall report into the alarm monitor for operator action.
- 2. For each alarm and event in the system, administrators shall have the option to:
 - a. Rename the alarm or event from its factory default.
 - b. Rename, where applicable, the return to normal state name for the alarm or event.
 - c. Assign an event type that shall set the default configuration for the alarm or event.
 - d. Display the alarm or event in the alarm monitor.
 - e. Mask the alarm or event from displaying in the alarm monitor.

- f. Display text instructions that shall guide the operator in responding to the alarm.
 - g. Automatically send an email message to a recipient.
 - h. Have the alarm display in priority order based on the priority of the alarm. A minimum of 99 priorities shall be supported.
 - i. Set the priority of the alarm or event, as well as its associated return to normal event priority.
 - j. For video related alarms or events, automatically launch the video player to display a live video feed from the camera associated with the device that generated the alarm or event.
 - k. Store the alarm or event information for later retrieval.
 - l. Create distinct schedules that shall be able to be assigned to different alarm types.
 - m. Create a schedule to enable/disable global events, which should include, but not be limited to:
 - 1) Shunt/un-shunt doors.
 - 2) Mass denial of credentials (lock down).
3. Alarm and event logging: All alarms and events in the ACS shall log by default to the ACS server internal data storage logging structure.
4. Off-line alarm/event shall queue alarms and events that occur:
 - a. While the alarm monitor is off-line with the rest of the system.
 - b. When an operator is not logged in to the alarm monitor.
5. Alarm and event types shall support creation of alarm and event types:
 - a. Alarm and event templates shall be created as part of the installation.
 - b. Event types shall contain configuration of parameters including, but not limited to:
 - 1) Priority.
 - 2) Text instructions.
 - 3) Masking and masking schedule.
 - 4) Logging.
 - 5) Reporting.
 - 6) Email notifications.
 - c. Each alarm and event type shall be able to support multiple alarm and event assignments.
6. Alarm/event synchronization: The ACS shall support alarm synchronization for alarm and events that report into multiple alarm monitors. When an alarm or event is acknowledged or cleared by an alarm monitor operator, it shall be cleared from all other alarm monitors.
7. Alarm reporting based on schedule: The ACS shall support the reporting of alarms to alarm monitors based on schedules. Each alarm in the system shall have the ability to have its own associated schedule.

8. Alarm/event text instructions: The ACS shall allow each alarm and event in the system to have associated text instructions. Text instructions shall be able to contain a minimum of 200,000 characters.
- B. Access control functionality:
1. Access groups shall consist of card the following:
 - a. Access groups of any number of card readers in the system assigned to a single schedule.
 - b. Any card reader shall have the ability to belong to any access group and a card reader shall have the ability to belong to multiple access groups.
 - c. The ACS shall allow credential holder access to secure areas based on:
 - 1) Card reader.
 - 2) Time.
 - 3) Day.
 - d. The ACS shall support a minimum of:
 - 1) 255 access groups per intelligent controller
 - e. Access groups shall support conventional names up to 50 alphanumeric characters.
 2. The ACS shall support the creation of schedules:
 - a. Schedules shall serve as templates for application parameters including, but not limited to:
 - 1) Access groups.
 - 2) Masking devices.
 - 3) Device modes.
 - b. The ACS shall support a minimum of 255 schedules. Each schedule shall be set to one of 3 operating modes:
 - 1) On: The schedule is active 24-hours per day/7-days per week.
 - 2) Off: The schedule is never active.
 - 3) Scan: The schedule is active during the assigned intervals.
 - c. Each schedule shall have the ability to be assigned a predetermined interval:
 - 1) Each interval shall have the ability to be assigned to any day(s) of the week.
 - 2) Shall be assigned to function on up to 8 holiday types.
 - 3) Up to 10 intervals shall be supported.
 - d. Schedules shall be downloaded to all related intelligent controllers for local processing and decision making.
 - e. Schedules shall support conventional names up to 50 alphanumeric characters.
 3. Holidays shall allow specific dates and/or ranges to be defined as a holiday:
 - a. The ACS shall support a minimum of 255 holidays.

- b. A holiday shall have the ability to be assigned up to eight (8) different holiday types.
- c. The following parameters of the ACS can be temporarily altered, adjusted, or suspended, including, but not limited to:
 - 1) Card reader modes.
 - 2) An identity access rights.
 - 3) Masking schedules.
- d. The ACS shall support an embedded calendar to assist in configuration of holidays.
- e. Holidays shall support conventional names up to 50 alphanumeric characters.
- 4. Card reader shall allow the following options to be defined for card readers in the system:
 - a. Specify the card reader is an active card reader.
 - b. Specify the off-line mode operations should the card reader lose communications with the intelligent controller/intelligent field controller.
 - c. Specify door forced filter shall reduce false alarms for doors that "bounced." Opening the door within 3-seconds of the door closing shall not report a door forced open alarm.
 - d. Extended cardholder door held open time shall allow a card reader's door held-open time to be extended beyond the normal configured time:
 - 1) The extended door held open time shall be definable up to 6-seconds.
 - 2) ACS shall be able to define application of this functionality by:
 - a) Card reader.
 - b) Credential holder.
 - e. Duress access to a card reader shall support a duress mode for a credential holder's entry through a card reader:
 - 1) When a credential holder is gaining entry under duress, they shall append the number "5" to the end of their PIN code. A credential holder with PIN of 9999 would enter 99995 when entering an area under duress.
 - 2) Duress access shall be made for card readers in:
 - a) Card and PIN mode.
 - b) Card or PIN mode.
 - c) PIN mode only.
 - 3) Upon entrance to a card reader under duress, an alarm shall be sent to the alarm monitor and logged to the audit database.
 - 4) The ACS shall be capable of denying a credential holder access to the card reader during duress, even if that credential holder entered the proper duress code. An alarm shall generate at the Alarm Monitor noting duress access was requested and denied.
 - f. Specify strike node or strike operations allowing administrators to define, upon a valid access:

- 1) Door strike remains active for the entire strike time.
- 2) Door strike turns off after the door has closed.
- 3) Door strike deactivates as soon as the door is open.
- 4) Do not pulse door strike on rex as door strike disabled during a valid request to exit.
- 5) The ACS shall allow a card reader's strike to be extended beyond the normal strike time for specific individual credential holders:
 - a) The extended strike time shall be definable up to 255 seconds.
 - b) The extended strike time shall be definable by card reader.
 - c) The extended strike time shall be definable by credential holder.
- g. Log all access as used in instances where there is not a door contact at the door to monitor door position, the ACS shall assume entry and report an event into the alarm monitor.
- h. Do not log rex (request to exit) transactions to the directory structure.
- i. Two-card control shall require that two valid access requests occur prior to granting access to the door:
 - 1) Both requests must occur within a 10-second period.
 - 2) In the event a second valid access has not occurred within 10-seconds of the first valid access request, the card reader shall reset, and the first credential shall have to be presented again.
- j. Activate Schedule shall allow administrators to activate outputs attached to the card reader on a scheduled basis. Whether a card reader is part of an anti-passback area and if so, it is related configuration.
- k. Use shunt relay shall have the ability to shunt a door contact of separate intrusion detection systems:
 - 1) When the ACS provides an access grant, a dedicated auxiliary output shall first trigger and bypass the door contact of the separate intrusion detection system, and then the door locking mechanism shall unlock.
 - 2) Once the door returns to a secure state, the door contact of the separate intrusion detection system shall return to its normal state.
5. The ACS shall support a door held open pre-alarm capability. When a door has been held open for a pre-determined amount of time after a valid access grant, a local audible annunciation shall alert the credential holder to close the door. Failure to close the door between the pre-alarm annunciation and the configured door held open time shall generate an alarm at the alarm monitor. Pre-alarm parameters apply to:
 - a. Door held open time.
 - b. Pre-alarm time.
 - c. Shall be configurable up to 6-seconds.
 - d. Pre-alarm setting shall be distinct for each door.

6. The ACS shall support the ability for card reader modes to be overridden from the standard mode on a scheduled basis. Based on the card reader type, custom modes shall include:
 - a. Card only.
 - b. Card and PIN.
 - c. Card or PIN.
 - d. Locked.
 - e. Unlocked.
 - f. Facility code.
 - g. At the end of the scheduled override, the card reader shall return to its default standard mode.
7. The ACS shall support cipher mode, which shall emulate the presenting of a credential to a card reader with a keypad:
 - a. In cipher mode, an authorized credential holder shall attempt access by entering their credential ID/card format at the keypad:
 - 1) The card reader shall treat the information as a magnetic card format read.
 - 2) The number sequence must match an existing magnetic card format configured in the system, including facility code.
 - 3) Correct entry of code will allow access.
 - 4) Incorrect entry of code will be ignored and deny access to the card reader.
 - 5) Will not send a transaction to the alarm monitor.
 - b. A card reader in card and PIN mode and cipher mode shall also require that the credential holder's PIN be entered after the original sequence.
8. Changes in card reader mode shall not remove a card reader from cipher recent door transactions. The ACS shall provide a form listing the most recent transaction activity associated with a door, without having to run a report. Information provided shall include:
 - a. Transaction activity.
 - b. Time/date.
 - c. Identity.
 - d. Token related details.
9. The ACS shall support an invalid PIN attempts count on a per card reader basis. Invalid PIN attempts parameters shall include, but not be limited to:
 - a. Unknown PIN entry at a card reader configured as card or PIN mode
 - b. Invalid cipher entry at a card reader in cipher mode
 - c. Invalid PIN entered for a given card at a card reader configured as card and PIN mode.
 - d. The denied PIN attempts value shall be configurable from 0 to 255.

- e. The following events shall cause the counter to rest to zero:
 - 1) X (user defined) minutes pass without any of the above denial types.
 - 2) An access grant at the given card reader.
 - f. When the current deny count reaches the threshold configured for the card reader, a deny count exceeded transaction shall be reported:
 - 1) This transaction shall only be reported when the limit is initially reached.
 - 2) It shall not report on subsequent denials.
 - g. Define the number of invalid PIN attempts may be presented before generating an alarm to the alarm monitor.
10. The ACS shall support macro/trigger functionality when the deny count exceeded transaction occurs. Actions shall include, but not be limited to:
- a. Lock down the card reader.
 - b. Annunciating a local siren.
 - c. Shall be configured to execute for a given card reader.
 - d. Multiple complementary modes can be assigned per reader.
11. Buttons in the graphical user interface (GUI) shall be available to control the operational state of the door including:
- a. Disable.
 - b. Lock.
 - c. Unlock.
 - d. Grant.
 - e. Restore.
 - f. Mask held.
 - g. Unmask held.
 - h. Mask forced.
 - i. Unmask forced.
 - j. Mode.
12. The ACS shall support a door summary and status page that shall display a list of all doors defined in the system. For each door in the system, the door summary and status page shall display:
- a. Door name
 - b. Current door mode
13. Door status including forced and held states, masking states, as well as communications and tamper states.
14. Results displayed are capable of being filtered by door group or by other searchable criteria:
- a. Mask alarm filters shall filter alarms displayed on the workstation GUI.
 - b. Filter operator views to remove door forced open and door held open alarms to:

- 1) Mask permanently
 - 2) Mask during a schedule
- c. Distinct schedules shall be able to be assigned to different alarm types.
15. The ACS intelligent field controller and card readers shall all support a minimum of 8 card formats, including but not limited to:
 - a. Wiegand.
 - b. Magnetic Stripe.
 - c. The ACS shall support any industry standard format that uses:
 - 1) Card numbers.
 - 2) Facility codes.
 - 3) An issue code combination.
 - d. The ACS shall support:
 - 1) A maximum nineteen (19) digit card number.
 - 2) Two-digit issue codes.
16. The ACS shall support the hub from ASSA ABLOY, allowing connectivity to wireless readers.
17. The ACS shall allow administrators to define configurations to be assigned to alarm inputs for use with end-of-line resistance configurations:
 - a. Standard end-of-line resistance configurations shall include:
 - 1) Independently define request to exit and door contacts as normally open or normally closed.
 - 2) Independently define request to exit and door contacts as supervised or unsupervised.
 - b. Additionally, a minimum of 4 custom end-of-line resistance configurations shall be available.
 - c. Configurations shall be given a priority of low, medium, or high.
 - d. Configurations shall include options for low range and high range resistance thresholds.
 - e. Configuration options shall include the following input line statuses:
 - 1) Inactive.
 - 2) Active.
 - 3) Ground fault.
 - 4) Open.
 - 5) Short.
 - 6) Foreign.
 - 7) Non-setting.
18. The ACS provide elevator control:
 - a. Using standard access control field hardware.

- b. Permits the restriction of access to certain floors.
- c. Shall not restrict access to general admittance floors.
- d. Card readers shall be located in the cab of the elevator.
 - 1) Shall be able to control access for a minimum of 1-floor.
 - 2) Shall integrate to Input and Output Control Modules.
 - 3) Shall restrict which floor select buttons are accessible when a credential is swiped based on the identity access level.
 - 4) Shall permit only one authorized floor to be selected per single card swipe.
 - 5) Shall not require a swipe by any passenger to access floors programmed as public access.
- 19. Individual floors shall be configurable independently to allow visitor/general access to different floors during different times of the day.
- 20. The ACS shall be able to track which floor was selected by an individual cardholder for auditing and reporting purposes.
- 21. Anti-passback:
 - a. The ACS shall provide area control features including, but not limited to:
 - 1) Hard anti-passback.
 - 2) Soft anti-passback.
 - 3) Timed anti-passback.
 - 4) Two-person control.
 - 5) Occupancy count.
 - 6) A minimum of 127 areas shall be able to be created per ACS server.
 - b. In addition to functions specific to hard or soft anti-passback, either function shall include, but not be limited to:
 - 1) Initially (time 0) all credential holders are reset to area 0.
 - 2) Any credential holder shall enter a controlled area any time after time 0 by presenting a token to an entry card reader.
 - 3) A credential holder shall not exit the controlled area unless he/she has entered the area presenting a token to the area entry card reader.
 - 4) A credential holder shall not enter the controlled area a second time unless the credential holder has exited that area previously.
 - 5) A credential holder shall be able to enter through any entry card reader and exit through any exit card reader of a single controlled area.
 - 6) A forgiveness feature that shall allow the administrator to give credential holders one free pass to allow the ACS to move them into the next area they enter, regardless of their current anti-passback status.
 - 7) One free pass shall be given to an individual credential holder, to all credential holders in a single enterprise intelligent field controller, or to all credential holders in the ACS.

- 8) The ACS shall provide an anti-passback exempt option for privileged or VIP credential holders. Credential holders with this option will not have anti-passback rules applied to them.
 - 9) An area shall have the ability to be disabled/closed that shall not allow any access into the area except for those tokens with APB privileged status.
- c. Hard anti-passback (APB)
- 1) Shall require that a token always be used to enter and exit an area.
 - 2) The controlled areas shall have both entry and exit card readers at all portals.
 - 3) Entry and exit readers shall be confined to a single intelligent field controller.
 - 4) Areas shall be logically defined.
 - 5) Area control shall not be required to encompass every card reader in the system.
 - 6) Shall work in the following manner:
 - a) Once in an area, a credential holder must present their token at an exit card reader of the area they are currently in and wish to leave.
 - b) Once access has been granted to leave the area and enter a new area, the credential holder must present their token at an exit card reader of the new area.
 - c) Should a credential holder present their token at any other card reader involved in area APB, the credential holder shall be denied access and an alarm shall be reported.
 - 7) Nested control areas (areas inside areas) shall be definable with a minimum of 64 entry and exit card readers. It shall be possible to have an area within an area and/or multiple areas that are independent of each other in which Hard Anti-Passback rules shall apply.
- d. Soft APB shall require that a token be used to enter and exit an area:
- 1) The controlled areas shall have both entry and exit card readers at all portals.
 - 2) Entry and exit readers shall be confined to a single intelligent field controller.
 - 3) Areas shall be logically defined.
 - 4) Area control shall not be required to encompass every card reader in the system.
 - 5) Shall work in the following manner:
 - a) Once in an area, a credential holder must present their token at the exit card reader of the area they are currently in and wish to leave.
 - b) Once access has been granted to leave the area and enter a new area, the credential holder must present their token at an exit card reader of the new area.

- c) Should a credential holder attempt this, the credential holder shall be allowed access (if that credential holder has the appropriate access level to access the new area), and an alarm shall be reported.
 - 6) It shall be possible to have an area within an area and/or multiple areas that are independent of each other.
- e. Timed area APB shall allow an administrator to decide how long after a credential holder has swiped their token that they will have to wait before the same token will be accepted again at the same card reader:
 - 1) If a credential holder swipes their token a second time after initial entry and after the delay time has expired, access shall be granted, and an APB alarm shall be reported into the alarm monitor.
 - 2) Administrators shall be able to set the delay time up to 60-seconds.
- f. Two-person control shall be provided to restrict access to certain areas unless there are two (2) credential holders present. When an area is configured for two-person control, the following criteria shall prevail:
 - 1) The card reader shall grant access only if two valid credential holders (with authorized access privileges) swipe their badges one after the other. If a second authorized badge is not presented within 10-seconds of the first authorized badge, the card reader shall reset, and the first card will have to be swiped again.
 - 2) Once 2 people occupy an area, individual access shall be granted.
 - 3) Individual exit shall be permitted when an area is occupied by only 2 credential holders at which point the two-person control applies for exit, meaning both credential holders must present their cards at the exit reader within 10-second of each other and exit together.
- 22. Occupancy count/control shall restrict the number of credential holders that shall be present in an area at any given time:
 - a. The occupancy-controlled area shall be able to be defined by the administrator to limit up to 250,000 credential holders to be in that area at any given time.
 - b. Once the occupancy limit has been reached, a credential holder must swipe out of the exit card reader before the next credential holder may enter.
 - c. Each area for which occupancy control is enabled shall be definable with up to 64 entry/exit card readers.
 - d. Multiple occupancy-controlled areas shall be definable.
- 23. Custom device mappings/local alarms shall give administrators the ability to assign a unique group of alarm attributes to specific device-alarm combinations to override the global settings for generic attributes. Administrators may assign a different set of attributes to be applied to a forced door at a research lab than they would for a forced door at a perimeter location.
- 24. Administrators shall have the ability to set up entry/exit delays for inputs that are attached to any input control module, single reader interface module, or dual reader interface module:
 - a. Administrators shall have three options for entry/exit delay:

- 1) Administrators shall have the ability to set an input to non-latched entry. When non-latched entry mode is selected and an entry delay is specified, the following procedure ensues:
 - a) When an input activates, the alarm will not be reported until the entry delay expires. If the input is still active when the entry delay expires, the alarm will be reported.
 - b) If the input is not active when the entry delay expires, then the alarm will not report.
 - 2) Administrators shall have the ability to set an input to latched entry. When latched mode is selected and an entry delay is specified, the following procedure ensues:
 - a) When an input activates, the alarm will not be reported until the entry delay expires.
 - b) If the alarm has not been masked by the time the entry delay expires, the alarm will be reported.
 - c) If the input has been masked when the entry delay expires, then the alarm will not report.
 - 3) Administrators shall have the ability to set an input to exit delay that activates directly after an input has been unmasked. When an exit delay is specified, the following procedure ensues:
 - a) When an input activates, the alarm will not be reported (operates as if masked) until the exit delay expires.
 - b) If the input is still active when the exit delay expires, the alarm will be reported.
 - c) If the input is not active when the exit delay expires, the alarm will not be reported. This is useful to secure a door when an individual is leaving.
 - b. The ACS shall support a minimum of 6-seconds for entry and exit delays.
25. The ACS shall allow the following options to be defined for inputs or outputs in the input control module:
- a. Debounce time shall allow administrators to control the time that an input state change must remain consistent for it to be considered a real change of state.
 - b. End-of-line resistance shall give administrators the option to define an input as normally open or normally closed and define an input as supervised or unsupervised.
 - c. Hold time shall be the amount of time in seconds to wait to report an input activation as restored when an input goes active and then is restored. The hold time shall be configurable from 0-15 seconds.
 - d. Alarm masking shall allow the input to be masked either all the time or during a defined schedule.
 - e. Activate output shall allow administrators to configure an output to activate all the time or during a defined schedule.

- f. Installed shall define whether the ACS shall consider the input an active component of the on-line system.
 - g. Logging shall allow administrators to determine whether to log all change of state events or only when the event is not masked.
- 26. The ACS shall allow the following options to be defined for outputs in the relay output control module:
 - a. Installed shall define whether the ACS shall consider the output an active component of the on-line system.
 - b. Relay output mode shall set the default mode of the relay output.
 - c. Pulse time shall define how long the output shall pulse when the command is given.
 - d. Schedule shall define the time the relay output is active.
- 27. The ACS shall support input/output/event linkage, whereby an input/output/event in an intelligent field controller can trigger an action within the same intelligent field controller:
 - a. All linkage decisions shall be made local to the intelligent controller.
 - b. Administrators shall be able to create macros, each consisting of a sequence of actions to be performed, such as changing card reader modes and activating outputs.
 - c. Each macro shall include up to 30 actions.
 - d. Administrators shall then be able to link events to the macros such that a particular action will trigger a macro to execute.
- 28. The ACS shall provide administrators the ability to create action groups that may include multiple actions associated with a single event.
 - a. Identity filters shall be available to allow activity from specific identities to trigger an action.
 - b. Additional filters shall be applied so that an event input can be filtered to a specific hardware device and/or a specific credential holder token ID.
- 29. Inputs shall include any enterprise intelligent field controller level event, including but not limited to:
 - a. Intelligent field controller events:
 - 1) Cabinet tamper.
 - 2) Power failure.
 - b. Input control module events:
 - 1) Communication loss.
 - 2) Cabinet tamper.
 - 3) Power failure.
 - 4) Input points.
 - c. Card reader events:
 - 1) Cabinet tamper.

- 2) Communication loss.
- 3) Door contact tamper.
- 4) Door forced open.
- 5) Door held open.
- 6) Power failure.
- 7) Card reader tamper.

30. Macro actions shall include, but not be limited to:

- a. Activating an output control module output.
- b. Masking/unmasking an alarm input.
- c. Setting the active mode of a card reader.
- d. Activating/deactivating a schedule.

31. Macros shall be linked to devices and types of inputs shall include, but not be limited to:

- a. Intelligent field controller events:
 - 1) Cabinet tamper, power failure.
 - 2) Secure.
 - 3) Fault.
 - 4) Alarm.
- b. Card reader events:
 - 1) Communication status.
 - 2) Cabinet tamper, power failure, reader tamper, forced open, held open, door contact tamper, auxiliary input #1, auxiliary input #2.
 - 3) Secure.
 - 4) Fault.
 - 5) Alarm.
 - 6) Access activity.
 - 7) Access granted.
 - 8) Access denied.
 - 9) Duress.
- c. Input control module events:
 - 1) Communications status.
 - 2) Alarms: Cabinet tamper, power failure, alarm inputs.
 - 3) Secure.
 - 4) Fault.
 - 5) Alarm.
- d. An input/event may trigger multiple macros and a macro shall have the ability to be triggered by multiple inputs/events.

- e. The ACS shall support a minimum of 100 macros per intelligent field controller. Each macro shall support a minimum of 30 actions.

C. Identity management functionality:

1. The ACS shall offer an integrated identity management and enrollment functionality as part of the core system functionality. The identity management and enrollment module of the application shall not be written by a 3rd party source.
2. The ACS shall have to ability to import identity records and their associated image in a standard JPEG format. Identity records shall be able to be pre-loaded prior to implementation or added at any time after deployment.
3. The ACS shall provide a pre-configured one-time import utility, using standard comma separated value (.csv) files that shall allow the import of identity information based on the factory shipped data fields.
4. The ACS shall allow individual enrollment of identities. Each identity shall allow entry of required and optional fields. For identities that have access to the ACS application, the following security parameters must be defined during the enrollment process:
 - a. User account.
 - b. Account password.
 - c. Non-activity timeout.
5. The ACS shall use role base permissions. Roles shall be assigned during enrollment. Identity's role shall determine their access groups:
 - a. Which card readers they have access to.
 - b. Which times access to those card readers is allowed.
6. A token shall be created and assigned during enrollment:
 - a. For each token, credentials shall include, but not be limited to:
 - 1) A Badge ID.
 - 2) A minimum of a 19-digit badge ID shall be supported.
 - 3) Embossed number as required.
 - 4) PIN code shall be assigned as required.
 - 5) Activation and deactivation date.
 - 6) Associated settings for anti-passback as required.
 - b. Optional credential parameters shall include, but not be limited to:
 - 1) Adding a token to a group during enrollment.
 - 2) A group may have pre-defined role and policy settings that will drive the configuration of the identity information.
 - 3) Expiration of the credential due to non-use. The credential can be set to expire if not used within a certain timeframe. The parameters shall include, but not be limited to:
 - a) System wide for every credential.
 - b) Variable parameters per individual or access level.

- c) Individual or access levels can be exempt from expiration.
 - d) Scheduled time for expiration does to non-use shall be at least 1-year from date of activation.
- 7. During enrollment, the identity's image shall be captured or loaded in from a JPEG file format and a badge template shall be assigned.
- 8. The ACS shall enable FIPS-201 compliant validation and registration of identities through:
 - a. Integration with HID pivCLASS.
 - b. HID pivCLASS certificate manager and updating an existing cardholder record or inserting one if one did not already exist.
 - c. Shall support the import of the photograph and fingerprint biometric from the government issued smart card that is compliant with FIPS-201.
- 9. The ACS shall allow credential suspension if the card certificate serial number is on a designated list, including, but not limited to:
 - a. Certificate revocation list (CRL)
 - b. If the FASC-N is on TSA canceled card list (CCL).
- 10. The ACS shall support PIV, TWIC, CAC, and FRAC credentials.
- 11. Credential re-issuance:
 - a. The operator shall be able to deactivate the existing credential by marking it:
 - 1) Lost.
 - 2) Stolen.
 - b. The ACS shall be able to use the existing Identity information and photo for the new credential. The process shall not require re-enrollment of the credential holder.
 - c. The re-issuance process shall automatically:
 - 1) Remove access rights from the deactivated token.
 - 2) Enable those same rights in the new token.
 - 3) Automatically send the appropriate changes to the intelligent enterprise controllers.
- 12. Each identity shall have a unique record in the open LDAP directory structure. LDAP directory structure must include the use and definition of user defined fields and forms.
- 13. Highest level administrators shall be given the ability to delete identities. Bulk delete identities is the ability to delete a group of identities, based on a user defined search set.
- 14. The ACS shall allow administrators to assign access groups to roles. A Role shall then be assigned to an identity during enrollment. Each identity may have up to 8 access groups assigned to their record per intelligent controller through the assignment of one or more roles to their record.
- 15. Access group modifications or assignments shall be automatically downloaded to the appropriate intelligent controllers without operator intervention. Completed

as a push communication immediately after an identity record is saved.
Scheduled, batch updated are not accepted.

16. The ACS shall support an access group view form that allows operators to view:
 - a. All roles that have been assigned to an identity.
 - b. Which access groups are associated with the role.
 - c. What doors an identity has access to.
17. The ACS shall support a role-based permission methodology to be used in conjunction with identities:
 - a. Roles shall be assigned to identities to determine door access as well as access into the system application.
 - b. Multiple roles shall be able to be assigned to an identity:
 - 1) A parent/child relationship can be defined, per role.
 - 2) Duplicating role information for multiple roles shall not be required.
 - c. Identities shall aggregate all role assigned permissions.
 - d. Each role shall have a defined start and stop date:
 - 1) To allow assignment of roles on a temporary basis.
 - 2) Roles can be manually activated or deactivated through the use of a checkbox.
 - e. Each role shall consist of any combination of the following components that shall determine which roles an operator shall be able to assign to other identities during enrollment:
 - 1) Access groups.
 - 2) Delegation assignments.
 - 3) Role assignments.
18. The ACS shall support IP-based cameras for image capture device:
 - a. The operator shall be able to view a live image on screen of the identity to move them into a proper pose or position prior to freezing the image.
 - b. If the operator is not satisfied with the captured image, they shall be able to revert to a live view and freeze a new image.
 - c. Configuration settings for IP cameras, as well as viewing a live and still image of a person shall be user configurable.
19. The JPEG ACS shall support photo capture through use of an IP-based camera:
 - a. The operator shall be able to view a live image on screen of the identity to move them into a proper pose or position and then be able to freeze the image.
 - b. If the operator is not satisfied with the captured image, they shall be able to revert to a live view and freeze a new image.
20. Additionally, and optionally, the ACS shall support the ability to import industry standard JPEG photos from digital cameras or other image capture sources.

21. The ACS shall allow the captured photo to be cropped via use of the mouse to define the crop window. Only information inside the crop window shall be saved and stored in the directory structure. Images shall be associated with the Identity and shall be stored in the open LDAP directory.
22. The ACS shall support activation and deactivation dates for all tokens created:
 - a. A token shall have the ability to be configured to activate at a future date from time of creation.
 - b. When a token reaches its deactivation date/time, the ACS shall automatically deactivate the access rights associated with the token.
 - c. All access rights of a token shall be eliminated after the deactivation date.
 - d. Should the identity become authorized for access again, new access rights shall be applicable to the same token, and re-issue shall not be required.
 - e. Expiration of the credential due to non-use. The credential can be set to expire if not used within a certain timeframe. The parameters shall include, but not be limited to:
 - 1) System wide for every credential.
 - 2) Variable parameters per individual or access level.
 - 3) Individual or access levels can be exempt from expiration.
 - 4) Scheduled time for expiration due to non-use shall be at least 1-year from date of activation.
23. The ACS shall keep an on-line record of all tokens issued to an identity. For each record, details will be recorded including activation and deactivation dates, token status, and token ID.
24. The ACS shall support a minimum of a 2-digit issue code.
25. The ACS shall support up to 8-digit PIN codes:
 - a. Each credential holder in the ACS shall have the ability to choose a PIN to be associated with their record.
 - b. A credential holder's PIN shall have the ability to be changed should the original PIN code be compromised.
 - c. An identity shall be able to be exempted from PIN requirements within the system.
26. The ACS shall support industry standard pre-encoded physical credential options including:
 - a. Composite credentials such as PVC cards.
 - b. Proximity credentials including dual PVC technology that includes both proximity and magnetic stripe technology.
 - c. Contact smart credentials.
 - d. MiFare credentials.
 - e. DESFIRE credentials.
 - f. HID multiclass credentials.
27. A credential holder's last entry point:

- a. Shall be displayed on the main identity form.
 - b. Along with a date/time stamp for when entry occurred.
 - c. If a credential holder has multiple tokens, the tokens form shall also show the last entry point with date/time stamp for each token in a credential holder's possession.
28. The ACS shall display the date and time of the last modification to that identity record from the main identity form.
29. The ACS shall allow identities to have multiple active tokens associated with their record. A minimum of 25 active tokens may be assigned to an identity.
30. The ACS shall allow for printing on both sides of a credential.
31. The ACS shall allow operators to revoke access privileges from a credential holder by updating that credential holder's token status. A token with revoked access shall immediately stop functioning at all card readers.
32. The ACS shall have the ability to search identities by:
 - a. First name.
 - b. Last name.
 - c. Identity.
 - d. Token field in the system.
33. The ACS shall allow multiple field-based identity/token searches using and/or logic. Filters shall include, but not be limited to:
 - a. Equals.
 - b. Starts with.
 - c. Ends with.
 - d. Contains.
34. The ACS shall include a pick list builder that allows administrators to define operator selection options that appear in identity form pick lists. Each pick list shall have an unlimited number of pre-defined selections.
35. The ACS shall support the following:
 - a. Standard identity:
 - 1) Last name.
 - 2) First name.
 - 3) Middle name.
 - 4) External system ID.
 - 5) Address.
 - 6) City.
 - 7) State.
 - 8) Zip.
 - 9) Phone.
 - 10) Work phone.

- 11) Email address.
- 12) Title.
- 13) Department.
- 14) Division.
- 15) Site Location.
- 16) Building.
- b. Token fields:
 - 1) Last record modification.
 - 2) Status.
 - 3) Type.
 - 4) Issue date.
 - 5) Login.
 - 6) Password.
 - 7) Password confirmation.
 - 8) Inactivity timer.
 - 9) Last door accessed.
 - 10) Last time accessing last door.
 - 11) Photo.
 - 12) Embossed number.
 - 13) Internal number.
 - 14) PIN.
 - 15) Token status.
 - 16) Issue level.
 - 17) Activate date.
 - 18) Deactivate date.
- 36. The ACS shall provide a form listing the most recent transaction activity associated with an identity, without having to run a report. Information provided shall include:
 - a. Transaction activity.
 - b. Time/date.
 - c. Related token.
- 37. The ACS shall support the ability to add additional identity-based forms to support user-defined fields:
 - a. Up to 10 user-defined forms shall be able to be added.
 - b. Each user-defined field shall be given a field name/label and be defined as one of the following field types:
 - 1) String.

- 2) Integer.
 - 3) Boolean.
 - 4) Date.
 - c. Up to 300 user-defined fields shall be available.
38. The ACS shall support a tool to allow for the custom creation of identity/token badge layouts.
39. The ACS shall support any size badge provided the printer used for badge creation supports the desired badge size.
40. The ACS shall allow multiple objects to be configured for a badge layout including:
- a. Alphanumeric text fields.
 - b. Database fields.
 - c. Photos.
 - d. Identity photos.
 - e. Graphics (i.e., logos).
41. Each text and database field added to the layout shall have the ability to employ the following properties:
- a. Location of the object.
 - b. Height and width.
 - c. Background color.
 - d. Rotation.
 - e. Typeface of text.
 - f. Size of text.
 - g. Color of text.
 - h. Horizontal and vertical alignment of text.
42. Each photo and graphic field added to the layout shall have the ability to employ the following properties:
- a. Location of the object.
 - b. Height and width.
 - c. Maintain aspect ratio.
 - d. The ACS badge layout tool shall support a color palette that supports a minimum of 16.7 million colors that can be applied to applicable objects.
- D. Alarm and event monitoring:
- 1. The ACS shall support a tabbed view for the monitor user interface. The following tabs shall be supported:
 - a. Event monitor shall be used to monitor system level events such as operator activity and field level events.

- b. Alarm monitor shall be used to monitor field level events such as identity access activity, input alarms, and door alarms as well as system level events configured as alarms.
 - c. Swipe and show verification shall be used to view identity information in real-time as credential holders access specific doors.
 - d. Search shall be used to search for alarm and event transactions currently stored in the ACS.
 - e. Hardware status shall be used to view the real-time status of field hardware devices configured in the system, as well as to manipulate/override those devices.
2. The ACS shall allow administrators to configure how alarms and events annunciate into the alarm monitor. Support audible notification at the workstation when alarms arrive in the system:
 - 1) Users shall have the ability to adjust the configuration and parameters.
 - 2) Administrators shall be able to choose a specific sound to pair with each type of alarm.
3. Each alarm and event shall have the following configuration options:
 - a. Display in the alarm monitor.
 - b. Be masked from displaying in the alarm monitor.
 - c. Allow higher alarms to be displayed on top of the alarm monitor when an operator sorts based on alarm priority.
 - d. Display text instructions that shall guide the operator in alarm response.
 - e. Automatically send an email message to one or more recipients.
 - f. For video-related alarms and events, automatically launch the video player to display a live video feed from the camera that is associated with the generating alarm or event.
4. The ACS Alarm Monitor shall provide a real-time count of all alarms and events in the alarm monitor awaiting operator action.
5. The ACS shall support the following options for handling/responding to alarms and events upon selection:
 - a. Acknowledge the alarm.
 - b. Review text instructions on pre-defined alarm response.
 - c. Enter unlimited notes on reason for alarm and/or action taken in alarm response.
 - d. Review the history of the alarm.
 - e. For alarms and events that include a credential holder, call up the identity record of that credential holder.
 - f. Clear the alarm:
 - 1) Single operator enabled.
 - 2) Two-person control for clearing alarms shall enforce a policy that the operator clearing and alarm(s) from the alarm monitor cannot be the same operator that previously acknowledged the alarm.

- 3) Role-based clearing of alarms that shall allow system administrators to assign a role or roles to the alarm.
 - 4) The operator attempting to clear the alarm must be assigned one of the roles that are assigned to the alarm in order for him/her to clear the alarm from the alarm monitor.
6. The ACS shall support the ability to manage and handle multiple alarms. Operators shall have the ability to clear or acknowledge all selected alarms in a single action.
7. The ACS shall allow Identity-based alarm routing that shall route alarms to specific Identities monitoring the application based on:
 - a. Schedule.
 - b. Event type.
 - c. Device.
8. The ACS shall allow masking of specific alarms or alarm types based on pre-defined schedules or via manual overrides:
 - a. Masked alarms shall not report into the alarm monitors.
 - b. Logging the transaction database for reporting and audit trail shall not be affected by masked status.
 - c. An operator shall have the ability to mask or unmask any alarm point in the system based on permissions.
9. The ACS shall allow alarms and events to be sorted in the alarm monitor by any of the currently configured viewable columns.
10. The ACS shall provide the capability to emphasize alarm priority through the use of colored bars within the alarm monitor screen:
 - a. Each alarm priority shall have its own unique user-defined color assigned to it.
 - b. Color bars shall also have the ability to be assigned to individual alarm priorities or to a range of alarm priorities.
11. The ACS shall allow administrators to define which columns are displayed in the alarm monitor. Administrators shall also be able to set the column order of the alarm monitor. Columns available for configuration shall include:
 - a. Time.
 - b. Last access.
 - c. Token expire date.
 - d. Token issue date.
 - e. Panel date.
 - f. Priority.
 - g. Operator.
 - h. Identity first name.
 - i. Identity middle initial.
 - j. Identity last name.

- k. Card number.
 - l. Embossed number.
 - m. Message.
 - n. Event name/description.
 - o. Event type.
 - p. Panel.
 - q. Source.
 - r. Location.
 - s. Alternate source.
 - t. Input address.
 - u. Event address.
 - v. Source type.
 - w. Flags.
 - x. Status.
 - y. Issue level.
 - z. Role.
12. The ACS shall support integrated email capabilities:
- a. The ACS shall be able to generate an email message to send to one or more recipients upon a generated alarm or event.
 - b. The email function shall interface with any email server that uses SMTP as its protocol.
13. The ACS shall support an event monitoring tab that shall be used to monitor system level events such as operator activity:
- a. An operator shall be able to choose which field columns to display and shall be able to place those columns in their order of preference.
 - b. The operator shall also be able to sort the events by any currently displayed column in the event monitor.
 - c. Administrators shall have the ability to configure the number of recent events to display in the event monitor upon accessing the events tab.
14. The ACS shall support a real-time field hardware device status counter displaying a summary of the total number of doors, input points, intelligent enterprise controllers, and sub panels that are active, masked, and off-line.
15. The ACS shall support real-time system status that depicts all field hardware devices configured. The real-time system status tab shall list:
- a. Intelligent controllers.
 - b. Input control modules.
 - c. Alarm inputs.
 - d. Relay outputs.
 - e. Card readers.

- f. The hardware status shall show the real-time status of all these devices (on-line vs. off-line, alarms activated, masking status, etc.).
- 16. The system status shall include three counters:
 - a. Active counter: A counter of the number of active points.
 - b. Offline counter: A counter of the number of offline devices.
 - c. Masked counter: A counter of the number of masked points.
- 17. The hardware status tab shall display all hardware devices separately in their own row. The following shall exist in the tab:
 - a. Device name.
 - b. Intelligent controller/input control module/output control module name.
 - c. Current device status.
- 18. The ACS shall also allow operators to affect the access mode of card readers, open doors, mask/unmask alarm inputs, and activate/deactivate/pulse an output from the tab. The ACS shall also allow operators to affect the access mode of multiple devices with a single action by selecting multiple devices and then performing the command.
- 19. The ACS shall support integration with life safety power's N1 network module. When configured, the LSP power supply link shall appear in the field hardware device status tab and when the link is clicked, the N1 diagnostic and configuration window shall appear.
- 20. The ACS shall support the ability to call-up the history of an alarm. The history call-up window shall display the associated alarm information including time/date stamp, acknowledgement actions by operators, and entered notes. The operator shall not be required to exit the alarm monitor to access this information and this functionality shall not prevent additional alarm activity from reporting to the alarm monitor.
- 21. The ACS shall support the ability to call up the identity form to display the identity record associated with an alarm. The identity call-up window shall display the identity's information and photo. The operator shall not be required to exit the alarm monitor to access this information and this functionality shall not prevent additional alarm activity from reporting to the alarm monitor.
- 22. The ACS shall allow operators to manually control the state of field hardware devices and their input/output points from the alarm monitor:
 - a. Card readers:
 - 1) Manually control reader state or based on current schedule.
 - 2) Unlocked.
 - 3) Locked.
 - 4) Facility code.
 - 5) Card only.
 - 6) PIN only.
 - 7) Card and PIN.
 - 8) Pulse the door open.

- 9) Mask/unmask.
- 10) Door forced open/door held open.
- 11) Disable the door.
- 12) Restore the door to correct state.
- 13) Mask and unmask inputs.
- b. Outputs:
 - 1) Manually control reader state or based on current schedule.
 - 2) Turn on.
 - 3) Turn off.
 - 4) Pulse outputs.
- 23. Field hardware devices shall be available for operator control from the hardware status tab.
- 24. The ACS shall utilize a last command wins methodology. For example, if an output is set to off due to a schedule and an operator manually turns it on, then the output will remain on until it is manually turned off or until the next scheduled interval occurs.
- 25. All manual controls shall be recorded in the operator audit log with the time of the change, operator performing the function, and description of the activity performed.
- 26. The ACS shall support graphical maps through the import of map backgrounds from standard "off-the-shelf" drawing packages in the formats listed below:
 - a. Bitmap (.bmp, .dib).
 - b. JPEG (.jpg).
 - c. Portable network graphics (.png).
 - d. TIFF (.tif).
 - e. Windows metafile (.wmf, .emf).
 - f. Encapsulated post script (.eps).
- 27. The ACS administrator shall have the ability to place system icons, including card readers, input & output points, video cameras, and other access control field hardware to indicate their location in the facility.
- 28. Zoom capabilities shall be available to provide closer or farther views of the area. From the map, operators shall be able to:
 - a. Acknowledge an alarm.
 - b. Change the access mode of readers.
 - c. Mask/unmask inputs.
 - d. Pulse, set ON/OFF of relay outputs.
 - e. Launch a video "Window."
- 29. The alarm monitor shall provide status indicators to display the current status of multiple elements of the ACS including:

- a. Total number of pending unacknowledged alarms and events.
 - b. Status of all field hardware devices (intelligent system controllers, subpanels, card readers, inputs, and outputs) including off-line, active, and masked.
 - c. The hardware status tab will show all devices that are in alarm as well as the on-line /off-line status for all field hardware devices.
30. The ACS shall support swipe and show functionality that allows the display of the credential holder's photo as they swipe their badge through a specified card reader:
- a. Up to four card readers shall be active for swipe and show in each browser window.
 - b. Swipe and show allow operators to verify the credential holder to their photo as they enter a portal.
- E. System configuration and administration:
- 1. The ACS shall track and keep a comprehensive log of all alarm and event activity. All alarms and events that occur shall be logged with the following information:
 - a. Alarm name.
 - b. Time and date stamp.
 - c. Where the alarm occurred.
 - d. Acknowledgement information.
 - e. All operator actions associated with the alarm or event.
 - 2. Administrators shall be able to suppress certain alarms from logging during pre-defined scheduled times of the day.
 - 3. Alarm and event information can be viewed through the ACS reporting engine that shall list the total number of alarms and events that are logged in the ACS server. The number of stored alarms and events shall be limited only by the amount of disk space available in the ACS server.
 - 4. The ACS shall support an auto logout feature that shall allow the system to automatically log an operator out of the system after a period of inactivity. Auto logout timeout choices shall include:
 - a. 10-minutes.
 - b. 15-minutes.
 - c. 30-minutes.
 - d. 60-minutes.
 - e. 1-hour.
 - f. A selection shall be available to not log out an operator regardless of inactivity length.
 - 5. All major ACS features and functions shall be permission protected through the use of delegations:
 - a. Each operator account shall be assigned a role, which shall include a list of delegations assigned to that role.

- b. Operator access to ACS screens, as well as their ability to view, add, edit, or delete ACS objects shall be controlled through delegations.
6. The ACS shall support a software-based license enforcement model. A hardware key or dongle shall not be acceptable for controlling licensed features and functionality.
7. The ACS shall support the ability to analyze real-time diagnostic information for each ACS server by viewing the about page for the server. Diagnostic data shall include:
 - a. Number of days online.
 - b. Current load.
 - c. Memory.
 - d. Disk space usage.
 - e. Network communications data.
8. The ACS shall support on-line, context sensitive help to assist system users in the operation of the system. Once inside the help program, users shall be able to navigate the help files, moving to other areas of the documentation without having to go back into the application software. The help files shall have a linked table of contents, index, and search capability.
9. The ACS shall support operator accounts:
 - a. Each operator account shall require a unique user name password to access the system.
 - b. Each operator account shall also be assigned a role, which shall determine the permission level for that account, thus controlling what functions the operator can perform in the system.
 - c. All modifications to an operator account shall be reported to the event monitor and logged to the LDAP directory structure for audit and reporting processes.
 - d. The ACS shall support as many operator accounts as configured identities.
10. Each operator account shall require a unique user name and password that would tie that identity to delegation rights to access the ACS:
 - a. This denotes operator access to:
 - 1) Screens the operator can access.
 - 2) Tasks the operator can perform.
 - b. An operator shall be able to change their ACS password at any time.
 - c. Strong password parameters shall be supported:
 - 1) Requiring system users to enter at least 8-characters.
 - 2) Include at least one upper case letter, one lower case letter and one numeral.
11. The ACS shall support policies that shall act as templates to be applied to field hardware devices in the system to ease in configuration of similar devices. Each Policy shall consist of a template for card readers, inputs, or outputs. The ACS shall support an unlimited number of policies.

12. The ACS shall support grouping of parameters for ease of configuration. Grouping concepts should include, but not be limited to:
 - a. Roles.
 - b. Field hardware devices.
 - c. Policies.
13. The ACS shall provide the capability for advanced system partitioning:
 - a. Each partition shall be allowed its own group of identities, field hardware, and parameters such as schedules and access groups.
 - b. Identities shall be allowed to belong to one or multiple partitions.
 - c. Partitioning shall provide a flexible “tenant/landlord” architecture whereby partition users can only view, add, modify, and delete identities, system parameters and field hardware that belong to their respective partitions.
 - d. ACS operators may be assigned to more than one partition. A partition may be assigned to more than one operator.
14. The ACS shall track and keep a comprehensive log of all operator account activity. All changes that occur in the directory structure shall be logged including, but not limited to:
 - a. Operator account login/logout activity.
 - b. Adding, deleting, or changing identity records.
 - c. Change to system configurations to include, but not limited to field hardware, access groups, or schedules.
 - d. Activity performed inside the alarm and event monitor, include but are not limited to acknowledging alarms, opening doors, or clearing events.
15. The logged activities shall include, but not be limited to:
 - a. Operator account.
 - b. Date and time of the activity.
 - c. Activity that was performed.
 - d. Original data prior to change, if applicable.
 - e. New data that was updated.
16. The operator account activity information can be viewed through the ACS reporting engine that shall list the total number of operator events that are logged in the ACS server. The number of stored operator account events shall be limited only by the amount of disk space available in the ACS server.
17. The system scheduling utility shall allow system administrators to schedule actions:
 - a. On-demand or single-use.
 - b. Recurring basis.
 - c. The types of actions include, but not limited to running reports, updating identity profiles, apply door modes and running global actions.
 - d. The scheduling utility shall satisfy a wide range of scheduling needs, including, but not limited to:

- 1) Hourly: i.e., every day on the hour.
 - 2) Specific day, specific time: i.e., every Monday at 8:00 am.
 - 3) Monthly: i.e., the first Sunday of every month.
 - 4) Specific recurring date: i.e., every February 29th @ noon.
 - 5) Specific date in the future: i.e., December 7, 2017 @ 5pm.
 - 6) Recurring activities can be set to.
 - 7) A master start and stop date.
 - 8) Run indefinitely.
18. The scheduling utility shall provide a job monitor allowing the system administrator to:
- a. See the status of currently running tasks.
 - b. See a chronological list of future scheduled tasks.
 - c. See a history log of completed tasks.
19. The ACS shall support a minimum of 23-standard reports:
- a. Reports shall have the ability to be created as either:
 - 1) PDF document.
 - 2) Spreadsheet document.
 - b. Once generated, the report can be either:
 - 1) Saved to a file.
 - 2) Printed to a local or networked printer.
 - c. Each report shall have the ability to be customized/filtered on relevant data for each report.
 - d. Standard ACS reports shall include:
 - 1) The Access Grant Audit Report shall present information on all access grant activity that was manually generated by an operator and shall include the door that was opened, time, and operator executing the door grant.
 - 2) The Access Group Report shall present information on all defined ACS access groups, including but not limited to:
 - a) The roles that are assigned to the group.
 - b) The schedule assigned to the group.
 - c) The number of doors assigned to the group.
 - d) List of the doors assigned to the group.
 - 3) The Alarm Report shall present information on all alarms that occurred in the system including panel name, operator action taken, operator responding to the alarm, and any operator notes pertaining to the alarm.
 - 4) The Gateway Report shall present information on each defined ACS server, including:
 - a) The ACS server type.

- b) The DNS name and domain.
 - c) The local time zone and daylight savings time settings.
 - d) A list of field hardware manufacturers enabled.
 - e) A list of intelligent controllers configured to report to the panel.
- 5) The Area Report shall present information on all defined areas. Each area entry shall include area name, ACS server where the area exists, and doors assigned to the area.
- 6) The Audit Log Report shall present information about each change made to the ACS by an operator. Each audit log entry shall include:
- a) A date/time stamp.
 - b) Description.
 - c) The operator who made the change.
 - d) The type of change.
 - e) The details of the change.
 - f) The original information prior to the change (if any).
- 7) The Camera Report shall present information on each camera configured in the system including camera name and its attributes.
- 8) The Collaboration Report shall present information on all defined ACS collaboration scripts, including collaboration type and if the collaboration is active.
- 9) The Delegation Report shall present information on all defined ACS delegation groups, including which identities have been assigned to the delegation and what permission have been configured for that delegation.
- 10) The Door Access Report shall present information on credential holder access to each door in the ACS, including the schedule that the credential holder can access the door.
- 11) The Door Configuration Report shall present information on the complete configuration/settings of each door configured in the ACS.
- 12) The Event Report shall present information on defined events in the system along with their attributes including:
- a) Event name.
 - b) Assigned event type.
 - c) Priority.
 - d) Masking schedule.
 - e) If the event is configured to always mask and/or log the event.
- 13) The Event Type Report shall present information on each defined ACS event type, including:
- a) Suppression schedule.
 - b) Priority.
 - c) Retransmission time.

- d) Retransmission procedure.
 - e) Procedure.
 - f) If the event type is set to be masked, logged, and/or sent to the alarm monitor.
- 14) The Group Report shall present information on all defined groups, including group name, type, and members information such as card readers and roles.
- 15) The Holiday Report shall present information on each defined holiday, including the date of the holiday, number of days the holiday is in effect and the holiday type(s) assigned to the holiday.
- 16) The Identity Access Report shall present information on each defined Identity with respect to which doors they have access. The report shall include the schedule in which access has been granted to each reader as well as the access group and role assignments that allow access to each reader.
- 17) The Identity Summary Report shall present information on each defined identity with respect to identity status and type, token(s) issue and expiration date, and which roles and access groups have been assigned to the identity.
- 18) The Panel Report shall present information on the complete configuration/settings of each intelligent controller configured in the ACS.
- 19) The Policy Report shall present information on all defined policies in the ACS, including:
- a) Policy name.
 - b) Active status.
 - c) Which hardware components the policy encompasses.
- 20) The Role Report shall present information on each defined role, including:
- a) Parent information.
 - b) Activation/deactivation dates.
 - c) Child roles.
 - d) Identities assigned to that role.
 - e) Access Groups assigned to that role.
 - f) Doors assigned to that role.
- 21) The Schedule Report shall present information on each defined schedule, including its mode and each interval configured:
- a) Days of the week.
 - b) Holiday types.
 - c) Start and end times of the interval.
- 22) The token report shall present information on all tokens in the system including token number, identity to whom the token is assigned, and active/de-active status.

- 23) The Transaction Report shall present information on each transaction generated at the field hardware level. Each transaction log event shall include:
 - a) Date/time stamp.
 - b) Event source.
 - c) Event name and type.
 - d) Identity and token information.
- e. The ACS shall support Quick Reports:
 - 1) Each of the standard reports defined in the reports section shall have the ability to have relevant data filters applied to them, prior to running, in order to provide a report with more specific information than the generic report. Quick Report settings shall be designed to run once and shall not be saved.
 - 2) Quick Reports shall have the ability to output their results to a PDF file format or to a spreadsheet file format.
- f. The ACS shall support Custom Reports:
 - 1) Each of the standard reports defined in the reports section shall have the ability to have relevant data filters applied to them, prior to running, in order to provide a report with more specific information than the generic report.
 - 2) Custom Reports shall be designed to run multiple times and shall be saved in the reports form for fast future execution.
 - 3) Custom Reports shall have the ability to output their results to a PDF file format or to a spreadsheet file format.
 - 4) Each Custom Report shall be given a unique name to identify it in the reports list.
20. The ACS shall have remote support capability to allow value added reseller or manufacturer to access customer's server for:
 - a. Troubleshooting.
 - b. Diagnostics.
 - c. Load review.
 - d. Assistance with configuration.
21. The ACS shall offer the ability to obtain software log data out of the system server logs for further application support.
22. The ACS shall support automated grid-based replication architecture of the server directory structure for customers that deploy multiple servers:
 - a. The replication architecture shall be peer-to-peer and not require a dedicated database server to enable replication of identities and configuration data across servers.
 - b. The ACS shall support encrypted communications between servers using SSL encryption.

- c. Replication shall allow the LDAP data of all servers to be synchronized with each of the others in the system, allowing for the ACS server to rebuild itself from replicated data found on another server found in the system.
- 23. The ACS shall support a hot standby, auto-failover architecture. For each server, a hot standby server shall be configured to monitor the status of its primary partner device. Should a server fail to function, the hot standby server shall be able to automatically detect a problem and assume control of the system.
- 24. The ACS shall support software updates via downloading from the manufacturer web site or receiving via email the update files. No physical interaction with the ACS server shall be required to perform a successful update or upgrade to the system software.
- 25. The ACS shall have the ability to backup and restore the LDAP directory structure. Backups shall run concurrently with the rest of the system and shall not require all operators to log out of the ACS:
 - a. Backups shall include transaction data and system configuration data.
 - b. Server backups be encrypted using AES encryption.
 - c. Server backups to:
 - 1) USB storage device.
 - 2) Windows shared directory or network shared folder.
 - 3) Secured SCP servers.
 - d. Backups shall be performed:
 - 1) Automatically on a predefined daily schedule.
 - 2) Manually via the user interface.
- 26. The ACS shall support restart and shutdown capabilities of the server. The ACS user interface shall support both re-start and shutdown of the server. Rights and access to re-start and shutdown of the server shall be denoted by login.
- 27. The ACS shall support localized date and time display.
- 28. The ACS shall support system data logs to assist with diagnostics and troubleshooting. Standard logs shall include web server logs, field hardware communication logs, system software logs, and system transaction logs. All logs shall be viewable in a plain text format.
- F. 3rd party collaboration:
 - 1. The ACS shall support a collaboration utility that shall allow for real-time or scheduled transfer of information, including images and events, between the ACS and 3rd party IT, security, and other systems.
 - 2. A user interface shall allow for the generation of import and export collaborations. A start and stop date shall be applied to run the collaboration during the scheduled intervals only between certain dates.
 - 3. The ACS shall support a minimum of 32-collaborations per ACS server.
 - 4. The ACS shall support the following collaboration types:
 - a. Identity LDAP pull.
 - b. Identity Oracle RDBMS pull.

- c. Identity LDAP SQL server pull.
 - d. Events push to ArcSight CEF.
 - e. Events push to Splunk.
 - f. Events push to Syslog.
 - g. Events push to SNMP.
 - h. Events push to Milestone Video.
 - i. One time import of identity records using factory shipped fields.
5. Identity pull collaborations shall allow identity, token, and role related data to be imported into the system directory structure:
- a. Importing of information shall occur in the following method:
 - 1) Add/modify: If a record in the file exists in the directory structure, it shall be replaced according to the layout configuration specified.
 - 2) Records that do not already exist shall be added to the directory structure.
 - b. Identity pull collaborations shall support BLOB image file formats to be imported into the open LDAP directory structure.
 - c. The ability to encrypt the exported identity information shall be available using SSL encryption.
 - d. Each collaboration shall utilize an error log that shall report all errors that occur during a file import. All errors can then be viewed from this log and once corrected the import may be run a second time to download the corrected records.
 - e. As a collaboration pull completes, imported changes shall be automatically downloaded to intelligent controllers on a real-time basis as information is being imported into the directory structure.
6. Event push collaborations shall allow alarm and events to be exported from the ACS to other 3rd party reporting engines.
- a. Each event push collaboration shall be defined with specific event types to be exported along with the schedule in which they are to be exported.
 - b. Events shall have the option to be exported with detailed alarm response information including acknowledgments, clears, and operator notes.
7. Collaborations shall allow administrators to select a subset of data for export or import operations. Filters shall be used to define which records would be selected for the import or export.

2.5 ACCESS CONTROL FIELD EQUIPMENT

- A. The access control panels shall include integrated power supplies, intelligent controller, two door modules (up to 8 modules) and input/output modules as required.
- 1. Intelligent controller:
 - a. The intelligent controller shall provide decision making, event reporting, and database storage for hardware platform. Two reader interfaces shall provide control for two doors and capable of supporting up to an additional 62 doors

in paired and or alternate reader configurations with peripheral interface devices.

- b. The controller shall communicate with the host via on-board 10BaseT/100BaseTX Ethernet port.
- c. Two physical barriers shall be controlled. Each reader port shall accommodate a read head that utilizes Wiegand, magnetic stripe, or 2-wire RS-485 electrical signaling standards, one or two wire LED controls, and buzzer control.
- d. Technical specifications:
 - 1) Primary power: 12 to 24 volts DC, +/- 10-percent, 500mA maximum.
 - 2) Communications ports:
 - a) Host port 0: 10/100 Ethernet.
 - b) Host port 1: RS-232.
 - c) Peripheral interface port: RS-485, 2-wire.
 - 3) Inputs:
 - a) Eight (8) general purpose, programmable circuit type.
 - b) Two (2) dedicated: Tamper and power monitor.
 - 4) Outputs: Four (4) relays, Form-C, 5 amp, 30volt DC.
 - 5) Readers ports, two (2) reader ports:
 - a) Unregulated pass-through (150mA maximum) or regulated 12 volt DC.
 - b) Signaling clock/data, Wiegand or 2-wire RS-485.
 - 6) Keypad: Multiplexed with card data.
 - 7) LED: Two-wire or one-wire bicolor support.
 - 8) Buzzer: One-wire LED mode.
 - 9) Temperature: 0 to 70 degrees C operational, -55 to 85 degrees C storage.
 - 10) Humidity: 10 to 95-percent relative humidity, non-condensing (RHNC).
 - 11) Standards:
 - a) UL294 recognized, CE compliant, RoHS.
 - b) FCC Part 15 Class A, NIST certified encryption
 - 12) Technical features for connectivity: 10/100 Ethernet, RS-232, Dial-up.
- e. Door control:
 - 1) Two-reader ports: Clock/data, Wiegand, or RS-485.
 - 2) Eight (8) programmable inputs, four (4) relays, diagnostic LEDs.
- f. Access control:
 - 1) 240,000 cardholder capacity, 50,000 transaction buffer, 32 access levels per cardholder, 19-digit (64-bit) user ID and 15-digit PIN numbers maximum. Activation and deactivation dates, if/then macro capability.

- g. Card formats:
 - 1) Eight (8) active card formats per intelligent controller.
 - 2) 19-digit (64-bit) user ID and 15-digit PIN numbers maximum.
 - 3) PIV-II, CAC, TWIC card compatible.
 - h. Card reader functions:
 - 1) Multiple card format support by reader.
 - 2) Paired reader support.
 - 3) Alternate reader support.
 - 4) Elevator support.
 - 5) Turnstile support.
 - 6) Biometric device support.
 - 7) Open supervised device protocol (OSDP) compliant.
 - 8) Occupancy count.
 - 9) Support of multi-occupancy rules.
 - 10) Anti-passback support.
 - 11) Area-based, reader-based, or time-based.
 - 12) Nested area, hard, soft, or timed forgiveness.
 - 13) Supports host-based approval rules.
 - 14) Keypad support with programmable user commands, card input.
 - 15) Shunt relay support.
 - 16) Strike follower relay support.
 - i. Database functions:
 - 1) Configurable card database.
 - 2) Supports up to nineteen (19) digital card numbers.
 - 3) Supports pin codes up to fifteen (15) digits.
 - 4) Programmable card activation and deactivation times and dates.
 - 5) Card issue code, ADA and VIP flags (up to 32-bits); PIV (75-bits); smart card (200-bits).
 - 6) Up to 128 access levels per user.
 - 7) Ability to track people and objects.
 - j. Intrusion alarm functions:
 - 1) Supports entry delays and exit delays.
 - 2) Area monitoring.
 - 3) Standard alarm masking.
 - 4) Provides control and alarm processing from the keypad.
2. Two door controllers:

- a. The peripheral interface device shall provide a solution for interfacing to TTL/Wiegand/RS-485 type readers and door hardware. The intelligent controller shall accept data from a reader with clock/data, Wiegand or RS-485 signaling, provide a tri-stated LED control and buzzer control. It shall also provide six (6) Form-C relay outputs and eight (8) supervised inputs for monitoring. The controller shall communicate via a 2-wire, RS-485 interface.
- b. Technical specifications:
 - 1) Primary power:
 - a) 12 to 24 volt DC. +/- 10-percent, 500mA maximum.
 - b) 12 volt DC @ 450mA nominal, plus reader current.
 - c) 24 volt DC @ 270mA nominal, plus reader current.
 - 2) Communications ports:
 - a) Peripheral interface port: RS-485, 2-wire.
 - b) Reader interface: Two (2) reader ports, data card/keypad, clock/data, data-1/data-0, or 2-wire RS-485.
 - 3) LED: One-wire bi-color LED support or two-wire.
 - 4) Buzzer: One-wire LED mode.
 - 5) Keypad: 8-bit Mercury, 8-bit Dorado, or 4-bit HID
 - 6) Reader Power: Pass-through or 12 volt DC regulated power, 125mA each reader.
 - 7) Inputs: Eight (8) general purpose programmable type and two dedicated for tamper and power monitor.
 - 8) Outputs: Six (6) relays, Form-C, 5 amp at 28 volt DC.
 - 9) Temperature: 0 to 70-degrees C operational, -55 to 85-degrees C storage.
 - 10) Humidity: 10 to 95-percent RHNC
 - 11) Standards: UL 294 recognized, CE compliant, RoHS
- c. Technical features:
 - 1) Card formats:
 - a) Eight (8) active card formats per intelligent controller.
 - b) 19-digit (64-bit) user ID and 15-digit PIN numbers maximum.
 - c) PIV-II, CAC, TWIC card compatible.
 - 2) Card reader functions:
 - a) Multiple card format support by reader.
 - b) Paired reader support.
 - c) Alternate reader support.
 - d) Turnstile support.
 - e) Biometric device support.
 - f) Keypad support with programmable user commands, card input.

- g) Shunt relay support.
 - h) Strike follower relay support.
 - 3) Database functions: Supports up to nineteen (19) digital card numbers.
 - 4) Intrusion alarm functions:
 - a) Supports entry delays and exit delays.
 - b) Provides control and alarm processing from the keypad.
 - c) Offline mode operation.
 - d) Door mode: Unlocked, locked, facility code only.
 - e) Relay mode: Programmable for offline conditions.
- 3. In/out modules:
 - a. Input and output modules shall be used for the connection of peripheral sensors and electric locks at the door if required when devices are greater than the door controllers can support.
 - b. Input modules:
 - 1) The peripheral interface device shall be used to monitor sixteen (16) inputs.
 - 2) Primary power:
 - a) 12 to 24 volt DC, ± 10 -percent, 350mA maximum.
 - b) 12 volt DC at 300mA nominal.
 - c) 24 volt DC at 220mA nominal.
 - 3) Communication: 2-wire RS-485, 4,000-feet using Belden #9841.
 - 4) Inputs: Sixteen (16) general purpose programmable type and two (2) dedicated for tamper and power monitor.
 - 5) Outputs: Two (2) relays, Form-C, 5amp, 28 volt DC.
 - 6) Temperature: 0 to 70-degrees C operational, -55 to 85-degrees C storage.
 - 7) Humidity: 10 to 95-percent RHNC.
 - 8) Standards: UL 294 recognized, CE compliant, RoHS.
 - 9) Offline mode operation.
 - 10) Relay mode.
 - 11) Programmable for offline conditions.
 - c. Output modules:
 - 1) The peripheral interface device shall be used to provide sixteen (16) dry contact outputs to auxiliary equipment such as locks or to activate alarm.
 - 2) Primary power:
 - a) 12 to 24 volt DC, ± 10 -percent, 1100mA maximum.
 - b) 12 volt DC at 850mA nominal.
 - c) 24 volt DC at 450mA nominal.

- 3) Communication: 2-wire RS-485, 4,000-feet using Belden #9841.
- 4) Inputs: Two (2) dedicated for tamper and power monitor.
- 5) Outputs: Sixteen (16) relays, Form-C, 5amp at 28 volt DC.
- 6) Temperature: 0 to 70-degrees C operational, -55 to 85-degrees C storage.
- 7) Humidity: 10 to 95-percent RHNC.
- 8) Standards: UL 294 recognized, CE compliant, RoHS.
- 9) Offline mode operation.
- 10) Relay mode.
- 11) Programmable for offline conditions.

B. Proximity card readers:

1. Provide one reader at each new card reader access control door opening noted on the Drawings.
2. Card reader specifications:
 - a. Frequency:
 - 1) 125kHz contactless smart cards supported. HID, Indala, Casi Rusco, AWID, Farpointe, others.
 - 2) 13.56 MHz contactless smart cards supported. uTrust, PIV, PIV-I, CAC, TWIC, MIFARE Classic, MIFARE DESFire EV1, PLAID [AS 5185-2010], ISO15693 UID, ISO 14443 A/B UID.
 - b. Protocol: Open supervised device protocol (OSDP) mode, Wiegand, clock/data modes.
 - c. Voltage: 5 to 16 volt DC.
 - d. Power supply: Linear DC.
 - e. Cable Distance: 500-feet.
 - f. Color: Black
 - g. Mount readers on shallow depth single gang, double-gang electrical boxes as required or mullion mount.
 - h. Provide read tamper switch.

C. Door monitor switch:

1. Provide low-voltage magnetic door position sensor, as follows:
 - a. Mounting: Recessed.
 - b. Switch type: Single pole, double throw switch.
 - c. Gap distance: 0.5" maximum.
 - d. Installation: For wood, steel, and hollow metal doors.
2. Roll-up doors:
 - a. Mounting: Surface.
 - b. Switch type: Normally closed contacts.

- c. Gap distance: 3.0" maximum.
 - d. Wiring: MC cable, 36" minimum.
- D. Access control cards:
 - 1. Format: Weigand 35-bit.
 - 2. Frequency: 125kHz and 13.56mHz.
 - 3. Cards shall feature graphic-quality surface that supports direct-to-card printing.
 - 4. Capable of being produced with holograms, ultra-violet fluorescent inks, or other anti-counterfeiting features.
 - 5. Provide 100 proximity cards.
- E. Request-to-exit (REX) motion sensors:
 - 1. Power: 12 or 24 volt DC, 35mA.
 - 2. Relay output: Two (2) Form C, will be connected to the reader controller input. Includes adjustable relay latch time.
 - 3. Programmable retrigger or non-retrigger mode.
 - 4. Radio frequency interference (RFI): Immunity range from 26 to 1,000mHz at 50v/m.
 - 5. Color: Light gray or white color to match adjacent finishes.
 - 6. Mount device on ceiling or door frame. Exact location will depend on existing conditions and the required coverage area. Unless noted otherwise on Drawings, conceal wireways and junction box.
- F. Power Supplies and accessories:
 - 1. Power supplies at panel assembly:
 - a. Provide power supplies with 12 and 24 volt DC outputs for all electrically controlled door locks. Power supplies shall permit simultaneous continuous-duty activation of all door locks, with an additional minimum 30-percent capacity on each supply. Provide battery back-up sufficient for 25 activations for all DC locks.
 - b. Power supply, as required by the system manufacturer.
 - c. Integrated battery charger.
 - 2. Power supplies at door controllers:
 - a. Shall be able to house the access control door controller boards and in/out modules in a single panel.
 - b. System requirements:
 - 1) 120 volt AC input.
 - 2) 12 and 24 volt DC outputs.
 - 3) On board fire alarm interface.
 - 4) Continuous and resettable DC.
 - 5) Distributed outputs, auxiliary and controlled.
 - 6) Network monitoring and reporting.

3. Batteries:

- a. Batteries shall be UL Listed and suitable for the purpose of backing up power to ACS equipment, field devices, electric locks, etc.
- b. System requirements:
 - 1) Voltage: 12 volt DC
 - 2) Amps: 12
 - 3) Chemistry: SLA or VRLA
 - 4) Termination: Spade protected terminals.
- 4. Accessories: If necessary, provide interfacing relays between access control panel (ACP) and electric locks being controlled.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Contractor shall thoroughly examine Project site conditions for acceptance of the access control system installation to verify conformance with Manufacturer and Specification tolerances. Do not commence with installation until all conditions are made satisfactory.

3.2 COORDINATION

- A. Coordinate all installation requirements for door locks with other trades. Refer to door hardware.
- B. Install conduits, ceiling access panels, panel interface module, door hardware and connections to doors and frames for complete operating installation. All connections shall be concealed.

3.3 PROGRAMMING

- A. Special coordination is required with the owners facilities Office regarding programming requirements. Meet with owner representatives and submit proposed labels for all input and output points for review and comment. Software labels shall be consistent between various integrated systems.
- B. Program automatic door unlock, time specifications, and access levels as directed by the Owner.

3.4 INSTALLATION

- A. All electrical power work, conduit work, and power wire pulling shall be by licensed electricians, and all card reader installation and interconnection work shall be by the access control system certified technicians.
- B. Provide all wiring in conduit when exposed.
- C. Method and routing of any exposed raceways or wiring shall be approved by the owner prior to installation.
- D. Wiring shall be grouped and harnessed to facilitate access to all equipment, as well as maintenance and replacement of equipment.
- E. All cable shall be labeled at origin and termination, referencing to a master legend schedule shown on submittal drawings. Labeling and any splice locations shall be noted on Record Drawings.

- F. Provide 120 volt receptacle outlets dedicated to the access control panel power supplies.

3.5 WIRE AND CABLE PRODUCTS

- A. Security contractor shall follow the manufacturers' recommendation for cabling or the minimum requirements of the Specifications, whichever provides for the most stringent requirements.
- B. Cables are to be shielded as necessary to preclude any outside noise or interference from entering the cable and degrading system performance. All cables shall be UL Listed, and appropriate for the application.
- C. Coordinate with the owner's IT department connections to onsite monitoring.
- D. Cables run underground, under slab, or in slab shall be installed in conduit and rated for direct-burial application. Cables exposed to weather shall be rated for that use.
- E. Mixing of low-voltage cables with telephone/data cables is not permitted.
- F. All cables shall be run in unbroken lengths of 1,000-feet or less. When cable cannot be run in unbroken lengths due to cable spool limitations.
- G. The use of all screw type connectors i.e., snap caps, wire nuts, and the "twist and tape" method are prohibited.
- H. All 24 volt AC power cabling shall be of stranded construction. Terminal strips and fork spade lugs shall be utilized for all terminations.
- I. Wiring shall be grouped, bundled, harnessed, and dressed neatly to facilitate access to all equipment, as well as maintenance and replacement of equipment.
- J. All cable shall be labeled at origin and termination, referencing to a master legend schedule as shown on "As-Built" Record Drawings. Labeling and any splice locations shall be noted on "As-Built" Record Drawings. All labels shall be done using machine generated cable tags in the "flagged" position. Handwritten labels are not acceptable.

3.6 FIELD QUALITY CONTROL

- A. Manufacturer's field service: Contractor shall arrange and pay for the services of a factory-authorized service representative to supervise the initial start-up, pretesting, and adjustment of the access control system.
- B. Pretesting objectives shall be to:
 - 1. Assure system installation conforms to specified requirements and operates within specified tolerances.
 - 2. Field test and inspect to ensure operation in accordance with Manufacturer's recommendations and Specifications.
 - 3. Prepare final test report including results, observations, failures, adjustments, and remedies.
 - 4. Apply label on security system control panel upon satisfactory completion of tests and results.
 - 5. Verify settings and make final adjustments.
- C. At least three weeks prior to any testing, notify the Engineer so that arrangement can be made for witnessing test, if deemed necessary. All pretesting shall have been tested satisfactorily prior to the Engineer's witnessed test.

D. Pre-functional testing:

1. Visual and mechanical inspection:

- a. Inspect for physical damage, defects alignment and fit.
- b. Perform mechanical operational tests in accordance with Manufacturer's instructions.
- c. Compare nameplate information and connections to Contract Documents.
- d. Check tightness of all control and power connections.
- e. Check that all covers, barriers, and doors are secure.

2. Electrical tests:

- a. The system shall be completely tested prior to final acceptance testing. All points shall be tested from point of initiation to the final point or points of annunciation. All circuits shall be tested for continuity and ability to transmit the required signal correctly to the controller. Any problem due to wrong wire type, wire twist, impedance, mismatches, noise filtering or shielding shall be completely corrected during pretesting and prior to any final acceptance tests.
- b. Testing shall include each device in the system. Coordinate with other trades as necessary for testing.
 - 1) Door controllers: Verify controller is powered and connected to the network.
 - 2) Card reader: Ensure that card reader provides feedback from illuminated LED display, green if successful, red if not successful, with audible beep.
 - 3) Request to exit: Ensure that request to exit devices disengage electric locks and re-engage the locked position after door returns to closed position.
- c. Test report:
 - 1) Provide a complete report listing every device, the date it was tested, the results and the date retested (if failure occurred during the previous test). The test report shall indicate that every device tested successfully.
 - 2) Submit two typed copies of the test report in a neatly bound folder for review and approval. Failure to comply with this will result in a delay of final testing and acceptance.

E. In the event that the system fails to function properly during the testing, as a result of inadequate pretesting or preparation, the Contractor shall bear all costs incurred by the necessity for retesting including test equipment, transportation, subsistence and the Engineer's hourly rate.

F. Contractor shall replace at no costs to the Owner all devices which are found defective or do not operate within factory specified tolerances.

G. Contractor shall submit the Testing Agency's final report for review prior to Project closeout and final acceptance by the Owner. Test report shall indicate test dates, devices tested, results, observation, deficiencies, and remedies. Test report shall be included in the operation and maintenance manuals.

3.7 TRAINING

- A. Factory authorized service representative shall conduct an 8-hour training seminar for Owner's Representatives upon completion and acceptance of system. Instructions shall include safe operation, maintenance, and testing of equipment with both classroom training and hands-on instruction.
- B. Contractor shall schedule training with a minimum of 7-days advance notice.

END OF SECTION

SECTION 31 00 00
EARTHWORK

PART 1 - GENERAL

1.01 INCLUSION OF OTHER CONTRACT DOCUMENTS

- A. The General Conditions, Supplementary Conditions and Division 1 are fully applicable to this Section, as if repeated herein.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 015000, Construction Facilities and Temporary Controls.
- B. Section 015713, Erosion Control
- C. Section 312333, Trenching and Backfilling.
- D. Section 313200, Soil Stabilization
- E. Section 321200, Asphalt Concrete Paving.
- F. Section 321600, Site Concrete.
- G. Section 328000, Irrigation.
- H. Section 329000, Landscaping.
- I. Section 334000, Site Drainage.

1.03 QUALITY ASSURANCE

- A. Use only new materials and products, unless existing materials or products are specifically shown otherwise on the Drawings to be salvaged and re-used.
- B. All materials, components, assemblies, workmanship and installation are to be observed by the Owner's Inspector of Record. Work not so inspected is subject to uncovering and replacement.
- C. The representatives of the Owner's testing lab will not act as supervisor of construction, nor will they direct construction operations. Neither the presence of the Owner's testing lab representatives nor the testing by the Owner's testing lab shall excuse the contractors or subcontractors for defects discovered in their work during or following completion of the project. Correcting of inadequate compaction or moisture content is the sole responsibility of the contractor.
- D. Tests (See Part 3 for Compaction Testing).
- E. Contractor shall be solely responsible for all subgrades built. Failures resulting from inadequate compaction or moisture content are the responsibility of the contractor. Contractor shall be solely responsible for any and all repairs.

1.04 SUBMITTALS

- A. Refer to Section 013300.

- B. Manufacturer's Data: Submit list and complete descriptive data of all products proposed for use. Include manufacturer's specifications, published warranty or guarantee, installation instructions, and maintenance instructions.

1.05 WARRANTY

- A. Refer to General Conditions and Section 017836.

1.06 REFERENCES AND STANDARDS

- A. General: Site survey, included in the drawings, was prepared by Warren Consulting Engineers and is the basis for data regarding current conditions. While the survey is deemed generally accurate, there exists discrepancies and variations due to elapsed time, weather, etc. Existing dirt grades may vary 0.2 ft. from that shown.
- B. Geotechnical Engineering Report was prepared by Geocon. Report is entitled Dixon Fire Station 82 and is on file with Architect. Soils information is taken from this Report. Contractor is responsible for any conclusions drawn from this data; should he prefer not to assume such risk he is under obligation to employ his own experts to analyze available information and/or to make additional explorations, at no cost to Owner, upon which to base his conclusions. Neither Owner, Soils Engineer nor Architect guarantees information will be continuous over entire site of work.
- C. Site Visitation: All bidders interfacing with existing conditions shall visit the site prior to bid to verify general conditions of improvements. Discrepancies must be reported prior to the bid for clarification.
- D. ANSI/ASTM D698-e1 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (56,000 ft-lbf/ft³ (2,700 kN-m/m³)).
- E. ANSI/ASTM D1556-e1 - Test Method for Density of Soil in Place by the Sand-Cone Method.
- F. ANSI/ASTM 698-12e2 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m³)).
- G. ANSI/ASTM D 3017-05 Test Methods for Moisture Content of Soils and Soil-Aggregate Mixture by Nuclear Methods (Shallow Depth).
- H. ANSI/ASTM D 4318-10e1 Test Method for Liquid Limit, Plastic Limit, and Plasticity Limit.
- I. CALTRANS Standard Specifications Section 17.
- J. CAL-OSHA, Title 8, Section 1590 (e).
- K. Any work within the street, highway or right-of-way shall be performed in accordance with the requirement of the governmental agencies having jurisdiction, and shall not begin until all of those governing authorities have been notified.

1.07 DELIVERY, STORAGE AND HANDLING

- A. Transport, store and handle in strict accord with the local jurisdiction.
- B. Make delivery to job when notified by Contractor verifying that the job is ready to receive the work of this Section and that arrangements have been made to properly store, handle and protect such materials and work.

1.08 PROJECT CONDITIONS

- A. Existing civil, mechanical and electrical improvements are shown on respective site plans to the extent known. Should the Contractor encounter any deviation between actual conditions and those shown, he is to immediately notify the Architect before continuing work.
- B. Excavation dewatering may be necessary. Contractor shall provide any and all tools, equipment and labor necessary for excavation dewatering no matter what the source. Dewatering shall be continuous until all site utilities are installed and backfilled.

1.09 EXISTING SITE CONDITIONS

- A. Contractor shall acquaint himself with all site conditions. If unknown active utilities are encountered during work, notify Architect promptly for instructions. Failure to notify will make Contractor liable for damage to these utilities arising from Contractor's operations subsequent to discovery of such unknown active utilities.

1.10 ON SITE UTILITY VERIFICATION AND REPAIR PROCEDURES

- A. Ground-breaking requirements:
 - 1. All underground work performed by a Contractor must be authorized by the District's Construction Manager or the Low Voltage Consultant prior to start of construction.
 - 2. The Contractor is to obtain and keep the original School's construction utility site plans on site during all excavation operations. Contractor can contact the District's Construction Manager, Facilities Manager, or the Low Voltage Consultant to procure the drawings.
- B. Underground Utility Locating:
 - 1. The contractor shall hire an Underground Utility Locating Service to locate existing underground utility pathways in areas affected by the scope of work for excavation.
 - 2. Contractor must use an underground utility locator service with a minimum of 3 years' experience. The equipment operator must have demonstrated experience.
 - 3. The Underground Utility Locator Service must have the use of equipment with the ability to locate by means of inductive clamping, induction, inductive metal detection, conductive coupling, or TransOnde (Radio detection) to generate signals, passive locating (free scoping) for "hot" electric, and metal detector.
 - 4. The Underground Utility Locator Service must be able to locate existing utilities at a depth of at least 72".
 - 5. The Underground Utility Locator Service must be able to locate but are not limited to locating the following types of utility pathways:
 - a) All conduit pathways containing 110 volt or greater 50-60Hz electrical wire.
 - b) All conduit pathways containing an active cable TV system.
 - c) All conduit pathways containing wire or conductor in which a signal can be attached and generated without damaging or triggering the existing systems.
 - d) All empty conduit pathways or pipe in which a signal probe or sonde (miniature transmitter) can be inserted.
 - e) All conduit pathways containing non-conductive cables or wires in which a signal probe or sonde (miniature transmitter) can be inserted.
 - f) All plastic and other nonconductive water lines in which a TransOnde Radio Detection or

other "transmitter" can be applied to create a low frequency pressure wave (signal) without damaging or triggering the existing systems.

- g) All copper or steel waterlines and plastic or steel gas lines
- 6. All markings made by the Underground Utility Locator Service or other shall be clear and visible.
- 7. The contractor shall maintain all markings made by Underground Utility Locator Service or other throughout the entire length of the project.
- 8. The Underground Utility Locator Service shall provide the contractor with two sets of maps showing the location of utilities and average depth. They will be referenced to permanent buildings. Contractor will deliver one copy to the district at no additional charge.
- 9. Contractor is responsible to contact Underground Service Alert (U.S.A. 800/227-2600) and receive clearance prior to any excavation operations.
- 10. Contractor shall inform the Owner no later than five (5) days prior to the date scheduled for the utility locator service to be on site.

1.11 PROTECTION

- A. Adequate protection measures shall be provided to protect workmen and passers-by on and off the site. Adjacent property shall be fully protected throughout the operations. Blasting will not be permitted. Prevent damage to adjoining improvements and properties both above and below grade. Restore such improvements to original condition should damage occur. Replace trees and shrubs outside building area disturbed by operations.
- B. In accordance with generally accepted construction practices, the Contractor shall be solely and completely responsible for working conditions at the job site, including safety of all persons and property during performance of the work. This requirement shall apply continuously and shall not be limited to normal working hours.
- C. Any construction review of the Contractor's performance conducted by the Geotechnical Engineer is not intended to include review of the adequacy of the Contractor's safety measures, in, on, or near the construction site.
- D. Provide shoring, sheeting, sheet piles and or bracing to prevent caving, erosion or gullyng of sides of excavation.
- E. Surface Drainage: Provide for surface drainage during period of construction in manner to avoid creating nuisance to adjacent areas. The contractor shall make a reasonable effort on a daily basis to keep all excavations and the site free from water during entire progress of work, regardless of cause, source, or nature of water.
- F. Adjacent streets and sidewalks shall be kept free of mud, dirt or similar nuisances resulting from earthwork operations.
- G. The site and adjacent influenced areas shall be watered as required to suppress dust nuisance. Dust control measures shall be in accordance with the local jurisdiction.

1.12 SEASONAL LIMITS

- A. No fill material shall be placed, spread or rolled during unfavorable weather conditions. When work is interrupted by rains, fill operations shall not be resumed until field tests indicate that moisture content and density of fill are satisfactory.

- B. Excessively wet fill material shall be bladed and aerated per section 3.08, B.

1.13 TESTING

- A. General: Refer to Section 014500 – Quality Requirements.
- B. Geotechnical Engineer: Owner is retaining a Geotechnical Engineer to determine compliance of fill with Specifications, and to direct adjustments in fill operations. Costs of Geotechnical Engineer will be borne by Owner; except those costs incurred for re-tests or re-inspection will be paid by Owner and back charged to Contractor.
 - 1. If Contractor elects to process or mine onsite materials for use as Suitable Fill, Aggregate Sub Base, Aggregate Base, Rock, Crushed Rock or sand the cost of all testing of this material shall be paid for by the Contractor.
 - 2. Testing of import fill for compliance with Department of Toxic Substance Control (DTSC) shall be paid for by the Contractor.

1.14 ARCHEOLOGICAL AND CULTURAL RESOURCES

- A. If archeological or cultural resources are discovered during the Work, the Contractor must cease all construction operations in the vicinity of the discovery until a qualified archeologist can assess the value of these resources and make recommendations to the State Historic Preservation Officer. Archeological and cultural resources include artifacts, large amounts of bone, shell, or flaked stone, and other evidence of human activity. If the State Historic Preservation Officer or the Owner directs that work be temporarily ceased at the location of an archeological or cultural find, the Contractor must temporarily suspend work at the location.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Engineered Fill Materials: All fill shall be of approved local materials supplemented by imported fill if necessary. "Approved" local materials are defined as local soils tested and approved by Geotechnical Engineer free from debris, and concentrations of clay and organics; and contain rocks no larger than 1-inches in greatest dimension. The soil and rock should be thoroughly blended so that all rock is surrounded by soil. This may require mixing of the soil and rock with a dozer prior to placement and compaction. Clods, rocks, hard lumps or cobbles exceeding 1-inches in final size shall not be allowed in the upper 12 inches of any fill.
- B. Imported Engineered Fill Material: Imported fill may be required to complete work. Proposed import fill material shall meet the above requirements; shall be similar to the native soils. Import fill shall meet the above requirements; shall have a maximum particle size of 6 inches, with sufficient fines to act as a binder to reduce caving potential. Shall have a plasticity index less than or equal to 15 and an expansion index of less than 50. All import fill material shall be tested and approved by Soils Engineer prior to transportation to the site.
- C. Landscape Backfill Material:
 - 1. The top 3" of native topsoil stripped from the site may be used for landscape backfill material provided it meets the requirements as specified in Section 329000.
 - 2. Imported Topsoil may be required to complete work. See Section 329000 for requirements. Proposed Topsoil material shall comply with DTSC guidelines to include Phase 1 environmental site assessment and related tests. Refer to the October 2001 DTSC

Information Advisory for clean imported fill material.

- D. Water: Furnish all required water for construction purposes, including compaction and dust control. Water shall be potable.
- E. Aggregate Base: Provide Class 2 3/4" Aggregate Base conforming to standard gradation as specified in Cal Trans Standard Specifications, Section 26,-1.02A.
- F. Decomposed Granite: Decomposed Granite shall be well graded mixture of fine to 1/8" particles in size with no clods. The material shall be free of vegetation, other soils, debris and rock. The material shall be reddish-tan to tan in color.
- G. Decomposed Granite Solidifier: PolyPavement or equal.

PART 3 – EXECUTION

3.01 INSPECTION LAYOUT AND PREPARATION

- A. Prior to installation of the work of this Section, carefully inspect and verify by field measurements that installed work of all other trades is complete to the point where this installation may properly commence
- B. Layout all work, establish grades, locate existing underground utilities, set markers and stakes, setup and maintain barricades and protection facilities; all prior to beginning actual earthwork operations. Layout and staking shall be done by a licensed Land Surveyor or Professional Civil Engineer.
- C. Verify that specified items may be installed in accordance with the approved design.
- D. In event of discrepancy, immediately notify Owner and the Architect. Do not proceed in discrepant areas until discrepancies have been fully resolved.

3.02 PERFORMANCE

A. GENERAL:

- 1. General: Do all grading, excavating and cutting necessary to conform finish grade and contours as shown. All cuts shall be made to true surface of subgrade.
- 2. Archaeological Artifacts: Should any artifacts of possible historic interest be encountered during earthwork operations, halt all work in area of discovery and immediately contact the Architect for notification of appropriate authorities.
- 3. Degree of Compaction: Percentage of maximum density, hereinafter specified as degree of compaction required, means density equivalent to that percentage of maximum dry density determined by ASTM D1557 Compaction Test method, and such expressed percentage thereof will be minimum acceptable compaction for specified work.
- 4. Moisture Content: Moisture content shall be as noted below and as called for on the plans. Moisture content shall be maintained until subgrade is covered by surfacing materials.

3.03 DEMOLITION, DISPOSAL AND DISPOSITION OF UNDESIRABLE MAN-MADE FEATURES

- A. All other obstructions, such as abandoned utility lines, septic tanks, concrete foundations, and the like shall be removed from site. Excavations resulting from these removal activities shall be cleaned of all loose materials, dish shaped, and widened as necessary to permit access for compaction equipment. Areas exposed by any required over-excavation should be scarified to a

depth of 8", moisture-conditioned to (2% above optimum moisture content, and recompacted to at least 90% of the maximum dry density.

3.04 TESTING AND OBSERVATION

- A. All grading and earthwork operations shall be observed by the Geotechnical Engineer or his representative, serving as the representative of the Owner.
- B. Field compaction tests shall be made by the Geotechnical Engineer or his representative. If moisture content and/or compaction are not satisfactory, Contractor will be required to change equipment or procedure or both, as required to obtain specified moisture or compaction. Notify Geotechnical Engineer at least 48 hours in advance of any filling operation.
- C. Earthwork shall not be performed without the notification or approval of the Geotechnical Engineer or his representative. The Contractor shall notify the Geotechnical Engineer at least two (2) working days prior to commencement of any aspect of the site earthwork.
- D. If the Contractor should fail to meet the compaction or design requirements embodied in this document and on the applicable plans, he shall make the necessary readjustments until all work is deemed satisfactory, as determined by the Geotechnical Engineer or Architect/Engineer.
- E. After each rain event Geotechnical Engineer shall test fill material for optimum moisture. Do not place any fill material until desired moisture is achieved.

3.05 CLEARING AND GRUBBING

- A. Prior to grading, remove all debris off-site. Remove trees and brush including the root systems. Holes resulting from tree and brush removal should be prepared and backfilled in accordance with paragraphs 3.07, 3.08, 3.09, and 3.10. This may require deepening and/or widening the holes to adequately remove disturbed soil and provide room for compaction equipment. Strip the surface of all organics. Stripping's meeting the requirements of Section 329000 may be used in landscape areas only.

3.06 CUTTING

- A. Building pads that are located within a cut/fill transition area will have to be overexcavated to provide a semi-uniform fill beneath the building pad. The portions of building pads located in cut areas shall be overexcavated to provide no more than 1 foot difference in fill placed in the same building pad.
- B. Do all cutting necessary to bring finish grade to elevations shown on Drawings.
- C. When excavation through roots is necessary, cut roots by hand.
- D. Carefully excavate around existing utilities to avoid unnecessary damage. The contractor shall anticipate and perform hand work near existing utilities as shown on the survey, without additional claims or cost.

3.07 STRUCTURAL EXCAVATION

- A. General: Excavate to bear on firm material at contract depth shown on Structural Drawings.
- B. Footings: All footing excavations shall be of sufficient width for installation of formwork, unless earth will retain its position during concreting. All portions of footings above grade must be formed. In the event that footings are placed against earth, footing widths below grade shall be increased 2 inches from those shown on Drawings and positive protection shall be provided for

top corners of trench.

- C. Unsuitable Ground: Any errors in structural excavation, soft ground, or clay soils found when excavating shall be reported to Architect. In no case shall work be built on any such soft or clayey unsuitable surface without direction from the Architect. Restore excavations to proper elevation with engineered fill material compacted to 90% of dry density.

3.08 SUBGRADE PREPARATION

- A. Grade compact and finish all subgrades within a tolerance of 0.10' of grades as indicated on Drawings and so as not to pool water. Subgrade within building pads and concrete walks shall be within 0.05' of grades indicated.
- B. After clearing, grubbing and over-excavation, subsurface shall be plowed or scarified to a depth of at least 12", until surface is free from ruts, hummocks or other uneven features and uniform and free from large clods. Moisture condition to at least 2% above optimum moisture content and recompact to at least 90% of the maximum dry density as determined by ASTM Test Method D1557. If the existing soils are at a water content higher than specified, the contractor shall provide multiple daily aerations by ripping, blading, and/or disking to dry the soils to a moisture content where the specified degree of compaction can be achieved. After seven consecutive working days of daily aerations, and the moisture content of the soil remains higher than specified, the contractor shall notify the architect. If the existing soils have a moisture content lower than specified, the contractor shall scarify, rip, water and blade existing soil to achieve specified moisture content. The contractor shall make proper allowance in schedule and methods to complete this work.
- C. Subgrade in areas to receive landscaping shall be compacted to 90%.
- D. Where Contractor over-excavates building pads through error, resulting excavation shall be recompacted as engineered fill at Contractor's expense.

3.09 PLACING, SPREADING AND COMPACTING FILL MATERIAL IN BUILDING PAD AND PAVEMENT AREAS

- A. Selected fill material shall be placed in layers which, when compacted, shall not exceed 6 inches in compacted thickness. Each layer shall be spread evenly and thoroughly mixed to insure uniformity in moisture content.
- B. Selected fill material shall be moisture-conditioned to specified moisture content. Selected fill material shall be unfrozen. When moisture content of fill material is below that specified, add water until proper moisture content is achieved. When moisture content is above that specified, aerate by blading or other methods mentioned in 3.08 B until moisture content is satisfactory.
- C. After each layer has been placed, mixed and spread evenly, it shall be thoroughly compacted to a minimum of 90% as determined by the ASTM D1557 Compaction Test. Compact each layer over its entire area until desired density has been obtained.
- D. Recomposition of Fill in Trenches and Compaction of Fill Adjacent to Walls: Where trenches must be excavated, backfill with material excavated. Place in lifts that when compacted do not exceed 6", moisture conditioned to at least 2% above optimum moisture content, and compact to a minimum of 90% relative compaction in building pad and paved areas, and to 90% relative compaction in landscape areas.
- E. Jetting of fill materials will not be allowed.

3.10 FINAL SUBGRADE COMPACTION

- A. Building Pads: Upper 12" of building pad shall be lime treated per specification section 313200.
- B. Paved Areas: Upper 12" of all paved areas shall be lime treated per specification section 313200.
- C. Other Fill and Backfill: Upper 12" of all other final subgrades or finish grades shall be compacted to 90% of maximum dry density.
- D. Gravel Fill: Do not place compacted gravel fill until after underground work and foundations are in place. Compact gravel fill with vibratory plate or similar equipment to preclude settlement.

3.11 PLACING, SPREADING, AND COMPACTION OF LANDSCAPE BACKFILL MATERIALS

- A. All landscaped areas shall receive topsoil. After subgrade under landscape area has been scarified and brought to 90% maximum dry density, top soil shall be placed evenly to depth of 12" at 85% of maximum dry density.
- B. Project Inspector must verify that materials are uniformly spread to minimum depth specified.

3.12 DECOMPOSED GRANITE COMPACTION AND STABILIZATION

- A. Decomposed granite paving, paths or track shall be placed uniformly to the required depth and treated with PolyPavement or approved equal. Apply PolyPavement using Application Method 1 or a mixed application method.

3.13 SLOPE CONSTRUCTION

- A. Cut slopes shall be constructed to no steeper than 2:1 (horizontal:vertical). Fill slopes shall be constructed to no steeper than 2:1 (horizontal:vertical). Prior to placement of fill on an existing slope the existing slope shall be benched. The benches shall be in a ratio of 2 horizontal to 1 vertical. The face of the fill slopes shall be compacted as the fill is placed, or the slope may be overbuilt and then cut back to the design grade. Compaction by track walking will not be allowed.

3.14 FINISH GRADING

- A. At completion of project, site shall be finished graded, as indicated on Drawings. Finish grades shall be "flat graded" to grades shown on the drawing. Mounding of finish grades will not be allowed unless otherwise directed on the landscape drawings. Tolerances for finish grades in drainage swales shall be $\pm 0.05'$. Tie in new and existing finish grades. Leave all landscaped areas in finish condition for lawn seeding. Landscaped planters shall be graded uniformly from edge of planter to inlets. If sod is used for turf areas the finish grade on which it is placed shall be lowered to allow for sod thickness.
- B. All landscape areas shall be left free of rock or foreign material as specified in Section 329000.
- C. All landscape areas shall be approved by Architect prior to any planting.

3.15 SURPLUS MATERIAL

- A. Excavated material not required for grading or backfill shall be removed from site at contractor's expense.

3.16 CLEANING

- A. Refer to Section 017400.
- B. Remove from fill all vegetation, wood, form lumber, casual lumber, and shavings, in contact with ground; buried wood will not be permitted in any fill.

END OF SECTION

SECTION 31 23 33
TRENCHING AND BACKFILLING

PART 1 – GENERAL

1.01 INCLUSION OF OTHER CONTRACT DOCUMENTS

- A. The general conditions, supplementary conditions and Division 1 are fully applicable to this section as if repeated herein.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 01 50 00, Construction Facilities and Temporary Controls.
- B. Section 31 00 00, Earthwork.
- C. Section 31 32 00 Soil Stabilization
- D. Section 33 40 00, Site Drainage.
- E. Section 33 00 00, Site Utilities.
- F. Section 32 80 00, Irrigation.
- G. Section 32 12 00, Asphalt Concrete Paving

1.03 QUALITY ASSURANCE

- A. Use only new materials and products, unless existing materials or products are specifically shown otherwise on the Drawings to be salvaged and re-used.
- B. All materials, components, assemblies, workmanship and installation are to be observed by the Owner's Inspector of Record. Work not so inspected is subject to uncovering and replacement.
- C. Contractor / Installer shall have been in business for five (5) years providing/finishing similar size projects and complexity.

1.04 SUBMITTALS

- A. Refer to Section 01 33 00.
- B. Submit Manufacturers data and shop drawings.

1.05 WARRANTY

- A. Submit fully executed warranty for work and materials in this section per 01 78 36.

1.06 REFERENCES AND STANDARDS

- A. California Building Code current edition.
- B. California Plumbing Code current edition.

1.07 DELIVERY, STORAGE AND HANDLING

- A. Transport, store and handle in strict accord with the local jurisdiction.
- B. Make delivery to job when notified by Contractor verifying that the job is ready to receive the work of this Section and that arrangements have been made to properly store, handle and protect such materials and work.

1.08 PROJECT CONDITIONS

- A. Contractor shall acquaint himself with all existing site conditions. If unknown active utilities are encountered during work, notify Architect promptly for instructions. Failure to notify will make Contractor liable for damage to these utilities arising from Contractor's operations subsequent to discovery of such unknown active utilities.
- B. Field verify that all components, backing, etc. by others are installed correctly to proceed with installation of products as herein specified.
- C. Trench dewatering may be necessary. Contractor shall provide any and all tools, equipment and labor necessary for trench dewatering no matter what the source. Dewatering shall be continuous until all site utilities are installed and backfilled.

1.09 PROTECTION

- A. Adequate protection measures shall be provided to protect workers and passers-by on and off the site. Adjacent property shall be fully protected throughout the operations. Blasting will not be permitted. Prevent damage to adjoining improvements and properties both above and below grade. Restore such improvements to original condition should damage occur. Replace trees and shrubs outside building area disturbed by operations. Repair all trenches in grass areas with new sod (seeding not permitted) and "stake-off" for protection.
- B. Contractor shall be solely and completely responsible for working conditions at the job site, including safety of all persons and property during performance of the work. This requirement shall apply continuously and shall not be limited to normal working hours.
- C. Any construction review of the Contractor's performance conducted by the Architect or Owner is not intended to include review of the adequacy of the Contractor's safety measures, in, on or near the construction site.
- D. Provide shoring, sheeting, sheet piles and or bracing to prevent caving, erosion or gullyng of sides of excavation.
- E. Surface Drainage: Provide for surface drainage during period of construction in manner to avoid creating nuisance to adjacent areas. Keep all excavations free from water during entire progress of work, regardless of cause, source or nature of water.
- F. Adjacent streets and sidewalks shall be kept free of mud, dirt or similar nuisances resulting from earthwork operations.
- G. The site and adjacent influenced areas shall be watered as required to suppress dust nuisance.
- H. Trees: Carefully protect existing trees which are to remain.

1.10 TRENCH SAFETY PROVISIONS

- A. General Contractor shall be solely responsible for safety design, construction and coordination with agencies having jurisdiction. If such plan varies from shoring system

standards established by Construction Safety Orders, plan shall be prepared by registered civil or structural engineer.

- B. Nothing herein shall be deemed to allow use of shoring, sloping or protective system less effective than that required by Construction Safety Orders of California State Division of Industrial Safety.
- C. When trenching through paved surface, provide steel trench plates to cover open trenches daily until trenches are backfilled.

1.11 SEASONAL LIMITS

- A. No backfill material shall be placed, spread or rolled during unfavorable weather conditions. When work is interrupted by heavy rains, full operations shall not be resumed until field tests indicate that moisture content and density of fill are satisfactory.
- B. Material above optimum moisture shall be processed per section 310000, 3.08, B.

1.12 TESTING

- A. General: Refer to Section 01 45 00 – Quality Requirements.

PART 2 – PRODUCTS

2.01 MATERIALS

- A. Backfill materials: Pipeline and conduit trench backfill as shown on the plans and as specified below.
 - 1. $\frac{3}{4}$ inch crush rock.
 - 2. Native Materials: Soil native to Project Site, free of wood, organics, and other deleterious substances. Rocks shall not be greater than 3-inches.
 - 3. Sand: Fine granular material, free of organic matter, mica, loam or clay.
 - 4. Lean Mix Concrete/Controlled Density Backfill: 2 sacks cement slurry.
 - 5. Class 2 aggregate base, $\frac{3}{4}$ " rock, per Caltrans section 26-1.02B
- B. Water: Furnish all required water for construction purposes, including compaction and dust control. Water shall be potable.
- C. Provide other bedding and backfill materials as described and specified in Section 31 00 00, Section 33 40 00 and Divisions 15 and 16.

PART 3 – EXECUTION

3.01 INSPECTION

- A. Verification of Conditions:
 - 1. Examine areas and conditions under which work is to be performed.
 - 2. Identify conditions detrimental to proper or timely completion of work and coordinate with General Contractor to rectify.

3.02 COORDINATION

- A. General Contractor shall coordinate work as herein specified, in accordance with drawings and as required to complete scope of work with all related trades.

3.03 INSTALLATION

- A. Perform work in accordance with pipe manufacturer's recommendations, as herein specified and in accordance with drawings.

3.04 TRENCHING

- A. Make all trenches open vertical construction with sufficient width to provide free working space at both sides of trench around installed item as required for caulking, joining, backfilling and compacting; not less than 12 inches wider than pipe or conduit diameter, unless otherwise noted.
- B. Carefully excavate around existing utilities to avoid unnecessary damage. The contractor shall anticipate and perform hand work near existing utilities as shown on the survey, without additional claims or cost.
- C. Trench straight and true to line and grade with bottom smooth and free of edges or rock points.
- D. Where depths are not shown on the plans, trench to sufficient depth to give minimum fill above top of installed item measured from finish grade above the utility as follows:
 - 1. Sewer pipe: depth to vary
 - 2. Storm drain pipe: depth to vary
 - 3. Water pipe - Fire Supply: 36 inches
 - 4. Water pipe – Domestic Supply: 30 inches
- E. Where trench through existing pavement saw cut existing pavement in straight lines. Grind existing asphalt on each side of trench 6" wide x $\frac{1}{2}$ the depth of the section. Apply tack coat to vertical surfaces before installing new asphalt. Replace asphalt and concrete pavement sections to matched existing conditions. In concrete pavement provide expansion and control joints to match existing joint layout.

3.05 BACKFILL

- A. Pipe Trench Backfill is divided into two zones:
 - 1. Bedding: Layer of material directly under the pipe upon which the pipe is laid.
 - 2. Initial Backfill: Backfill from the top of the bedding to 12 inches (compacted) over the top of the pipe.
- B. Bedding and Initial Backfill:
 - 1. Type of material for Bedding and Pipe Zone shall be as required by Drawings.
 - 2. Compaction of Bedding and Initial Backfill shall be achieved by vibratory plate as necessary to consolidate material.
 - 3. Backfill shall be brought up at substantially the same rate on both sides of the pipe and care shall be taken so that the pipe is not floated or displaced. Material shall not be dropped directly on pipe.
- C. Backfill Compaction:

1. Backfill shall be placed in layers which, when compacted shall not exceed 6 inches in thickness. Each layer shall be spread evenly and thoroughly mixed to insure uniformity. Do not backfill over, wet, frozen or soft subgrade surfaces. Employ a placement method that does not disturb or damage foundation walls, perimeter drainage, foundation damp-proofing, waterproofing or protective cover.
2. When moisture content of fill material is below that required to achieve specified density, add water until proper moisture content is achieved. When moisture content is above that required, aerate by blading or other methods until specified moisture content is met, see section 310000, 3.08, B.
3. After each layer has been placed, mixed and spread evenly, it shall be thoroughly compacted to 90% of maximum dry density while at specified moisture content. Compact each layer over its entire area until desired density has been obtained.
4. The top 12 inches of subgrade compaction under pavement or building shall be per Earthwork section 31 00 00.
5. Compaction: All backfill operations shall be observed by the Inspector of Record and/or Geotechnical Engineer. Field density tests shall be made to check compaction of fill material. If densities are not satisfactory, Contractor will be required to change equipment or procedure or both, as required to obtain specified densities. Notify Inspector and Architect at least 24 hours in advance of any operation.

E. Backfill in Areas Previously Lime Treated

1. If trenching is necessary in areas that have been previously lime treated the contractor shall backfill the trench with class 2 aggregate base, with minimum section equal to the lime treated section and compacted to 95%.

3.06 TRENCH AND SITE RESTORATION

- A. Finished surface of trenches shall be restored to a condition equal to, or better than the condition as existed prior to excavation work.

3.07 PROTECTION

- A. Protect existing surfaces, structures, and utilities from damage. Protect work by others from damage. In the event of damage, immediately repair or replace to satisfaction of Owner.
- B. Repair existing landscaped areas to as new condition. Replant trees, shrubs or groundcover with existing materials if not damaged or with new materials if required. Replace damaged lawn areas with sod, no seeding will be permitted.
- C. Replace damaged pavement with new compatible matching materials. Concrete walks to be removed to nearest expansion joint and entire panel replaced. Asphalt to be cut neatly and replaced with new materials.
- D. Any existing materials removed or damaged due to trenching to be returned to new condition.

3.08 SURPLUS MATERIAL

- A. Remove excess excavated material, unused materials, damaged or unsuitable materials from site.

3.09 CLEANING

- A. Refer to Section 01 74 00.
- B. Contractor will keep the work areas in a clean and safe condition so his rubbish, waste, and debris do not interfere with the work of others throughout the project and at the completion of work.
- C. After completion of work in this section, remove all equipment, materials, and debris. Leave entire area in a neat, clean, acceptable condition.

END OF SECTION

SECTION 31 32 00
SOIL STABILIZATION

FOR USE WITH LIME TREATMENT
PART 1 – GENERAL

1.01 INCLUSION OF OTHER CONTRACT DOCUMENTS

- A. The General Conditions, Supplementary Conditions and Division 1 are fully applicable to this Section, as if repeated herein.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 01 50 00, Construction Facilities and Temporary Controls.
- B. Section 31 00 00 Earthwork
- C. Section 31 23 33, Trenching and Backfilling.

1.03 QUALITY ASSURANCE

- A. Use only new materials and products, unless existing materials or products are specifically shown otherwise on the Drawings to be salvaged and re-used.
- B. All materials, components, assemblies, workmanship and installation are to be observed by the Owner's Inspector of Record. Work not so inspected is subject to uncovering and replacement.
- C. The representatives of the Owner's testing lab will not act as supervisor of construction, nor will they direct construction operations. Neither the presence of the Owner's testing lab representatives nor the testing by the Owner's testing lab shall excuse the contractors or subcontractors for defects discovered in their work during or following completion of the project. Correcting inadequate compaction is the sole responsibility of the contractor.
- D. Tests (See Part 3 for Compaction Testing).
- E. Contractor shall be solely responsible for all subgrades built. Any repairs resulting from inadequate compaction are the responsibility of the contractor.
- F. Failures due to the lack of continuous moisture control during the curing period will be the sole responsibility of the contractor.
- G. Any trenching through the finished cured lime/cement section will result in the contractor having to backfill trench with class 2 aggregate base rock, or cement/sand slurry,

1.04 SUBMITTALS

- A. Refer to Section 01 33 00.

1.05 WARRANTY

- A. Refer to General Conditions and Section 01 78 36.

1.01 SCOPE OF WORK

- A. Description: Provide Lime Stabilization Treatment, including spreading and mixing lime and water with in-place materials, and compacting the mixture to the lines, grades and dimensions shown on the plans and/or specified.
- B. Related Work Specified Elsewhere:
 - 1. Measure and Payment: Section 01 29 00.

1.02 QUALITY ASSURANCE

- A. General: All Quality Assurance procedures specified on the drawings shall apply to this Section in addition to those shown below.
- B. Testing:
 - 1. Geotechnical Engineer: Owner is retaining a Geotechnical engineer to determine compliance of Lime Stabilization Treatment with Specifications, and to direct adjustments in fill operations. Costs of Geotechnical Engineer will be borne by Owner; except that costs incurred for re-tests or re-inspection will be paid by Owner and back charged to Contractor.
- C. Inspection: Work shall not be performed without the physical presence and approval of Geotechnical Engineer. The Contractor shall notify the Geotechnical Engineer at least two working days prior to commencement of any aspect of site earthwork.
- D. Field Density: Field density and phenolphthalein reaction tests shall be made by the Geotechnical Engineer after completion of compaction. Where compaction equipment has disturbed the surface to a depth of several inches, density tests shall be taken in the compacted material below the disturbed surface.

1.03 SUBMITTALS

- A. Weighmaster Certificates: Provide certificates as required in Section 2.01B.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Lime Treated Engineered Fill: The materials to be treated shall consist of on-site soils or approved import material as described in Section 31 00 00.
- B. Lime: The percentage of lime shall be based on a soil weight of 100 pcf; hence, 4.5 pounds lime should be utilized per square foot. A certification of compliance shall be submitted to the Geotechnical Engineer with each delivery of lime.
- C. Water: Water shall be added during the preliminary mixing operations and, if necessary, during final mixing and to keep the cured material moist until curing is complete. The amount of water added shall be subject to the approval of the Geotechnical Engineer at all times.

PART 3 - EXECUTION

3.01 PREPARATION

- A. General: Layout all work, establish grades, locate existing underground utilities, set markers and stakes, set up and maintain barricades and protection facilities; all prior to beginning actual earthwork operations.

3.02 EQUIPMENT

- A. Lime Spreader: The lime shall be spread by equipment which shall uniformly distribute the required amount of lime. The rate of spread per square foot of blanket shall not vary more than 5 percent from the designated rate, unless otherwise approved by the Geotechnical Engineer.
- B. Mixing Equipment: Mixing equipment shall be capable of mixing or remixing the materials to a uniform mixture free of streaks or pockets of lime to the full required depth.

3.03 START OF WORK UNDER THIS SECTION

- A. General: Prior to starting physical work under this Section, the property line is to be clearly staked and identified. No lime treated materials shall be allowed to contaminate areas outside of the property.
- B. Utilities; Contractor is to engage with a licensed contractor specialized in the Utility Locating Business. The contractor shall locate any and all utilities and pothole the same. The frequency of potholing shall be enough to establish the elevations of all utilities located.

3.04 LIME SPREADING

- A. Engineered Fill: Provide lime treatment in areas shown on plans and extending a minimum distance of 5 feet from outside edge of perimeter building footings and 2 feet beyond edge of paving.
- B. Temperature: Lime shall not be spread while the atmospheric temperature is below 35 degrees Fahrenheit or when conditions indicate that the temperature may fall below 35 degrees Fahrenheit within 24 hours.

3.05 MIXING

- A. Lime shall be added to the material to be treated at a rate of 4.5 pounds lime per square foot based on a soil unit weight of 100 pcf.
- B. Lime shall be spread by equipment that will uniformly distribute the required amount of lime for the full width of the prepared material. The rate of spread per linear foot of blanket shall not vary more than five percent (5%) from the designated rate.
- C. The spread lime shall be prevented from blowing by suitable means selected by the Contractor. Quicklime shall not be used to make lime slurry. The spreading operations shall be conducted in such a manner that a hazard is not present to construction personnel or the public. All lime spread shall be thoroughly mixed into the soil the same day lime spreading operations are performed.
- D. The distance which lime may be spread upon the prepared material ahead of the mixing operation will be determined by the Geotechnical Engineer.
- E. No traffic other than the mixing equipment and water truck will be allowed to pass over the spread lime until after the completion of mixing. After mixing, grading and compacting are completed, only the water truck is allowed on the treated area to maintain the optimum moisture for curing.
- F. Mixing equipment shall be equipped with a visual depth indicator showing mixing depth, an odometer or footmeter to indicate travel speed and a controllable water additive system for regulating water added to the mixture.

- G. Mixing equipment shall be of the type that can mix the full depth of the treatment specified and leave a relatively smooth bottom of the treated section. Mixing and re-mixing, regardless of equipment used, will continue until the material is uniformly mixed free of streaks, pockets, or clods of lime, and moisture is at approximately two percent (2%) over optimum and the mixture complies with the following requirements:

<u>Minimum Sieve Size</u>	<u>Percent Passing</u>
1-1/2"	100
1"	95
No. 4	60

- H. Non-uniformity of color reaction when the treated material, exclusive of one inch or larger clods, as tested with the standard phenolphthalein alcohol indicator, will be considered evidence of inadequate mixing.
- I. Lime-treated material shall not be mixed or spread while the atmospheric temperature is below 35°F. The entire mixing operation shall be completed within seventy-two (72) hours of the initial spreading of lime, unless otherwise permitted by the Geotechnical Engineer.

3.06 SPREADING AND COMPACTING

- A. The treated mixture shall be spread to the required width, grade and cross-section. The maximum compacted thickness of a single layer may be determined by the Contractor provided he can demonstrate to the Geotechnical Engineer that his equipment and method of operation will provide uniform distribution of the lime and the required compacted density throughout the layer. If the Contractor is unable to achieve uniformity and density throughout the thickness selected, he shall rework the affected area using thinner lifts until a satisfactory treated subgrade meeting the distribution and density requirements is attained, as determined by the Geotechnical Engineer, at no additional cost to the Owner.
- B. The finished thickness of the lime-treated material shall not vary more than five hundredths of a foot (0.05') from the planned thickness at any point.
- C. The lime-treated soils shall be compacted to a relative compaction of not less than ninety five percent (95%) as determined by the ASTM D1557-01 Compaction Test.
- D. Initial compaction shall be performed by means of a sheepsfoot type roller or a vibratory padfoot roller. Final rolling shall be by means of a smooth drum roller.
- E. Areas inaccessible to rollers shall be compacted to meet the minimum compaction requirement by other means satisfactory to the Geotechnical Engineer.
- F. Final compaction shall be completed within thirty-six (36) hours of final mixing. The surface of the finished lime-treated material shall be the grading plane and at any point shall not vary more than five hundredths of a foot (0.05') foot above or below the grade established by the plans.
- G. Before final compaction, if the treated material is above the grade tolerance specified in this section, uncompacted excess material may be removed and used in areas inaccessible to mixing equipment. After final compaction and trimming, excess material shall be removed and disposed of off site. The trimmed and completed surface shall be rolled with steel or pneumatic-tired rollers. Minor indentations may remain in the surface of the finished materials so long as no loose material remains in the indentations.

- H. At the end of each day's work, a construction joint shall be made in thoroughly compacted material and with a vertical face. After a part-width section has been completed, the longitudinal joint against which additional material is to be placed shall be trimmed approximately three inches (3") into treated material, to the neat line of the section, with a vertical edge. The material so trimmed shall be incorporated into the adjacent material to be treated.
- I. An acceptable alternate to the above construction joints, if the treatment is performed with cross shaft rotary mixers, is to actually mix three inches (3") into the previous day's work to assure a good bond to the adjacent work.

3.07 FINAL GRADING

- A. Finish all lime treated engineered fill grades to within a tolerance of 0.05' of grades shown for top of lime/cement stabilization treatment or as indicated by drawings and specifications.
- B. Leave all areas in suitable condition for subsequent work.
- C. Excess materials not needed for final grading operations shall be removed from the site.

3.07 CURING

- A. The surface of compacted and finish graded lime treated soil shall be kept moist for at least 3 days after final trimming, rolling and compacting. No equipment or traffic shall be permitted on the lime treated material during the 3 day cure, except for the water truck to keep the treated area at or above the optimum moisture. After the 3 day cure apply aggregate base. Maintain moisture curing at optimum level until aggregate base is placed

END OF SECTION

SECTION 32 12 00
ASPHALT CONCRETE PAVING

PART 1 - GENERAL

1.01 INCLUSION OF OTHER CONTRACT DOCUMENTS

- A. The General Conditions, Supplementary Conditions and Division 1 are fully applicable to this Section, as if repeated herein.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 015000, Construction Facilities and Temporary Controls.
- B. Section 310000, Earthwork.
- C. Section 313200, Soil Stabilization
- D. Section 312333, Trenching and Backfilling.
- E. Section 328000, Irrigation
- F. Section 334000, Site Drainage.

1.03 QUALITY ASSURANCE

- A. Use only new materials and products, unless existing materials or products are specifically shown otherwise on the Drawings to be salvaged and re-used.
- B. All materials, components, assemblies, workmanship and installation are to be observed by the Owner's Inspector of Record. Work not so inspected is subject to uncovering and replacement.
- C. The representatives of the Owner's testing lab will not act as supervisor of construction, nor will they direct construction operations. Neither the presence of the Owner's testing lab representatives nor the testing by the Owner's testing lab shall excuse the contractors or subcontractors for defects discovered in their work during or following completion of the project. Correcting inadequate compaction is the sole responsibility of the contractor.
- D. Contractor shall provide verification that asphalt mix temperature meets the requirements of this specification at time of application.
- E. Contractor shall be solely responsible for all subgrades built. Any repairs resulting from inadequate compaction are the responsibility of the contractor.
- F. Sieve analysis from testing laboratories identifying rock/sand percentages within the asphalt mix shall have a testing date within 90 days of contract signing.
- G. Sieve analysis from a testing laboratory identifying rock/sand percentages within the class 2 aggregate base rock shall have a testing date within 90 days of contract signing.

1.04 SUBMITTALS

- A. Refer to Section 013300.
- B. Manufacturer's Data: Submit list and complete descriptive data of all products proposed for

use. Include manufacturer's specifications, published warranty or guarantee, installation instructions, and maintenance instructions.

1.05 WARRANTY

- A. Refer to General Conditions and Section 017836.

1.06 REFERENCES AND STANDARDS

- A. ANSI/ASTM D698-00 - Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures, Using 5.5 lb (2.49 Kg) Rammer and 12 inch (304.8 mm) Drop.
- B. ANSI/ASTM D1556-00 - Test Method for Density of Soil in Place by the Sand-Cone Method.
- C. ANSI/ASTM D1557-02 - Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 10 lb. (4.54 Kg) Rammer and 18 inch (457 mm) Drop.
- D. ANSI/ASTM D 3017-05 Test Methods for Moisture Content of Soils and Soil-Aggregate Mixture by Nuclear Methods (Shallow Depth).
- E. ANSI/ASTM D 4318-05 Test Method for Liquid Limit, Plastic Limit, and Plasticity Limit.
- F. CALTRANS Standard Specifications.
- G. CAL-OSHA, Title 8, Section 1590 (e).
- H. Any work within the street, highway or right-of-way shall be performed in accordance with the requirement of the governmental agencies having jurisdiction, and shall not begin until all of those governing authorities have been notified.

1.07 DELIVERY, STORAGE AND HANDLING

- A. Transport, store and handle in strict accord with the local jurisdiction.
- B. Make delivery to job when notified by Contractor verifying that the job is ready to receive the work of this Section and that arrangements have been made to properly store, handle and protect such materials and work.

1.08 PROJECT CONDITIONS

- A. Environmental Requirements:
 - 1. Base Course: Do not lay base course on muddy subgrade, during wet weather, or when atmospheric temperature is below 40 degrees F.
 - 2. Asphalt Surfacing: Do not apply asphaltic surfacing on wet base, during wet weather, or when
 - 3. atmospheric temperature is below 50 degrees F.

1.09 EXISTING SITE CONDITIONS

- A. Contractor shall acquaint himself with all site conditions. If unknown active utilities are encountered during work, notify Architect promptly for instructions. Failure to notify will make Contractor liable for damage to these utilities arising from Contractor's operations subsequent to discovery of such unknown active utilities.

1.10 PROTECTION

- A. Adequate protection measures shall be provided to protect workmen and passers-by on and off the site. Adjacent property shall be fully protected throughout the operations. Blasting will not be permitted. Prevent damage to adjoining improvements and properties both above and below grade. Restore such improvements to original condition should damage occur. Replace trees and shrubs outside building area disturbed by operations.
- B. In accordance with generally accepted construction practices, the Contractor shall be solely and completely responsible for working conditions at the job site, including safety of all persons and property during performance of the work. This requirement shall apply continuously and shall not be limited to normal working hours.
- C. Any construction review of the Contractor's performance conducted by the owner's representative is not intended to include review of the adequacy of the Contractor's safety measures, in, on, or near the construction site.
- D. Surface Drainage: Provide for surface drainage during period of construction in manner to avoid creating nuisance to adjacent areas. The contractor shall make a reasonable effort on a daily basis to keep all excavations and the site free from water during entire progress of work, regardless of cause, source, or nature of water.
- E. Adjacent streets and sidewalks shall be kept free of mud, dirt or similar nuisances resulting from earthwork operations.
- F. The site and adjacent influenced areas shall be watered as required to suppress dust nuisance. Dust control measures shall be in accordance with the local jurisdiction.

1.11 SEASONAL LIMITS

- A. No fill material shall be placed, spread or rolled during unfavorable weather conditions. When work is interrupted by rains, fill operations shall not be resumed until field tests indicate that moisture content and density of fill are satisfactory.

1.12 TESTING

- A. General: Refer to Section 014000 – Quality Requirements.
- B. Geotechnical Engineer: Owner is retaining a Geotechnical Engineer to determine compliance of fill with Specifications, and to direct adjustments in fill operations. Costs of Geotechnical Engineer will be borne by Owner; except those costs incurred for re-tests or re-inspection will be paid by Owner and backcharged to Contractor.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Sterilant: Soil sterilizer shall be CIBA GEIGY's Pramitol 25-E, Treflan EC or Thompson-Hayward Casoron.
 - 1. Soil sterilizer shall be applied in strict accordance with manufacturer's instructions.
- B. Base Course Aggregate: State Specifications, Section 26, Class 2 aggregate base (3/4" max.).
- C. Asphalt Binder: Steam-refined paving asphalt conforming to State Specifications, Section 92, viscosity grade PG 64-10. Asphalt binder additives for WMA per Caltrans approved list of manufacturer's.

- D. Liquid Asphalt Tack Coat: Per CALTRANS section 94.
- E. Surface Course Aggregate: Mineral aggregates for Type "A" asphalt concrete, conforming to 2018 Caltrans Standard Specifications (Section 39)
- F. Seal Coat: shall be a pre-mixed asphalt emulsion blended with select fillers and fibers such as:
 - 1. "Park-Top No. 302", Western Colloid Products.
 - 2. "OverKote", Reed and Gram.
 - 3. "Drivewalk", Conoco Oil.
- G. Wood Headers and Stakes: Pressure treated.
- H. Pavement Marking: Colors as directed by Architect. Colors of painted traffic stripes and pavement markings must comply with ASTM D 6628.
 - 1. Waterborne traffic line - colors white, yellow and red, State specification PTWB-01R3.
 - 2. Waterborne traffic line for the international symbol of accessibility and other curb markings – blue, red and green, Federal specification TT-P-1952F.
- I. Precast Concrete Bumpers: 3000 psi at 28 day minimum strength; 48" length unless otherwise indicated; provide with steel dowel anchors and concrete epoxy.
- J. Pavement Epoxy; K-Lite; Ktepx-590; Ennis Epoxy HPS2 or an approved equal.
- K. Crack Filler;
 - 1. Cracks up to ½": QPR model CAR08, 10oz asphalt crack filler; Star STA-FLEX Trowel Grade crack filler or approved equal.
 - 2. Cracks ¼" – 1": "Docal 1100 Viscolastic, distributed by Conoco, Inc., Elk Grove, CA, (916) 685-9253, or approved equal.
 - 3. Cracks greater than 1": Hot Mix, Topeka.
- L. Reclaimed Asphalt Pagment (RAP). HMA Type A or Type B may be produced using RAP providing it does not exceed 15% of the aggregate blend.

2.02 MIXES

- A. General: Plant mixed conforming to Type A Hot Mix Asphalt per 2018 Caltrans Standard Specifications (Section 39)
- B. Temperature of Hot Mix Asphalt: Not less than 275 degrees F nor more than 325 degrees F when added to aggregate.
- C. Temperature of Hot Mix Aggregate: Not less than 250 degrees F nor more than 325 degrees F when asphalt is added.
- D. Temperature of Hot Mix Asphalt Concrete: Asphalt shall be not less than 285 degrees at time of application, nor more than 350 degrees. Asphalt not meeting the required temperature shall not be used.
- E. Temperature of Warm Mix Asphalt: Mixing and placement; Per the approved manufactures heat range recommendations for mixing and placement.

PART 3 - EXECUTION

3.01 EXAMINATION OF CONDITIONS

- A. Conditions of Work in Place: Subsurfaces which are to receive materials specified under this Section shall be carefully examined before beginning work hereunder, and any defects therein shall be reported, in writing, to the Architect. Work shall not be started until such defects have been corrected. Starting of work shall imply acceptance of conditions as they exist.

3.02 PREPARATION

- A. Sub-Grade: Clean, shape and compact to hard surface free from elevations or depressions exceeding 0.05' in 10' from true plan. Compact per Section 310000. Compaction and moisture content shall be verified immediately prior to placement of aggregate base. Proof roll subbase in presence of geotechnical engineer prior to placement of aggregate base.
- B. Cleaning: Existing surfaces and new surface shall be clean of all dirt, sand, oil or grease. All cracks shall be cleaned and free of all debris and vegetation. Hose down entire area with a strong jet of water to remove all debris.

3.03 INSTALLATION

A. Headers:

1. General: Install as edging to asphalt paving, except where adjoining existing pavement, concrete curbs, walks or building.
2. Existing Headers: Remove existing headers where new paving will join existing. Saw cut existing asphalt to provide clean edge.
3. Lines and Levels: Install true to line and grade. Cut off tops of stakes 2-inches below top of header so they will not be visible on completion of job.

B. Asphalt Paving:

1. Base Course: Install in accord with State Specifications, Section 26. Compact to relative compaction of not less than 95%, ASTM D1557. The material shall be deposited on the subgrade in such a manner as to provide a uniform section of material within five percent tolerance of the predetermined required depth. Deposition will be by spreader box or bottom dump truck to prevent segregation of the material. The material so deposited on the subgrade shall have sufficient moisture which, in the opinion of the Architect is adequate to prevent excessive segregation. It shall then be immediately spread to its planned grade and cross section. Undue segregation of material, excessive drifting or spotting of material will not be permitted. If in the opinion of the site geotechnical engineer, the material is unsuitably segregated, it shall be removed or completely reworked to provide the desired uniformity of the material.
 - a. Moisture content and compaction of base material shall be tested immediately prior to placement of asphalt paving.
2. Sterilant: Apply specified material at manufacturer's recommended rate. Applicator of sterilant material shall be responsible for determining location of all planter areas. Apply specified material over entire base course area just prior to application of asphalt. Follow manufacturer's printed directions.
3. Liquid Asphalt Tack Coat: Apply as "tack coat" to all vertical surfaces of existing paving, curbs, walks, and construction joints in surfacing against which paving is to be placed.
4. Asphalt Concrete Surface Course:

- a. Comply with State Specifications, 39-6 except as modified below.
 - 1) Final gradation shall be smooth, uniform and free of ruts, humps, depressions or irregularities, with a minimum density of 91% of the theoretical maximum specific gravity determined by California Test Method #309. Maximum variation 1/8 inch in 10' when measured with steel straightedge in any one direction. Test paved areas for proper drainage by applying water to cover area. Correct portions that do not drain properly by patching with plant mix. In no case shall accessible parking spaces or loading and unloading areas exceed 2% slope in any direction.
 - 2) Asphalt material shall be delivered to the project site in a covered condition to maintain acceptable temperature. Onsite inspector shall verify temperature of asphalt upon truck arrival to the site.
 5. Placement and adjustment of Frames, Covers, Boxes and Grates: The Contractor shall set and adjust to finish grade all proposed and existing frames, covers, boxes, and grates of all manholes, drop inlets, drain boxes, valves, cleanouts, electrical boxes and other appurtenant structures prior to placement of asphaltic concrete.
 6. Water Testing: All paved areas shall be water tested, to check drainage, in the presence of the project inspector prior to placement of seal coat. The surface of asphalt paving shall not vary more than 1/8 inch above or below the grade established on the plans. If variations in grade are present, they will be corrected by overlaying paving and/or pavement removal and replacement as directed by the Architect.
 7. Patching: Cut existing paving square and plumb at all edges to be joined by new paving. In trenches; grind existing asphalt on each side of trench 3" wide x 1/2 the depth of the section. Apply tack coat to vertical surfaces before installing new work. Warp carefully to flush surface, with seal over joints, and feather edge. Sawcut, remove and patch existing paving where cutting is necessary for installation of piping or conduits under Divisions 2, 15 and 16.
- C. Seal Coat:
1. Seal coat shall be applied no sooner than 30 days from time of asphalt placement, no exceptions.
 2. Surface Preparation: surface and cracks shall be clean of all dirt, sand, oil or grease. All cracks shall be filled to a level condition after curing. Make multiple fill applications until a level condition is achieved. Failure to do so will be the reason for rejection. Hose down entire area with a strong jet of water to remove all debris. Remove soft, loose, or otherwise damaged areas of asphalt concrete to full depth of damage and replace with compacted hot mix asphalt concrete as specified herein. Minor holes and imperfections may be patched using hot mix asphalt or mastic using sand/SS-1-H. Use wire brush for removal of oil and grease; prime with shellac or synthetic resin as recommended by manufacturer of pavement sealer material.
 3. Seal Coat Seal Application: Thoroughly mix materials and apply in the presence of the onsite inspector. Failure to do so will be cause for rejection. Apply in accordance with manufacturer's written instructions.
 - a. The minimum application rate for each applied coat shall be 30gals per 1000 sq. ft. Two coats of sealcoat will be required.
 - b. Clean-Up and Precautions: As recommended by pavement sealer material manufacturer.
- D. Pavement Marking: pavement markings shall be done only after the seal coat has thoroughly dried. Existing surfaces to be striped with traffic paint shall be cleaned of dust, dirt, grime, oil, rust or other contaminants which will impair the quality of work or interfere with proper bond of

paint coats. Surfaces shall be thoroughly cleaned by whatever means necessary that will satisfactorily accomplish the purpose without damage to asphalt concrete. Provide measured layouts, temporary markings, templates, and other means necessary to provide required marking. Prepare and apply paint in accordance with manufacturer's instructions; paint shall be applied by spray and shall achieve complete coverage free from voids and thin spots. Where indicated on the Drawings, paint parking stall strips, lettering, arrows, accessible symbols, playfield markings, etc. on asphalt concrete paving. Paint strips shall be 4 inches wide (except otherwise indicated) and applied with two (2) coats of herein specified Traffic Line Paint; white (except as otherwise specified or indicated).

1. Paints shall be delivered to the site in unopened containers.
 - a. Paint shall not be diluted, or watered down.
 - b. Paint shall be applied in 10-12 wet mil thickness (4-6 mil dried). Each coat thickness shall be verified by the project inspector.
2. International Accessible Symbol: Symbol shall be white figures on a blue background. Blue shall be equal to color No. 15090 in Fed. Std. 595c. Lines and symbols shall be accurately formed and true to line and form; lines shall be straight and uniform in width. Painted edges shall be clean cut and free from raggedness, and corners shall be cut sharp and square. Tolerances: Apply striping within a tolerance 1/2 inch in 50 feet. Apply markings and striping to widths indicated with a tolerance of 1/4 inch on straight sections and 1/2 inch on curved sections.

E. Colors: As directed by Architect

F. Precast Concrete Bumpers: Install in location where shown, using steel rebar dowels, and epoxy.

3.04 DEFECTIVE ASPHALT;
Defective asphalt is as described below.

- A. Exposed rock pockets on the finished surface that lack the # 8- #200 fines that is required per the sieve analysis.
- B. Asphalt not placed to the design grades.
- C. Asphalt that ponds water.
- D. Asphalt that was compacted below the minimum required temperature and is cracked.
- E. Asphalt that fails to meet the minimum compaction requirements.
- F. Asphalt that lacks the minimum thickness required per plan.
- G. New asphalt contaminated by a petroleum product, or spilled paint.
- H. Asphalt that has depressions, cracks, scored divits from dumpster wheels, heavy equipment use, heavy construction products,
- I. Asphalt placed on pumping, unstable sub-grades.

3.05 CLEANING

- A. Refer to Section 017400.
- B. Upon completion of work of this Section promptly remove from the working area all scraps,

debris and surplus material of this Section.

C. Clean excess material from surface of all concrete walks and utility structures.

END OF SECTION

SECTION 32 16 00

SITE CONCRETE

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. The Section describes the requirements for providing portland cement concrete paving, including accessibility ramps, sidewalks, accessible routes of travel, vehicular travel, drain structures, sewer structures, thrust blocks and for other non-structural or non-vehicular applications.

1.02 INCLUSION OF OTHER CONTRACT DOCUMENTS

- A. The General Conditions, Supplementary Conditions and Division 1 are fully applicable to this Section, as if repeated herein.

1.03 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 014500, Testing Lab Services.
- B. Section 310000, Earthwork.

1.04 QUALITY ASSURANCE

- A. Use only new materials and products.
- B. Use materials and products of one manufacturer whenever possible.
- C. All materials, components, assemblies, workmanship and installation are to be observed by the Owner's Inspector of Record. Work not so inspected is subject to uncovering and replacement.
- D. Sieve analysis from testing laboratories identifying rock/sand percentages within the concrete mix; or class 2 aggregate base shall have the current project name and project location identified on the report. Outdated analytical reports greater than 90 days old will not be accepted

1.05 SUBMITTALS

- A. Refer to Section 133300.
- B. Manufacturer's Data: Submit list and complete descriptive data of all products proposed for use. Include manufacturer's specifications, published warranty or guarantee, installation instructions, and maintenance instructions.
- C. Materials list: Submit to the Architect a complete list of all materials proposed to be used in this portion of the work. Submitted items should include but are not limited to sand, gravel, admixtures, surface treatments, coloring agents, sealers, fibers, cast-in-place accessories, forming and curing products and concrete mix designs.
- D. With concrete submittal, provide documented history of mix design performance.

1.06 WARRANTY

- A. Refer to General Conditions and Section 017836.

1.07 REFERENCES AND STANDARDS

- A. California Building Code, latest edition.
- B. ACI Standards, ACI 211.1, ACI 318-14, ACI 302, IR-04, ACI 301-16, ACI 305R-10, ACI 306R-16, ACI 308-16.
- C. ASTM C-94, Specification for Ready-Mixed Concrete.
- D. Concrete Reinforcing Steel Institute (CRSI) Manual of Standard Practice (latest edition).
- E. ASTM – American Society for Testing and Materials.

1.08 DELIVERY, STORAGE AND HANDLING

- A. Deliver undamaged products to job in manufacturer's sealed containers and/or original bundles with tags and labels intact.
- B. Store materials in protected, dry conditions off of ground and in areas so as to not interfere with the progress of the work.
- C. Transport, store and handle in strict accord with the manufacturer's written recommendations.
- D. Make delivery to job when notified by Contractor verifying that the job is ready to receive the work of this Section and that arrangements have been made to properly store, handle and protect such materials and work.
- E. Store cement in weather tight building, permitting easy inspection and identification. Protect from dampness. Lumpy or stale cement will be rejected.
- F. Aggregates: Prevent excessive segregation, or contamination with other materials or other sizes of aggregate. Use only one supply source for each aggregate stock pile.

1.09 TESTING

- A. General: Refer to Section 014000 – Quality Requirements.
- B. Cement and Reinforcing shall be tested in accordance with CBC Section 1910A. Testing of reinforcing may be waived in accordance with Section 1910A.2 when approved by the Structural Engineer and DSA.

1.10 ADEQUACY AND INSPECTION

- A. Design, erect, support, brace and maintain formwork and shoring to safely support all vertical and lateral loads that might be applied until such loads can be carried by concrete.
- B. Notify Inspector, Architect and DSA at least 48 hours prior to placing of concrete.

1.11 PROTECTION

- A. Finish surfaces shall be protected at all times from concrete pour. Inspect forming against such work and establish tight leak-proof seal before concrete is poured. Finish work damaged, defaced or vandalized during the course of construction shall be replaced by contractor at contractor expense.

1.12 FIELD MEASUREMENTS

- A. Make and be responsible for all field dimensions necessary for proper fitting, slopes and completion of work. Report discrepancies to Architect before proceeding.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Cement: Portland cement, ASTM C150, Type II, per ACI 318-14 Section 26.4.
- B. Concrete Aggregates: Normal weight aggregates shall conform to ASTM C33, except as modified by this section. Combined grading shall meet limits of ASTM C33. Lightweight aggregate shall conform to ASTM C330, suitably processed, washed and screened, and shall consist of durable particles without adherent coatings.
- C. Water: Clean and free from deleterious amounts of acids, alkalis, scale, or organic materials and per ACI 318-14 Section 26.4.1.3.1.
- D. Fly Ash: Western Fly Ash, conforming to ASTM C618 for Class N or Class F materials (Class C is not permitted). Not more than 15% (by mass) may be substituted for portland cement.
- E. Water Reducing Admixture: Admixture to improve placing, reduce water cement ratio, and ultimate shrinkage may be used. Provide WRDA 64 by Grace Construction Products or approved equal. Admixture shall conform to ASTM C494 and ACI 318-14 Section 26.4.1.4.19(a). Such admixture must receive prior approval by the Architect, Structural Engineer, and the Testing Lab, and shall be included in original design mix.
- F. Air-entraining Admixture: Daravair 1000 by Grace Construction Products or approved equal. Admixture must conform to ASTM C260 and ACI 318-14, section 26.4.1.4.
- G. Surface Retarder (for exposed aggregate finishes): Rugasol-S by Sika Corporation or approved equal.
- H. Form Coating: Material which will leave no residue on concrete surface that will interfere with surface coating, as approved by the Architect.
- I. Reinforcement Bars: New billet steel deformed bars conforming to requirements of ASTM A615 or ASTM A706; Grade 60. Dowels for installation through expansion joints or construction joints to existing sidewalks or concrete features shall be smooth or shall be sleeved on one end for slippage.
- J. Reinforcing supports: Galvanized metal chairs or spacers or metal hangers, accurately placed 3'-0" O.C.E.W. Staggered and each support securely fastened to steel reinforcement in place. Bottom bars in footings may be supported with 3" concrete blocks with embedded wire ties. Concrete supports without wire ties will not be allowed.
- K. Truncated Domes: Vitrified Polymer Composite (VPC), Cast-In-Place Detectable/Tactile Warning Surface Tiles; "Armor-Tile", "Access Tile Tactile Systems", or approved equal. Tiles shall comply with Americans with Disabilities Act and the California Code of Regulations (CCR) Title 24, Part 2, Chapter 11B (dome spacing shall be 2.35"). Install tiles as recommended by manufacturer. Color, federal yellow (FS 33538).
- L. Curing Compound (for exterior slabs only): Burke Aqua Resin Cure by Burke by Edoco, 1100 Clear by W.R. Meadows or accepted equal. Water based membrane-forming concrete curing compound meeting ASTM C 309 and C1315.
- M. Concrete Bonding Agent: Weld-Crete by Larson Products Corp., Daraweld C by Grace Construction Products or accepted equal.
- N. Patching Mortar: Meadow-Crete GPS, one-component, trowel applied, polymer enhanced, shrinkage-compensated, fiber reinforced, cementitious repair mortar for horizontal, vertical and overhead applications as manufactured by W.R. Meadows or accepted equal.

- O. Non-shrink Grout: Masterflow 713 Plus by Master Builders or approved equal. Premixed, non-metallic, no chlorides, non-staining and non-shrinking per CRD-C621, Corps of Engineers Specification and ASTM C 1107, Grades B and C.
- P. Aggregate Base: Class 2 AB per Caltrans specification section 26-1.02A.
- Q. Expansion Joint Material: Preformed 3/8" fiber material, full depth of concrete section, with bituminous binder manufactured for use as concrete expansion joint material, as accepted by the Architect.
- R. Joint sealant for expansion joints: Single component silicone sealant, Type S, ASTM D5893.
 - 1. Reference Standard: ASTM C920, Grade P, Class 25, Use T.
 - 2. Dow Corning 890-SL (self-leveling) Silicone, or accepted equal.
 - 3. Dow Corning 888-NS (non-sagging) Silicone, at slopes exceeding 5%. May not be used at asphalt surfaces.
 - 4. Color: Custom color as selected by Architect.
- S. Pre- Formed plastic Expansion Joint; W.R. Meadows 3/8" "Snap Cap", Tex-Trude expansion joint cap, or an approved equal.
- T. Adhesive Anchoring (Epoxy): Hilty HIT-HY 200 Safe Set, or approved equal.

2.02 CONCRETE DESIGN AND CLASS

- A. Class "B": Concrete shall have 1" max. size aggregate, shall have 3000 psi min. at 28 day strength with a maximum water to cementitious ratio no greater than 0.50. Use for exterior slabs, including walks, vehicular paved surfaces, manhole bases, poured-in-place drop inlets, curbs, valley gutters, curb & gutter and other concrete of like nature.
- B. Slump Limits: Provide concrete, at point of final discharge, of proper consistency determined by Test Method ASTM C143 with a slumps of 4" plus or minus 1".
- C. Mix Design: All concrete used in this work will be designed for strength in accordance with provisions of ASI 318-14 Section 26.4. Should the Contractor desire to pump concrete, a modified mix design will need to be submitted for review. Fly ash may be used in concrete to improve workability in amounts up to 15% of the total cementitious weight.
- D. Air Entrainment; Per the Local Jurisdiction minimum requirements, or 3% minimum.

2.03 MIXING OF CONCRETE

- A. Conform to requirements of CBC, Chapter 19A.
- B. All concrete shall be mixed until there is uniform distribution of material and mass is uniform and homogenous; mixer must be discharged completely before the mixer is recharged.
- C. Concrete shall be Ready-mixed Concrete: Mix and deliver in accordance with the requirements set forth in ASTM C94 and ACI 301. Batch Plant inspection may be waived in accordance with CBC Section 1705A.3.3.1, when approved by Structural Engineer and DSA.
 - 1. Approved Testing Laboratory shall check the first batching at the start of the work and furnish mix proportions to the Licensed Weighmaster.
 - 2. Licensed Weighmaster to positively identify materials as to quantity and to certify to each load by ticket.
 - 3. Ticket shall be transmitted to Project Inspector by truck driver with load identified thereon.

Project Inspector will not accept load without load ticket identifying mix and will keep daily record of pours, identifying each truck, its load and time of receipt and will transmit two copies of record to DSA.

4. At end of project, Weighmaster shall furnish affidavit to DSA on form satisfactory to DSA, certifying that all concrete furnished conforms in every particular and to proportions established by mix designs.
5. Placement of concrete shall occur as rapidly as possible after batching and in a manner which will assure that the required quality of the concrete is maintained. In no case may concrete be placed more than 90 minutes from batch time.
6. Water may be added to the mix only if neither the maximum permissible water-cement ratio nor the maximum slump is exceeded. In no case shall more than 10 gallons of water shall be added to a full 9 yard load, or 1 gal. per yard on remaining concrete within the drum providing load tag indicates at time of mixing at plant will allow for additional water.

2.04 MATERIALS TESTING

- A. Materials testing of concrete and continuous batch plant inspection may be waived in accordance CBC Sections 1704A.4.4 when approved by Structural Engineer and DSA.
- B. Testing of concrete shall be performed per article 3.12 of this specification.

2.05 EQUIPMENT

- A. Handling and mixing of concrete: Project Inspector may order removal of any equipment which in his opinion is insufficient or in any way unsuitable.

PART 3 - EXECUTION

3.01 APPROVAL OF FORMS AND REINFORCEMENTS

- A. Forms and reinforcements are subject to approval by the Project Inspector, and notice of readiness to place first pour shall be given to DSA, Architect and Structural Engineer 48 hours prior to placement of concrete. Before placing concrete, clean tools, equipment and remove all debris from areas to receive concrete. Clean all reinforcing and other embedded items off all coatings oil, and mud that may impair bond with concrete.
- B. All reinforcing steel and or W.W.F. shall be adequately supported by approved devices on centers close enough to prevent any sagging.
- C. All reinforcing bar lap splices shall be staggered a minimum of 5 ft.
- D. Additional reinforcing steel shall be placed around all utility boxes, valve boxes, manhole frames and covers that are located within the concrete placements.
 1. The bars shall be placed so that there will be a minimum of 1 ½" clearance and a maximum of 3" clearance. The reinforcing steel shall be placed mid-depth of concrete slab.
- E. At all right angles or intersections of concrete walks, additional 2'x2' #5, 90 degree bars shall be added at all inside corners for additional crack control. The bars shall be placed 2" from concrete forms and supports at mid-depth of slab.

3.02 PROTECTION

- A. Protect work and materials of this Section prior to and during installation, and protect the installed work and materials of other trades.

- B. In the event of damage, make all repairs and replacements necessary to the approval of the Architect at no additional cost to the Owner.
- C. Sub-Grade in vehicular concrete paved areas: Subgrade shall be clean, shaped and compact to hard surface free from elevations or depressions exceeding 0.05' in 10' from true plan. Compact per Section 310000. Compaction and moisture content shall be verified immediately prior to placement of concrete. Proof roll subbase in presence of geotechnical engineer prior to placement of aggregate base.

3.03 CLEANING

- A. Reinforcement and all other embedded items at time of placing concrete to be free of rust, dirt oil or any other coatings that would impair bond to concrete.
- B. Remove all wood chips, sawdust, dirt, loose concrete and other debris just before concrete is to be poured. Use compressed air for inaccessible areas. Remove all standing water from excavations.

3.04 FORMING

- A. Form material shall be straight, true, sound and able to withstand deformation due to loading and effects of moist curing. Materials which have warped or delaminated, or require more than minor patching of contact surfaces, shall not be reused.
- B. Build forms to shapes, lines, grades and dimensions indicated. Construct form work to maintain tolerances required by ACI 301. Forms shall be substantial, tight to prevent leakage of concrete, and properly braced and tied together to maintain position and shape. Butt joints tightly and locate on solid backing. Chamfer corners where indicated. Form bevels, grooves and recesses to neat, straight lines. Construct forms for easy removal without hammering, wedging or prying against concrete.
- C. Space clamps, ties, hangers and other form accessories so that working capacities are not exceeded by loads imposed from concrete or concreting operations.
- D. Build openings into vertical forms at regular intervals if necessary to facilitate concrete placement, and at bottoms of forms to permit cleaning and inspection.
- E. Build in securely braced temporary bulkheads, keyed as required, at planned locations of construction joints.
- F. Slope tie-wires downward to outside of wall.
- G. Brace, anchor and support all cast-in items to prevent displacement or distortion.
- H. During and immediately after concrete placing, tighten forms, posts and shores. Readjust to maintain grades, levels and camber.
- I. Concrete paving, Curbs, Curb and Gutters, Ramps:
 - 1. Expansion Joints: Install at locations indicated, and so that maximum distance between joints is 20' for exterior concrete unless otherwise shown. Expansion joint material shall be full depth of concrete section. Recess for backer rod and sealant where required. Expansion joints shall not exceed ¼ inch depth measured from finish surface to top of felt or sealant, and ½ inch width.
 - 2. Curbs, Valley Gutter, and Curb & Gutter: Install expansion joints at 60' on center, except when placing adjacent to concrete walks, the expansion joints shall align with the expansion joints shown for the concrete walks. Expansion joint material shall be full depth of concrete section. Recess for backer rod and sealant will be required.

3. Isolation Joints: 3/8" felt between walls and exterior slabs or walks so that paved areas are isolated from all vertical features, unless specifically noted otherwise on plans.
4. Exterior Concrete Paving: Install expansion joints at 20' on center maximum, both directions, unless shown otherwise on plans.
5. Ramps; whether shown or not all ramps shall have control joints and expansion joints.
 - a. Control joints on ramps shall be aligned and be placed in between with the vertical posts for the handrails. The curbs, if required shall have control joints that align with the handrail posts.
 - b. Expansion joints shall be placed at the upper, intermediate, and bottom landings.

3.05 FORM COATING

- A. Before placement of reinforcing steel, coat faces of all forms to prevent absorption of moisture from concrete and to facilitate removal of forms. Apply specified material in conformance with manufacturer's written directions.
- B. Before re-using form material, inspect, clean thoroughly and recoat.
- C. Seal all cut edges.

3.06 INSTALLATION

- A. General: Reinforcement shall be accurately placed at locations indicated on the drawings within required tolerances and providing required clearances. Reinforcement shall be secured prior to placement of concrete such that tolerances and clearances are maintained. Coverage shall be in accordance with Section 1907A.7 of the CBC. Keep a person on the job to maintain position of reinforcing as concrete is placed. Reinforcement must be in place before concreting is begun. Install dowels as shown on drawings. Give notice whenever pipes, conduits, sleeves, and other construction interferes with placement; obtain method of procedure to resolve interferences. All expansion and construction joints in concrete shall have dowels of size and spacing as shown, or as approved by Architect.
- B. Placing Tolerances:
 1. Per ACI 301 or CRSI/WCRSI Recommended Practice for Placing Reinforcing Bars, unless otherwise shown.
 2. Clear distance between parallel bars in a layer shall be no less than 1", the maximum bar diameter not 1 1/2 times the maximum size of coarse aggregate.
- C. Splices:
 1. General: Unless otherwise shown on drawings, splice top reinforcing at midspan between supports, splice bottom reinforcing at supports and stagger splices at adjacent splices 5 foot minimum. Bar laps shall be wired together. Reinforcing steel laps shall be as follows:
 - a. Lap splices in concrete: Lap splice lengths shall not be less than 62 bar diameter for No. 5 bar, 56" minimum for No. 6 bars. No. 4 bar shall have a minimum of 24" splice. 93 bar diameters for No. 7 bars and larger.
 - b. All splices shall be staggered at 5 feet minimum.

3.07 INSPECTION

- A. Approval of reinforcing steel, after installation, must be received from Inspector. Architect, Structural Engineer and DSA must be notified 48 hrs. in advance of beginning of concrete placement operations.

- B. Slope of concrete forms and finish condition shall be checked with a two foot (2') digital level.

3.08 PLACING OF CONCRETE

- A. Adjacent finish surfaces shall be protected at all times during the concrete pour and finishing. Verify that all formwork is tight and leak-proof before concrete is poured. Finish work defaced during the concrete pour and finishing shall be replaced at no extra cost to the owner.
- B. Transport concrete from mixer to place of final deposit as rapidly as practicable by methods which will prevent separation or loss of ingredients. Deposit as close as practicable in final position to avoid re-handling or flowing. Partially hardened concrete must not be deposited in work. Concrete shall not be wheeled directly on top of reinforcing steel.
- C. Placing: Once started, continue concrete pour continuously until section is complete between predetermined construction joints. Prevent splashing of concrete onto adjacent forms or reinforcement and remove such accumulation of hardened or partially hardened concrete from forms or reinforcement before work proceeds in that area. Free fall of concrete shall not to exceed 4'-0" in height. If necessary, provide lower openings in forms to inject concrete and to reduce fall height.
- D. Remove form spreaders as placing of concrete progresses.
- E. Place footings as monolithic and in one continuous pour.
- F. Keep excavations free of standing water, but moisture condition sub-grade before concrete placement.
- G. Compacting: All concrete shall be compacted by mechanical vibrators. Concrete shall be thoroughly worked around reinforcement and embedded fixtures and into corners of forms. Vibrating shall not be applied to concrete which has already begun to initially set nor shall it be continued so long as to cause segregation of materials.
- H. Concrete Flatwork:
 - 1. All flatwork shall be formed and finished to required line and grades. Flatwork shall be true and flat with a maximum tolerance of 1/8" in 10' for flatness. Flatwork which is not flat and are outside of the maximum specified tolerances shall be made level by the Contractor at no additional expense to the Owner.
 - 2. Thoroughly water and soak the flatwork subgrade as required to achieve required moisture content prior to the concrete pour. Provide damming as required to keep water within the formed area and to allow for proper saturation of the subgrade.
 - 3. Thoroughly water and soak the exterior slabs, curbs, curb and gutters, footing subgrades with multiple daily waterings for at least three (3) days or as required to achieve required moisture content prior to the concrete pour in order to place the subgrade soils in full expansion. Provide damming as required to keep standing water within the formed area and to allow for proper saturation and full expansion of the subgrade soils. Remove any standing water before concrete placement.
- I. Placing in hot weather: Comply with ACI 305R-10. Concrete shall not exceed 85 degrees F at time of placement. Concrete shall be delivered, placed and finished in a sufficiently short period of time to avoid surface dry checking. Concrete shall be kept wet continuously after tempering until implementation of curing compound procedure in accordance with this specification.
- J. Placing in cold weather: Comply with ACI 306R-16. Protect from frost or freezing. No antifreeze admixtures are permitted. When deposited concrete during freezing or near-freezing weather, mix shall have temperature of at least 50 degrees F but not more than 90 degrees F. Concrete shall be maintained at temperature of at least 50 degrees F for not less than 72 hours

after placing or until it has thoroughly hardened. Provide necessary thermal coverings for any flat work exposed to freezing temperatures.

- K. Horizontal construction joint: Keep exposed concrete face of construction joints continuously moist from time of initial set until placing of concrete; thoroughly clean contact surface by chipping entire surface not earlier than 5 days after initial pour to expose clean hard aggregate solidly embedded, or by approved method that will assure equal bond, such as green cutting. If contact surface becomes contaminated with soil, sawdust or other foreign matter, clean entire surface and re-chip entire surface to assure proper adhesion.

3.09 CONCRETE FINISHES

- A. Concrete Slab Finishing: Finish slab as required by ACI 302.1R. Use manual screeds, vibrating screeds to place concrete level and smooth. Use "jitterbugs" or other special tools designed for the purpose of forcing the coarse aggregate below the surface leaving a thick layer of mortar 1 inch in thickness. Surface shall be free from trowel marks, depressions, ridges or other blemishes. Tolerance for flatness shall be 1/8" in 10'. Provide final finish as follows:
 - 1. Flatwork, medium broom finish: Typical finish to be used at all exterior walks and stairs.
 - 2. Ramps, heavy broom finish: Concrete surfaces with slope greater than 5% including all ramps. Brooming direction shall run perpendicular to slope to form non-slip surface
 - 3. Under no circumstances can water be added to the top surface of freshly placed concrete.
- B. Curb Finishing: Steel trowel.
- C. Joints and Edges: Mark-off exposed joints, where indicated, with 1/4" radius x 1" deep jointer or edging tool. Joints to be clean, cut straight, parallel or square with respect to concrete walk edge. Tool all edges of exposed expansion and contraction joints, walk edges, and wherever concrete walk adjoins other material or vertical surfaces.
 - 1. The expansion joints shall be full depth as shown in the plan details. Failure to do so will result in non-compliance and shall be immediately machine cut by the contractor at his expense.
- D. Exposed Concrete Surface Finishing (not including top surface of flatwork): Remove fins and rough spots immediately following removal of forms from concrete which is to be left exposed. Damaged and irregular surfaces and holes left by form clamps and sleeves shall be patched with grout. Tie wires are to be removed to below exposed surface and holes pointed up with neat cement paste similar to procedure noted under "Patching" below. Removal of tie wires shall extend to distance of 2" below established grade lines. Ends of tie wires shall be cut off flush at all other, unexposed locations. Care shall be taken to match adjacent finishes of exposed concrete surface. After patching, all concrete that is to remain exposed, shall be sacked with a grout mixture of 1-part cement, 1 1/2- parts fine sand and sufficient water to produce a consistency of thick paint. After first wetting the concrete surface, apply mixture with a brush and immediately float entire surface vigorously using a wood float. Keep damp during periods of hot weather. When set, excess grout shall be scraped from wall with edge of steel trowel, allowed to set for a time, then wiped or rubbed with dry burlap. Entire finishing operation of any area shall be completed on the same day. This treatment shall be carried to 4" below grade, and all patching and sacking shall be done immediately upon removal of the forms.
- E. Stair Treads and Risers: Tool exterior stair tread nosing per ADA requirements and as detailed. Paint or stain tooled area at every stair tread nosing or as detailed. Stair tread nosing shall contain no pockets, voids or spalls. Patching is not allowed. Damaged nosing shall be replaced.

3.10 CURING

- A. Cured Concrete in Forms: Keep forms and top on concrete between forms continuously wet until removal of forms, 7 days minimum. Maintain exposed concrete in a continuous wet condition for 14 days following removal of forms.
- B. Flatwork/Variable Height Curbs, Curb and gutter, Valley Gutter: Cure utilizing Curing Compound. If applicable, the Contractor shall verify that the approved Curing Compound is compatible with the approved colorant system. Upon completion of job, wash clean per manufacturer's recommendations.
 - 1. Curing compound shall be applied in a wet puddling application. Spotty applications shall be reason for rejection and possibly concrete removal and replacement at the contractor's expense with no compensation from the owner.
- C. No Curing Compound shall be applied to areas scheduled to receive resilient track surface including, curbs, ramps, run ways, etc.

3.11 DEFECTIVE CONCRETE

- A. Determination of defective concrete shall be made by the Architect or Engineer. His opinion shall be final in identifying areas to be replaced, repaired or patched.
- B. The Owner reserves the right to survey the flatwork, if it is determined to be outside of the maximum tolerance for flatness. If the flatwork is found to be out of tolerance, then the Contractor will be required to replace concrete. The Contractor will be responsible for reimbursing the Owner for any surveying costs incurred. Determination of flatwork flatness, surveying and any remedial work must be completed far enough in advance so that the project schedule is maintained, delays are avoided and the new flatwork or flatwork repairs are properly cured.
- C. As directed by Architect, cut out and replace defective concrete. All defective concrete shall be removed from the site. No patching is to be done until surfaces have been examined by Architect and permission to begin patching has been provided.
- D. Permission to patch any area shall not be considered waiver of right, by the Owner, to require removal of defective work, if patching does not, in opinion of Architect, satisfactorily restore quality and appearance of surface.
- E. Defective concrete is:
 - 1. Concrete that does not match the approved mix design for the given installation type.
 - 2. Concrete not meeting specified 28-day strength.
 - 3. Concrete which contains rock pockets, voids, spalls, transverse cracks, exposed reinforcing, or other such defects which adversely affect strength, durability or appearance.
 - 4. Concrete which is incorrectly formed, out of alignment or not plumb or level.
 - 5. Concrete containing embedded wood or debris.
 - 6. Concrete having large or excessive patched voids which were not completed under Architect's direction.
 - 7. Concrete not containing required embedded items.
 - 8. Excessive Shrinkage, Traverse cracking, Cracking, Curling; or Defective Finish. Remove and replace if repair to an acceptable condition is not feasible.
 - 9. Concrete that is unsuitable for placement or has set in truck drum for longer than 90 minutes from the time it was batched.
 - 10. Expansion joint felt that is not isolating the full depth of the concrete section, and recessed as required for backer rod and sealant where required.

11. Concrete that is excessively wet or excessively dry and will not meet the minimum or maximum slump required per mix design.
12. Finished concrete with oil stains from equipment use, and or rust spots that cannot be removed.
13. Control joints (weakened planed joints) that do not meet the required minimum depth shown on the drawings.

F. Patching: Install specified Patching Mortar per manufacturer's recommendations. REPAIRS TO DEFECTIVE CONCRETE WHICH AFFECT THE STRENGTH OF ANY STRUCTURAL CONCRETE MEMBER OR COMPONENT ARE SUBJECT TO APPROVAL BY THE ARCHITECT AND DSA.

3.12 CONCRETE TESTING

- A. Comply with CBC Section 1903A, 1905A.1.16, 1910A and 1705A.3 and as specified in B. below. Costs of tests will be borne by the Owner.
- B. Four identical cylinder samples for strength tests of each class of concrete placed each day shall be taken not less than once a day, or not less than once for each 50 cubic yards of concrete, or not less than once for each 2,000 square feet of surface area for slabs or walls. In addition, samples for strength tests for each class of concrete shall be taken for seven-day tests at the beginning of the concrete work or whenever the mix or aggregate is changed.
- C. Strength tests will be conducted by the Testing Lab on one cylinder at seven (7) days and two cylinders at twenty-eight (28) days. The fourth remaining cylinder will be available for testing at fifty-six (56) days if the 28-day cylinder test results do not meet the required design strength.
- D. On a given project, if the total volume of concrete is such that the frequency of testing required by paragraph B. above would provide less than five strength tests for a given class of concrete, tests shall be made from at least five randomly selected batches or from each batch if fewer than five batches are used.
- E. Cost of retests and coring due to low strength or defective concrete will be paid by Owner and back-charged to the Contractor.
- F. Each truck shall be tested for slump before concrete is placed.

3.13 REMOVAL OF FORMS

- A. Remove without damage to concrete surfaces.
- B. Sequence and timing of form removal shall insure complete safety of concrete structure.
- C. Forms shall remain in place for not less than the following periods of time. These periods represent cumulative number of days during which temperature of air in contact with concrete is 60 degrees F and above.
 1. Vertical forms of foundations, walls and all other forms not covered below: 5 days.
 2. Slab edge screeds or forms: 7 days.
 3. Concrete columns and beam soffits: 28 days.
- D. Concrete shall not be subjected to superimposed loads (structure or construction equipment) until it has attained its full design strength and not for a period of at least 21 days after placing. Concrete systems shall not be subjected to construction loads in excess of design loads.

3.14 CLEANING

- A. Refer to Section 017400.
- B. Upon completion of work of this Section promptly remove from the working area all scraps, debris and surplus material of this Section.
- C. Clean excess material from surface of all concrete walks and utility structures.
- D. Power wash all concrete surfaces to remove stains, dried mud, tire marks, and rust spots.

END OF SECTION

SECTION 32 17 26
TACTILE WARNING SURFACING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Embedded tactile warning surface tile, with an inline dome pattern, for application on ramps and level walking surfaces.
- B. Tactile Tile Installation Method: As indicated on Drawings, and as follows:
 - 1. New Concrete: Installation in cast-in-place uncured (wet) concrete.

1.2 RELATED SECTIONS

- A. Section 03 30 00 – Cast-In-Place Concrete.

1.3 REFERENCES

- A. The publications listed below form a part of this Section to the extent referenced. The publications are referred to in the text by the basic designation only. Refer to Division 01 for definitions, acronyms, and abbreviations.
- B. Standards, manuals, and codes refer to the latest edition of such standards, manuals, and codes in effect as of the date of issue of this Project Manual, unless indicated otherwise in CBC Chapter 35 and CFC Chapter 80.
- C. Referenced Standards:
 - 1. AASHTO HB-17 – Standard Specifications for Highway Bridges.
 - 2. ASTM B117 – Standard Practice for Operating Salt Spray (Fog) Apparatus.
 - 3. ASTM C293 – Standard Test Method for Flexural Strength of Concrete (Using Simple Beam With Center-Point Loading).
 - 4. ASTM C1028 – Standard Test Method for Determining the Static Coefficient of Friction of Ceramic Tile and Other Like Surfaces by the Horizontal Dynamometer Pull-Meter Method.
 - 5. ASTM D543 – Standard Practices for Evaluating the Resistance of Plastics to Chemical Reagents.
 - 6. ASTM D570 – Standard Test Method for Water Absorption of Plastics.
 - 7. ASTM D638 – Standard Test Method for Tensile Properties of Plastics.
 - 8. ASTM D695 – Standard Test Method for Compressive Properties of Rigid Plastics.
 - 9. ASTM D1037 – Standard Test Methods for Evaluating Properties of Wood-Base Fiber and Particle Panel Materials.
 - 10. ASTM D2486 – Standard Test Methods for Scrub Resistance of Wall Paints.
 - 11. ASTM D5420 – Standard Test Method for Impact Resistance of Flat, Rigid Plastic Specimen by Means of a Striker Impacted by a Falling Weight (Gardner Impact).
 - 12. ASTM E84 – Standard Test Method for Surface Burning Characteristics of Building Materials.

- 13. ASTM G155 – Standard Practice for Operating Xenon Arc Light Apparatus for Exposure of Non-Metallic Materials.

1.4 SUBMITTALS

- A. Submit under provisions of Division 01.
- B. Shop Drawings: Show detailed plans of tile profile, fastener locations, and installation methods.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Firm specializing in manufacturing products specified in this Section with a minimum five years' experience.

1.6 REGULATORY REQUIREMENTS

- A. General: Provide detectable (tactile) warning products in accordance with California Code of Regulations (CCR). Title 24, Part 1, 2022 California Administrative Code, Chapter 5 "Access to Public Buildings by Persons with Disabilities".
 - 1. Article 3 "Acceptance of Detectable Warning and Directional Surface Products for Manufacturers and Design Professionals".
 - 2. Article 4 "Application for Independent Entity Evaluation Approval (IEEA)".
- B. Definition of Detectable Warning: Conform to 2022 California Building Code, Chapter 2 "Definitions", Section 202, "Definitions".
 - 1. Chapter 11B "Accessibility to Public Buildings, Public Accommodations, Commercial Buildings and Public Housing," Section 11B-106.5 "Defined Terms" for detectable warning.
- C. Detectable Warnings for Site Accessibility: Provide detectable warning system in accordance with 2022 California Building Code, Chapter 11B, "Accessibility to Public Buildings, Public Accommodations, Commercial Buildings and Public Housing", Section 11B-705.1, Section 11B-705.1.1.4, and the following:
 - 1. Detectable Warnings at Curb Ramps: Chapter 11B, Section 11B-206 "Accessible Routes", Section 11B-406.5.12, "Detectable Warnings", and Section 11B-705.1.2.2, "Curb Ramps".
 - 2. Detectable Warnings at Hazardous Vehicular Areas: Chapter 11B, Section 11B-206, "Accessible Routes", Section 11B-406.5.12, "Detectable Warnings", and Section 11B-705.1.2.5, "Hazardous Vehicular Areas".
 - 3. Detectable warning surfaces shall differ from adjoining surfaces in resiliency or sound-on-cane contact per Section 11B-705.1.1.4.
 - 4. Dome size and spacing shall comply with Chapter 11B, Section 11B-705.1.1.1 and Section 11B-705.1.1.2.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store and handle packaged products in original containers with seals unbroken and labels intact until the time of installation.
- B. Store delivered products in a clean, safe, dry area.

1.8 WARRANTY

- A. Five years.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Basis of Design: Engineered Plastics Inc., Williamsville, NY; 800-682-2525, <http://www.armor-tile.com>. Product:

- 1. Cast-In-Place Type Armor-Tile for embedding in cast-in-place uncured (wet) concrete.

- B. Substitutions: Under provisions of Division 01.

2.2 MATERIALS

- A. Tactile Warning Tiles: An epoxy polymer composite with an ultraviolet stabilized coating containing aluminum oxide particles in the truncated domes.

- 1. Cast-In-Place Type Tile for Embedding in Cast-In-Place Uncured (Wet) Concrete:

- a. Tile thickness to be 0.3875 inch at domes and 0.1875 inch in flat areas between domes. Total thickness at perimeter to be 1.375 inches; dome height to be 0.20 inch.
 - b. Tile underside to have embedment flanges with 0.625-inch diameter holes; long sides to have 0.1875-inch diameter vent holes.
 - c. Tile to have sound amplifying plastic plates attached between flanges, with an air space between tile bottom surface and sound amplifying plastic plates.
 - d. Tile face to have non-slip texture.

- B. Color and Size:

- 1. Safety Yellow, (Federal Color #33538 of Federal Standard 595A) colorfast, UV stabilized coating. Color shall be uniform throughout the tile.
 - 2. Sizes: As indicated on Drawings.

- C. Performance Requirements: Tactile warning tiles shall meet or exceed the following criteria:

- 1. Water Absorption: 0.05 percent, maximum, when tested in accordance with ASTM D570.
 - 2. Slip Resistance: 0.80, minimum combined wet/dry static coefficient of friction on top of domes and field area, when tested in accordance with ASTM C1028.
 - 3. Compressive Strength: 28,000 psi, minimum, when tested in accordance with ASTM D695.
 - 4. Tensile Strength: 19,000 psi, minimum, when tested in accordance with ASTM D638.
 - 5. Flexural Strength: 25,000 psi, minimum, when tested in accordance with ASTM C293.
 - 6. Gardner Impact: 550 inch-pounds per inch minimum, when tested in accordance with ASTM D5420.
 - 7. Chemical Stain Resistance: No discoloration or staining when exposed to ten percent hydrochloric acid, urine, saturated calcium chloride, black stamp pad ink, chewing gum, red aerosol paint, ten percent ammonium hydroxide, one percent soap solution, turpentine, five percent Urea, diesel fuel, motor oil, and tested in accordance with ASTM D543.

8. Wear Depth: 0.06 inch, maximum, after 1000 abrasion cycles of 40 grit Norton Metallite sandpaper, tested in accordance with ASTM D2486.
9. Flame Spread: 15 maximum, when tested in accordance with ASTM E84.
10. Accelerated Weathering: No deterioration, fading or chalking, when tested for 3,000 hours in accordance with ASTM G155.
11. Accelerated Aging and Freeze Thaw Test of Tile and Adhesive System: No cracking, delamination, warping, checking, blistering, color change, loosening of tiles, or other detrimental defects, when tested in accordance with ASTM D1037.
12. Salt and Spray Performance: No evidence of deterioration or defects after 200 hours of exposure, when tested in accordance with ASTM B117.
13. AASHTO HB-17 Single Wheel HS20-44 Loading Test for Cast-In-Place Type Tile: Mounted on concrete platform with 1/2 inch air space at the underside of tile and subjected to a maximum load of 10,400 pounds, corresponding to 8000 pound individual wheel load and thirty percent impact factor; no visible damage at maximum loading.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install tactile warning surface tiles in accordance with manufacturer's printed instructions.
- B. Install Cast-In-Place Type tiles over cast-in-place, uncured (wet) concrete.
- C. Ensure that the surfaces being prepared and fabricated to receive the tiles are constructed correctly and adequately for tile installation.
- D. Installation in Cast-In-Place Uncured (Wet) Concrete: Maintain concrete in 4 inch to 7 inch slump range. Lay tactile warning surface tiles (without removing protective plastic wrap) in uncured (wet) concrete and tamp each tile in place. Place weights over tiles to prevent floating, as recommended by the manufacturer. After curing, remove protective plastic wrap, and clean tile surfaces.

END OF SECTION

SECTION 32 31 19
DECORATIVE METAL FENCES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Ornamental Picket Fencing and Accessories.

1.2 RELATED SECTIONS

- A. Section 03 30 00 – Cast-In-Place Concrete.
- B. Section 32 31 19.13 – Sliding Decorative Metal Gates.
- C. Section 32 31 19.16 – Swinging Decorative Metal Gates.

1.3 REFERENCES

- A. The publications listed below form a part of this Section to the extent referenced. The publications are referred to in the text by the basic designation only. Refer to Division 01 for definitions, acronyms, and abbreviations.
- B. Standards, manuals, and codes refer to the latest edition of such standards, manuals, and codes in effect as of the date of issue of this Project Manual, unless indicated otherwise in CBC Chapter 35 and CFC Chapter 80.
- C. Referenced Standards:
 - 1. ASTM A653/A653M – Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 - 2. ASTM B117 – Standard Practice for Operating Salt Spray (fog) Testing Apparatus.
 - 3. ASTM D523 – Standard Test Method for Specular Gloss.
 - 4. ASTM D714 – Standard Test Method for Evaluating Degree of Blistering in Paint.
 - 5. ASTM D822 – Standard Practice for Conducting Tests on Paint and Related Coatings and Materials using Filtered Open-Flame Carbon-Arc Light and Water Exposure Apparatus.
 - 6. ASTM D1654 – Standard Test Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments.
 - 7. ASTM D2244 – Standard Test Method for Calculation of Color Differences from Instrumentally Measured Color Coordinates.
 - 8. ASTM D2794 – Standard Test Method for Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact).
 - 9. ASTM D3359 – Standard Test Method for Measuring Adhesion by Tape Test.
 - 10. ASTM F2408 – Ornamental Fences Employing Galvanized Steel Tubular Pickets.

1.4 SUBMITTALS

- A. Submit under provisions of Division 01.

- B. Shop Drawings: Layout of fences and gates with dimensions, details and finishes of components, accessories and post foundations.
- C. Product Data: Manufacturer's catalog cuts indicating material compliance and specified options.

1.5 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Sufficient experience manufacturing similar products.
- B. Erector's Qualifications: Sufficient experience installing similar products.

1.6 PROTECTION

- A. Damage to Adjoining Property and Existing Surfaces: Contractor shall assume all responsibility for damage to building surfaces and materials and shall restore them to their original condition should damage occur.

1.7 DELIVERY, STORAGE AND HANDLING

- A. Deliver, store and handle materials so as to avoid damage under provisions of Division 01.

PART 2 PRODUCTS

2.1 MANUFACTURER

- A. Basis-of-Design: Ameristar. Product: Ornamental Picket Fence: Montage II, Genesis Style three rail.
- B. Master Halco.
- C. Substitutions: Under provisions of Division 01.

2.2 ORNAMENTAL PICKET FENCE

A. Materials:

1. Steel material for fence panels and posts shall conform to the requirements of ASTM A653/A653M, with a minimum yield strength of 45,000 psi and a minimum zinc (hot-dip galvanized) coating weight of 0.90 ounces per square foot, Coating Designation G-90.
2. Material for pickets shall be 1 inch square x 14 gauge tubing. The rails shall be steel channel, 1.75 inches x 1.75 inches x 0.105 inch. Picket holes in the rail shall be spaced 4.715 inches on center. Fence posts and gate posts shall meet the minimum size requirements of Table 1 below.

B. Fabrication:

1. Pickets, rails, and posts shall be pre-cut to specified lengths. Rails shall be pre-punched to accept pickets.
2. Pickets shall be inserted into the pre-punched holes in the rails and shall be aligned to standard spacing using a specially calibrated alignment fixture. The aligned pickets and rails shall be joined at each picket-to-rail intersection by manufacturer's proprietary fusion welding process completing the rigid panel assembly, producing a virtually seamless appearance, equally attractive from either side of the panel.

3. The manufactured fence system shall be capable of meeting the vertical load, horizontal load, and infill performance requirements for Industrial weight fences under ASTM F2408.
- C. Finish: The manufactured panels and posts shall be subjected to an inline electrodeposition coating (E-Coat) process consisting of a multi-stage pretreatment/wash, followed by a duplex application of an epoxy primer and an acrylic topcoat. The minimum cumulative coating thickness of epoxy and acrylic shall be 2 mils (0.058 mm). The color shall be Black. The coated panels and posts shall be capable of meeting the performance requirements for each quality characteristic shown in Table 2 below. The requirements in Table 2 meet or exceed the coating performance criteria of ASTM F2408.

2.3 ACCESSORIES

- A. Rail Attachment Brackets: Pressed steel or cast malleable iron.
- B. Ornamental Picket Fence Accessories: Provide indicated items required to complete fence system. Galvanize each ferrous metal item in accordance with ASTM A653/A653M and finished to match framing.
- C. Post Caps: Formed steel, cast or malleable iron or aluminum alloy, weathertight closure cap. Provide one standard post cap for each post.
- D. Picket Tops: Provide standard steel top.

2.4 SETTING MATERIALS

- A. Concrete: Minimum 28 day compressive strength of 3,000 pounds per square inch for setting fence posts. Refer to Section 03 30 00.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify areas to receive fencing are completed to final grades and elevations.
- B. Ensure property lines and legal boundaries of work are clearly established.

3.2 ORNAMENTAL PICKET FENCE INSTALLATION

- A. Install fence in accordance with manufacturer's instructions.
- B. Fence post shall be spaced according to Table 3 below, plus or minus 1/2 inch. For installations that must be raked to follow sloping grades, the post spacing dimension shall be measured along the grade. Fence panels shall be attached to posts with brackets supplied by the manufacturer.
- C. Concrete Footings: Drill holes in firm, undisturbed or compacted soil. Holes shall have diameter four times greater than outside dimension of posts and depths approximately 6 inches deeper than post bottom. Excavate deeper as required for adequate support in soft and loose soils and for posts with heavy lateral loads. Set post bottom below surface when in firm, undisturbed soil. Place concrete around posts in a continuous pour. Trowel finish around post and slope to direct water away from posts. Posts shall be set in concrete footers having a minimum depth of 36 inches; refer to Drawings for footing size.

- D. Check each post for vertical and top alignment and maintain in position during placement and finishing operations.
- E. Align fence panel posts. Panels shall be attached to posts using mechanically fastened panel brackets supplied by the manufacturer.
- F. When cutting/drilling rails or posts adhere to the following steps to seal the exposed steel surfaces:
 - 1. Remove all metal shavings from cut area.
 - 2. Apply zinc-rich primer to thoroughly cover cut edge and/or drilled hole; let dry.
 - 3. Apply two coats of custom finish paint matching fence color. Failure to seal exposed surfaces per steps 1-3 above will negate warranty. Manufacturer's spray cans or paint pens shall be used to prime and finish exposed surfaces; it is recommended that paint pens be used to prevent overspray. Use of parts or components not provided by manufacturer will negate the manufactures' warranty.

3.3 ACCESSORIES

- A. Install post caps and other accessories to complete fence.

3.4 CLEANING

- A. Cleaning and Finishing: Upon completion of the work, clean all exposed surfaces, removing any discoloration or foreign matter.
- B. Touch up all abraded or scraped areas with touch-up paint to match fence color. Touch-up shall not be obvious.
- C. Protect all installed work against damage from other construction work.
- D. Clean Up: Upon completion of the work of this Section, remove all surplus materials, rubbish, and debris from the fence installation area.

Table 1 – Minimum Sizes for Montage II Posts

<u>Fence Posts</u>	<u>Panel Height</u>		
2-1/2 inches x 12 gauge	Up to and including 6 feet height		
3 inches x 12 gauge	Over 6 feet and up to and Including 8 feet height		
<u>Gate Leaf</u>	<u>Gate Height</u>		
	<u>Up to and Including 4 feet</u>	<u>Over 4 feet and up to and including 6 feet</u>	<u>Over 6 feet and up to and including 8 feet</u>
Up to 4'	2-1/2" x 12 gauge	3" x 12 gauge	3" x 12 gauge
4'-1" to 6'	3" x 12 gauge	4" x 11 gauge	4" x 11 gauge
6'-1" to 8'	3" x 12 gauge	4" x 11 gauge	6" x 3/16"
8'-1" to 10'	4" x 11 gauge	6" x 3/16"	6" x 3/16"
10'-1" to 12'	4" x 11 gauge	6" x 3/16"	6" x 3/16"
12'-1" to 14'	4" x 11 gauge	6" x 3/16"	6" x 3/16"
14'-1" to 16'	6" x 3/16"	6" x 3/16"	6" x 3/16"

Table 2 – Coating Performance Requirements

<u>Quality Characteristics</u>	<u>ASTM Test Method</u>	<u>Performance Requirements</u>
Adhesion	D3359 – Method B	Adhesion (Retention of Coating) over 90 percent of test area (Tape and knife test).

Corrosion Resistance	B117, D714, and D1654	Corrosion Resistance over 1,500 hours (Scribed per ASTM D1654; failure mode is accumulation of 1/8 inch coating loss from scribe or medium #8 blisters).
Impact Resistance	D2794	Impact Resistance over 60 inch pounds (Forward impact using 0.625 inch ball).
Weathering Resistance	D523, D822, and D2244 (60° Method)	Weathering Resistance over 1,000 hours (Failure mode is 60 percent loss of gloss or color variance of more than 3 delta-E color units).

Table 3 – Montage II – Post Spacing By Bracket Type						
Span	8 feet nominal for 92-5/8 inch long rail					
Post Size	2-1/2 inches	3 inches	2-1/2 inches	3 inches	2-1/2 inches	3 inches
Bracket Type	Industrial Universal 2.5 inches (BB302) 3 inches (BB303)		Industrial Flat Mount (BB301)		Industrial Swivel (BB304)*	
Post Settings ± 1/2 inch on center	96 inches	96-1/2 inches	96 inches	96-1/2 inches	*96 inches	*96-1/2 inches
*Note: When using BB304 swivel brackets on either or both ends of a panel installation, care must be taken to ensure the spacing between post and adjoining pickets meets applicable codes. This will require trimming one or both ends of the panel.						

END OF SECTION

SECTION 32 31 19.13
SLIDING DECORATIVE METAL GATES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Sliding gates, framework, and accessories.
- B. Gate operator.

1.2 RELATED SECTIONS

- A. Section 03 30 00 – Cast-In-Place Concrete.
- B. Division 26 – Electrical: Connections to gate operator and controls.
- C. Section 32 31 19 – Decorative Metal Fences.
- D. Section 32 31 19.16 – Swinging Decorative Metal Gates.

1.3 REFERENCES

- A. The publications listed below form a part of this Section to the extent referenced. The publications are referred to in the text by the basic designation only. Refer to Division 01 for definitions, acronyms, and abbreviations.
- B. Standards, manuals, and codes refer to the latest edition of such standards, manuals, and codes in effect as of the date of issue of this Project Manual, unless indicated otherwise in CBC Chapter 35 and CFC Chapter 80.
- C. Referenced Standards:
 - 1. ASTM A513 – Standard Specification for Electric-Resistance-Welded Carbon and Alloy Steel Mechanical Tubing.
 - 2. ASTM A653/A653M – Standard Specification for Steel Sheet, Zinc Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by the Hot-Dip Process.
 - 3. ASTM B117 – Standard Practice for Operating Salt Spray (fog) Testing Apparatus.
 - 4. ASTM F2200 – Standard Specification for Automated Vehicular Gate Construction.
 - 5. UL 325 – Door, Drapery, Gate, Louver, and Window Operators and Systems.

1.4 SUBMITTALS

- A. Submit under provisions of Division 01.
- B. Shop Drawings: Shop drawings shall show gate elevation, dimensions, all component parts, operator including electrical requirements, and all fabrication details.
- C. Product Data: Manufacturer's catalog cuts indicating material compliance and specified options.

1.5 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Sufficient experience manufacturing similar products.
- B. Erector Qualifications: Sufficient experience installing similar products.

1.6 PROTECTION

- A. Damage to Adjoining Property and Existing Surfaces: Contractor shall assume all responsibility for damage to building surfaces and materials and shall restore them to their original condition should damage occur.

1.7 DELIVERY, STORAGE AND HANDLING

- A. Deliver, store and handle materials so as to avoid damage under provisions of Division 01.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Basis of Design: Ameristar. Product: Ornamental Picket Sliding Gates: Passport II, Genesis Style three rail with roll gate hardware kit #PGKOD. Gates, accessories, and finish shall match decorative metal fencing.
- B. Master Halco.
- C. Substitutions: Under provisions of Division 01.

2.2 MATERIALS

- A. Materials for gate framework (i.e., pickets, rails and posts) shall be manufactured from coil steel having a minimum yield strength of 45,000 psi. All steel shall be galvanized to meet the requirements of ASTM A653 with a minimum zinc coating weight of 0.90 ounces per square foot (coating designation G-90), hot dip process. Gate sizes as indicated on Drawings.
- B. Pickets: Material for gate pickets shall be 1 inch square x 14 gauge tubing.
- C. Rails: The cross-sectional shape of the rails shall conform to the manufacturer's standard design, with outside cross section dimensions of 2 inches square x 11 gauge at top rails, uprights, and diagonal braces, and 2 inches x 4 inches x 11 gauge at bottom rail. Picket holes in rail shall be spaced 4-3/4 inches on center.
- D. Gate Posts: Posts at gates shall be 4 inch square x 11 gauge, ASTM A513 hot-rolled structural quality steel, 50,000 pounds per square inch tensile strength, with ASTM A653 hot-dipped galvanized G90 coating. Provide top cap at each post.
- E. Track: Galvanized steel angles sized to accommodate trucks.
- F. Trucks: Two swivel type zinc die cast trucks having four sealed lubricant ball bearing wheels, 4 inches in diameter by 1 inch in width, with two side rolling wheels to insure alignment of truck in track shall be provided for each gate leaf. Trucks shall be held to post brackets by 7/8 inch diameter ball bolts with 1/2 inch shank. Truck assembly shall be designed to take the same reaction load as the track.

- G. Guide Roller Assembly: Provide for each supporting post 4 inch rubber guide rollers. Each assembly shall consist of rubber wheels 4 inches in diameter with oil impregnated bearings and shall be attached to post so that the bottom horizontal member will roll between the wheels which can be adjusted to maintain plumb gate frames and proper alignment.
- H. Accessories: All gate hangers, latches, brackets, guide assemblies and stops shall be malleable iron or steel, galvanized after fabrication.
- I. Finish: Galvanized framework shall be subject to six-stage pretreatment/wash (with zinc phosphate) followed by an electrostatic spray application of a two-coat powder system. The base coat is a thermosetting epoxy powder coating (gray in color) with a minimum thickness of 2 mils to 4 mils. Topcoat shall be a TGIC polyester powder coat finish with a minimum thickness of 2 mils to 4 mils. The color shall be black. Coated galvanized framework shall have a salt spray resistance of 3500 hours using Test Method B117 without loss of adhesion. Paint system used shall not contain lead.

2.3 FABRICATION

- A. Sliding gates shall be constructed as specified in this Section and as indicated on Drawings.
- B. Use materials of size and thickness indicated or, if not indicated, as required to produce strength and durability in finished product for use intended. Work to dimensions shown or accepted on shop drawings, using proven details of fabrication and support. Use type of materials shown or specified for various components of work.
- C. Form exposed work true to line and level with accurate angles and surfaces and straight sharp edges. Ease exposed edges to a radius of approximately 1/32 inch unless otherwise indicated.
- D. Weld corners and seams continuously, complying with AWS recommendations. At exposed connections, grind exposed welds smooth and flush to match and blend with adjoining surfaces.
- E. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners.
- F. Fabricate to design, dimensions and details indicated. Provide members formed of galvanized steel tube of sizes indicated.
- G. Interconnect members by butt-welding or welding with internal connectors, at fabricator's option. Provide closures, flanges, miscellaneous fittings and anchors for interconnections of tube and attachment of members to other work.
- H. Fabricate and furnish gates complete with all hardware.

2.4 GATE OPERATOR

- A. Manufacturers:
 - 1. LiftMaster, Product: Elite Series #SL3000.
 - 2. Substitutions: Under provisions of Division 01.

B. Slide Gate Operator:

1. Chassis 1/4 inch gold zinc plated steel.
2. Cover: 1 piece high density UV resistant polyethylene.
3. Operation: Gear driven.
4. Meet UL 325, UL 991, and ASTM F2200.
5. Motor: 115 VAC, continuous duty type, sized to gate conditions.
6. Traveling speed: 12 inches per second.
7. Monitoring and controls:
 - a. Internet connectivity: MyQ technology with 50 channel FHSS.
 - b. Radio receiver: Security+ 2.0 technology.
 - c. Monitored retro-reflective photo eyes.
 - d. Monitored small profile wired safety edge.
8. Accessories:
 - a. Monitored safety devices: Thru-beam photo eyes.
 - b. Wired monitored safety edges: Large profile edge.
 - c. Plug-in loop detector.
 - d. Wireless commercial keypad.
 - e. Two button rolling code Security+ 2.0 learning remote control.
 - f. Commercial access control receiver.

C. Vehicle Detector: Saratec Model 515B or accepted equal:

1. Tuning: Automatic – Less than 1 second.
2. Output: Prescence Relay. 2 amps. N.O.
3. Lightning Protection: Accepts 10 Microfarads @ 2000 volts between loop and ground. 10 Microfarads @ 1000 volts across open loop terminals.
4. Frequency Separation: Three position switch on front panel.
5. Holding Time: 30 minutes to 60 minutes, depending on vehicle and loop configuration.
6. Maximum Lead-In: 1,000 feet.
7. Loop Inductance: 30 – 1000 Microphenries (1-1/2' x 6' x 10' x 100' loops fall within this range). Similar loops may be used in seriesparallel.
8. Loop Isolation: Total – will operate and “Self-Tune” with low quality loops.
9. Operating Temperature: -40 degrees F to +185 degrees F.
10. Indicator: Front panel solid-state light.
11. Connector: Eleven-pin amphenol type, front mounted.
12. The digital vehicle detector shall be completely “self-tuning” the moment power is applied. The detector will tune itself to a pre-determined sensitivity level. The only field adjustment required shall be the setting of the three-position switch which sets to loop frequency. When two or more loop detectors are used in close proximity, this “Low/Medium/High” adjustment switch shall be set so that each detector is operating on a different frequency. Momentarily remove power from the detector so it can automatically re-tune to the new frequency.

13. The detector shall constantly monitor the frequency of the loop several times per second. It shall compare and adjust for changes such as loop aging, moisture, mechanical deterioration, foreign bodies in the loop, etc.

D. Entrance gate shall have two loops:

1. One placed on outside of gate and one placed on inside (secure side) both to act as safety function.

E. Exit gate shall have two loops:

1. One placed on outside for safety function only, one placed on inside (secure side) to act as free exit device and safety function.

F. Do not commence work until any unsatisfactory conditions have been corrected.

2.5 SETTING MATERIALS

A. Concrete: Minimum 28 day compressive strength of 3,000 pounds per square inch for setting gate posts. Refer to Section 03 30 00.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify areas to receive gates are completed to final grades and elevations.

3.2 INSTALLATION

A. Install gates and operators in accordance with manufacturer's instructions.

B. Workmanship: All work shall be installed level and plumb and securely anchored to the fence structure.

C. Gate: Install gate plumb, level and secure for a full opening without interference. Install and adjust operator for smooth operation and lubricate where necessary. Gate shall operate freely and without bind.

1. Adjust fencing prior to anchoring to insure matching alignment at abutting joints.

2. Cutting, Fitting and Placement: Perform cutting, drilling and fitting required for installation of gates. Set work accurately in location, alignment and elevation, plumb, level, true and free of rack, measured from established lines and levels. Install in concrete foundations as indicated.

3. Fit exposed connections accurately together to form tight hairline joints. Weld connections which are not to be left as exposed joints, but cannot be shop welded because of shipping size limitations. Grind exposed joints smooth and touch-up galvanizing and shop prime coats.

4. Field Welding: Comply with AWS Code for procedures of manual shielded metal-arc welding appearance and quality of welds made.

D. Coordinate installation of gates with installation of fencing, gate operator, and controls.

3.3 ADJUST AND CLEAN

- A. Adjusting: Adjust gate as required for smooth, unhindered operation.
- B. Cleaning and Finishing: Upon completion of the work, clean all exposed surfaces, removing any discoloration or foreign matter.
- C. Touch up all abraded or scraped areas with touch-up paint to match gate color. Touch-up shall not be obvious.
- D. Protect all installed work against damage from other construction work.
- E. Clean Up: Upon completion of the work of this Section, remove all surplus materials, rubbish and debris from the gate installation area.

END OF SECTION

SECTION 32 31 19.16
SWINGING DECORATIVE METAL GATES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Gates, framework, and accessories.

1.2 RELATED SECTIONS

- A. Section 03 30 00 – Cast-In-Place Concrete.
- B. Section 32 31 19 – Decorative Metal Fences.
- C. Section 32 31 19.13 – Sliding Decorative Metal Gates.

1.3 REFERENCES

- A. The publications listed below form a part of this Section to the extent referenced. The publications are referred to in the text by the basic designation only. Refer to Division 01 for definitions, acronyms, and abbreviations.
- B. Standards, manuals, and codes refer to the latest edition of such standards, manuals, and codes in effect as of the date of issue of this Project Manual, unless indicated otherwise in CBC Chapter 35 and CFC Chapter 80.
- C. Referenced Standards:
 - 1. ASTM B117 – Standard Practice for Operating Salt Spray (fog) Testing Apparatus.
 - 2. ASTM D523 – Standard Test Method for Specular Gloss.
 - 3. ASTM D714 – Standard Test Method for Evaluating Degree of Blistering in Paint.
 - 4. ASTM D822 – Standard Practice for Conducting Tests on Paint and Related Coatings and Materials using Filtered Open-Flame Carbon-Arc Light and Water Exposure Apparatus.
 - 5. ASTM D1654 – Standard Test Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments.
 - 6. ASTM D2244 – Standard Test Method for Calculation of Color Differences from Instrumentally Measured Color Coordinates.
 - 7. ASTM D2794 – Standard Test Method for Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact).
 - 8. ASTM D3359 – Standard Test Method for Measuring Adhesion by Tape Test.
 - 9. ASTM F2408 – Ornamental Fences Employing Galvanized Steel Tubular Pickets.

1.4 SUBMITTALS

- A. Submit under provisions of Division 01.
- B. Shop Drawings: Shop drawings shall show gate elevation, dimensions, all component parts, and all fabrication details.
- C. Product Data: Manufacturer's catalog cuts indicating material compliance and specified options.

1.5 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Sufficient experience manufacturing similar products.
- B. Erector Qualifications: Sufficient experience installing similar products.

1.6 REGULATORY REQUIREMENTS

- A. All accessible gates shall meet all applicable requirements for doors per CBC Chapter 11B, Sections 11B-206.5 and 11B-404.1.
- B. Hand-activated opening hardware, handles, pulls, latches, locks and other operating devices for accessible gates shall have a shape that is easy to grasp with one hand and does not require tight grasping, tight pinching or twisting of the wrist to operate per CBC Sections 11B-309.4 and 11B-404.2.7.
- C. The lever of lever actuated latches or locks for an accessible gate shall be curved with a return to within 1/2 inch of the face of gate per California Referenced Standards code, Title 24, Part 12, Section 12-10-202, Item (F).
- D. The bottom 10 inches of an accessible gate shall have a smooth, uninterrupted surface on each side. Bottom of the gates shall be within 3 inches of finish surface of the path of travel. Maximum effort to operate a gate shall not exceed 5 pounds per CBC Sections 11B-404.2.9.
- E. Gate hardware installed at exterior locations subject to moisture or other weather-related elements shall be UL listed for all-weather use in wet locations and installation shall conform to 2022 CBC/CFC Section 1010.2.9, CCR Title 19 and UL 305.

1.7 PROTECTION

- A. Damage to Adjoining Property and Existing Surfaces: Contractor shall assume all responsibility for damage to building surfaces and materials and shall restore them to their original condition should damage occur.

1.8 DELIVERY, STORAGE AND HANDLING

- A. Deliver, store and handle materials so as to avoid damage under provisions of Division 01.

PART 2 PRODUCTS

2.1 MANUFACTURER

- A. Basis of Design: Ameristar. Product: Ornamental Picket Swinging Gates: Montage II, Genesis Style three rail. Gates, accessories, and finish shall match decorative metal fencing.

- B. Master Halco.
- C. Substitutions: Under provisions of Division 01.

2.2 MATERIALS

- A. Swing gates shall be fabricated using 1.75 inch x 14 gauge double channel rail, 2 inches square x 12 gauge gate ends, and 1 inch square x 14 gauge pickets. Gates that exceed 6 feet in width shall have a 1.75 inch square x 14 gauge intermediate upright. All rail and upright intersections shall be joined by welding. All picket and rail intersections shall also be joined by welding. Gusset plates shall be welded at each upright to rail intersection. Gate sizes as indicated on Drawings.
- B. Gate Posts: Refer to Section 32 31 19. Provide top cap at each post.
- C. Bracing: Provide cable kits for additional trussing for all gates leaves over 6 feet wide.
- D. Gate Hardware: Refer to Drawings.
 - 1. Provide metal fabrications to accept gate hardware as indicated on Drawings.
- E. Finish: The manufactured panels and posts shall be subjected to an inline electrodeposition coating (E-Coat) process consisting of a multi-stage pretreatment/wash, followed by a duplex application of an epoxy primer and an acrylic topcoat. The minimum cumulative coating thickness of epoxy and acrylic shall be 2 mils (0.058 mm). The color shall be Black. The coated panels and posts shall be capable of meeting the performance requirements for each quality characteristic shown in Table 1 below. The requirements in Table 1 below meet or exceed the coating performance criteria of ASTM F2408.

2.3 FABRICATION

- A. Swinging gates shall be constructed as specified in this Section and as indicated on Drawings.
- B. Use materials of size and thickness indicated or, if not indicated, as required to produce strength and durability in finished product for use intended. Work to dimensions shown or accepted on shop drawings, using proven details of fabrication and support. Use type of materials shown or specified for various components of work.
- C. Form exposed work true to line and level with accurate angles and surfaces and straight sharp edges. Ease exposed edges to a radius of approximately 1/32 inch unless otherwise indicated.
- D. Weld corners and seams continuously, complying with AWS recommendations. At exposed connections, grind exposed welds smooth and flush to match and blend with adjoining surfaces.
- E. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners.
- F. Fabricate to design, dimensions and details indicated. Provide members formed of galvanized steel tube sizes indicated.
- G. Interconnect members by butt-welding or welding with internal connectors, at fabricator's option. Provide closures, flanges, miscellaneous fittings and anchors for interconnections of tube and attachment of members to other work.

H. Fabricate and furnish gates complete with all hardware as indicated.

I. Bracing: Provide diagonal adjustable length truss rods on gates to prevent sag.

2.4 SETTING MATERIALS

A. Concrete: Minimum 28 day compressive strength of 3,000 pounds per square inch for setting gate posts. Refer to Section 03 30 00.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify areas to receive gates are completed to final grades and elevations.

3.2 INSTALLATION

A. Install gates in accordance with manufacturer's instructions.

B. Gate posts shall be spaced according to the manufacturers' gate drawings, dependent on standard out-to-out gate leaf dimensions and gate hardware selected.

C. Workmanship: All work shall be installed level and plumb and securely anchored to the wall structure.

D. Gate: Install gate plumb, level and secure for a full opening without interference. Gate shall operate freely and without bind.

1. Adjust fencing prior to anchoring to insure matching alignment at abutting joints.

2. Cutting, Fitting and Placement: Perform cutting, drilling and fitting required for installation of gate assemblies. Set work accurately in location, alignment and elevation, plumb, level, true and free of rack, measured from established lines and levels. Install in concrete foundations as indicated.

3. Fit exposed connections accurately together to form tight hairline joints. Weld connections which are not to be left as exposed joints, but cannot be shop welded because of shipping size limitations. Grind exposed joints smooth and touch-up galvanizing and shop prime coats.

4. Field Welding: Comply with AWS Code for procedures of manual shielded metal-arc welding appearance and quality of welds made.

E. Coordinate installation of gates with installation of fencing.

3.3 ADJUST AND CLEAN

A. Adjusting: Adjust gate as required for smooth, unhindered operation.

B. Cleaning and Finishing: Upon completion of the work, clean all exposed surfaces, removing any discoloration or foreign matter.

C. Touch up all abraded or scraped areas with touch-up paint to match gate color. Touch-up shall not be obvious.

D. Protect all installed work against damage from other construction work.

E. Lubricate hardware and other moving parts.

- F. Clean Up: Upon completion of the work of this Section, remove all surplus materials, rubbish and debris from the gate installation area.

Table 1 – Coating Performance Requirements		
<u>Quality Characteristics</u>	<u>ASTM Test Method</u>	<u>Performance Requirements</u>
Adhesion	D3359 – Method B	Adhesion (Retention of Coating) over 90 percent of test area (Tape and knife test).
Corrosion Resistance	B117, D714, and D1654	Corrosion Resistance over 1,500 hours (Scribed per ASTM D1654; failure mode is accumulation of 1/8 inch coating loss from scribe or medium #8 blisters).
Impact Resistance	D2794	Impact Resistance over 60 inch pounds (Forward impact using 0.625 inch ball).
Weathering Resistance	D523, D822, and D2244 (60° Method)	Weathering Resistance over 1,000 hours (Failure mode is 60 percent loss of gloss or color variance of more than 3 delta-E color units).

END OF SECTION

SECTION 32 84 00

LANDSCAPE IRRIGATION

PART 1 GENERAL

1.1 SUMMARY

- A. Irrigation system required for this work includes but is not limited to the furnishing of all labor, tools, materials, appliances, tests, permits, taxes, etc., necessary for the installation of a landscape irrigation system as herein specified and shown on the drawings, and the removal of all debris from the site.
 - 1. Furnish and install all materials and equipment for a fully operational automatic irrigation system.
 - 2. Trenching, boring or drilling for all lines, backfilling and repair of all damage.
 - 3. Testing and startup of the irrigation system.
 - 4. Clean up and disposal of all excess and surplus material.
 - 5. Prepare as-built drawings and furnish all turnover materials.
 - 6. Maintenance of the irrigation system during the proscribed maintenance period.
- B. The system shall efficiently and evenly irrigate all areas and be complete in every respect and shall be left ready for operation to the satisfaction of the Owner's Representative.
- C. Coordinate with other trades as needed to complete work, including but not limited sleeves under paving and elsewhere, water and electrical Points of Connection (POC), equipment, and equipment pads.

1.2 CONTRACT DOCUMENTS

- A. Construction drawings and these specifications are a part of the contract documents. Refer to contract for a complete list of all contract documents. The documents are to be considered as one. Whatever is called for by any parts shall be as binding as if called for in all parts.

1.3 REFERENCES

- A. American Society of Testing Materials (ASTM): cited section numbers.
- B. National Sanitation Foundation (NSF): rating system.
- C. American Society of Agricultural and Biological Engineers (ASABE) ICC 802, latest edition.

1.4 VERIFICATION

- A. Irrigation piping and related equipment are drawn diagrammatically. Scaled dimensions are approximate only. Before proceeding with work, carefully check and verify dimensions and immediately notify the Owner's Representative of discrepancies between the drawings or specifications and the actual conditions. Although sizes and locations of plants and or irrigation equipment are drawn to scale wherever possible, it is not within the scope of the drawings to show all necessary offsets, obstructions, or site conditions. The Contractor shall be responsible for installing the work in conformance to site conditions, complete, and in good working order.
- B. Piping and equipment is to be located within the designated planting areas wherever possible unless specifically defined or dimensioned otherwise.

1.5 PERMITS AND REGULATIONS

- A. The Contractor shall obtain and pay for all permits related to this section of the work unless previously excluded under provision of the contract or general conditions. The Contractor shall comply with all applicable laws and ordinances.
- B. Wherever references are made to standards or codes in accordance with which the work is to be performed or tested, the edition or revision of the standards and codes current on the effective date of this contract shall apply, unless otherwise expressly set forth.
- C. In case of conflict among any referenced standards or codes or between any referenced standards and codes and the specifications, the more restrictive standard shall apply unless determined otherwise by the Owner's Representative.

1.6 PROTECTION OF WORK, PROPERTY, AND PERSONS

- A. The Contractor shall adequately protect the work, adjacent property, and the public, and shall be responsible for any damages or injury due to the Contractor's actions.

1.7 CORRECTION OF WORK

- A. The Contractor shall re-execute any work that fails to conform to the requirements of the contract and shall remedy defects due to faulty materials or workmanship upon written notice from the Owner's Representative, at the soonest as possible time that can be coordinated with other work, and seasonal weather demands, but not more than 90 (ninety) days after notification.

1.8 DEFINITIONS

- A. Owner's Representative: The person appointed by the Owner to represent their interest in the review and approval of the work and to serve as the contracting authority with the Contractor. The Owner's Representative may appoint other persons to review and approve any aspects of the work.
- B. Substantial Completion: The date at the end of the Planting, Planting Soil, and Irrigation installation where the Owner's Representative accepts that all work in these sections is complete and the Warranty period has begun. This date may be different than the date of substantial completion for the other sections of the project.
- C. Final Acceptance: The date when the Owner's Representative accepts that the plants and work in this section meet all the requirements of specification. It is intended that the materials and workmanship warranty for Planting, Planting Soil, and Irrigation work run concurrently.

1.9 SUBMITTALS

- A. Comply with general conditions, special conditions, Division 1 sections and other contract documents. All submittals shall be made at least 4 weeks prior to delivery of materials.
- B. Product data
 - 1. Submit list all irrigation equipment to be used, including specification (cut) sheets, within 15 days after the notice to proceed. This submission may be done digitally and all documents shall be submitted in one PDF document.
 - 2. The submittals shall be packaged and presented in an organized manner, in the quantity described in Division 1 of the specifications. Provide a table of contents of all submitted items.
 - 3. Clearly identify on each submitted sheet by underlining or highlighting (on each copy) the specific product being submitted for approval. Failure to clearly identify the specific

product being submitted will result in a rejection for the entire submittal. No substitutions of material or procedures shall be made without the written approval by the Owner's Representative.

4. Equipment or materials installed or furnished without prior approval of the Owner's Representative, may be rejected by the Owner's Representative and the Contractor shall be required to remove such materials from the site at their own expense.
 5. Approval of substitution of material and/or products, other than those specified shall not relieve the Contractor from complying with the requirements of the contract documents and specifications. The Contractor shall be responsible, at their own expense, for all changes that may result from the approved substitutions, which affect the installation or operations other items of their own work and/or the work of other Contractors.
- C. Samples: Samples of the equipment may be required at the request of the Owner's Representative if the equipment is other than that specified.
- D. Other Submittals: Submit for approval:
1. Documentation of the installer's qualifications (prior to bid).
 2. Testing data from all required hydrostatic pressure testing.
 3. Backflow prevention device testing: as required by 17 CCR § 7605 (d), provide testing as required by the local authority immediately upon installation or relocation.
 4. Booster pump certification: Certification from the manufacturer's representative of correct installation per the manufacturer's requirements.
 5. Irrigation controller certification (if applicable): Certification from the manufacturer's representative of correct installation per the manufacturer's requirements.
 6. Turnover materials as listed within this specification section.

1.10 OBSERVATION OF THE WORK

- A. The Owner's Representative may observe the work at any time. They may remove samples of materials for verification or testing. Rejected materials shall be immediately removed from the site and replaced at the Contractor's expense. The cost of testing materials not meeting specifications, and re-testing of replacement materials, shall be paid by the Contractor
- B. The Owner's Representative shall be informed of the progress of the work so that the work may be observed at the following key times in the construction process. Failure of the Owner's Representative to make field observations shall not relieve the Contractor from meeting all the requirements of this specification. The following observations are anticipated, with required advance notification times:
1. Trenching, directional boring, and sleeving review: 7 days
 2. Hydrostatic pressure testing: 7 days
 3. Adjustment and coverage test: 7 days
 4. Pre-maintenance observation: 7 days
 5. Final acceptance / system malfunction corrections: 7 days

1.11 QUALITY ASSURANCE

- A. The contractor shall furnish and install a complete irrigation system, delivering sufficient water to maintain optimum plant health at all times and in an efficient manner. The irrigation system will provide water to all plants, even when not shown on the drawings.

- B. The Owner's Representative shall be the sole judge of the intent of the drawings and specifications and of the quality of all materials furnished in performance of the contract.
- C. The Contractor shall keep one copy of all drawings and specifications on the work site, in good order. The Contractor shall make these documents available to the Owner's Representative when requested.
- D. In the event of any discrepancies between the drawings and the specification, the more stringent shall apply, unless determined otherwise by the Owner's Representative.
- E. Installer Qualifications: The installer shall be a firm having at least 5 years of successful experience of a scope similar to that required for the work.
 - a. Installer Field Supervision: The installer shall maintain on site an experienced full-time supervisor who can communicate in English with the Owner's Representative.
 - b. Submit the installer's qualifications for approval.

1.12 WARRANTY:

- A. The Contractor shall Warrantee all workmanship and materials for a period of 1 year (s), following final acceptance. This warranty shall run concurrently with plant warranty under Section 32 90 00 – Landscape Installation.
- B. Any parts of the irrigation work that fails or is defective shall be replaced or reconstructed at no expense to the Owner including but not limited to: restoring grades that have settled in trenches and excavations related to the work. Reconstruction shall include any plantings, soil, mulch or other parts of the constructed landscape that may be damaged during the repair or that results from soil settlement.
- C. Neither the final acceptance nor any provision in the contract documents shall relieve the Contractor of responsibility for faulty materials or workmanship. The Contractor shall remedy any defects within a period of 7 days (s) from the date of notification.

1.13 SITE CONDITIONS

- A. It is the responsibility of the Contractor to be aware of all surface and sub-surface conditions, and to notify the Owner's Representative, in writing, of any circumstances that would negatively impact the installation of the work. Do not proceed with work until unsatisfactory conditions have been corrected.

1.14 DELIVERY, STORAGE, AND HANDLING

- A. All materials and equipment shall be stored properly and protected as required by the manufacturer. The Contractor shall be entirely responsible for damages or loss by weather or other cause to work under the contract. Materials shall be furnished in ample quantities and at such times as to ensure uninterrupted progress of the work.
- B. Deliver the products to the job site in their original unopened container with labels intact and legible at time of use.

1.15 PROTECTION

- A. The Contractor shall continuously maintain adequate protection of all their work from damage, destruction, or loss, and shall protect the owner's property from damage arising in connection with this contract. Contractor shall repair or make compensation for any such damage, destruction, loss or injury. Contractor shall adequately protect adjacent property as provided by law and the contract documents.
- B. The Contractor shall maintain sufficient safeguards, such as railings, temporary walks, lights, etc., against the occurrence of accidents, injuries or damage to any person or

property resulting from their work, and shall alone be responsible for the same if such occurs.

- C. All existing paving, structures, equipment, work, and plant material shall be protected at all times from damage by workers and equipment. The Contractor shall follow all protection requirements including plant protection provisions. All damages shall be repaired or replaced at the Contractor's expense. Repairs and or replacement shall be to the satisfaction of the Owner's Representative, including the selection of a Contractor to undertake the repair or maintenance. Repairs shall be at no cost to the owner.
 - 1. For trees damaged such that they are not expected to survive or which are severely disfigured, and that are too large to replace, the cost of damages shall be as determined by the Owner's arborist using accepted tree value evaluation methods.
- D. Refrain from mechanical trenching within the drip line of any existing tree to remain. The Owner's Representative may require the Contractor to relocate proposed irrigation work, bore lines beneath roots, use hand tools, air spade, or similar technology to excavate trenches through and under the root system to avoid damage to existing tree root areas.

1.16 EXCAVATING AROUND UTILITIES

- A. Notification of Underground Service Alert (USA), 811, is required for all excavation.
- B. Contractor shall carefully examine the civil, as-built, record, and survey drawings to become familiar with the existing underground conditions before digging. The Contractor is responsible for knowing the location and avoiding utilities that are not covered by USA.
- C. Determine location of underground utilities and perform work in a manner that will avoid possible damage. Hand excavate, as required. Maintain stakes and or markings set by others until parties concerned mutually agree to their removal.
- D. Damage to existing work, including utilities, shall be repaired at the contractor's sole expense.

1.17 POINT OF CONNECTION

- A. The contractor shall coordinate water and power sources. All electrical connections shall be made by a licensed electrical Contractor per governing codes at the location(s) shown on the drawings.

1.18 TEMPORARY UTILITIES

- A. All temporary water, power, piping, wiring, meters, panels and other related appurtenances required between source of supply and point of use shall be provided by the Contractor and coordinated with the Owner's Representative. Existing utilities may be used with the written permission of the owner.

1.19 CUTTING, PATCHING, TRENCHING AND DIGGING

- A. The Contractor shall do all cutting, fitting, trenching or patching of their work that may be required to make its several parts come together as shown upon, or implied by, the drawings and specifications for the completed project.

1.20 USE OF PREMISES

- A. Contractor parking, and material and equipment storage shall be limited to areas approved by the Owner's Representative.

1.21 AS BUILT DRAWINGS

- A. Immediately upon the installation of any buried pipe or equipment, the Contractor shall indicate on the progress record drawings the locations of said pipe or equipment. The

progress record drawings shall be made available at any time for review by the Owner's Representative.

- B. Provide a completed as built set of drawings, in .pdf format, showing the irrigation system work as built to the Owner's Representative. The drawings shall include all information shown on the original contract documents and revised to reflect all changes in the work. The drawings shall include the following additional information:
1. All valves shall be numbered by station and corresponding numbers shall be shown on the as built set of drawings.
 2. All main line pipe and irrigation equipment including sleeves, valves, controllers, irrigation wire runs which deviate from the locations on the contract documents.
 3. Controllers, backflow preventers, remote control valves, grounding rods, shut-off valves, wire splice locations, sleeves, and quick coupling valves shall be located by two (2) measured dimensions, to the nearest one-half foot. Dimensions shall be given from permanent objects such as buildings, sidewalks, curbs, walls, structures and driveways. All changes in direction and depth of main line pipe shall be noted exactly as installed. Dimensions for lines shall be shown at no greater than a 50 ft. maximum interval.
 4. As built record set of drawings shall be signed and dated by the Contractor attesting to and certifying the accuracy of the as built record set of drawings. As built set of drawings shall be labeled on each sheet "As Built Drawings", and include the company name, address, phone number and the name of the person who created the drawing and the contact name (if different).

1.22 CONTROLLER CHARTS:

- A. Provide one controller chart for each automatic controller installed.
1. Inside each automatic controller, prepare and mount a color-coded chart showing the valves, main line, and systems of that controller. All valves shall be numbered to match the operation schedule and the drawings. Only those areas controlled by that controller shall be shown. This chart shall be a plan, entire or partial, showing building, walks, roads and walls. The plan, reduced as necessary and legible in all details, shall be made to a size that will fit into the controller cover. The chart shall be approved by the Owner's Representative and shall be protected in laminated in a plastic cover and be secured to the inside back of the controller cabinet door.

1.23 TURNOVER MATERIALS

- A. Prepare and deliver to the Owner's Representative within ten calendar days prior to completion of construction, and in any case prior to final acceptance,
1. Operations and Maintenance Binders: two 3-ring hard cover binders containing the following information:
 - a. Index sheet stating Contractor's address and telephone number, list of equipment with name and addresses of local manufacturers' representatives.
 - b. Catalog and parts sheets on all material and equipment.
 - c. Warranty statement on company letterhead. The start of the warranty shall be the date of final acceptance by the Owner.
 - d. Complete operating and maintenance instructions for all equipment.
 - e. Irrigation equipment manufacturers' warranties.
 2. As-built drawings
 3. Backflow prevention device testing certification
 4. Pump and Controller certifications (if required)

5. Equipment to be furnished under this section, including all parts, accessories, etc, and a minimum of (1) quick-coupler key, and an additional key for each (20) valves installed.

PART 2 PRODUCTS

2.1 GENERAL

- A. All materials shall be new when installed.
- B. Approval of any items or substitutions indicates only that the product(s) apparently meet the requirements of the drawings and specifications based on the information or samples submitted. The Contractor shall be responsible for the performance of substituted items. If the substitution proves to be unsatisfactory or not compatible with other parts of the system, the Contractor shall replace said items with the originally specified items, including all necessary work and modifications to replace the items, at no cost to the owner.

2.2 PIPING

A. Plastic pipe:

1. All pipe shall be free of blisters, internal striations, cracks, or any other defects or imperfections. The pipe shall be continuously and permanently marked with the following information: manufacturer's name or trade mark, size, class and type of pipe pressure rating, quality control identifications, date of extrusion, and National Sanitation Foundation (NSF) rating.
2. Pipe shall be rigid virgin polyvinyl chloride (PVC) 1220, Type 1, Grade 2 conforming to ASTM D 1785 and D2665 (scheduled pipe) or ASTM D2241 (Standard diameter ratio (SDR)).
3. Mainlines (constant-pressure):
 - a. Pipe up to 2 inch diameter shall be Schedule 40 with solvent welded joints.
 - b. Pipes 2-1/2" to 3 inches in diameter shall be Class 315 (SDR 13.5) with solvent welded (SW) joints.
 - c. Pipe larger than 3 inch diameter shall be manufactured rigid virgin polyvinyl chloride (PVC), Type 1, Grade 2 conforming to ASTM D 1785, designated as bell and gasket Class 315 (SDR 13.5) with PVC with mechanical joint restraints.
4. Laterals (non-constant pressure) shall be Schedule 40, 3/4" minimum size, with solvent welded joints.
5. Sleeves shall be schedule 40, minimum twice the diameter of the pipe, conduit, or other item to be sleeved.

B. Metal pipe:

1. Brass pipe shall be used only where specifically identified on the drawings, and shall be red brass, conforming to Federal Specification WW-P-351, with threaded fittings.
2. Galvanized pipe shall be used only where specifically identified on the drawings, and shall be hot dip galvanized continuous welded, seamless, Schedule 40, conforming to applicable current ASTM standards, with threaded fittings.

2.3 FITTINGS AND CONNECTIONS:

- A. Polyvinyl chloride pipe fittings and connections: Type II, Grade 1, Schedule 40 or 80 conforming to ASTM D2466 and D2467, as indicated, high impact molded fittings, manufactured from virgin compounds as specified for piping tapered socket or molded thread type, suitable for either solvent weld or threaded connections. Machine threaded fittings and plastic saddle and flange fittings are not acceptable unless specifically noted.

Furnish fittings permanently marked with following information: nominal pipe size, type and schedule of material, and National Sanitation Foundation (NSF) seal of approval.

- a. All fittings at valve assemblies shall be schedule 80,
 - b. Unless otherwise specified, all other fittings shall be schedule 40
- B. Brass pipe fittings, unions and connections: standard 125 pound class 85% red brass fittings and connections, IPS threaded.
- C. PVC Schedule 80 threaded risers and nipples: Type I, grade 1, Schedule 80, high impact molded, manufactured from virgin compounds as specified for piping and conforming to ASTM D2464. Threaded ends shall be molded threads only. Machined threads are not acceptable.
- D. Galvanized pipe fittings shall be galvanized malleable iron ground joint Schedule 40 conforming to applicable current ASTM standards.

2.4 SOLVENT CEMENTS, PRIMERS, AND THREAD LUBRICANT

- A. Solvent cements shall be Low-VOC and comply with ASTM D2564. Primers shall be Low-VOC, any comply with ASTM F656. Socketed solvent welded joints shall be made per recommended procedures for joining PVC plastic pipe and fittings with PVC solvent cement and primer by the pipe and fitting manufacturer and procedures outlined in the appendix of ASTM D2564.
- B. Thread lubricant shall be Teflon tape, "extra-heavy," or "full density", color: pink.
- C. Pipe Joint Compound (Pipe dope) shall be used on metal threaded connections only, contain PTFE (Polytetrafluoroethylene), and shall be suitable for use with plastic materials. Ensure no compound enters the lines.

2.5 BACKFLOW PREVENTION DEVICES

- A. Backflow prevention devices shall be certified to NSF/ANSI 372 shall be ASSE Listed 1013, rated to 180 degree F, on "List of Approved Backflow Prevention Assemblies maintained by the USC Foundation and available at <http://fccchr.usc.edu/list.html>, and supplied with full port ball valves at each side for testing.
- B. Backflow preventers shall be as indicated on the drawings.
- C. Provide freeze protection as indicated on the drawings. If not indicated, minimum accepted shall be a green lockable blanket, consisting of minimum R-13 fiberglass matte core and UV-resistant exterior polyvinyl shell, color: green, as manufactured by Bestchoice, Vallejo CA, or equal.

2.6 PRESSURE REGULATOR

- A. Pressure regulator shall be NSF/ANSI 372 certified, consisting of low lead cast bronze body (ASTM B 584), with a separate bronze (ASTM B 584) or brass (ASTM B 16) access cap threaded to the body.
- B. Pressure regulator shall be as indicated on the drawings.

2.7 WYE STRAINER

- C. Wye strainer shall be as indicated on the drawings.

2.7 BACKFLOW PREVENTER ENCLOSURE

- A. A heavy-duty steel mesh enclosure with rust proof finish. The cage shall be sized to allow space for the all piping and equipment associated with the Backflow Preventer. The enclosure shall include a tamper-resistant locking mechanism. Lock(s) shall be provided by the Owner. Enclosure shall be installed on a concrete pad, minimum 4" thick.

B. Backflow Preventer enclosure shall be as indicated on the drawings.

2.8 SHUT OFF VALVES

A. For constant pressure applications, shut-off valves shall be gate-type.

1. For mainlines 3 inches in diameter or less, valves shall be rated for 200 PSI, cast bronze with threaded ends, Nibco T-113 or equal.
2. For mainlines 4 inches in diameter or greater, valves shall be rated for 250 PSI, epoxy coated cast iron body with push-on ends, Leemco LMV series, American Series 2500, Nibco P-619 series, or equal.

B. For Remote Control Valve (RCV) assemblies, shut-off valves shall be ball-type.

1. For assemblies up to 2-1/2 inches in diameter, PVC schedule 80 rated for 235 psi or greater with integral unions and EDPM O-rings, Spears True Union, Cepex True Union, or equal.
2. For assemblies 3 inches in diameter or greater, brass or bronze body with a continuous working pressure of at least 300 psi.

C. All ball valves located at a valve manifold shall be the same size as the sub-main line (1 inch minimum). Provide pipe-reducing adapters, as required. All ball valves in line shall be the same size as the pipe.

2.9 CHECK VALVES

A. Point-of-Connection Swing or spring check valves 2 inch and smaller shall be 200 lbs., W.O.G., bronze construction with replaceable composition, neoprene or rubber disc and shall meet or exceed federal specification WW-V- 5ld, class a, type iv.

B. Anti-drain valves shall be of heavy-duty virgin PVC construction with female pipe thread inlet and outlet. Internal parts shall be stainless steel and neoprene. Anti-drain valves shall be field adjustable against draw out from 5 to 40 feet of head.

C. Inline Check Valves, as required to prevent low head drainage, where head exceeds available manufacturer's options for check valve(s) at emitter(s):

1. Where emitters are higher in elevation relative to RCV's, install spring-assisted swing check valves (only install swing check valves if available pressure is insufficient)
2. Where emitters are lower in elevation relative to RCV's install adjustable spring check valves to allow flow during normal operation, but restrict flow after control valve operation.
3. Acceptable manufacturers include Spears, Dultimeter, or equal.

D. Other valves as indicated on the plans.

2.10 REMOTE CONTROL VALVES (RCV)

A. Remote control valves shall be electrically operated, single seat, normally closed configuration, equipped with flow control adjustment and capability for manual operation.

B. Valves shall be actuated by a normally closed low wattage solenoid using 24 volts, 50/60 cycle solenoid power requirement. Solenoid shall be epoxy encased.

2.11 MASTER CONTROL VALVES

A. Master Control Valve shall be compatible with the irrigation controller and shall be as indicated on the drawings.

2.12 FLOW SENSOR

- A. Flow sensor shall be compatible with the irrigation controller and shall be as indicated on the drawings.

2.13 HYDROMETER

- A. Hydrometer shall be compatible with the irrigation controller and shall be as indicated on the drawings.

2.14 QUICK COUPLER VALVES

- A. Quick coupler valves shall be a one or two-piece, heavy-duty brass construction with a working pressure of 150 PSI with a built in flow control and a self-closing valve.
- B. Quick coupler shall be equipped with red brass cap covered with durable yellow thermo-plastic rubber cover. Key size shall be compatible with quick coupler and of same manufacturer.
- C. Quick coupler valves shall be as indicated on the drawings.

2.15 HEADS, BODIES, EMITTERS, AND NOZZLES

- A. All equipment shall conform to ASABE ICC 802 and shall be as indicated on the drawings.
- B. All sprinkler bodies shall have check valves installed where required to prevent low head drainage. Swing joints, risers, and nipples for all heads shall be the same size as the riser opening in the sprinkler body and fabricated as shown on the drawings.
- C. All drip emitters shall be pressure compensating (PC)

2.16 AUTOMATIC CONTROLLER

- A. Controller shall be housed in a sturdy, locking, weather-resistant case, furnished for maximum exterior protection.
- B. Controller shall be equipped with evapo-transpiration (ET) sensor, which adjusts the controller programming based on local climatic conditions. The sensor shall also have a rain sensing shut-off switch, wind sensing shut off switch, and freeze sensing shut-off of switch.
 - 1. If a moisture sensor is used in lieu of an evapo-transpiration sensor an additional sensor, which has a rain-sensing shut-off switch, wind sensing shut-off switch, and freeze sensing shut-off switch shall be provided.
- C. Automatic controller shall be as indicated on the drawings.

2.17 CONTROLLER DECODERS

- A. All decoders shall be per the controller manufacturer's specifications.
- B. Decoder model number shall be as shown on the drawings.

2.18 LOW VOLTAGE, TWO-WIRE SYSTEMS

- 1. All wiring shall be per the controller manufacturer's specifications and recommendations, including sizing based on the longest leg or loop, and ASIC guidelines for grounding.
 - a. For Toro/RainMaster DX3 two-wire systems:
 - 1) Two-wire cable shall be Rainmaster TW-CAB-14, Paige Specification P7072D, or other approved two-conductor, minimum 14-gauge, solid-core copper wire, double-jacketed insulation manufactured of high-density, sunlight-resistant polyethylene or UF-B UL PVC with a minimum wall thickness of .060". A protective overall jacket (outer sheath) must be manufactured of polyethylene or PVC material conforming to ICEA S-61-402 or NEMA WC5, with a minimum wall thickness of .045" and approved for direct burial installation.

- 2) Wire splices and ends shall be made with Rainmaster TW-SPLICE, 3M-DBY/R-6, or equal wire nut and gel-filled encapsulating connectors.
- b. For Hunter ACC2 two-wire systems:
 - 1) Two-wire cable shall be Hunter IDWIRE, Paige P7354D, or other approved two-conductor, minimum 14-gauge, solid-core copper wire, twisted with a minimum lay of 4", and PE insulation with a minimum wall thickness of .045". A protective overall jacket must be manufactured of HDPE, with a minimum wall thickness of .035", and approved for direct burial installation.
 - 2) Wire splices and ends shall be made with Hunter DBRY-6, 3M-DBY/R-6, or equal wire nut and gel-filled encapsulating connectors.

2.19 VALVE BOXES AND MATERIALS

- A. Valve boxes: valve boxes shall be constructed of ABS (acrylonitrile butadiene styrene) plastic, green for turf areas, brown for planting areas, but purple for all boxes in recycled water systems, with rigid base and sides and shall be supplied with bolted cover secured with stainless steel bolts. Provide box extensions as required.
 1. Master valves, flow sensors, and remote control irrigation valves shall use a 14 inch x 19 inch x 12 inch rectangular box.
 2. Quick coupler valves, shut-off valves, quick coupler valves, wire splices, and grounding rods shall use a 10 inch circular box.

2.20 CONCRETE THRUST BLOCKS

- A. Concrete thrust blocks shall be constructed for all lines 2-1/2" or greater without restrained joints, and sized per the pipe manufacturers' requirements, as indicated on the drawings, or per local requirements, whichever is most stringent.

2.21 VALVE IDENTIFICATION TAGS

- A. Valve Identification Tags shall be 2.25 inch x 2.65 inch polyurethane. Color: yellow for non-potable water; purple for recycled water. Tags shall be permanently attached to each RCV with tamper-resistant seals as indicated on the drawings. Tags shall be consistently labeled X-ZZ or XZZ (where X is the controller letter and ZZ is the valve number).

2.22 EQUIPMENT TO BE FURNISHED TO OWNER

- A. Two (2) sets of keys for each automatic controller.
- B. Two (2) 48 inch tee wrenches for operating gate valves 3" or larger.
- C. Three (3) sets of special tools required for removing, disassembling and adjusting each type of sprinkler and valve supplied on this project.
- D. Five (5) sprinkler heads, nozzles, shrub adapters, nozzle filter screens, for each type used on the project.
- E. Two (2) quick coupler keys to match manufacturer type of quick coupler.

2.23 INCIDENTAL MATERIALS AND EQUIPMENT

- A. Furnish all materials and equipment not specified above, but which are necessary for completion of the work as intended.

2.24 MAINLINE LOCATOR TAPE

- A. 3 inch wide plastic detectable locator tape.

2.25 RESTRAINED JOINTS AND FITTINGS

- A. IPS sized, class 350 ductile iron per ASTM A-536, Grade 65-45-12 and AWWA C153, with epoxy coating per ANSI/AWWA C116/A21.16.09.
 - 1. Fittings with integral restrained joints: Leemco LH-series, or equal
 - 2. Pipe-to-Pipe restraints: Leemco LB-series, Romac, Harco, or equal.
 - 3. Pipe-to-Pipe for valves: Leemco LG-series, Harco, or equal.

2.26 BEDDING SAND

- A. Sand shall consist of natural or manufactured granular material, free of organic material, mica, loam, clay or other substances not suitable for the intended purpose.
- B. Sand shall be masonry sand ASTM C 144 or coarse concrete sand, ASTM C 33.

PART 3 EXECUTION

3.1 GENERAL REQUIREMENTS

- A. Code requirements shall be those of state and municipal codes and regulations locally governing this work, providing that any requirements of the drawings and specifications, not conflicting therewith, but exceeding the code requirements, shall govern unless written permission to the contrary is granted by the Owner's Representative.
- B. Exercise extreme care in excavating and working in the project area due to existing utilities and irrigation systems to remain (if any). Contractor shall be fully responsible for expenses incurred in the repair of damages caused by their operation.
 - 1. The Contractor is responsible for identifying and maintaining existing irrigation main lines that supply water to areas on the site as noted on the drawings and outside of the proposed limit of work. The Contractor shall relocate or replace existing irrigation main line piping as required to provide uninterrupted sufficient water to maintain plant health to all irrigated areas on site. Providing water includes hand watering and/or watering trucks.
- C. Plan locations of backflow preventers, valves, controllers, irrigation lines, sleeves, and other equipment are diagrammatic and indicate the spacing and relative locations. Final locations shall be determined on-site and adjusted as necessary and as directed to meet existing and proposed conditions and obtain complete water coverage. Changes from locations shown shall be made if necessary to avoid existing and proposed plants, piping, utilities, structures, etc. or when directed by the Owner's Representative and at the Contractor's expense.
- D. Prior to any work the Contractor shall stake out locations of all mainlines, valves, pumps, controllers, and backflow devices using an approved staking method and maintain the staking of the approved layout in accordance with the drawings and any required modifications. Flag or mark all overhead emitter locations. Verify all horizontal and vertical site dimensions prior to staking of heads. Do not exceed spacing shown on drawings for any given area.
- E. Stub out main line at all end runs and as shown on drawings. Stub out wires for future connection where indicated on plan and as directed.
- F. Permission to shut off any existing in-use irrigation or water line must be obtained 48 hours in advance, in writing from the Owner. The Contractor shall receive instructions from the Owner's Representative as to the exact length of time of each shut-off.
- G. No fittings shall be installed on pipe underneath pavement or walls.

- H. Prior to starting any work, Contractor shall measure the existing static water pressure (no flow condition) at the designated point of connection and immediately submit written verification of pressure with date and time of recording to Owner's Representative.

3.2 TRENCHING, DIRECTIONAL BORING AND SLEEVEING

- A. Perform all trenching, directional boring, sleeving and excavations as required for the installation of the work included under this section, including shoring.
- B. The Contractor may directional bore lines where it is practicable or where required on the plans.
 - 1. Extend the bore 1' past the edge of pavement unless noted differently on the plans.
 - 2. Cap ends of each bore and locate ends at finished grade using 4 x 4 posts.
- C. Make trenches for mains, laterals and control wiring straight and true to grade and free of protruding stones, roots or other material that would prevent proper bedding of pipe or wire.
- D. Excavate trenches wide enough to allow a minimum of 3 inches between parallel lines and 8 inches from lines of other trades. All lines shall be able to be serviced or replaced without disturbing the other lines.
- E. Trenches for pipelines shall be made of sufficient depth to provide the minimum cover from finished grade as follows:
 - 1. Pressure mainline: 18 inches below finish grade in planted areas and 24 inches below paved areas in Schedule 40 PVC sleeves.
 - 2. Lateral lines: 12 inches below finish grade and 24 inches below paved areas in Schedule 40 PVC sleeves.
 - 3. Polyethylene drip distribution tubing: 4 to 6 inches below grade.
 - 4. Sub-surface inline drip tubing: 4 to 6 inches below grade.
 - 5. Control wiring: to the side of pressure main line and 24 inches below paved areas in Schedule 40 PVC sleeves.
- F. Backfill the trench per the requirements in paragraphs "Backfilling and Compacting" below.

3.3 PIPE INSTALLATION

- A. General Pipe Installation
 - 1. Exercise caution in handling, loading and storing, of plastic pipe and fittings to avoid damage.
 - a. The pipe and fittings shall be stored under cover until using and shall be transported in a vehicle with a bed long enough to allow the length of pipe to lay flat so as not to be subjected to undue bending or concentrated external load at any point.
 - b. All pipe that has been dented or damaged shall be discarded.
 - 2. Trench depth shall be as specified above from the finish grade to the top of the pipe.
 - 3. Installation of all pipe and fittings shall be in strict accordance with manufacturer's specifications.
- B. Polyvinyl Chloride Pipe (PVC) Installation
 - 1. Under no circumstance is pipe to rest on concrete, rock, wood blocks, construction debris or similar items.
 - 2. No water shall be permitted in the pipe until a period of at least 24 hours has elapsed for solvent weld setting and curing.
 - 3. Install assemblies and pipe to conform to drawings and where shown diagrammatically on drawings. All fittings that are necessary for proper connections such as swing joints,

offsets, and reducing bushings that are not shown on details shall be installed as part of the work.

4. Solvent weld or threaded plastic pipe:
 - a. Pipe shall be cut using approved PVC pipe cutters where practicable. Sawed cuts 1" or smaller lines are disallowed. All field cuts shall be beveled to remove burrs and excess before gluing.
 - b. Welded joints shall be given a minimum of 15 minutes to set before moving or handling. Excess solvent on the exterior of the joint shall be wiped clean immediately after assembly.
 - c. Plastic to metal connections shall be made with schedule 80 nipples. No male metal threads shall be connected to plastic materials. Connection shall be made with two (2) wraps of Teflon tape and hand tightened plus one turn with a strap wrench.
 - d. Snake pipe in trench to allow one (1) foot of expansion and contraction per 100 feet of straight run.
 - e. Threaded pipe joints shall be made using Teflon tape. Solvent or Pipe-dope shall not be used with threaded joints. Pipe shall be protected from tool damage during assembly. All damaged pipe shall be removed and replaced. Take up threaded joints with light wrench pressure.
 - f. Load pipe at 10 foot intervals with backfill to prevent arching and slipping under pressure. Other than this preliminary backfill, all pipe joints, fittings and connections are to remain uncovered until successful completion of hydrostatic testing and written approval of the testing report.
 - g. Concrete thrust blocks shall be constructed behind all non-restrained pipe fittings 2-1/2" inches in diameter or larger at all changes of direction of 45 degrees or more.

C. Metal Pipe Installation

1. All joints shall be threaded with Teflon tape or pipe joint compound used on all threads.
2. Dielectric bushings shall be used in any connections of dissimilar metals.

3.4 TRENCHING, DIRECTIONAL BORING, AND SLEEVING REVIEW:

- A. Upon completion and installation of all trenching, directional boring, and sleeving, the Owner's Representative shall visually observe all installed irrigation control wiring, lines, and fittings. Do not cover any wires, lines or fittings until they have been tested and observed by the Owner's Representative unless authorized in writing.

3.5 FLUSHING

- A. Openings in piping system during installation are to be capped or plugged to prevent dirt and debris from entering pipe and equipment. Remove plugs when necessary to flush or complete system.
- B. After completion and prior to the installation of any terminal fittings, the entire irrigation system shall be flushed to remove dirt, debris and other material.

3.6 HYDROSTATIC PRESSURE TESTING

- A. After flushing, and the installation of valves the following tests shall be conducted in the sequence listed below. The Contractor shall furnish all equipment; materials and labor necessary to perform the tests and all tests shall be conducted in the presence of the Owner's Representative.
- B. Water pressure tests shall be performed on all pressure main lines before any couplings, fittings, valves and the like are concealed.

- C. Immediately prior to testing, all irrigation lines shall be purged of all entrapped air or debris by adjusting control valves and installing temporary caps forcing water and debris to be discharged from a single outlet.
- D. Test all pressure main line at 150 PSI. For a minimum of four (4) hours with an allowable loss of 5 PSI. Pressure and gauges shall be read in PSI, and calibrated such that accurate determination of potential pressure loss can be ascertained.
- E. Re-test as required until the system meets the requirements. Any leaks, which occur during test period, will be repaired immediately following the test. All pipe shall be re-tested until final written acceptance.
- F. Submit a written, signed report to the Owner's Representative including the date, the start time and initial water pressure readings, the finish time and final water pressure readings, and the type of equipment used to perform the test.

3.7 BACKFLOW PREVENTER TESTING

- A. Test all installed backflow prevention devices as required by Title 17 of the California Code of Regulations Section 1706. Testing shall be performed by a Backflow Prevention Assembly Tester with a current certification from the American Water Works Association, and all local requirements.

3.8 BACKFILLING AND COMPACTING

- A. Irrigation trenches shall be backfilled with material free of rocks, clumps, or debris 1 inch in diameter or larger.
- B. Place backfill in lifts not exceeding 8" deep and compact as follows:
 - 1. Under pavement and within 1 foot of the edge of pavement: 95% or greater relative density.
 - 2. Backfill of subsoil in planting areas: Between 85 and 90% relative density.
- C. Finish grade of all trenches shall conform to adjacent grades without dips or other irregularities. Spread excess soil on site and dispose of debris off site at no additional cost to the Owner.
- D. Any settling of backfill material during the Establishment or Warranty period shall be repaired at the Contractor's expense, including any replacement or repair of soil, lawn, and plant material or paving surface.

3.9 RESURFACING PAVING OVER TRENCHES

- A. Restore all surfaces and repair existing underground installations damaged or cut as a result of the excavation to their original condition, satisfactory to the Owner's Representative.
- B. Trenches through paved areas shall be resurfaced with same materials quality and thickness as existing material. Paving restoration shall be performed by the project paving Sub-contractor or an approved Contractor skilled in paving work.
- C. The cost of all paving restoration work shall be the responsibility of the irrigation Contractor unless the trenching through the paving was, by previous agreement, part of the general project related construction.

3.10 EQUIPMENT INSTALLATION

- A. General:
 - 1. All equipment and accessories shall be installed per all installation requirements and recommendations of the product manufacturer.
 - 2. Install all equipment at the approximately at the location(s) and as designated and

- detailed on the drawings. Verify all locations with the Owner's Representative.
3. Install all valves within a valve box of sufficient size to accommodate the installation and servicing of the equipment. Group valves together and locate in planted areas.
 4. All irrigation systems that are using water from potable water systems shall require backflow prevention. All backflow prevention devices shall meet and be installed in accordance with requirements set forth by local codes and the health department.
- B. Pressure Regulators:
1. Set adjustable regulators for required PSI per manufacturer's specifications.
- C. Check Valve:
1. Install check valves at locations necessary to prevent low head run off, where elevation differences exceed manufacturer's option for in-head check valves.
- D. Remote Control Valves (RCV):
1. Install one RCV per valve box.
 2. Install boxes no closer than 8 inches from edge of paving and perpendicular to edge of paving and parallel to each other. Allow 12 inches clearance between adjacent valve boxes.
- E. Quick coupler valve:
1. Install each quick coupler valve in its own valve box, aligned as indicated in the drawings.
 2. Install one stabilizer/anchor per manufacturer's instructions. Anchor shall be ductile iron, epoxy coated, with stainless steel fastening bolt, as manufactured by Harco, Leemco, or equal.
- F. Sprinkler Assemblies:
1. All main lines and lateral lines, including risers, shall be flushed and pressure tested before installing sprinkler heads.
 2. Install specified sprinkler heads as shown on the drawings. Adjust layout for full head-to-head coverage. Spacing of heads shall not exceed the maximum spacing recommended by the manufacturer.
 3. All sprinkler heads shall be offset from adjacent edges and set perpendicular to finish grade unless in sloped conditions as shown on the drawings.
 4. Risers and Swing Joints: shall be sized equal to the inlet of the head.
 - a. For pop-up ABS bodies with spray, bubbler, or and rotary nozzles: pre-manufactured with marlex or polyethylene street ells and polyethylene tubing, minimum 0.49 inch outside diameter, rated to 150 psi; Hunter SJ-series or equal.
 - b. For pop-up ABS rotors: shall be pre-manufactured PVC with O-Ring seals and three axis movement, Hunter HSJ-series, Lasco G-series, or equal.
 - c. For individual bubblers or drip emitters not on pop-up bodies: shall be premanufactured flexible risers, polyethylene or PVC, with male pipe thread ends, Hunter IH-series or equal, to include screen with integral check valve.
- G. Irrigation Controllers:
1. Connect control wiring in the numerical sequence as shown on the drawings.
 2. Controller shall be tested with completed electrical connections.
 3. Ground controller per manufacturer's requirements. At minimum, grounding shall include:
 - a. one 5/8-inch x 8-foot copper rod installed per irrigation controller (and where multiple controllers are not connected to the same ground rod), at the first decoder along the

two-wire path, and at decoders with intervals of every 300' (or the nearest decoder to the 300' interval) along the two wire path thereafter.

- b. The top of each rod shall be installed inside a 10-inch round valve box, with the rod installed as close as practical to the controller. If a pedestal enclosure is used, the ground rod may be installed through the pedestal base. Under no circumstances shall the rods be shortened.
- c. At controllers, a #6 AWG solid copper wire shall be used to connect from the ground lug of the transient protection board to the copper rod. Brass clamps specifically designed to secure the copper wire to the grounding rod shall be used. There shall be no kinks or sharp bends in the wire
- d. Each wire may be wrapped around the rod and brazed in place as an alternative to clamping. Braze the wire to the rod for at least one circumference of the rod.

H. Wiring:

1. General:

- a. All wire ends, including all wires from all decoders, valves, and other equipment, whether used or not, shall be encapsulated in waterproof connectors.
- b. All wire insulation shall be intact and free of nicks and cuts. Wire shall not be bent.
- c. Install lightning protection per the manufacturer's requirements and recommendations.

2. Traditional Low Voltage Control Wiring:

- a. Common wire shall be direct-burial #12 (or larger size), white, with a separately colored stripe for each controller (if multiple).
- b. Control (Pilot) wires shall be direct-burial #12 or #14 (minimum) size, red, with a separately colored stripe for each controller (if multiple). Do not exceed manufacturer's recommendations for wire runs.
- c. Wire connectors shall be 3M-DBY/DBR (30V rated), or equal.
- d. Wiring between controller and electrical valves shall be installed in the same trench as the main line where practicable. The wire shall be bundled and secured to the mainline at 10 foot intervals with plastic electrical tape.
- e. An expansion loop shall be provided inside each valve box, and at intervals not greater than 500 feet. Expansion loop shall be formed by wrapping at least 8" of wire around a 3/4" inch pipe and withdrawing pipe.
- f. Run two (2) spare #14 wires from controller along entire main line to last RCV on each leg of main line. Spare wires shall be yellow.
- g. For fixed-station controllers, run additional spare wires equal to the number of unused stations, as above. Color for these wires shall be the same as control wires. Label as "Spare" at controller and ends of wires.
- h. All control wire splices not occurring at control valve shall be installed in a separate splice valve box. Splices shall only be permitted with prior written authorization.
- i. Label wires at the terminal strip of the controller with pre-printed water and UV resistant labels. At the terminal strip mark each wire clearly indicating valve circuit number.

3. High Voltage

- a. All electrical work shall conform to local codes, ordinances and any authorities having jurisdiction. All high voltage electrical work to be performed by licensed electrician.
- b. The Contractor shall provide 120-volt power connection to the automatic controller unless noted otherwise on drawings.

I. Valve boxes:

1. Install one valve box for each type of valve, installed as shown on the drawings.
2. Gravel shall be installed after compaction of all trenches. Final portion of gravel shall be placed inside valve box after valve is backfilled and compacted.
3. Permanently label valve type on valve box lid by either: pre-lettered tags affixed with stainless steel rivets, or heat-branding using typeset tools, or other method approved by the Owner's Representative. Valves labeled as follows: shut-off valve box lids: SO; remote control valve box lids: RCV quick coupler box lids: QC, master valve: MV, and flow sensor: FS.

J. Tracer wire:

1. Tracer wire shall be installed with non-metallic plastic irrigation main lines where controller wires are not buried in the same trench as the main line.
2. The tracer wire shall be placed on the bottom of the trench under the vertical projection of the pipe with spliced joints soldered and covered with insulation type tape.
3. Tracer wire shall be of a color not used for valve wiring. Terminate wire in a valve box. Provide enough length of wire to make a loop and attach wire marker with the designation "tracer wire".

K. Drip Installation:

1. Install pressure reducers when operating pressure exceeds specific drip tubing fitting recommendation or requirement.
2. Cap or plug all openings as soon as lines have been installed to prevent the intrusion of materials that would obstruct the pipe. Leave in place until removal is necessary for flushing or completion of installation.
3. Thoroughly flush all water lines before installing emitters.

3.11 ADJUSTMENT AND COVERAGE TEST

A. Adjustment: The Contractor shall flush and adjust all sprinkler heads, valves and all other equipment to ensure function according to the manufacturer's data. Adjust all sprinkler heads not to overspray or runoff onto walks, roadways and buildings when under normal operating pressure and during times of normal prevailing winds.

B. Coverage test:

1. The Contractor shall perform a coverage test in the presence of the Owner's Representative after all sprinkler heads have been installed, flushed and adjusted. Test each valve or zone to demonstrate uniform and adequate coverage.
2. Any adjustments shall be done by the Contractor prior to substantial completion at the direction of the Owner's Representative at no additional cost. Adjustments may include realignment of lines, addition or removal of heads, and changes in nozzle type or size.
3. The entire irrigation system shall be operating properly prior to beginning any planting operations, unless approved otherwise by the Owner's Representative.

3.12 CLEAN-UP

A. During installation, keep the site free of trash, pavements reasonably clean and work area in an orderly condition at the end of each day. Remove trash and debris in containers from the site no less than once a week.

1. Immediately clean up any spilled or tracked soil, fuel, oil, trash or debris deposited by the Contractor from all surfaces within the project or on public right of ways and neighboring property.

B. Once installation is complete, wash all soil from pavements and other structures.

C. Make all repairs to grades ruts, and damage to the work or other work at the site.

- D. Remove and dispose of all excess soil, packaging, and other material brought to the site by the Contractor.

3.13 PROTECTION & MAINTENANCE

- A. The Contractor shall protect the work from damage due to operations during Landscape Installation, other Contractors, trespassers, and all other forces except natural disasters.
- B. Maintain the irrigation system through the Establishment Period, according to Section 32 98 00 – Landscape Maintenance, until final project acceptance.

END OF SECTION 32 84 00

SECTION 32 90 00

LANDSCAPE INSTALLATION

PART 1 GENERAL

1.1 SUMMARY

- A. The scope of work includes all labor, materials, and any other items, facilities, transportation and services necessary for, and incidental to performing all operations in connection with furnishing, delivery, and complete installation of planting (also known as "landscaping"), as shown on the drawings and as specified herein.
- B. The scope of work in this section includes, but is not limited to, the following:
 - 1. Locate, purchase, deliver and install all specified plants.
 - 2. Care of installed plant material and related work, including watering, mulching, fertilizing, staking, and pruning.
 - 3. Finish grading of all planting areas
 - 4. Maintenance of work until the beginning of the warranty period.
 - 5. Clean up and disposal of all excess and surplus material.
 - 6. Maintenance of all specified plants during the Establishment Period.
 - 7. Warranty.

1.2 CONTRACT DOCUMENTS

- A. Construction drawings and these specifications are a part of the contract documents. Refer to contract for a complete list of all contract documents. The documents are to be considered as one. Whatever is called for by any parts shall be as binding as if called for in all parts.

1.3 REFERENCES

- A. The following specifications and standards of the organizations and documents listed form a part of the specification to the extent required by the references thereto. If the requirements of any referenced specifications and standards conflict with each other, the more stringent requirement shall apply unless determined otherwise by the Owner's Representative.
 - 1. State of California, Department of Food and Agriculture, Regulations for Nursery Inspections, Rules and Grading.
 - 2. ANSI Z60.1 American Standard for Nursery Stock, most current edition.
 - 3. ANSI A 300 – Standard Practices for Tree, Shrub and other Woody Plant Maintenance, most current edition.
 - 4. Interpretation of plant names and descriptions shall reference the following documents. Where the names or plant descriptions disagree between the several documents, the most current document shall prevail.
 - a. The New Sunset Western Garden Book, Oxmoor House, latest edition.
 - b. Manual of Woody Landscape Plants; Michael Dirr; Stipes Publishing, Champaign, Illinois; latest edition.
 - c. Glossary of Arboricultural Terms, International Society of Arboriculture (ISA), latest edition.

1.4 VERIFICATION

- A. All scaled dimensions on the drawings are approximate. Before proceeding with any work, the Contractor shall check and verify all dimensions and quantities and shall immediately inform the Owner's Representative of any discrepancies between the information on the drawings and the actual conditions, refraining from doing any work in said areas until given

approval to do so by the Owner's Representative.

- B. In the case of a discrepancy in the plant quantities between the plan drawings and the plant call outs, list or plant legend, the number of plants or square footage of the planting area on the drawings shall be deemed correct and prevail.

1.5 PERMITS AND REGULATIONS

- A. The Contractor shall obtain and pay for all permits related to this section of the work unless otherwise noted. The Contractor shall comply with all laws and ordinances bearing on the operation or conduct of the work as drawn and specified. If a conflict exists between permit requirements and the work outlined in the contract documents, the Contractor shall promptly notify the Owner's Representative in writing, including a description of any necessary changes to the work and resulting changes to the contract price.
- B. Wherever references are made to standards or codes in accordance with which the work is to be performed or tested, the edition or revision of the standards and codes current on the effective date of this contract shall apply, unless otherwise expressly set forth.
- C. In case of conflict among any referenced standards or codes or between any referenced standards and codes and the specifications, the more restrictive standard shall apply unless determined otherwise by the Owner's Representative.

1.6 PROTECTION OF WORK, PROPERTY, AND PERSONS

- A. The Contractor shall adequately protect the work, adjacent property, and the public, and shall be responsible for any damages or injury due to his/her actions.

1.7 CORRECTION OF WORK

- A. The Contractor, at their own cost, shall re-execute any work that fails to conform to the requirements of the contract and shall remedy defects due to faulty materials or workmanship upon written notice from the Owner's Representative, at the soonest as possible time that can be coordinated with other work and seasonal weather demands.

1.8 DEFINITIONS

All terms in this specification shall be as defined in the "Glossary of Arboricultural Terms" or as modified below.

- A. Boxed plants: A container root ball package made of wood in the shape of a four-sided box.
- B. Container plant: Plants that are grown in and/or are currently in a container including boxed trees.
- C. Defective plant: Any plant that fails to meet the plant quality requirement of this specification.
- D. Final Acceptance: The date after completion of the establishment period when the Owner's Representative accepts the project. This period may extend past the time listed in this specification if maintenance during the establishment period is not performed satisfactorily, or if the project is not ready for acceptance at the end of the Establishment period.
- E. Field grown trees: Trees growing in field soil for at least 12 months prior to harvest.
- F. Healthy: Plants that are growing in a condition that expresses leaf size, crown density, color; and with annual growth rates typical of the species and cultivar's horticultural description, adjusted for the planting site soil, drainage and weather conditions.
- G. Establishment period: The time period, as defined in this specification, during which the Contractor provides maintenance until project acceptance.
- H. Planting Soil: native or imported topsoil in planting areas, amended as required by this

section.

- I. Root ball: The mass of roots including any soil or substrate that is shipped with the tree within the root ball package.
- J. Root collar (root crown, root flare, trunk flare, flare): The region at the base of the trunk where the majority of the structural roots join the plant stem, usually at or near ground level.
- K. Shrub: Woody plants with mature height approximately less than 15 feet.
- L. Substantial Completion: The date when the work in this section is substantially complete and the Owner's Representative authorizes the establishment period to begin. The date of substantial completion may be different than the date of substantial completion for the other sections of the project.
- M. Stem girdling root: Any root more than 1/4 inch in diameter currently touching the trunk, or with the potential to touch the trunk, above the root collar approximately tangent to the trunk circumference or circling the trunk. Roots shall be considered as Stem Girdling that have, or are likely to have in the future, root to trunk bark contact.
- N. Structural root: One of the larger roots emerging from the root collar.
- O. Tree: Single and multi-stemmed plants with mature height approximately greater than 15 feet.

1.9 SUBMITTALS

- A. Comply with general conditions, special conditions, Division 1 sections and other contract documents. All submittals shall be made at least 4 weeks prior to delivery of materials.
 - 1. Product data: Submit manufacturer product data and literature describing all products required by this section to the Owner's Representative for approval.
 - 2. Samples: Submit samples of each product and material noted in the contract documents to the Owner's Representative for approval. Label samples to indicate product, characteristics, and locations in the work.
 - 3. Plant sources: within 30 days of award of contractor, and at least 30 days prior to delivery, submit sources of all plants and substitution requests, if any, to the Owner's Representative for approval.
 - 4. Soils Fertility Test Results: obtain soil samples, quantity as indicated on the drawings, from representative planting areas, and at anticipated plant rooting depths. Mix multiple samples together. Submit for agronomic testing to a certified laboratory.
- B. Close out submittals: Submit to the Owner's Representative for approval:
 - 1. Plant maintenance data and requirements.
 - 2. Warranty on company letterhead

1.10 QUALIFICATIONS

- A. Installer Qualifications: The installer shall be a firm having at least 5 years of successful experience of a scope similar to that required for the work, including the handling and planting of large specimen trees in urban areas. The same firm shall install or amend planting soil, establish final grades in planting areas, and install and plant material.
 - 1. Installer Field Supervision: When any planting work is in progress, installer shall maintain, on site, a full-time supervisor with a minimum of five years' experience with the work, and who can communicate in English.
 - 2. The installer's crew shall have a minimum of 2 years experienced in the installation of Planting Soil, Plantings, and Irrigation (where applicable) and interpretation of plans and specifications.

3. Prior to bidding the work, submit references of past projects, employee training, and certifications that support that the Contractor(s) meet all the above installer qualifications and applicable licensures.

1.11 PRE-CONSTRUCTION CONFERENCE

- A. Schedule a pre-construction meeting with the Owner's Representative at least seven (7) days before beginning work to review any questions the Contractor may have regarding the work, administrative procedures during construction, and the project schedule.

1.12 OBSERVATIONS

- A. The Owner's Representative may observe the work at any time. They may remove samples of materials for verification or testing. Rejected materials shall be immediately removed from the site and replaced at the Contractor's expense. The cost of testing materials not meeting specifications, and re-testing of replacement materials, shall be paid by the Contractor.
- B. The Owner's Representative shall be informed of the progress of the work so that the work may be observed at the following key times in the construction process. Failure of the Owner's Representative to make field observations shall not relieve the Contractor from meeting all the requirements of this specification. The following observations are anticipated, with required advance notification times:
 1. SITE CONDITIONS PRIOR TO THE START OF PLANTING: review the soil and drainage conditions: 7 days.
 2. PLANT LAYOUT REVIEWS(S): Review of the plant layout: 7 days.
 3. PLANT QUALITY: Review at the time of delivery and prior to installation: 7 days
 4. COMPLETION OF THE PLANTING: Review the completed planting: 10 days

1.13 WARRANTY

- A. Warranty shall begin on the date of Final Acceptance and continue for 1 year. If When the work is accepted in parts, the warranty periods shall extend from each of the partial Substantial Completion Acceptances to the terminal date of the last warranty period. Thus, all warranty periods for each class of plant warranty, shall terminate at one time.
- B. Plants determined to be defective by the Owner's Representative shall be removed by the contractor immediately upon notification by the Owner's Representative and replaced by the contractor without cost to the Owner, as soon as weather conditions permit and within the specified planting period.
- C. The Contractor is exempt from replacing plants, during the warranty period, that are removed by others, lost, or damaged due to occupancy of project, lost or damaged by a third party, vandalism, or any natural disaster.
- D. Replacements shall closely match adjacent specimens of the same species. Replacements shall be subject to all requirements stated in this specification. Make all necessary repairs due to plant replacements. Such repairs shall be done at no extra cost to the Owner.
- E. The warranty of all replacement plants shall extend for an additional one-year period from the date of their acceptance after replacement. If a replacement plant is not acceptable during or at the end of the extended warranty period, the Owner's Representative may elect alternate replacement items or credit. Alternate replacement items are not protected under a warranty period.

1.14 SELECTION AND OBSERVATION OF PLANTS

- A. Submit to the Owner's Representative, for approval, plant sources including the names and locations of nurseries, and a list of the plants they will provide. The plant list shall include the botanical and common name and the size.

- B. For all trees greater than 24: box, submit photographs of plants or representative samples of plants. Photographs shall be legible and clearly depict the plant specimen. Each submitted image shall contain a height reference, such as a measuring stick. The approval of plants by the Owner's Representative via photograph does not preclude the Owner's Representative's right to reject material while on site.
- C. The Owner's Representative may review all plants, prior to delivery, during delivery, or after delivery. Unacceptable material shall be rejected, or if substandard elements can be corrected, corrective action may be taken by the contractor at his/her sole expense. Review or approval of any plant shall not prevent that plant from later rejection if the plant quality changes or previously existing defects become apparent that were not observed.
- D. All plants that are rejected shall be immediately removed from the site and acceptable replacement plants provided at no cost to the Owner.

1.15 PLANT SUBSTITUTIONS

- A. Submit all requests for substitutions of plant species, or size to the Owner's Representative, for approval, prior to purchasing the proposed substitution. Request for substitution shall be accompanied with a list of nurseries contacted in the search for the required plant. Requests shall include proposed substitutions with similar characteristics to the specified material.

1.16 SITE CONDITIONS

- A. It is the responsibility of the Contractor to be aware of all surface and sub-surface conditions, and to notify the Owner's Representative, in writing, of any circumstances that would negatively impact the health of plantings. Do not proceed with work until unsatisfactory conditions have been corrected.
 - 1. Should subsurface drainage or soil conditions be encountered which would be detrimental to the plant material, the Contractor shall notify the Owner's Representative in writing, stating the conditions and submit a proposal covering cost of corrections. If the Contractor fails to notify the Owner's Representative of such conditions, he/she shall remain responsible for plant material under the warranty.
- B. This specification requires that all Landscape Irrigation (if applicable) work be completed and accepted prior to the installation of any plants.
 - 1. Planting operations shall not begin until such time that the irrigation system is completely operational for the area(s) to be planted, and the irrigation system for that area has been observed and approved by the Owner's Representative.
- C. Planting shall be performed during those periods when weather and soil conditions are suitable in accordance with locally accepted horticultural practices.
 - 1. Do not install plants into saturated or frozen soils. Do not install plants during inclement weather, such as rain, snow, or during extremely hot, cold or windy conditions.

1.17 UTILITIES

- A. Notification of Underground Service Alert (USA), 811, is required for all planting areas.
- B. Contractor shall carefully examine the civil, as-built, record, and survey drawings to become familiar with the existing underground conditions before digging. The Contractor is responsible for knowing the location and avoiding utilities that are not covered by USA.
- C. Determine location of underground utilities and perform work in a manner that will avoid possible damage. Hand excavate, as required. Maintain grade stakes set by others until parties concerned mutually agree upon removal.
- D. Damage to existing work, including utilities, shall be repaired at the contractor's sole

expense.

1.18 TEMPORARY UTILITIES

- A. All temporary water, power, piping, wiring, meters, panels and other related appurtenances required between source of supply and point of use shall be provided by the Contractor and coordinated with the Owner's Representative. Existing utilities may be used with the written permission of the owner.

PART 2 PRODUCTS

2.1 PLANTS: GENERAL

- A. Standards and measurement: Provide plants of quantity, size, genus, species, and variety or cultivars as shown and scheduled in contract documents.
 - 1. Containerized Plants: class size shall conform to ANSI Z60.1 for each size and type of plant. Container stock shall have been grown in specified container size for at least 4 months, but not more than 18 months. Root ball shall be neither under-developed nor over-developed.
 - 2. All plants including the root ball dimensions or container size to trunk caliper ratio shall conform to ANSI Z60.1 "American Standard for Nursery Stock", unless modified by provisions in this specification. When there is a conflict between this specification and ANSI Z60.1, this specification section shall be considered correct.
 - 3. Plants larger than specified may be used if acceptable to the Owner's Representative. Use of such plants shall not increase the contract price. If larger plants are accepted the root ball size shall be in accordance with ANSI Z-60.1. Larger plants may not be acceptable if the resulting root ball cannot be fit into the required planting space.
- B. Proper Identification: All trees shall be true to name as ordered or shown on planting plans and shall be labeled individually or in groups by genus, species, variety and cultivar.
- C. Compliance: All trees shall comply with federal and state laws and regulations requiring observation for plant disease, pests, and weeds. Observation certificates, if required by law, shall accompany each shipment of plants.
- D. Plant Quality:
 - 1. General: Provide healthy stock, grown in a nursery and reasonably free of die-back, disease, insects, eggs, bores, and larvae. At the time of planting all plants shall have a root system, stem, and branch form that will not restrict growth, stability and health for the expected life of the plant. Plants shall be healthy with the color, shape, size and distribution of trunk, stems, branches, buds and leaves typical to the plant type specified.
 - 2. Plant quality above the soil line shall comply with branching structure details and the following.
 - a. Crown: The form and density of the crown shall be typical for a young specimen of the species or cultivar pruned to a central and dominant leader (requirement does not apply to plants that have been specifically trained in the nursery as topiary, espalier, multi-stem, clump, or unique selections such as contorted or weeping cultivars).
 - b. Leaves: The size, color, and appearance of leaves shall be typical for the time of year and stage of growth of the species or cultivar. Trees shall not show signs of prolonged moisture stress or over watering as indicated by wilted, shriveled, or dead leaves.
 - c. Trunk: The tree trunk shall be relatively straight, vertical, and free of wounds that penetrate to the wood (properly made pruning cuts, closed or not, are acceptable and are not considered wounds), sunburned areas, conks (fungal fruiting bodies),

wood cracks, sap leakage, signs of boring insects, galls, cankers, girdling ties, or lesions (mechanical injury). Trunk caliper and taper shall be sufficient so that the lower five feet of the trunk remains vertical without a stake. An auxiliary stake may be used to maintain a straight leader in the upper half of the tree.

d. Branches:

- 1.) Shoot growth (length and diameter) throughout the crown should be appropriate for the age and size of the species or cultivar. Trees shall not have dead, diseased, broken, distorted, or otherwise injured branches.
- 2.) Main branches shall be distributed along the central leader not clustered together. They shall form a balanced crown appropriate for the cultivar/species.
- 3.) Branch diameter shall be no larger than two-thirds (one-half is preferred) the diameter of the central leader measured 1 inch above the branch union.

e. Tree Branching structure:

- 1.) Central Leader: Trees shall have one central leader. If the leader was headed, a new leader (with a live terminal bud) at least one-half the diameter of the pruning cut shall be present. All trees are assumed to have one central leader trees unless a different form is specified in the plant list or drawings.
- 2.) The attachment of the largest branches (scaffold branches) shall be free of included bark.
- 3.) Temporary branches, unless otherwise specified, can be present along the lower trunk below the lowest main (scaffold) branch, particularly for trees less than 1 inch in caliper.

f. Grafts: graft unions, where applicable, shall be completely closed without visible sign of graft rejection. All grafts shall be visible above the soil line.

3. Plant quality at or below the soil line:

a. Plant roots shall be typical to the plant type specified. Root observations shall take place without impacting tree health. Root quality at or below the soil line shall comply with the project Root Structure details and the following:

- 1.) The roots shall be reasonably free of scrapes, broken or split wood.
- 2.) The root system shall be reasonably free of injury from biotic (e.g., insects and pathogens) and abiotic (e.g., herbicide toxicity and salt injury) agents. Wounds resulting from root pruning used to produce a high-quality root system are not considered injuries.
- 3.) A minimum of three structural roots reasonably distributed around the trunk (not clustered on one side) shall be found in each plant. Root distribution shall be uniform throughout the root ball, and growth shall be appropriate for the species.
- 4.) The root collar shall be within the upper 2 inches of the substrate/soil. Two structural roots shall reach the side of the root ball near the top surface of the root ball. The grower may request a modification to this requirement for species with roots that rapidly descend, provided that the grower removes all stem girdling roots above the structural roots across the top of the root ball.
- 5.) The root system shall be reasonably free of stem girdling roots over the root collar or kinked roots (angled greater than 90 degrees).
- 6.) At time of observations and delivery, the root ball shall be moist throughout. Roots shall not show signs of excess soil moisture conditions as indicated by stunted, discolored, distorted, or dead roots.

2.2 PLANTING SOIL

- A. Planting Soil shall be native or imported topsoil. Planting soil shall be fertile, friable soil containing less than 5% by volume of subsoil, refuse, rocks, clay (heavy, sticky or stiff), sticks, brush, or litter. Soil shall not contain weeds or seeds in quantities causing noticeable

weed growth in planting areas, or any material deleterious to plant growth. Obtain and submit a two-gallon soil sample and agronomic testing results for all proposed imported soils. Imported topsoil shall meet the following criteria:

1. Soil texture: USDA loam, sandy clay loam or sandy loam with clay content between 15 and 25%. And a combined clay/silt content of no more than 55%.
2. pH value shall be between 5.5 and 7.0.
3. Percent organic matter (OM): 2.0-5.0%, by dry weight.
4. Soluble salt level: Less than 2 mmho/cm.

2.3 SOIL AMENDMENTS

- A. Compost: shall be blended and ground leaf, wood and other plant-based material, composted for a minimum of 9 months and at temperatures sufficient to break down all woody fibers, seeds and leaf structures, free of toxic material. Compost shall be commercially prepared and meet US Compost Council STA/TMECC criteria. Compost shall comply with the following parameters:
1. pH: 5.5 - 7
 2. Soil Salt (electrical conductivity): maximum 3 dS/m (mmhos/cm).
 3. Moisture content%, wet weight basis: 30-60.
 4. Particle size, dry weight basis: 98 percent passing through 3/4 inch screen.
 5. Stability carbon dioxide evolution rate: mg CO₂ -C/g OM/day<2.
 6. Solvita maturity test:> 6
 7. Physical contaminants, percent dry weight: <1percent.
 8. Chemical contaminants, mg/kg (ppm): meet or exceed US EPA Class A standard, 40 CFR & 503.13, Tables 1 and 3 levels.
 9. Biological contaminants meet or exceed US EPA Class A standard 40 CFR & 503.32 (a) level requirements.
- B. Gypsum: Agricultural grade product containing 98 percent minimum calcium sulfate.
- C. Iron Sulfate: 20 percent iron (expressed as metallic iron), derived from ferric and ferrous sulfate, 10 percent sulfur (expressed as elemental).
- D. Fertilizer: pelleted or granular form, mixed by a commercial fertilizer supplier, consisting of the following percentages by weight, if not otherwise recommended by agronomic testing:
1. 16 percent nitrogen
 2. 6 percent phosphoric acid
 3. 8 percent potash
- E. Plant Fertilizer Tablets: slow-release as manufactured by Agriform, Best, or equal, with the following percentages by weight:
1. 20 percent nitrogen
 2. 10 percent phosphoric acid
 3. 5 percent potash
 4. 2.6 percent combined calcium
 5. 1.6 percent combined sulfur
 6. 0.35 percent iron (elemental)

2.4 MULCH

- A. Mulch shall be "walk-on" grade, coarse, ground, from Douglas Fir, White Fir, or Red Fir. The size range shall have a minimum (less than 25% or less of volume) of fine particles 3/8 inch or less in size, and a maximum size of individual pieces (largest 20% or less of volume) shall be approximately 1 to 1-1/2 inch in diameter and maximum length of approximately 6

inches. Pieces larger than 5 inches long visible at the surface of the mulch shall be removed.

1. Acceptable products: SunUp Shredded Cedar, Redi-gro "Red Fir Walk-On Bark," K&M Forest Products "Walk-On Bark," or equal.
2. Submit supplier's product specification data sheet and a one gallon sample for approval.
 - a.

2.5 TREE STAKING AND GUYING MATERIAL

- A. Tree guying to be flat woven polypropylene material, 3/4 inch wide, and 900 lb. break strength, color: green. ArborTie, manufactured by Deep Root Partners, L.P., or equal.
- B. Tree ties: vinyl or nylon-reinforced vinyl, with UV inhibitors; Cinch-Tie by VIT, Super Tree Tie by Arthur Enterprises, or equal.
- C. Stakes shall be lodge pole stakes free of knots, minimum 2 inch diameter, lengths appropriate to the size of plant as required to adequately support the plant.

2.6 ROOT BARRIERS

- A. 18" or 24" deep (as indicated on drawings) linear polypropylene panels or roll, with stiffening ribs; UB-18-2/UB24-2 by DeepRoot Green Infrastructure LLC, EP-series by NDS, or equal.

2.7 SAND

- A. Clean, washed silica

2.8 DRAINAGE ROCK

- A. Crushed, angular rock, 1/4 to 1 inch in diameter, hard, durable, uniform, and free of any deleterious material.

PART 3 EXECUTION

3.1 SITE EXAMINATION

- A. Examine the surface grades and soil conditions to confirm rough grading and all prior work is completed. Notify the Owner's Representative in writing of any unsatisfactory conditions. Beginning work constitutes acceptance of site conditions.

3.2 COORDINATION WITH PROJECT WORK

- A. The Contractor shall coordinate with all other trades and work that may impact this work.
- B. Coordinate the relocation of any irrigation lines, heads, or other items that conflict with tree locations. Root balls shall not be altered to fit around lines. Notify the Owner's Representative of any conflicts encountered.

3.3 LAYOUT AND PLANTING SEQUENCE

- A. General: Plant trees before other plants are installed. Relative positions of all plants and trees are subject to approval of the Owner's Representative. Make adjustments as required by the Owner's Representative including relocating previously installed plants.

3.4 PLANTING SOIL PREPARATION

- A. After approximate finish grades have been established, amend planting areas by tilling into into the top 6-8" of soil amendments indicated by soils agronomic testing, local requirements, or the following, whichever is most stringent:
 1. Compost: 4 cubic yards per 1,000 square feet
 2. Fertilizer: 15 lbs per 1,000 square feet
 3. Gypsum: 50 lbs per 1,000 square feet

4. Iron Sulfate: 2 lbs per 1,000 square feet

3.5 PLANTING SOIL PROTECTION

- A. Protect soil from compaction during the delivery of plants to the planting locations, digging of planting holes and installing plants.
 1. Deliver and plant trees that require the use of heavy mechanized equipment (larger than 48" box) prior to final soil preparation and tilling. Where possible, restrict the driving lanes to one area instead of driving over and compacting a large area of soil. Where soil has been driven over, till soil to a depth of 6 inches, and ensure compaction is not above 85% relative density with 18 inches of finish grade.

3.6 ROOT BARRIER INSTALLATION

- A. Place root barrier flush and tight to back of adjacent work, plumb and straight, with top edge 1/2 inch above finish grade, and 1/2 to 1 inch below adjacent work.
- B. Roll stock shall be unrolled and straightened prior to installation. Joints shall be lapped 12" minimum and welded with manufacturer-specified solvent.
- C. "Surround" type configurations encircling plants or encroaching on planting area are not allowed and will be rejected.

3.7 PLANT DELIVERY, STORAGE, AND HANDLING

- A. Protect materials from deterioration during delivery and storage. Adequately protect plants from drying out, exposure of roots to sun, wind or extremes of heat and cold temperatures. If planting is delayed more than 24 hours after delivery, set plants in a location protected from sun and wind. Provide adequate water to the root ball package during the shipping and storage period.
 1. All plant materials must be available for observation prior to planting.
 2. Maintain soil moisture above the wilting point and below field capacity. Measure soil moisture using a soil moisture meter.
- B. Do not deliver more plants than can be stored on site. Provide a suitable storage and staging area for plants, materials, and equipment.
 1. The Owner's Representative shall approve the duration, method, and location of plant storage.
- C. Immediately prior to transporting, treat all plant material in full leaf with an anti-desiccant, following manufacturer's instructions. Provide protective covering over all plants during transporting.

3.8 PLANTING CONDITIONS

- A. Adverse weather conditions: No planting shall take place during extremely hot, dry, windy, or freezing weather.
- B. Volumetric soil moisture level, in both the planting soil and the root balls of all plants, prior to, during and after planting, shall be above permanent wilting point and below field capacity for each type of soil texture within the following ranges.

Soil type	Permanent wilting point	Field capacity
Sand, Loamy sand, Sandy loam	5-8%	12-18%
Loam, Sandy clay, Sandy clay loam	14-25%	27-36%
Clay loam, Silt loam	11-22%	31-36%

Silty clay, Silty clay loam	22-27%	38-41%

1. Volumetric soil moisture shall be measured with a digital moisture meter. The meter shall be the Digital Soil Moisture Meter, DSMM500 by General Specialty Tools and Instruments, or approved equivalent.
2. Verify soil moisture levels with a moisture meter. If the moisture is too high, suspend planting operations until the soil moisture drains to below field capacity.

3.9 PLANTING HOLE PREPARATION

- A. Excavation: Using hand tools or tracked mini-excavator, excavate the planting hole to the depth of the root ball measured after any root ball modification to correct root problems, and wide enough for working room around the root ball to the size indicated on the drawings, or at least twice the diameter of the root ball, whichever is greater.
 1. For trees and shrubs planted in soil areas that are NOT tilled or otherwise modified to a depth of at least 8 inches, over a distance of more than 10 feet from each tree, or 5 feet from each shrub, the soil around the root ball shall be loosened as follows:
 - a. The area of loosening shall be a minimum of 3 times the diameter of the root ball at the surface sloping to 2 times the diameter of the root ball at the depth of the root ball.
 - b. Loosening is defined as digging into the soil and turning the soil to reduce the compaction. Lifting and turning may be accomplished with a tracked mini excavator, or hand shovels.
 2. If an auger is used to dig the initial planting hole, the soil around the auger hole shall be loosened as defined above for trees and shrubs planted in soil areas that are NOT tilled or otherwise modified.
 3. The measuring point for root ball depth shall be the average height of the outer edge of the root ball after any required root ball modification.
 4. If motorized equipment is used to deliver plants to the planting area over exposed planting areas or used to loosen the soil or dig the planting holes, all soil that has been driven over shall be tilled to a depth of 6 inches.
- B. Where soil has been prepared to a depth deeper than the root ball depth, compact the soil under the root ball using a mechanical tamper to assure a firm bedding for the root ball. If there is more than 12 inches of planting soil under the root ball excavate and tamp the planting soil in lifts not to exceed 12 inches.
- C. Percolation testing: Test holes for 1 out of 5 trees planted, and at least one test of tree or shrub hole in every bioswale or stormwater feature. Fill holes with water and verify drainage within 24 hours. Where drainage does not occur, auger a minimum 1 foot diameter by 8 foot deep hole and backfill with drainage rock.
- D. Hardpan: where encountered, use powered equipment to break through the impervious layer at each tree and shrub location. Remove hardpan in an area at least 18" wider than the diameter of the plant. Backfill with Planting Soil.

3.10 PLANTING TREES AND SHRUBS

- A. Observe each plant after delivery and prior to installation for damage of other characteristics that may cause rejection of the plant. Replace such plants.
- B. No more plants shall be distributed than can be planted and watered on the same day.
- C. Remove containers carefully to avoid damage to the root system. Do not lift or handle plants by the tops, stems, or trunks. Do not mar or damage the bark of any plant.
- D. Container and Boxed Root Ball root pruning: remove all circling, descending, and matter

roots from the outer surfaces of all plants in containers and boxes, including the top, sides, and bottom of the root ball. Slice root mass at four locations around the perimeter of the root ball. Where required for 15 gallon or larger plants, shave root ball to remove 1/2 inch to 2 inches of root mat to eliminate all root segments that are not growing approximately radial to the trunk. Shaving shall be performed using saws, knives, sharp shovels or other suitable equipment that is capable of making clean cuts on the roots.

- E. Set top outer edge of the root ball at the average elevation of the proposed finish. Set the plant plumb and upright in the center of the planting hole. The tree graft, if applicable, shall be visible above the grade. Do not place soil on top of the root ball. Set the plant in the same orientation as it was grown, however, the Owner's Representative may request that plants orientation be rotated when planted based on the form of the plant.
- F. Backfill the space around the root ball with the material excavated for the planting hole. Tamp Planting Soil around the lower portion of the root ball. Place additional Planting Soil around base and sides of ball in six-inch (6") lifts. Lightly tamp each lift using foot pressure or hand tools to settle backfill, support the tree and eliminate voids. DO NOT over compact the backfill or use mechanical or pneumatic tamping equipment. Over compaction shall be defined as greater than 85% relative density.
 - 1. When the planting hole has been backfilled to three quarters of its depth, pour water around the root ball and allow to soak in to settle the soil without flooding. Place Plant Fertilizer Tablets around rootball as indicated on the drawings. Air pockets shall be eliminated and backfill continued until the Planting Soil is at finish grade.
- G. Where indicated on the drawings, build and tamp a berm of Planting Soil around the outside of the root ball to retain water.

3.11 TREE STAKING AND GUYING

- A. Maintain all plants in a plumb position throughout the Establishment Period. Straighten all trees that move out of plumb including those not staked. Plants to be straightened shall be excavated and the root ball moved to a plumb position, and then re-backfilled. Do not straighten plants by pulling the trunk.
- B. Staking and guy trees with materials specified. Tie guys with a slack loop to prevent girdling. Refer to manufacturer's recommendations and planting details for installation.

3.12 PLANTING GROUNDCOVER, PERENNIALS, ORNAMENTAL GRASS, AND ANNUALS

- A. Preparation:
 - 1. Ensure that soil moisture is within the required levels prior to planting. Irrigation, if required, shall be applied at least 12 hours prior to planting to avoid planting in muddy soils. Ensure that soil grades in the planting areas are smooth and as shown on the plans. Schedule the planting to occur prior to application of the mulch. If the area is already mulched, pull the mulch from around the hole and plant into the soil. Do not plant the root system in the mulch. Pull mulch back so it is not on the root ball surface.
- B. Installation:
 - 1. Plants shall be planted in even, triangularly spaced rows, at the intervals called out for on the drawings, unless otherwise noted. The first row of Annual flower plants shall be 8 inches from the planting area edge unless otherwise directed. Dig planting holes sufficiently large enough to insert the root system without deforming the roots. Set the top of the root system at the grade of the soil. Press soil to bring the root system in contact with the soil. Spread any excess soil around in the spaces between plants.

3.13 PRE-EMERGENT

- A. Apply pre-emergent to all planting areas after planting and prior to mulch. Use Dimension or equal and follow all manufacturer's directions. Do not apply to sensitive plants, bare-rooted plants, plugs, stolons, or seeded areas.

3.14 PRUNING TREES AND SHRUBS

- A. Do not allow plants to be topped, pruned, or trimmed prior to delivery.
- B. Prune plants to address structural deficiencies or as directed by the Owner's Representative. Follow recommendations within ANSI A 300. Except for plants specified as multi-stemmed or as otherwise instructed by the Owner's Representative, preserve or create a central leader.
- C. All pruning shall be performed by a person experienced in structural tree pruning. Pruning shall be done with clean, sharp tools. No tree paint or sealants shall be used.
- D. Pruning of large trees shall be done using pole pruners or if needed, from a ladder or hydraulic lift to gain access to the top of the tree. Do not climb in newly planted trees. Small trees can be structurally pruned by laying them over before planting.
- E. Remove and replace excessively pruned or malformed stock resulting from improper pruning.

3.15 PLANTING AREA FINISHING

- A. After planting, smooth out all grades between plants before mulching. Taper finish grade at all planting area edges as shown in the drawings.

3.16 MULCH

- A. Apply mulch to a depth of 3 inches after settlement, covering the entire planting area. Install no more than 1 inch of mulch over the top of the root balls of all plants. Taper mulch when abutting pavement.
- B. For trees planted in lawn areas the mulch shall extend to a 5 foot radius around the tree or to the extent indicated on the plans.
- C. Lift all leaves, stems, and other portions of plants out of the mulch if covered.

3.17 WATERING

- A. The Contractor shall ensure that adequate water is provided to all plants from installation until the date of Substantial Completion, and through the Establishment Period (if existing). The Contractor shall adjust the automatic irrigation system, if available, and apply additional or adjust for less water using hoses as required.
- B. Immediately after installation of all planting, hand water root balls of all plants, and sodded areas, to ensure that the roots and root balls have moisture above wilt point and below field capacity.

3.18 CLEAN-UP

- A. During installation, keep the site free of trash, pavements reasonably clean and work area in an orderly condition at the end of each day. Remove trash and debris in containers from the site no less than once a week.
 - 1. Immediately clean up any spilled or tracked soil, fuel, oil, trash or debris deposited by the Contractor from all surfaces within the project or on public right of ways and neighboring property.
- B. Once installation is complete, wash all soil from pavements and other structures. Ensure

that mulch is confined to planting areas and that all tags, and markers are removed from the site. After observation by Owner's Representative, remove all nursery plant tags and ribbons.

- C. Make all repairs to grades, ruts, and damage by the plant installer to the work or other work at the site.
- D. Remove and dispose of all excess planting soil, subsoil, mulch, plants, packaging, and other material.

3.19 PROTECTION DURING CONSTRUCTION

- A. The Contractor shall protect planting and related work and other site work from damage due to planting operations, operations by other Contractors or trespassers. Maintain protection until Final Acceptance.
- B. Damage done by the Contractor, or any of their sub-contractors to existing or installed plants, or any other parts of the work or existing features to remain, including roots, trunk or branches of large existing trees, soil, paving, utilities, lighting, irrigation, other finished work and surfaces including those on adjacent property, shall be cleaned, repaired or replaced by the Contractor at no expense to the Owner. The Owner's Representative shall determine when such cleaning, replacement or repair is satisfactory.

3.20 SUBSTANTIAL COMPLETION / ESTABLISHMENT PERIOD

- A. Upon written notice from the Contractor, the Owner's Representative shall observe the work to determine if Landscape Installation is substantially complete.
 - 1. Notification shall be at least 7 days prior to the observation.
 - 2. The substantial completion review will not occur until all sodded, seeded, or hydroseeded turf areas demonstrate a full, even, vigorous stand of grass, or after the second mowing, whichever is later.
- B. The Establishment Period begins at date of written notification of substantial completion from the Owner's Representative. The date of substantial completion may be different than the date of substantial completion for the other sections of the project.
- C. The Establishment Period consists of plant and other maintenance as described in Section 32 98 00 – Landscape Maintenance. Any day of improper maintenance, as determined by the Owner's Representative, will extend the Establishment period.

3.21 PROJECT ACCEPTANCE / END OF WARRANTY OBSERVATION

- A. At the end of the Establishment Period, upon written notice from the contractor, the Owner's Representative shall observe the work to verify that all provisions of the contract are complete and the work is satisfactory.
 - 1. Notification shall be at least 7 days prior to the date the contractor is requesting the observation.
 - 2. If the work is satisfactory, the Establishment Period will end on the date of the final observation.
 - 3. If the work is deemed unsatisfactory, the Establishment Period will continue at no additional expense to the Owner until the work has been completed, observed, and approved by the Owner's Representative.
 - 4. If the work fails to pass final observation, a subsequent observation must be scheduled. The cost to the Owner for subsequent observations will be charged to the Contractor at the prevailing hourly rate of the Owner's Representative.
- B. At the end of the Warranty Period, the Owner's Representative shall again observe the work to verify that the Landscape Planting is healthy and satisfactory.

END OF SECTION

SECTION 32 98 00

LANDSCAPE MAINTENANCE

PART 1 GENERAL

1.1 SUMMARY OF WORK

- A. During the Establishment Period, or until project acceptance, whichever is longer, provide all maintenance to keep plants in a healthy state and the planting areas clean and neat. The Establishment Period will be as a minimum of 90 days, or until the project is accepted. Any day of improper maintenance, as determined by the Owner's Representative, will extend the Establishment period.

1.2 QUALITY ASSURANCE:

- A. All work shall be undertaken by trained landscape maintenance workers under the supervision of a foreman with a minimum of 2 years experience supervising commercial landscape maintenance crews.
- B. All chemical and fertilizer applications shall be made by licensed applicators for the type of chemicals to be used. All work and chemical use shall comply with all applicable local, state, and federal requirements.

1.3 ACCESS AND SAFETY

- A. Assure that hoses and watering equipment and other maintenance equipment does not block paths or be placed in a manner that may create tripping hazards. Use standard safety warning barriers and other procedures to maintain the site in a safe manner for visitors at all times.
- B. All workers shall wear required safety equipment and apparel appropriate for the tasks being undertaken.
- C. The Contractor shall not store maintenance equipment at the site at times when they are not in use unless authorized in writing by the Owner's Representative.
- D. Maintenance vehicles shall not park on the site including walks and lawn areas at any time without the Owner's Representative's written permission.

1.4 RECORDS

- A. Maintain a detailed log of all maintenance activities including types of tasks, date of task, types and quantities of materials and products used, watering times and amounts, and number of each crew. Submit logs to the Owner's Representative monthly.
- B. Meet with the Owner's Representative at final acceptance to formally transfer the responsibilities of maintenance to the Owner's Representative. Provide all information on past maintenance activities and provide a list of critical tasks that will be needed over the next 12 months. Provide all maintenance logs and soil test data not previously submitted.
- C. Contractor's supervisor shall be available for a minimum of three months after the end of the Establishment Period to answer questions about past maintenance.

1.5 REPAIR

- A. Repairs shall be made within 24 hours of written notification by Owner's Representative. Repairs due to defective materials, improper work, or regular use shall be made at no cost to the owner.
- B. Repair of damage by visitors and events beyond normal use and wear, vandalism, or natural

disasters, are not part of this maintenance. The Owner's Representative may request that the Contractor repair damage from such events at an additional cost. All additional work shall be approved in advance by the Owner's Representative.

PART 2 PRODUCTS

2.1 GENERAL

- A. As specified in Section 32 90 00 – Landscape Installation.

PART 3 EXECUTION

3.1 WATERING

- A. Provide all water required to keep soil within and around the root balls at optimum moisture content for plant growth.
 - 1. Maintain Irrigation system and equipment, including a visual observation, by station, at least monthly. Adjust programming as required to provide optimum water, and to minimize overspray, runoff, or saturation below the root zone.
 - 2. Hand-water as required. Use a hose-end diffuser to prevent plant damage and soil disturbance.
 - 3. Monitor soil moisture to provide sufficient water. Check soil moisture and root ball moisture with a soil moisture meter on a regular basis and record moisture readings. Do not over water.

3.2 FERTILIZATION

- A. Soil nutrient levels: Take a minimum of 4 soil samples from around the site in the spring and fall and have them tested by an accredited agronomic soil testing lab for chemical composition of plant required nutrients, pH, salt and % organic matter. Test results shall include laboratory recommendations for nutrient applications. Apply fertilizers at rates recommended by the soil test.
 - 1. Make any other soil test and/or plant tissue test that may be indicated by plant conditions that may not be related to soil nutrient levels such as soil contaminated by other chemicals or lack of chemical uptake by the plant.

3.3 PRUNING

- A. Remove cross-over branches, shorten or remove developing co-dominant leaders, dead wood and winter-damaged branches.
- B. Unless directed by the Owner's Representative, or where a formal hedge is clearly indicated by plant type and spacing, do not shear plants.
- C. In no case shall pruning result in individually boxed or balled plantings. Adjacent plants of the same species shall be allowed to grow together. Head-back or pinch buds to encourage lateral growth filling in planter areas.

3.4 REPLACEMENT

- A. Replace all plants that are defective or unsatisfactory as described in Section 32 90 00 as soon as the plant decline is obvious and in suitable weather and season for planting as outlined in above sections. Plants that become defective during the maintenance period shall be covered and replaced under the warranty provisions.
- B. Replace all damaged materials with same materials as originally installed.

3.5 MULCHING

- A. Prior to final acceptance, top-off all mulched areas to assure complete coverage at an average depth of 3 inches, but do not over mulch. At no time shall the overall mulch thickness be greater than 4 inches. Do not re-apply mulch within 6 inches of the trunks or stems of any plants. Replacement mulch shall meet the requirements of the original approved material. Mulch shall be no more than one inch on top of the root ball surface.

3.6 GENERAL

- A. Mowing: mow all turf areas once per week after establishment. From December through February, mowing frequency may be reduced to twice per month if warranted. Mow height shall maximize leaf area while maintaining turf function (ornamental, casual use, or sports use)
- B. Edging: trim turf area edges with a mechanical edge trimmer, maintaining a perpendicular edge between turf and adjacent materials. Do not over-cut edges. Trimming shall occur not less than every other week. Trim all groundcovers and other plants to maintain growth within planting areas.
- C. Debris removal: Remove trash, fallen leaves, spent flowers, fruit and plant part accumulations from beds and paved surfaces. Maintain all surface water drains free of debris. Debris removal shall be undertaken at each visit. Legally dispose of all debris off-site unless otherwise directed by Owner's representative.
- D. Settlement: Reset any plants that have settled or are leaning as soon as the condition is noticed. Repair any settlement in finished grades.
- E. Guying and staking: Maintain plant guys in a taught position. If left during maintenance, Remove all nursery stakes prior to final acceptance unless otherwise directed by Owner's Representative.
- F. Weed control: Keep all planting areas free of weeds. Hand-remove all weeds and any plants that do not appear on the planting plan. Chemical weed control is permitted only with the approval of the Owner's Representative. Schedule weeding as needed but not less than 8 times per year.
- G. Plant pest control: Maintain disease, insects and other pests at manageable levels. Manageable levels shall be defined as damage to plants that may be noticeable to a professional but not to the average person. Use least invasive methods to control plant disease and insect outbreaks.
 - 1. The Owner's Representative must approve all chemical pesticide applications in advance.

END OF SECTION 32 98 00

SECTION 33 00 00

SITE UTILITIES

PART 1 - GENERAL

1.01 INCLUSION OF OTHER CONTRACT DOCUMENTS

- A. The General Conditions, Supplementary Conditions and Division 1 are fully applicable to this Section, as if repeated herein.

1.02 SCOPE OF WORK

- A. The work includes, but is not necessarily limited to, the following:
 - 1. Domestic water piping system.
 - 2. Fire protection piping systems.
 - 3. Sewer piping system.
- B. Other items that may be specified or shown on the Drawings.

1.03 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 015000, Construction Facilities and Temporary Controls.
- B. Section 312333, Trenching and Backfilling.
- C. Section 321600, Site Concrete.
- D. Section 330000, Earthwork.

1.04 QUALITY ASSURANCE

- A. Use only new materials and products, unless existing materials or products are specifically shown otherwise on the drawings to be salvaged and re-used.
 - 1. Sun damaged or discolored PVC pipe will be rejected.
- B. All materials, components, assemblies, workmanship and installation are to be observed by the Owner's Inspector of Record. Work not so inspected is subject to uncovering and replacement.
- C. The representatives of the Owner's testing lab will not act as supervisor of construction, nor will they direct construction operations. Neither the presence of the Owner's testing lab representatives nor the testing by the Owner's testing lab shall excuse the contractors or subcontractors for defects or deficiencies discovered in their work during or following completion of the project. Correcting inadequate compaction is the sole responsibility of the contractor.
- D. Contractor shall be solely responsible for all subgrades built. Any repairs resulting from inadequate compaction or incorrect grades will be the responsibility of the contractor.
- E. Per 2016 NFPA 13 provide Contractor's material and test certificate to the Owner, Architect, Project Inspector and Local Fire Authority.

1.05 SUBMITTALS

- A. Refer to Section 013300.
- B. Manufacturer's Data: Submit list and complete descriptive data of all products proposed for use. Include manufacturer's specifications, published warranty or guarantee, installation instructions, and maintenance instructions.
- C. Provide sieve analysis from accredited testing lab on pipe bedding material. Analysis shall have a current date not older than project contract signing date.
- D. Substitution: Provide all data of proposed material being submitted as a substitution. Provide comparison with specified product data and identify all differences. Failure to provide comparison will be reason for rejection.

1.06 FEES, PERMITS, AND UTILITY SERVICES

- A. Obtain and pay for permits and service charges required for installation of Work. Arrange for required inspections and secure written approvals from authorities having jurisdiction.
- B. Upon completion of work within right-of-way, provide copies of written final approval to the Architect.

1.07 WARRANTY

- A. Refer to General Conditions and Section 017836.

1.08 REFERENCES AND STANDARDS

- A. ANSI/ASTM D698-00 - Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures, Using 5.5 lb (2.49 Kg) Rammer and 12 inch (304.8 mm) Drop.
- B. ANSI/ASTM D1556-00 - Test Method for Density of Soil in Place by the Sand-Cone Method.
- C. ANSI/ASTM D1557-02 - Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 10 lb. (4.54 Kg) Rammer and 18 inch (457 mm) Drop.
- D. ANSI/ASTM D 3017-05 Test Methods for Moisture Content of Soils and Soil-Aggregate Mixture by Nuclear Methods (Shallow Depth).
- E. ANSI/ASTM D 4318-05 Test Method for Liquid Limit, Plastic Limit, and Plasticity Limit.
- F. CALTRANS Standard Specifications.
- G. CAL-OSHA, Title 8, Section 1590 (e).
- H. Any work within the street, highway or right-of-way shall be performed in accordance with the requirement of the governmental agencies having jurisdiction, and shall not begin until all of those governing authorities have been notified.
- I. NFPA 13, 24 and 25, latest editions.
- J. California State Health and Safety Code Section 116875, Lead Free Public Water Systems.
- K. California Plumbing Code, latest edition.

1.09 DELIVERY, STORAGE AND HANDLING

- A. Transport, store and handle in strict accord with the local jurisdiction.
- B. Make delivery to job when notified by Contractor verifying that the job is ready to receive the work of this Section and that arrangements have been made to properly store, handle and protect such materials and work.

1.10 PROJECT CONDITIONS

- A. Existing civil, mechanical and electrical improvements are shown on respective site plans to the extent known. Should the Contractor encounter any deviation between actual conditions and those shown, he is to immediately notify the Architect before continuing work.

1.11 EXISTING SITE CONDITIONS

- A. Contractor shall acquaint himself with all site conditions. If unknown active utilities are encountered during work, notify Architect promptly for instructions. Failure to notify will make Contractor liable for damage to these utilities arising from Contractor's operations subsequent to discovery of such unknown active utilities.

1.12 PROTECTION

- A. Adequate protection measures shall be provided to protect workmen and passers-by on and off the site. Adjacent property shall be fully protected throughout the operations. Blasting will not be permitted. Prevent damage to adjoining improvements and properties both above and below grade. Restore such improvements to original condition should damage occur. Replace trees and shrubs outside building area disturbed by operations.
- B. In accordance with generally accepted construction practices, the Contractor shall be solely and completely responsible for working conditions at the job site, including safety of all persons and property during performance of the work. This requirement shall apply continuously and shall not be limited to normal working hours.
- C. Any construction review of the Contractor's performance conducted by the Geotechnical Engineer is not intended to include review of the adequacy of the Contractor's safety measures, in, on, or near the construction site.
- D. Provide shoring, sheeting, sheet piles and or bracing to prevent caving, erosion or gullyng of sides of excavation.
- E. Surface Drainage: Provide for surface drainage during period of construction in manner to avoid creating nuisance to adjacent areas. The contractor shall make a reasonable effort on a daily basis to provide pumps and all equipment necessary to keep all excavations and the site free from water during entire progress of work, regardless of cause, source, or nature of water.
- F. Adjacent streets and sidewalks shall be kept free of mud, dirt or similar nuisances resulting from earthwork operations.
- G. The site and adjacent influenced areas shall be watered as required to suppress dust nuisance. Dust control measures shall be in accordance with the local jurisdiction.
- H. Trees: Carefully protect existing trees that are to remain. Provide temporary irrigation as

necessary to maintain health of trees.

1.13 SEASONAL LIMITS

- A. No fill material shall be placed, spread or rolled during unfavorable weather conditions. When work is interrupted by rains, fill operations shall not be resumed until field tests indicate that moisture content and density of fill are satisfactory.

1.14 RECORD DRAWINGS

- A. Keep a daily record of all pipe placed in ground, verified by Project Inspector.
- B. Upon completion of this Contract, furnish one tracing showing all outside utility lines, piping, etc., installed under this Contract. Locate and dimension all work with reference to permanent landmarks.
- C. All symbols and designations used in preparing "RECORD" drawings shall match those used in Contract drawings.
- D. Properly identify on as-builts and provide dimensions for all stubs for future connections. Provide concrete markers 6" dia. 12" deep, flush with finish grade at the ends of all stubbed pipes.

PART 2 – PRODUCTS

2.01 MATERIALS - GENERAL

- A. Provide each item listed herein or shown on drawings of quality noted or approved equal. All material shall be new, full weight, standard in all respects and in first-class condition. Insofar as possible, all materials used shall be of same brand or manufacture throughout for each class of material or equipment. Materials shall be of domestic manufacture and shall be tested within Continental United States.
- B. Grade or quality of materials desired is indicated by trade names or catalog numbers stated herein.
- C. Dimensions, sizes, and capacities shown are minimum and shall not be changed without permission of Architect.
- D. All materials in this section used for any public water system or domestic water for human consumption shall be lead free.
 - 1. For the purposes of this section, "lead free" means not more than 0.2 percent lead when used with respect to solder and flux and not more than 8 percent when used with respect to pipes and pipe fittings.
 - 2. All pipe, pipe or plumbing fitting or fixtures, solder, or flux shall be certified by an independent American National Standards Institute (ANSI) accredited third party, including, but not limited to, NSF International, as being in compliance with this section.
- E. All materials used for fire system piping shall be UL and FM approved.

2.02 VALVE BOXES

- A. Provide at each valve or cock in ground a Christy, Brooks, or equal to Christy G05CT,

concrete valve box with cover marked for service, domestic water shall be marked "Water" and fire supply shall be marked "Fire". Furnish extension handles for each size square nut valve, and provide "fork" handle for each size of "wheel handle" valve as required. Do not locate valve boxes in walk, or covered passages, curbs, or curb & gutters, unless necessary. If valve location is within concrete or asphalt paved surface valve box shall be as detailed on plans for such condition. Provide valve box extensions as required to set bottom of valve box to bottom of piping in which valve is installed. Provide Owner with set of special wrenches and/or tools as required for operation of valves.

2.03 PIPES AND FITTINGS

- A. Sanitary Sewer: PVC sewer pipe and fittings with Ring-Tite joints, ASTM D3034 SDR35.
- B. Domestic water Lines 3 1/2" and smaller: Type K copper tubing, hard temper, with wrought copper fittings. Schedule 80 PVC.
- C. Water lines 4" and larger: AWWA C-900 Class 150/DR18 with rubber gasket joints.
- D. Fire lines 4" and larger: AWWA C-900 Class 200/DR14 with rubber gasket joints.
- E. Solder: Lead Free. 95/5; 95% Tin / 5% Antimony.
- F. Ductile Iron Pipe; Class 350, Cement Lined
- G. Ductile Iron Pipe Fittings; AWWA C110, C153, Ebba Iron, Star Romac, Sigma, or approved equal.
- H. Mechanical Fitting Bolts; Bolts and nuts shall be carbon steel with a minimum 60,000 psi tensile strength conforming to ASTM A 307, Grade A. Bolts shall be standard ANSI B1.1 Class 2A course threads. Nuts shall conform to ASTM A 563 and be standard ANSI B1.1, Class 2A course thread. All bolts and nuts shall be zinc coated.
- I. Fasteners Anti-Rust Coatings; After assembly, coat all fasteners with an Asphaltic Bituminous coatings conforming to latest edition NFPA 24.
- J. Ductile Iron Pipe Wrap; 8 mil polyethylene pipe wrap conforming to ANSI/AWWA C105/A21.5 standards.
- K. Pipe Insulation; Pipe exposed to atmospheric conditions 1/2" thru 4" NPT; Johns Manville rigid fiberglass insulation, Micro Lok HP; Owens Corning Fiberglas SSL II; Conforming to ASTM C 612, Type 1A or type 1B.
- L. Aluminum field applied pipe insulation jacket; comply with ASTM B209, ASTM C1729, ASTM C1371 Manufacturers; Childers Metals; ITW Insulation Systems Aluminum Jacketing; or an approved equal.
 - 1. Finish shall be flat mill finish
 - 2. Factory Fabricated Fitting Covers; 45 and 90 degree elbows, tee's, valve covers, end caps, unions, shall be of the same thickness and finish of jacket.
 - 3. The fittings shall be composed of 2-pieces
 - 4. Adhesives; per the manufacturers requirements
 - 5. Joint Sealant; shall be silicone, and shall be aluminum in color.

2.04 SANITARY SEWER MANHOLES

- A. Shall be constructed as shown on plan details.

2.05 CLEANOUTS

- A. Cleanouts of same diameter as pipe up to 8" in size shall be installed in all horizontal soil and waste lines where indicated and at all points of change in direction. Cleanouts shall be located not less than 18" from building so as to provide sufficient space for rodding. No horizontal run over 100 feet shall be without cleanout whether shown on drawings or not.
- B. All cleanout boxes shall be traffic rated with labeled lid, Christy G05CT or approved equal. Lid shall be vandal proof with stainless steel screws

2.06 UNIONS

- A. Furnish and install one union at each threaded or soldered connection to equipment and 2 unions, one on each side of valves on pipes 1/2" to 3".
- B. Locate unions so that piping can be easily disconnected for removal of equipment or valve. Provide type specified in following schedule:

Type of Pipe Union

Steel Pipe:	150 lb. Screwed malleable ground joint, brass, brass-to-iron seat, black or galvanized to match pipe.
Copper tubing:	Brass ground joint with sweat connections.
PVC Sch 80 pipe:	PVC union, FIPT X FIPT

2.07 VALVES

- A. Provide valves as shown and other valves necessary to segregate branches or units. Furnish valves suitable for service intended. Valves shall be properly packed and lubricated. Valves shall be non-rising stem. Place unions adjacent to each threaded or sweat fitting valve. Install valves with bonnets vertical. All valves shall be lead free.
- B. Valves 1/2" thru 2"; shall be made of bronze, full size of pipe and lead free. Nibco S-113-FL Series; American G-300 Series; Matco 511 FL Series; Apollo 102T-FL Series. Brass valves of brass parts within valves will not be accepted.
- C. Valves, 2 1/2" thru 3" shall be class 150; Shall be made of bronze, full size of pipe; Jenkins Fig. 2310 J; Lunkinheimer Fig. 2153; Crane Fig. 437; Stockham Fig. B-128.
- D. Valves, Flanged; 4" thru 12" Ductile Iron Resilient Wedge Gate Valve; Nibco F 609 RW; American 2500 Series; Kennedy 8561; Mueller 2360 Series.

2.07 FIRE HYDRANTS

- A. Clow 960 Factory Painted or per Local Jurisdiction Requirements, or an approved equal, 36" minimum bury, two 2-1/2" hose nozzles, one 4-1/2" pumper nozzle, and break-off check valve, Clow LBI 400A or approved equal. Hydrant shall conform to, and installation shall comply with the Local Jurisdiction.

2.08 POST INDICATOR

- A. Post Indicator shall be Mueller Co. A-20806 (adjustable) with tamper switch or an approved equal.

2.09 BACKFLOW PREVENTERS

Double Check Valve, Double Check Detector and Reduced Pressure Backflow Preventers

- A. Backflow preventers shall be as approved by the local agency and by the State of California's Department of Health Services most recent list of approved reduced pressure backflow preventers. All approved backflow preventers shall have ductile iron bodies.
 - 1. Provide Backflow preventer blankets with locking device. Weatherguard R-30 insulated or equal.
 - 2. Provide ball valve at all test ports with brass plug in valve.
 - 3. Provide a minimum of 2 valve tamper switches on fire prevention Backflows.

2.10 TAPPING SLEEVE

- A. Shall be used on pipe sizes 6" thru 12" and shall be made with stainless steel material including stainless steel bolts. Flanges shall be ductile iron or high carbon steel. Gaskets shall seal full circumference of pipe. Shall be manufactured for operating pressure of 200 psi, and shall pass test pressure of 300 psi. Romac SST series; Smithblair 662; Mueller H304; Ford "FAST" tapping sleeve.

2.11 SERVICE SADDLES

- A. Shall be used on pipe size 2" thru 4". Body shall be made from ductile iron with epoxy coating or bronze. Cascade Style CSC-1; A.Y. McDonald model 3891 AWWA/3892 FNPT; Smith-Blair #317; Ford S70, S71, S90, (style B).

2.11 TRACER WIRE

- A. No. 12 insulated copper wire. Solder all joints

PART 3 - EXECUTION

3.01 DRAWINGS AND COORDINATION

- A. General arrangement and location of piping, etc., are shown on Drawings or herein specified. Install work in accord therewith, except for minor changes that may be necessary on account of other work or existing conditions. Before excavation, carefully examine other work that may conflict with this work. Install this work in harmony with other craft and at proper time to avoid delay of work.
- B. Verify invert elevations at points of connection to existing systems prior to any excavation. If invert elevations differ from that shown on drawings, notify Architect immediately.
- C. In advance of construction, work out minor changes if conflicts occur with electrical or mechanical. Relocate services to suit actual conditions and work of other trades to avoid conflict therewith. Any adjustments or additional fittings to make adjustments shall not be cause for additional costs to the owner.
- D. Execute any work or apparatus shown on drawings and not mentioned in specifications, or vice versa. Omission from Drawings or Specifications of any minor details of construction,

installation, materials, or essential specialties does not relieve Contractor of furnishing same in place complete.

- E. Graded pipes shall take precedence. If conflict should occur while placing the domestic water and fire service piping, the contractor shall provide any and all fittings necessary to route the water lines over or under such conflicting pipes at no additional costs to the owner.

3.02 ACCESS

- A. Continuously check for clearance and accessibility of equipment or materials specified herein to be placed. No allowance of any kind shall be made for negligence on part of Contractor to foresee means of installing his equipment or materials into proper position.

3.03 EXCAVATING AND BACKFILLING

A. Excavation and Bedding:

1. General: Trench straight and true to line and grade with bottom smooth and free of irregularities or rock points. Trench width to be a minimum of 12" wider than outside diameter of pipe. Follow manufacturer's recommendations for use of each kind and type of pipe.
2. Bedding: Provide a bedding as noted on drawing details for the full length of the pipe. Bedding shall have a minimum thickness beneath the pipe of 4" or 1/8 the outside diameter of the pipe, which ever is greater. Provide bell holes and depressions for pipe joints only of size required to properly make joint.
3. If the trenches for the site utilities falls within areas to be lime/cement treated, the piping shall be installed prior to any lime treatment operations, providing the elevation of the piping is below the treatment section.
 - a. If trenching is necessary in areas that have been previously lime treated the contractor shall backfill the trench with class 2 aggregate base, with minimum section equal to the lime treated section and compacted to 95%.

B. Laying of Pipe:

1. General: Inspect pipe prior to placing. Sun damaged pipe will be rejected. Set aside any defective or damaged material. Do not place pipe in water nor place pipe when trenches or weather are unsuitable. Lay pipe bell up grade, true to line and grade.
 - a. Sewer pipe shall be laid in strict conformity to the prescribed line and grade, with grade bars set and each pipe length checked to the grade line. Three consecutive points on the same rate of slope shall be used at all times to detect any variation from a straight grade. In any case of discrepancy, work shall be stopped and the discrepancy immediately reported to the Owner's Representatives. In addition, when requested by the Owner's Representative, a string line shall be used in the bottom of the trench to insure a straight alignment of the sewer pipe between manholes. The maximum deviation from grade shall not be in excess of 1/4 inch. In returning the pipe to grade, no more than 1/4" depression shall result.
 - b. The Contractor shall expose the end of existing pipe to be extended, for verification of alignment and elevation, prior to trenching for any pipe which may be affected. All costs of such excavation and backfill shall be included in the price paid for the various items of work.
 - c. A temporary plug, mechanical type shall be installed on sewer pipe at the point of

connection to existing facilities. If connecting to a public facility the plug shall conform to the requirements of the local jurisdiction. This plug shall remain in place until the completion of the balling and flushing operation.

2. Bell and Spigot Joints: Lubricate inside of bells and outside of spigots with soap solution. Wedge joints tight. Bell of bell and spigot pipe to be pointed upgrade.

C. Backfilling:

1. General: Do not start backfill operations until required testing has been accomplished.
2. Compaction and Grading: Remainder of backfill shall be in accordance with Section 312333 – TRENCHING AND BACKFILLING.
3. If trenching in area previously lime or cement treated backfill top of trench section, same depth as lime or cement treatment with Class 2 Aggregate Base compacted to 95% minimum relative compaction.

3.04 INSTALLATION OF WATER PIPING

- A. Immediately cap or plug ends of, and opening in, pipe and fittings to exclude dirt until final connections made. Use reducing fittings where any change in pipe size occurs. Bushings shall not be used.
- B. General: Should existing conditions or other work prevent the running of pipes or the setting of equipment at the points indicated by drawings, changes as authorized by the Architect shall be made without additional cost to the Owner.
- C. All bolts used on mechanical fittings shall be thoroughly coated with an asphaltic bituminous coating conforming to 2016 NFPA 24, 10.4.1.1.
- D. All buried metal shall be incased with 8 mil polyethylene wrap so that no soil is in contact with metal. Ends of polyethylene wrap shall be taped to provide seal with pipe.
- E. Do not install water lines in same trench with non-metallic sewer lines unless bottom of water pipe at all points is at least 12" above top of sewer line and water line is placed on solid shelf excavated at one side of common trench with a minimum of 12 inch horizontal separation.
- F. Under no circumstance shall a fitting be located directly under a structural footing without prior approval from the Architect.
- G. In locations where existing domestic pipe is rerouted, the new pipe shall be assembled using restrained fittings at all joints including factory pipe joints. Tapped restrained blind flanges shall be temporarily installed at each end of the assembled pipes until testing and chlorination is completed and approved.

3.05 CLOSING IN OF UNINSPECTED WORK

- A. Do not allow or cause work installed to be covered up or enclosed before it has been inspected, tested, and approved. Should work be enclosed or covered up before it has been approved, uncover work at own expense. After it has been inspected, tested and approved, make repairs necessary to restore work of other contractors to condition in which it was found at time of cutting.

3.06 CARE AND CLEANING

- A. Repair or replace broken, damaged, or otherwise defective parts, materials, and work. Leave entire work in new condition satisfactory to Architect. At completion, carefully clean and adjust equipment, fixtures and trim that are installed as part of this work. Leave systems and equipment in satisfactory new operating condition.
- B. Drain and flush piping to remove grease and foreign matter.
- C. Sewer piping shall be balled and flushed.
- D. Clean out and remove surplus materials and debris resulting from the work, including surplus excavated material.
- E. Flush fire service piping 3 times in the presence of the project inspector. Each flushing shall be 3 minutes minimum.

3.07 SEWER INTERNAL INSPECTIONS

- A. Upon completion of construction and prior to final inspection, the Contractor shall clean the entire new pipeline of all dirt and debris. Any dirt or debris in previously existing pipes or ditches in the area, which resulted from the new installation, shall also be removed. Pipes shall be cleaned by the controlled balling and flushing method. Temporary plugs shall be installed and maintained during cleaning operations at points of connection to existing facilities to prevent water, dirt, and debris from entering the existing facility.

3.08 TEST OF PIPING

- A. Pressure Test piping at completion of roughing-in, in accord with following schedule, and show no loss in pressure or visible leaks after minimum duration or four (4) hours at test pressures indicated.
- B. Chlorination tests shall be performed after all fixtures and any required mechanical devices are installed and the entire system is complete and closed up.
- C. In cases where new domestic water piping is assembled for re-routing of existing domestic water pipe, the contractor shall perform the following testing prior to connecting the new water pipe to the existing system.
 - 1. The pipe shall be pressure tested and per the test schedule.
 - 2. The pipe shall be pressure tested down within the trench.
 - 3. The contractor shall dig a temporary ditch below the existing pipe to drain to a sump that is lower than the bottom of the trench and to the side of the trench. The sump shall be 30% larger than the total volume of water within the testing pipe assembly.
 - 4. After pressure testing and chlorination has taken place and accepted, the contractor shall drain the pipe into the sump and pump the sump out as it is filling.
 - 5. The temporary test fittings at each end of the pipe assembly shall be removed and the final restrained couplings installed.
 - 6. The existing piping shall be cut and the water within the pipe shall drain below the pipe to the temporary sump. Pump the sump as it is being filled up. Take extreme caution not to contaminate the existing pipe with any contaminants within the trench.
 - 7. Before making the final coupling connections, the restrained couplings at each end of the new pipe shall be thoroughly swabbed inside the fitting with a solution of chlorine

mixed with water at a rate of 1part chlorine to 4 parts potable water.

8. After final connections are made, a visual inspection shall be made after fittings are wiped off. If after 1 hr, no noticeable drips are noted the pipe can be backfilled.
9. The contractor shall flush all water piping affected by chlorination until it is within acceptable levels approved by certified testing lab.

TEST SCHEDULE

<u>System Tested</u>	<u>Test Pressure PSIG Test With</u>
Public water mains	Per local jurisdiction requirements.
Private domestic water piping and fire mains serving fire hydrants:	150 Lbs. Water 4 hrs.
Fire Protection Piping from PIV to fire riser:	200 Lbs. Water pressure, 4 hrs duration with no pressure loss.
Sanitary Sewer Piping:	Sewer system shall be tested for leakage per local jurisdiction requirements.

- D. Testing equipment, materials, and labor shall be furnished by contractor.

3.09 WATER SYSTEM STERILIZATION

- A. Public Water Mains: Shall be flushed and disinfected per the local jurisdiction requirements
- B. Clean and disinfect all site water systems connected to the domestic water systems in accordance with AWWA Standard C651 and as required by the local Building and Health Department Codes, and EPA.
 1. Clean and disinfect industrial water system in addition to the domestic water system.
 2. Disinfect existing piping systems as required to provide continuous disinfection upstream to existing valves. At Contractors option, valves may be provided to isolate the existing piping system from the new piping system.
- C. Domestic water sterilization shall be performed by a licensed "qualified applicator" as required by CAL-EPA Pesticide Enforcement Branch for disinfecting and sterilizing drinking water.
- D. Disinfecting Agent: Chlorine product that is a registered product with Cal-EPA for use in California potable water lines, such as Bacticide, CAL-EPA Registration No. 37982-20001.
- E. Contractor to provide a 1" service valve connected to the system at a point within 2'-0" of its junction with the water supply line. After sterilization is complete Contractor to provide cap at valve.
- F. Sterilization Procedure to be as follows:
 1. Flush pipe system by opening all outlets and letting water flow through the system until clear water flows from all outlets.
 2. Inject disinfecting agent to provide a minimum chlorine residual concentration of at least 50 parts per million (ppm) of free chlorine at each outlet.

3. Provide sign at all outlets which reads "Water Sterilization in Progress – Do not operate". Remove signs at conclusion of test.
 4. Close all outlets and valves, including valve connecting to water supply line and 1" service valve. Retain treated water in pipe for a minimum of twenty-four hours. Should chlorine residual at pipe extremities be less than 50 PPM at this time, pipe shall be re-chlorinated. As an option, the water systems may be filled with a water-chlorine solution containing a minimum of 200 PPM of chlorine and allowed to stand for three hours.
 5. After chlorination, flush lines of chlorinated water and refill from domestic supply. Continue flushing until residual chlorine is less than or equal to 0.2 ppm, or a residual the same as that of the test water.
- G. Chemical and bacteriological tests shall be conducted by a state-certified laboratory and approved by the local authorities having jurisdiction.
- H. Submit written report to Health Department as required by State Regulations. Provide a copy of report to Architect prior to completion of project.
- I. The costs of sterilization and laboratory testing shall be paid for by the contractor.

3.10 CLEANING

- A. Refer to Section 017400.
- B. Upon completion of work of this Section promptly remove from the working area all scraps, debris and surplus material of this Section.

END OF SECTION

SECTION 33 40 00

SITE DRAINAGE

PART 1 - GENERAL

1.01 INCLUSION OF OTHER CONTRACT DOCUMENTS

- A. The General Conditions, Supplementary Conditions and Division 1 are fully applicable to this Section, as if repeated herein.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 015000, Construction Facilities and Temporary Controls.
- B. Section 312333, Trenching and Backfilling.
- C. Section 321200, Asphalt Concrete Paving.
- D. Section 321600, Site Concrete

1.03 QUALITY ASSURANCE

- A. Use only new materials and products, unless existing materials or products are specifically shown otherwise on the Drawings to be salvaged and re-used.
- B. All materials, components, assemblies, workmanship and installation are to be observed by the Owner's Inspector of Record. Work not so inspected is subject to uncovering and replacement.
- C. The representatives of the Owner's testing lab will not act as supervisor of construction, nor will they direct construction operations. Neither the presence of the Owner's testing lab representatives nor the testing by the Owner's testing lab shall excuse the contractors or subcontractors for defects discovered in their work during or following completion of the project. Correcting inadequate compaction is the sole responsibility of the contractor.
- D. Contractor shall be solely responsible for all subgrades built. Any repairs resulting from inadequate compaction are the responsibility of the contractor.

1.04 SUBMITTALS

- A. Refer to Section 013300.
- B. Manufacturer's Data: Submit list and complete descriptive data of all products proposed for use. Include manufacturer's specifications, published warranty or guarantee, installation instructions, and maintenance instructions.

1.05 WARRANTY

- A. Refer to General Conditions and Section 017836.

1.06 REFERENCES AND STANDARDS

- A. ANSI/ASTM D698-00 - Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures, Using 5.5 lb (2.49 Kg) Rammer and 12 inch (304.8 mm) Drop.
- B. ANSI/ASTM D1556-00 - Test Method for Density of Soil in Place by the Sand-Cone Method.

- C. ANSI/ASTM D1557-02 - Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 10 lb. (4.54 Kg) Rammer and 18 inch (457 mm) Drop.
- D. ANSI/ASTM D 3017-05 Test Methods for Moisture Content of Soils and Soil-Aggregate Mixture by Nuclear Methods (Shallow Depth).
- E. ANSI/ASTM D 4318-05 Test Method for Liquid Limit, Plastic Limit, and Plasticity Limit.
- F. CALTRANS Standard Specifications.
- G. CAL-OSHA, Title 8, Section 1590 (e).
- H. Any work within the street, highway or right-of-way shall be performed in accordance with the requirement of the governmental agencies having jurisdiction, and shall not begin until all of those governing authorities have been notified.
- I. California Plumbing Code current edition.

1.07 DELIVERY, STORAGE AND HANDLING

- A. Transport, store and handle in strict accord with the local jurisdiction.
- B. Make delivery to job when notified by Contractor verifying that the job is ready to receive the work of this Section and that arrangements have been made to properly store, handle and protect such materials and work.

1.08 PROJECT CONDITIONS

- A. Existing civil, mechanical and electrical improvements are shown on respective site plans to the extent known. Should the Contractor encounter any deviation between actual conditions and those shown, he is to immediately notify the Architect before continuing work.

1.09 EXISTING SITE CONDITIONS

- A. Contractor shall acquaint himself with all site conditions. If unknown active utilities are encountered during work, notify Architect promptly for instructions. Failure to notify will make Contractor liable for damage to these utilities arising from Contractor's operations subsequent to discovery of such unknown active utilities.

1.10 PROTECTION

- A. Adequate protection measures shall be provided to protect workmen and passers-by on and off the site. Adjacent property shall be fully protected throughout the operations. Blasting will not be permitted. Prevent damage to adjoining improvements and properties both above and below grade. Restore such improvements to original condition should damage occur. Replace trees and shrubs outside building area disturbed by operations.
- B. In accordance with generally accepted construction practices, the Contractor shall be solely and completely responsible for working conditions at the job site, including safety of all persons and property during performance of the work. This requirement shall apply continuously and shall not be limited to normal working hours.
- C. Any construction review of the Contractor's performance conducted by the Geotechnical Engineer is not intended to include review of the adequacy of the Contractor's safety measures, in, on, or near the construction site.

- D. Provide shoring, sheeting, sheet piles and/or bracing to prevent caving, erosion or gullyng of sides of excavation.
- E. Surface Drainage: Provide for surface drainage during period of construction in manner to avoid creating nuisance to adjacent areas. The contractor shall make a reasonable effort on a daily basis to provide pumps and all equipment necessary to keep all excavations and the site free from water during entire progress of work, regardless of cause, source, or nature of water.
- F. Adjacent streets and sidewalks shall be kept free of mud, dirt or similar nuisances resulting from earthwork operations.
- G. The site and adjacent influenced areas shall be watered as required to suppress dust nuisance. Dust control measures shall be in accordance with the local jurisdiction.
- H. Trees: Carefully protect existing trees that are to remain.

1.11 SEASONAL LIMITS

- A. No fill material shall be placed, spread or rolled during unfavorable weather conditions. When work is interrupted by rains, fill operations shall not be resumed until field tests indicate that moisture content and density of fill are satisfactory.

1.12 TESTING

- A. General: Refer to Section 014000 – Quality Requirements.
- B. Geotechnical Engineer: Owner is retaining a Geotechnical Engineer to determine compliance of fill with Specifications, and to direct adjustments in fill operations. Costs of Geotechnical Engineer will be borne by Owner; except those costs incurred for re-tests or re-inspection will be paid by Owner and backcharged to Contractor.

1.13 RECORD DRAWINGS

- A. Keep a daily record of all pipe placed in ground, verified by Project Inspector.
- B. Upon completion of this Contract, furnish one tracing showing all outside utility lines, piping, etc., installed under this Contract. Locate and dimension all work with reference to permanent landmarks.
- C. All symbols and designations used in preparing "RECORD" drawings shall match those used in Contract drawings.
- D. Properly identify all stubs for future connections, as to location and use, by setting of concrete marker at finished grade in the manner suitable to Architect.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Pipe: Use one of the following, unless noted on the Drawings otherwise.
 - 1. Polyvinyl Chloride Pipe (PVC): SDR35 conforming to ASTM D3034 with elastomeric joints conforming to ASTM D3212. Sun damaged pipe will be rejected.
 - 2. High density polyethylene pipe (HDPE): The pipe shall be corrugated exterior/smooth interior pipe and water tight per ASTM D3212 with dual wall water tight gasket fittings.

- B. Perforated Pipe (for subdrains): Shall be ADS N12 pipe, 3 hole, ASTM F 405, AASHTO M 252; PVC ASTM D3034 SDR-35 storm drain pipe
- C. Manhole: Shall be as shown on the drawing details.
- D. Drop Inlet: Shall be as shown on the drawing details.
- E. Curb Inlet: Shall be as shown on the drawing details.
- F. Mortar: For pipe connections to concrete drainage structures, conform to ASTM C270 type N mortar. Place within one half hour after adding water.
- G. Crushed Rock: Imported washed crushed rock. Minimum 100% passing 3/4 inch sieve.
- H. Trench drain: Polycast, Polydrain or equal and as shown on drawings.
- I. Area Drains: Shall be as shown on the drawing details.
- J. Floor Drains: Shall be as shown on the drawing details.
- K. Clean-outs: Shall be as shown on the drawing details.
- L. Planter drains: Shall be as detailed on the drawing details.
- M. Filter Fabric: Mirafi 140N.

PART 3 - EXECUTION

3.01 INSPECTION LAYOUT AND PREPARATION

- A. Prior to installation of the work of this Section, carefully inspect and verify by field measurements that installed work of all other trades is complete to the point where this installation may properly commence
- B. Layout all work, establish grades, locate existing underground utilities, set markers and stakes, setup and maintain barricades and protection facilities; all prior to beginning actual earthwork operations. Layout and staking shall be done by a licensed Land Surveyor or Professional Civil Engineer.
- C. Verify that specified items may be installed in accordance with the approved design.
- D. In event of discrepancy, immediately notify Owner and the Architect. Do not proceed in discrepant areas until discrepancies have been fully resolved.

3.02 INSTALLATION

- A. General: Installation shall be in strict conformance with referenced standards, the manufacturer's written directions, as shown on the drawings and as herein specified.
- B. Verify invert elevations at points of connection to existing systems prior to any excavation. If invert elevations differ from that shown on drawings, notify Architect immediately.
- C. Excavation and Bedding:
 - 1. General: Trench straight and true to line and grade with bottom smooth and free of irregularities or rock points. Trench width in accordance with pipe manufacturer's

- recommendations and as per the drawings. Follow manufacturer's recommendations for use of each kind and type of pipe.
2. Bedding: Provide bedding as detailed on plans for the full length of the pipe. Bedding shall have a minimum thickness beneath the pipe of 4" or 1/8 the outside diameter of the pipe, which ever is greater. Provide bell holes and depressions for pipe joints only of size required to properly make joint.
 3. If the trenches for the site drainage fall within areas to be lime treated, the piping shall be installed prior to any lime treatment operations.
 - a. If additional piping is added to previously lime treated areas, the contractor shall backfill the trench with class 2 aggregate base and compact to 95%.
- D. Laying of Pipe:
1. General: Inspect pipe prior to placing. Set aside any defective or damaged material. Do not place pipe in water nor place pipe when trenches or weather are unsuitable. Lay pipe upgrade, true to line and grade.
 2. Bell and Spigot Joints: Lubricate inside of bells and outside of spigots with soap solution or as recommended by manufacture. Wedge joints tight. Bell of bell and spigot pipe to be pointed upgrade.
 3. Pipe shall be bedded uniformly throughout its length.
 4. Pipe elevation shall be within 0.02 feet of design elevation as shown on plans.
 5. Off Site Work: All work beyond the property lines shall be done in strict conformance with the requirements of the governing agency.
- E. Backfilling:
1. General: Do not start backfill operations until required testing has been accomplished.
 2. Trenches and Excavations: Backfill with material as detailed on plans, filling both sides of the pipe at the same time, carefully tamping to hold pipe in place without movement. Refer to Section 312333 – TRENCHING AND BACKFILLING for fill above this layer.
- F. Grouting of Pipes: Grout pipes smooth and water tight at drop inlet, manholes, and curb inlets. Grout back side of hood at curb inlets all grouting shall be smooth and consistent.
- G. Off Site Work: All work beyond the property lines shall be done in strict conformance with the requirements of the local agency.
- H. Cutting and Patching: Remove and replace existing surface features per applicable specification section (i.e. asphaltic concrete or concrete paving) where pipe is installed in areas of existing improvements.

3.03 TOLERANCES

- A. Storm Drain structure grates
1. In landscape and lawn areas $\pm 0.05'$.
 2. In sidewalk and asphalt pavement $\pm 0.025'$.
 3. In curb and gutter application $\pm 0.0125'$.
- B. Cleanout Boxes and Lids
1. In landscape areas; 0.10 higher than surrounding finish grade, $\pm 0.05'$.

2. In sidewalks and asphalt pavement; Flush with surrounding finish grade, $\pm 0.025'$.

3.03 DEWATERING

- A. Contractor to provide trench dewatering as necessary, no matter what the source is, at no additional cost to the owner.
- B. If the previously excavated material from trenching is too wet to achieve trench backfill compaction the contractor shall make a reasonable effort to aerate and dry the material per section 310000, 3.08, B

3.04 FLUSHING

- A. The Contractor shall thoroughly ball and flush the storm drain system to remove all dirt and debris. Discharge water to an approved location.

3.05 CLEANING

- A. Refer to Section 017400.
- B. Upon completion of work of this Section promptly remove from the working area all scraps, debris and surplus material of this Section.
- C. Clean the dirt, rocks, and debris from all storm drain inlets, structures, and connecting pipes.

END OF SECTION