SECTION 03 35 23

POLISHED CONCRETE FLOORING

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

A. Volume 1 – Contracting Requirements and Division-01 General Requirements apply to the work of this section.

1.02 SCOPE

A. The work encompassed by this Section includes performing all operations and furnishing all labor, materials, tools, equipment, and incidentals as necessary to provide Polished Concrete Flooring on floors as indicated on the Room Finish Schedule.

B. Work to be performed:

1. Dry diamond grinding and polishing of concrete floors.
2. Applying densifying impregnator, sealer and dust-proofing chemicals.
3. Exposing aggregate to approved level.
4. Polishing to specified sheen level.

1.03 RELATED DOCUMENTS

A. Cast-In-Place Concrete: Section 03 30 00.

B. Concrete Floor Sealer: Section 03 35 00

1.04 SUMMARY

A. This section includes the following:

1. Polished Concrete Flooring

1.05 ACTION SUBMITTALS

A. Color charts for initial color selection.

B. Samples of color for final selection.

C. On-Site Mock-Up

1.06 INFORMATIONAL SUBMITTALS

A. Installer's Project References: Submit installer's list of success fully completed polished concrete floor system projects, including project name, location, client and

project architect. Define the type of project, quantity of area polished concrete flooring and system used.

B. Project Record Drawings

C. Product Data for each product specified including the following: Test Reports: Provide certified test reports, prepared by an independent testing laboratory, confirming compliance with specified performance criteria.

1. Submit special concrete finishes manufacturer's specifications and test data.

2. Submit special concrete finishes describing product to be provided, giving manufacturer’s name and product name for the specified material proposed to be provided under this section.

3. Submit special concrete finishes manufacturer's recommended installation procedures; which when approved by the Architect, will become the basis for accepting or rejecting actual installation procedure used on the work.

4. Submit special concrete finishes technical data sheet giving descriptive data, curing time, and application requirements.

5. Submit special concrete finishes manufacturer’s Material Safety Data Sheet (MSDS) and other safety requirements.

6. Follow all special concrete finishes published manufacturer’s installation instructions.

D. Installation instructions

E. Maintenance Data: Submit installer's maintenance manual, including maintenance and cleaning instructions for polished concrete floor system.

1.07 QUALITY ASSURANCE

A. American Society for Testing and Materials:

1.	ASTM C642	Standard Test Method for Density, Absorption, and Voids in Hardened Concrete.
2.	ASTM D5178	Standard Test Method for Mar Resistance of Organic Coatings.
3.	ASTM D4060	Standard Test Method for Abrasion Resistance of Organic Coatings by the Taber Abraser:
4.	ASTM G15	Standard Practice for Operating Fluorescent Ultraviolet (UV) LAMP Apparatus for Exposure of Nonmetallic Materials.
5.	ASTM D4541	Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers.

6. ASTM D2369 — Standard Test Method for Volatile Content of Coatings.

7. ASTM D2047 — Standard Test Method for Static Coefficient of Friction of Polish-Coated Flooring Surfaces as Measured by the James Machine. Concrete used as finish floor is required to be slip-resistant (per 11B-302.1).

8. ASTM C1378 — Standard Test Method for Determination of Resistance to Staining.

9. ASTM D2047 — Standard Test Method for Static Coefficient of Friction of Polish-Coated Flooring Surfaces as Measured by the James Machine. Concrete used as finish floor is required to be slip-resistant (per 11B-302.1).

10. ASTM C150 — Standard Specification for Portland Cement.

11. ASTM C33 — Standard Specification for Concrete Aggregates.

12. ASTM D523 — Standard Test Method for Specular Gloss.

13. ASTM D1455 — Standard Test Method for 60° Specular Gloss of Emulsion Floor Polish.

14. ASTM E1155 — Standard Test Method for Determining FF Floor Flatness and FL Floor Levelness Numbers.

B. American Concrete Institute

1. ACI 302.1R, Guide to Concrete Floor and Slab Construction

C. Reflectivity according to use of Horiba IG-320 Gloss Checker.Installer Qualifications:

1. Use an experienced installer and adequate number of skilled workmen which are thoroughly trained and experienced in the necessary craft.

2. The special concrete finish manufacturer shall certify applicator.

3. Applicator shall be familiar with the specified requirements and the methods needed for proper performance of work of this section.

D. Manufacturer's Certification:

1. Provide letter of certification from concrete finish manufacturer stating that installer is certified applicator of special concrete finishes, and is familiar with proper procedures and installation requirements required by the manufacturer.

E. Mock-ups:

1. Apply mock-ups of each type finish, to demonstrate typical joints, surface finish, color variation (if any) crack repair, and standard of workmanship.

2. Notify Architect or State Representative seven days in advance of dates and times when mockups will be constructed.

3. Obtain from the Architect or State Representative approval of mock-ups before starting construction.

4. If the Architect or State Representative determines that mock-ups do not meet requirements, demolish and remove them from the site if instructed to do so and cast others until mock-ups are approved.

5. Maintain mock-ups during construction in an undisturbed condition as a standard for judging the completed work.

6. State approved mock-ups may become part of the completed work if undisturbed at time of acceptance of the work.

F. Protection

1. No satisfactory chemical or cleaning procedure is available to remove petroleum stains from the concrete surface. Prevention is therefore essential.

2. All hydraulic powered equipment must be diapered to avoid staining of the concrete.

3. No trade will park vehicles on the inside slab. If necessary to complete their scope of work, drop cloths shall be placed under vehicles at all times.

4. No pipe cutting machine shall be used on the inside floor slab.

5. Steel shall not be placed on interior slab to avoid rust staining.

6. Acids and acidic detergents shall not come into contact with slab

7. All trades shall be informed that the slab must be protected at all times.

8. All equipment must be equipped with non-marking tires.

9. Provide protective covering such as “SKUDO” or equivalent.

G. Pre-Installation Conference:

1. Conduct conference at project site to comply with requirements in Division 1 Section “ Project Management and Coordination”

2. Notes of conference will be distributed to all attendees.

1.08 DELIVERY, STORAGE AND HANDLING

A. Delivery: Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly identifying product name and manufacturer.

B. Storage: Store materials in clean, dry area indoors in accordance with manufacturer's instructions. Keep materials from freezing.

C. Handling: Protect materials during handling and application to prevent contamination or damage.

PART 2 - PRODUCTS

2.01 SYSTEM DESCRIPTION

A. Polished Concrete: Includes grinding installation of silicate sealer, (hardener, densifier), polishing, and a stain repellant.

B. Performance Criteria

1. ASTM C642 Absorbability: Reduction of 75% of Control.

2. ASTM D5178 Balance Beam Mar Tester: Greater than 50% harder.

3. ASTM D2486e1 Abrasive Scrub: 1200 Cycles.

4. ASTM D4060 Modified Taber Abrasion 600 Rev: 0.37% treated vs. 0.68% untreated.

5. ASTM G154: 5000 HR QUV: No fade, change or erosion.

6. ASTM D4541 Bonding: Greater than 50 psi.

7. ASTM D2369 Solids: 18% Min.

8. Reflectivity: Change in gloss to 30, 60 or 80 depending on Certi-Shine system, as measured using a gloss meter in accordance with Horiba IG-320 Gloss Checker.

9. ASTM C137 Stain resistance: Food, Chemical, Oil and common stain resistance. See manufacturer's literature for list.

PART 3 - EXECUTION

3.01 PROJECT CONDITION

A. Floor Finish:

1. Slabs and flatwork shall be placed and finished monolithically.

2. Strike off and laser screed slabs to true, plane surfaces at required elevations.

3. Thoroughly compact concrete with vibrators, floats, and tampers to force coarse aggregate below the surface.

4. Power trowel with no hand finishing.

5. Pan float.

6. Steel finish.

7. Surface should not be burned due to excessive troweling.

8. Imprints are not acceptable (i.e. boots, foreign objects dropped into concrete).

B. Floor and Joints:

1. Free of debris and excessive dirt, dust, clay, and mud.

2. Dry.

C. Floor Surface Profile:

1. Floor Flatness Number (FF): 50 (preferred) 45 (minimum).

2. Floor Levelness Number (FL): 35 (preferred) 30 (minimum).

D. Concrete Compressive Strength: As noted on construction documents.

E. Concrete Curing: Minimum 8 days water cured or dissipating curing compound applied.

F. Concrete Adjacent to Floor Penetrations: Troweled flat and level with surrounding concrete.

G. Concrete Adjacent to Drains, clean-outs, etc: Finish level to the top of the structure.

3.02 SURFACE PREPERATION

A. Protect surrounding areas and adjacent surfaces from the following:

1. Minimal accumulation of dust from grinding and polishing

2. Contact with overspray of concrete densifier.

3. Contact with overspray of concrete sealer.

B. Prepare surfaces in accordance with installer's instructions.

C. Clean Surfaces: Remove dirt, dust, debris, oil, grease, curing agents, bond breakers, paint, coatings, and other surface contaminants which could adversely affect installation of polished concrete floor system.

3.03 INSTALLATION

A. Install polished concrete floor system in accordance with installer's instructions.

B. Start floor finish applications in presence of manufacturer’s technical representative if practical.

C. Aggregate Exposure: Small Aggregate: Mottled salt-and-pepper course aggregate exposure.

D. Polished Concrete Finish: Level 3 – High Gloss.

3.04 APPLICATION

A. Level floor by grinding with 40-grit metal-bonded diamonds (Note: The exact number of grinding and polishing steps required will be determined by the flatness achieved by the concrete finisher, along with the desired look that is specified).

B. Prepare concrete to accept densifier by grinding with 80-grit metal-bonded diamonds.

1. Apply concrete densifier to deeply saturate floor.

2. Remove residue of concrete densifier dried on floor surface by grinding with 150-grit metal-bonded diamonds.

C. Polishing

1. Remove 150-grit metal-bonded diamond scratches by grinding with 100-grit resin-bonded diamonds.

2. Remove 150-grit metal-bonded and 100-grit resin-bonded diamond scratches by grinding with 200-grit resin-bonded diamonds.

3. Prepare floor for polishing by grinding with 400-grit resin bonded diamonds.

4. Achieve light-reflective finish when viewed from a distance of 30 feet by grinding with 800-grit resin-bonded diamond.

D. Sealing, Hardening and Polishing of Concrete Surface

1. Concrete must be in place a minimum of 28 days or as directed by the manufacturer before application can begin.

2. Polish to pre-determined level based on test sample.

3. Application is to take place at least 10 days prior to racking and other in-store accessory installation, thus providing a complete, uninhibited concrete slab for application.

4. Applicable procedures must be followed as recommended by the product manufacturer and as required to match approved test sample.

5. Achieve hardening, dust-proofing, and abrasion resistance of the surface without changing the natural appearance of the concrete, except for the sheen.

6. Finish to within 3” of vertical surfaces where practical.

3.05 QUALITY CONTROL

A. Inspect completed polished concrete floor system with Contractor, Architect, and the State.

B. Review procedures with Architect to correct unacceptable areas of completed polished concrete floor system.

C. Testing: Test the following from completed polished concrete floor system:

1. Static Coefficient of Friction:

a. Dry surface.

b. Wet surface.

D. Specular Gloss/Reflectance (Test Test Method for Specular Gloss of Emulsion Floor Polish):

1. 20 degrees.

2. 60 degrees.

E. Floor Surface Profiles:

1. Floor Flatness Number (FF).

2. Floor Levelness Number (FL).

F. Test Results:

1. Report test results in writing to Contractor, Architect and the State within 24 hours after tests.

2. Compare test results from tests performed before and after installation of polished concrete floor system.

3.06 PROTECTION

A. Protect completed polished concrete floor system from damage until acceptance of the work.

1. Do not allow vehicle and pedestrian traffic on unprotected floor.

2. Do not allow construction materials, equipment, and tools on unprotected floor.

B. Immediately remove mortar splatter, spilled liquids, oil, grease, paint, coatings, and other surface contaminants which could adversely affect completed polished concrete floor system.

C. Repair damaged areas of completed polished concrete floor system to satisfaction of Architect.

END OF SECTION

SECTION 03 39 50

ALKALINITY AND VAPOR CONTROL

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

A. Volume 1 – Contracting Requirements and Division-01 General Requirements apply to the work of this section.

1.02 SCOPE

A. This Section includes multiple-component alkalinity and vapor emission control system for use on concrete slab-on-grade floors. This system applies to new concrete floor slabs scheduled to receive carpet, resilient flooring, conductive vinyl and resinous flooring systems.

1.03 RELATED DOCUMENTS

A. Cast-In-Place Concrete: Section 03 30 00

B. Concrete Floor Sealer: Section 03 35 00

C. Polished Concrete Flooring: Section 03 35 23

1.04 SUMMARY

A. This section includes the following:

1. Alkalinity and Vapor Emission Control Systems

1.05 INFORMATIONAL SUBMITTALS

A. Product warranty.

1.06 QUALITY ASSURANCE

A. Manufacturer Qualifications: The manufacturer of the system shall supply written proof of at least 5 years successful experience in vapor emission control system installation.

B. Applicator Qualifications: Applicator shall have received training and be certified as approved by the manufacturer of the system. Applicator shall provide written verification of such approval upon request.

C. Performance Standard: The system shall function to bring down ASTM F710 test results to the limit of 5 lb / 1000 sf / 24 hours in general or 3 lb / 1000 sf / 24 hours where required by resinous flooring, and shall control high alkalinity problems.

D. Quantification testing: Testing shall be conducted with calcium chloride test kits using the following schedule: Minimum of 3 kits for up to 1000 sf; and an additional test kit for

each additional 1000 sf or portion thereof. Kits shall be placed in either a rectangular or cross-diagonal pattern. Procedure shall be in strict conformance with ASTM F710.

E. Special Warranty: Written warranty, executed by manufacturer agreeing to repair or replace the entire failed flooring systems caused by alkalinity and vapor emission control system that fails in performance for ten years from date of Acceptance of the Work.

PART 2 - PRODUCTS

A. Product A for general use: A water based lithium formulation for curing concrete to control alkalinity and to reduce vapor emission to the limit of 5 lb / 1000 sf / 24 hours per ASTM F710.

1. VOC: Contains no volatile organic compounds.

B. Product B for use under resinous flooring: A 100% solids two-component primerless epoxy to penetrate into concrete to control alkalinity and to reduce vapor emission to the limit of 3 lb / 1000 sf / 24 hours per ASTM F710.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify existing conditions are suitable to receive the Work of the Section.

B. Do not begin application until unsuitable conditions have been corrected. Beginning application means acceptance of existing conditions.

3.02 PREPARATION

A. Remove or protect items not required to be coated.

B. Clean and prepare substrate surfaces in accordance with manufacturer's instructions.

C. Remove dust, dirt, loose and foreign materials.

D. Fill hairline cracks, holes, and similar defects with filler compatible with finish treatment.

3.03 APPLICATION

A. Mix and apply sealer in accordance with manufacturer's instruction, using brush, roller, or spray.

B. Apply at coverage rate recommended by manufacturer.

C. Edges abutting other materials and colors shall be sharp and clean without overlapping.

D. Finish surfaces shall be uniform in finish and color.

3.04 CLEANING

A. During progress of the Work, and upon completion, clean adjacent surfaces and materials of spills, splatters, and stains resulting from application. Remove using methods recommended by manufacturer and approved by State Representative, exercising care to prevent damage to finish surfaces and materials.

B. Touch up damaged surfaces before final acceptance.

END OF SECTION

SECTION 03 10 00

CONCRETE FORMS AND ACCESSORIES

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

A. Volume 1 – Contracting Requirements and Division-01 General Requirements apply to the work of this section.

1.02 SCOPE

A. All labor, materials and equipment and all operations required to complete all formwork to produce shapes and configurations as required.

B. Design, furnish and install forms for concrete as indicated on drawings and specified here. Remove forms and shores at specified time. Clean up.

1.03 RELATED DOCUMENTS

A. Reinforcing Steel: Section 03 21 00

B. Cast-in-Place Concrete: Section 03 30 00

C. Pertinent Sections of other Divisions specifying work to be embedded in concrete.

D. Pertinent Sections of other Divisions specifying work penetrating concrete foundations and formwork.

E. Pertinent Sections of Division 32-Exterior Improvements specifying site concrete paving requiring reinforcement.

1.04 SUMMARY

A. This Section includes the following:

1. Concrete Forms

2. Accessories for formwork

1.05 REFERENCES

A. California Building Code; California Code of Regulations, Title 24, Chapter 19A.

B. American Plywood Association (APA).

C. ACE 301 “Specifications for Structural Concrete”

D. ACI 303R “Guide to Cast-In-Place Architectural Concrete Practice”

E. ACI 318 “Building Code Requirements for Structural Concrete.”

F. ACI 347 "Guide to Concrete Formwork for Concrete."

G. ACI SP-004 “Formwork for Concrete.”

1.06 DESIGN REQUIREMENTS

A. Design, engineer and construct formwork, shoring and bracing to conform to design and code requirements, resist imposed loads; resultant concrete to conform to required shape, line and dimension.

1.07 ACTION SUBMITTALS

A. None

1.08 INFORMATIONAL SUBMITTALS

A. Qualification Data: For manufacturer

B. Product Certificates: For each type of product, signed by product manufacturer.

C. Product Data. Provide manufacturers data and installation instructions for the following:

1. Tie rods and spreaders.

2. Formwork for exposed concrete.

3. Form coatings and release agents

1.09 QUALITY ASSURANCE

A. General

1. All form materials shall be like-new condition at start of work utilizing recycled or salvaged material where applicable and acceptable by Architect. Produce high quality concrete construction. Minimize defects due to joints, deflection of forms, roughness of forms, nonconforming materials, concrete or workmanship.

2. Conform to all requirements of ACI 347.

3. Concrete formwork 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 shall be Contractor's responsibility. Formwork for exposed concrete shall be constructed to tolerances indicated in ACI 303R.

4. 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.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Form Materials:

1. Non-Exposed Surface Formwork Facing: Forms for concrete which is not exposed to view, may be of plywood APA Plyform 5/8 inch, Douglas Fir, steel or clean and sound 1 x 8 Standard Grade Douglas Fir.

2. Exposed Surface Formwork Facing:

a. Forms for all exterior and interior concrete flat surfaces shall be new or like new to achieve finish and joint patterns required. Material 5/8 inch minimum APA Plyform or steel.

b. All exposed concrete edges shall be chamfered to resist spall and cracking.

3. Exposed Surface Formwork - Special Pattern Form Liner:

a. Forms for all exterior and interior concrete flat surfaces indicated shall be as designated by Architect.

4. Fiber Forms - Tubular column forms spirally constructed of laminated plies of fiber. Plies shall be laminated using a non-water sensitive adhesive and surface wax impregnated for moisture protection. Forms shall give a smooth and seamless appearance to the cast concrete. Provide reveals, as shown on the drawings, as supplied by the form manufacturer. Forms shall be as manufactured by Sonoco Products, plastic lined; Burke Smoothtube by Burke Co.; or approved equal

B. Earth Forms: Allowed, subject to soil standing in excavations without ravel or caving.

C. Form Release Agent: Spray-on compound, not affecting color, bond or subsequent treatment of concrete surfaces

D. Accessories: Types recommended by manufacturers or referenced standards to suit conditions indicated;

E. Corner Chamfers and Rustications: Filleted, wood strip or foam type to result in clean uniform corners without spall or fractures.

F. Nails, Spikes, Lag Bolts, Through Bolts, Anchorages: Sized as required, of sufficient strength and character to maintain formwork in place while placing concrete.

G. Form Ties

1. Concrete exposed to view: Snap ties allowing full 1 inch break back.

2. Concrete concealed from view: Snap ties or wire.

3. Verify special spacing requirements with architectural drawings at exposed concrete.

H. Spreaders: Metal (no wood).

I. Form Coating: Non-grain and non-staining types of form coating that will not leave a residual matter on the face of the concrete or adversely affect proper bonding of any subsequent paint or other surface applications.

1. Form coating containing mineral oils or other non-drying materials will not be permitted for any concrete work.

J. Joint Tape: No. 471 plastic film tape 3 inches wide, as manufactured by the Industrial Tape Division of 3M Company, or approved equal.

K. Expansion Joint Filler (Preformed): 1/2 inch thick; Flexcell by Celotex Corporation, Elastic Fiber Expansion Joint by Phillip Carey Mfg. Co., or Sealtight Fiber Expansion Joint by W.R. Meadows, Inc., or approved equal.

L. Extruded Polystyrene Foam: ASTM C578 type IV. Dow Chemical Corp. "Styrofoam", UC Industries "Foamular", or approved equal.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Inspect the substrate and the conditions under which concrete formwork is to be performed. Correct conditions detrimental to timely and proper completion of the work.

B. Ensure that dimensions agree with drawings.

3.02 EARTH FORMS

A. If natural soil or compacted fill can be accurately cut and maintained, foundations and grade beams may be poured against earth without forming when requested by Contractor and approved by Architect.

B. Maintain earth forms free of water and foreign materials.

3.03 FORM CONSTRUCTION

A. Construct substantial forms to the shapes, lines, grades and elevations shown, sufficiently tight to prevent leakage of mortar, and tied, clamped and braced to prevent spreading, shifting or settling. Plywood joints shall be square and tight; plywood shall be arranged in such manner as to minimize number of joints and to provide a smooth, attractive finished concrete surface.

B. Sleeves, anchors and bolts, including those for angle frames, supports, ties and other materials in connection with concrete construction, shall be secured in position before the concrete is placed.

C. Proper provisions shall be made for openings, blockouts, sleeves, offsets, sinkages, recesses and depressions required by other trades and suppliers prior to placing concrete.

1. 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.

2. Coordinate with all trades to insure proper placement of all items in forms and to provide proper blockouts wherever required.

D. 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 State.

E. Form Not Required: Concrete footings may be poured directly against cut earth where feasible and when the Architect's approval has been obtained.

1. See structural drawings for requirements for placing concrete footings directly against earth without forms.

F. Use 3/4 inch minimum wood chamfer strips typical at all exposed corners unless noted otherwise on drawings.

3.04 ERECTION – FORMWORK

A. General: Construct formwork in accordance with calculations, and recommendations of ACI 347.

B. Formwork Construction: Erect formwork, shoring and bracing to achieve design requirements, in accordance with requirements of ACI 301.

3.05 APPLICATION - FORM RELEASE AGENT

A. Apply form release agent on formwork in accordance with manufacturer's recommendations.

B. Apply form coating to forms before reinforcing steel is in place.

3.06 INSERTS, EMBEDDED PARTS, AND OPENINGS

A. Provide formed openings where required for items to be embedded in passing through concrete work.

B. Construction Joints: Construct and locate generally so as not to impair the strength of the structure. Form keys in all cold joints shown or required.

C. Locate and set in place items that will be cast directly into concrete.

D. Rough Hardware and Miscellaneous Metal: Set inserts, sleeves, bolts, anchor, angles, and other items to be embedded in concrete. Set embedded bolts and sleeves for equipment to template and approved shop drawings prepared by trades supplying equipment.

E. Coordinate with work of other sections in forming and placing openings, slots, reglets, recesses, sleeves, bolts, anchors, other inserts, and components of other work.

F. Wood Inserts and Nailers: Provide approved preservative-treated lumber. Set all required nailing blocks, grounds, and other inserts as required

G. Install accessories in accordance with manufacturer's instructions, so they are straight, level, and plumb. Ensure items are not disturbed during concrete placement.

H. Piping: Do not embed piping in structural concrete unless specified on drawings.

I. Conduit: Place conduit below slabs-on-grade and only as specifically detailed on drawings.

J. Provide temporary ports or openings in formwork where required to facilitate cleaning, consolidation and inspection.

K. Install Form Liner inserts in accordance with manufacturer's recommendations, to produce patterns and textures indicated.

L. Install waterstops in accordance with manufacturer's recommendations to provide continuous waterproof barrier.

3.07 FORM CLEANING

A. Clean forms as erection proceeds, all dirt, chips, sawdust, rubbish, water, etc. shall be completely removed from form by water hosing and air pressure before any concrete is deposited therein. No wooden ties or blocking shall be left in concrete except where indicated for attachment of other work.

3.08 FOOTINGS

A. Verify elevations, provide final excavation required for footings and removal of loose material or water from excavations prior to placing of concrete and structure drawings.

3.09 EQUIPMENT BASES

A. Form concrete bases for all mechanical and electrical equipment in accordance with approved shop details furnished by other sections and construction documents.

3.10 FORMWORK TOLERANCES

A. Construct formwork to maintain tolerances required by ACI 301.

3.11 FIELD QUALITY CONTROL

A. Notify the Architect at least 48 hours in advance of the beginning of placement 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 for formwork, bulkheads and shorings.

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.

3.12 FORM REMOVAL

A. Do not loosen or remove forms before minimum curing period has elapsed without employment of appropriate alternate curing methods, approved by the structural engineer of record in writing.

B. Remove forms without damage to the concrete using means to insure complete safety of the structure and without damage to exposed beams, columns, wall edges, chamfers and inserts. Loosen forms carefully. Do not wedge pry bars, hammers, or tools against finish concrete surfaces scheduled for exposure to view.

3.13 CLEANING

A. Upon completion of this Work, clean up and remove from Site all equipment and debris resulting from this work.

B. Surfaces to be painted shall be smooth and free of substances such as dirt, wax, excessive latence, 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.

C. Remove excess material and debris associated with this work from the job site.

END OF SECTION

SECTION 03 21 00

REINFORCING STEEL

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

A. Volume 1 – Contracting Requirements and Division-01 General Requirements apply to the work of this section.

1.02 SCOPE

A. Unless noted otherwise, furnish and install reinforcing for all concrete, including dowels, chairs, spacers, bolsters, etc., necessary for supporting and fastening reinforcement in place as shown on the Drawings and specified herein.

1.03 RELATED DOCUMENTS (See also Table of Contents)

A. Concrete Forms and Accessories: Section 03 10 00.

B. Cast-In-Place Concrete: Section 03 30 00.

C. Concrete Unit Masonry: Section 04 20 00.

1.04 SUMMARY

A. This Section includes the following:

1. Reinforcing steel

2. Accessories for reinforcing steel

1.05 ACTION SUBMITTALS:

A. None.

1.06 INFORMATIONAL SUBMITTALS

A. Certified mill test reports of supplied reinforcing indicating chemical and physical analysis. Tensile and bend tests shall be performed by the mill in accordance with California Building Code Section 1910A and ASTM A615.

B. Product Data:

1. Manufacturer's specifications and installation instructions for splice devices.

2. Bar Supports.

C. Certificates of Compliance with specified standards:

1. Reinforcing bars.

2. Welded wire fabric.

3. Welding electrodes.

D. Samples: Only as requested by the Special Inspector.

E. Shop Drawings: Prepare in accordance ACI 315. Indicate bending diagrams, assembly diagrams, splicing and laps of bars and shapes, dimensions and details of bar reinforcing and assemblies. Correctness of all reinforcing requirements and work is the responsibility of Contractor. Identify such shop drawings with reference thereon to sheet and detail numbers from Contract Drawings.

1. Do not use scaled dimensions from Contract Drawings in determining the lengths of reinforcing bars.

2. No reinforcing steel shall be fabricated without approved shop drawings.

3. Any deviations from the contract documents must be clearly indicated as a deviation on the shop drawings.

4. Areas of high congestion, including member joints and embed locations shall be fully detailed to verify clearances and assembly parameters and coordination with other trades.

1.07 QUALITY ASSURANCE

A. General:

1. Acceptable Manufacturers: Regularly engaged in the manufacture of steel bar and welded wire fabric reinforcing.

2. 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.

3. Welding Qualifications: Welding procedures, welding operators and welders shall be qualified in accordance with AWS D1.4 "Structural Welding Code Reinforcing Steel".

a. Welders whose work fails to pass inspection shall be re-qualified before performing further welding.

4. Reinforcement Work shall conform to ACI 301 and CBC Chapter 19A, as minimum standards.

B. Standards and References: (Latest Edition unless otherwise noted):

1. American Concrete Institute (ACI).

a. ACI 301 - "Specifications for Structural Concrete".

b. ACI 315 - "Details and Detailing of Concrete Reinforcing".

c. ACI 318 – “Building Code Requirements for Structural Concrete”

2. American Society for Testing and Materials (ASTM).

a. ASTM A1064 - "Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete".

b. ASTM A615 - "Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement".

c. ASTM A706 – “Deformed and Plain Low-Alloy Steel Bars for Concrete Reinforcement”.

3. Concrete Reinforcing Steel Institute (CRSI) - "Manual of Standard Practice".

4. California Building Code (CBC)

C. Testing and Inspections:

1. DSA statement of structural tests and special inspections (DSA-103) shall be prepared by the registered design professional in responsible charge.

D. The DSA approved laboratory shall review all submittals and testing of materials per Chapters 22A and 19A of the CBC.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Reinforcement Bars: ASTM A615, Grade 40 for No. 3 and smaller bars; ASTM A615, Grade 60 for No. 4 and larger bars.

1. Bar reinforcement to be welded shall meet chemical requirements of ASTM A706.

B. Stirrups and Ties: ASTM A615, Grade 60 for No.4 and larger bars, ASTM A615, Grade 40 for No. 3 and smaller bars.

C. Steel Dowels: Same grade as bars to which dowels are connected.

D. Welded wire Fabric: ASTM A1064.

E. Tie Wires: FS-QQ-W-461, annealed steel, black, 16 gauge minimum.

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

G. Bar Supports:

1. Typical, unless noted otherwise; CRSI Class 2 wire supports.

a. Do not use wood, brick or other objectionable materials.

b. Do not use galvanized supports.

2. Supports placed against ground: Pre-cast concrete blocks not less than 4 inches square with embedded wire.

H. Mechanical and Welded Splices: Comply with ACI 318 Chapter 25.

PART 3 - EXECUTION

3.01 FABRICATION

A. Shop fabricate reinforcement to meet requirements of Drawings.

B. Fabricate reinforcement in accordance with the requirements of ACI 315 where specific details are not shown or where Drawings and Specifications are not more demanding.

3.02 CONDITION OF SURFACES

A. Examine surfaces and conditions receiving or affecting the work. Do not proceed until unsuitable conditions have been corrected.

3.03 GENERAL

A. Concrete shown without reinforcing shall be reinforced as similar parts shown with reinforcing except where concrete is specifically noted to be unreinforced on the construction documents.

3.04 PLACEMENT

A. 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.

B. 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 “Manual of Standard Practice, as a minimum standard.

C. Steel Adjustment:

1. Move within allowable tolerances to avoid interference with other reinforcing steel, conduits, or embedded items.

2. Do not move bars beyond allowable without concurrence in writing by the project Structural Engineer of Record.

3. Do not heat, bend, or cut bars without concurrence in writing by the project Structural Engineer of Record.

4. Reinforcement shall not be bent after being embedded in hardened concrete.

D. Splices:

1. Splice reinforcing as shown on Project Structural Engineer of Record reviewed shop drawings.

2. Lap Splices: Tie securely with wire to prevent displacement of splices during placement of concrete.

3. Splice Devices: Install in accordance with manufacturer's written instructions. Obtain Project Structural Engineer of Record’s review and written approval before using splice devices.

4. Do not splice bars except at locations shown on construction documents without concurrence of the project Structural Engineer of Record.

   a. Where splices in addition to those indicated are required, indicate location on shop drawings clearly and highlight "for Structural Engineer’s approval".

E. Welding:

1. Welding is not permitted unless specifically detailed on Drawings or approved by the project Structural Engineer of Record.

F. 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.

END OF SECTION

SECTION 03 30 00

CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

A. Volume 1 – Contracting Requirements and Division-01 General Requirements apply to the work of this section.

1.02 SCOPE

A. Section Includes: Provide all labor, materials, equipment and services to complete all concrete work required, including, but not limited to, the following:

1. Foundations, beams, columns, elevated slabs, slabs-on-grade, walls, and retaining walls.
2. Installation of all bolts, inserts, sleeves, connections, etc. in the concrete.
3. Joint devices associated with concrete work.
4. Miscellaneous concrete elements, including, but not limited to: equipment pads, light pole bases, flagpole bases, thrust blocks, and manholes.
5. Concrete curing.
6. Provide facilities for job curing of test cylinders and transporting to Testing Laboratory.
7. Coordination with other sections:

   a. Make all preparations and do all work necessary to receive or adjoin other work. Install all bolts and anchors, including those furnished by other sections, into formwork and provide all required blocking.

   b. Install all accessories embedded in the concrete and provide all holes, block-outs and similar provisions necessary for the work of other sections. Provide all patching or cutting made necessary by failure or delay in complying with this requirement shall be at the contractor's expense.

   c. Coordinate with other sections for the accurate location of embedded accessories.

1.03 RELATED DOCUMENTS

A. Pertinent Sections of Division 01 specifying Quality Control and Testing Laboratory services.

B. Pertinent Sections of other Divisions specifying site concrete: Formwork for site concrete.

C. Concrete Forms and Accessories: Section 03 10 00.

D. Reinforcing Steel: Section 03 21 00.

E. Polished Concrete Flooring: Section 03 35 23.

F. Pertinent Sections of other Divisions specifying work to be embedded in concrete.

G. Pertinent Sections of other Divisions specifying work penetrating concrete foundations and formwork.

H. Pertinent sections of other Divisions specifying floor finishes and sealants applied to concrete substrates.

1.04 SUMMARY

A. This section includes the following:

1. Concrete Mixes
2. Concrete Accessories

1.05 ACTION SUBMITTALS

A. Submit under provisions of Section 01 33 00 Submittal Procedures.

B. Submit for State Review

1. Project Record Documents: Accurately record actual locations of embedded utilities and components that will be concealed from view upon completion of concrete work. Incorporate information into as-built drawings.
2. Mock-up panel for architectural concrete surfaces.
3. Integral colored concrete.
4. Grout samples for sacked surface textures and colors.

1.06 INFORMATIONAL SUBMITTALS

A. Certificates of Compliance from Manufacturer

1. Cement certificates
2. Aggregates
3. Admixtures.

B. Data regarding hardeners and sealers.

C. Layout drawings for construction, control and expansion joints.

D. Transit-mix delivery slips:

1. Keep record at the job site showing time and place of each pour of concrete, together with transit-mix delivery slips certifying contents of the pour.
2. Make the record available to the Architect and State's Inspector for inspection upon request.
3. Upon completion of this portion of the work, deliver the record and the delivery slips to the Architect and State's Inspector.

E. See Section 03 21 00 for reinforcing steel submittals.

F. Concrete mix designs. See "Mix Design" below. Include results of test data used to establish proportions.

G. Product Data: For each product specified.

H. Installation instructions

1. Samples of color for final selection

2. On-site mock-up

I. Maintenance data

1.07 QUALITY ASSURANCE

A. California Building Code, CBC, Chapter 19A and AC 318.

B. American Concrete Institute (ACI)

1. ACI 117 Standard 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 lightweight concrete.

4. ACI 301 Specifications for Structural Concrete.

5. ACI 302.1R Guide for 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 Curing Concrete.

10. ACI 318 Building Code Requirements for Reinforced Concrete and Commentary.

C. American Society for Testing and Material (ASTM)

1. ASTM C 31 Making and Curing Concrete Test Specimens in the Field

2. ASTM C 33 Concrete Aggregates

3. ASTM C 39 Compressive Strength of Cylindrical Concrete Specimens

4. ASTM C 42 Obtaining and Testing Drilled Cores and Sawed Beams of Concrete

5. ASTM C 94 Ready-Mixed Concrete

6. ASTM C 109 Compressive Strength of Hydraulic Cement Mortars

7. ASTM C 143 Slump of Hydraulic Cement Concrete

8. ASTM C 150 Portland Cement

9. ASTM C 172 Sampling Freshly Mixed Concrete

10. ASTM C 192 Making and Curing Concrete Test Specimens in the Laboratory

11. ASTM C 260 Air-Entraining Admixtures for Concrete

12. ASTM C 330 Lightweight Aggregates for Structural Concrete

13. ASTM C 494 Chemical Admixtures for Concrete

14. ASTM C 618 Coal Fly Ash and Raw or Calcined Natural Pozzolan for use in Concrete

15. ASTM C685 Volumetric Batching and Continuous Mixing

D. ASTM C1157 Hydraulic-Cement Perform work of this section in accordance with ACI 301 and ACI 318.

E. Concrete construction verification and inspection to conform to CBC 1705A.3.

F. Common Sourcing: Provide each of the following materials from a single source for entire project.

1. Cement.
2. Fly ash or Slag.
3. Aggregate.

G. Follow recommendations of ACI 305R when concreting during hot weather.

H. Follow recommendations of ACI 306R when concreting during cold weather.

I. Services by the DSA approved laboratories (includes "Special" Inspections) as specified:

1. Perform tests and inspections specified below in articles SOURCE QUALITY CONTROL and FIELD QUALITY CONTROL. Duties and limitations of DSA approved laboratories, test costs and reports to be in conformance with pertinent Sections of Division 01.
2. Review mix designs and certifications. Provide letter authored by a Civil Engineer licensed in California recommending acceptance or rejection based upon conformance to specifications, and suitability of mix design for proposed use. Submit to Architect / Engineer for review and final distribution.
3. Review Contractor submittals specified in this section; batch plant certificates; admixtures, and similar information.

J. A testing program is required prior to start of construction. Testing program to be done in compliance with DSA Form DSA-103 Statement of Structural Tests and Special Inspections; CBC Chapters 17A and 19A and in collaboration with the Testing Laboratory, design team, contractor and owner.

K. 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 CBC Section 1903A.2, Chapter 17A and Section 1910A. A complete record of all tests and inspections shall be kept per CBC Section 1910A.

a. Compressive Strength: Make and cure in accordance with ASTM C-31. Test in accordance with ASTM C-39 and ACI Section 26.12.

a. A record shall be made of time and of locations of concrete from which samples were taken.

b. Four identical cylinders shall be taken from each pour of 50 cubic yards or 2000 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)

a. A record shall be made of time cylinders and of locations of concrete from which samples were taken.

b. 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.

c. Test specimens in accordance with ASTM C157.

c. Concrete consistency (slump) shall be tested in accordance with ASTM C143.

d. Provide full time inspection per CBC Section 1705A.3 during the taking of test specimens and during the placing of all concrete and embedded steel.

L. See Section 03 21 00 for reinforcing steel tests and inspections.

M. Provide concrete batch plant inspections per CBC Section 1705A.3.3.

1.08 MOCK-UP

A. Construct and erect mock-up panel for each architectural concrete surfaces indicated to receive special treatment or finish.

PART 2 - PRODUCTS

2.01 FORMWORK

A. Comply with requirements of Section 03 10 00 Concrete Forms and Accessories.

2.02 REINFORCEMENT

A. Comply with requirements of Section 03 21 00 Reinforcing Steel.

2.03 MATERIALS

A. General Requirements: All materials shall be new and best of their class or kind. All materials found defective, unsuitable, or not as specified, will be condemned and promptly removed from the premises.

B. Cementations Materials:

1. Portland Cement: ASTM C150, Type V, low alkali conforming to CBC Section 1910A.1.

2. Fly Ash (Pozzolan): ASTM C618, Class F.

C. Concrete Aggregates:

1. Coarse and Fine Aggregates: ASTM C33; Stone aggregate and sand. Specific source aggregate and/or sand or shrinkage characteristics as required for class of concrete specified.

2. Lightweight aggregate: ASTM C330 and C332.

3. Source shall remain constant throughout the duration of the job. The exact portions of the fine aggregates and coarse aggregates to be used in the mix shall be determined by the mix design.

4. Aggregate size shall conform to grading requirements of appropriate ASTM Standards and ACI 318.

D. 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.

1. Products offered by manufacturers to comply with the above requirements include: A-H Alox; Anti-Hydro Waterproofing Co., Toxgrip; Toch Div. - Carboline, or approved equal.

E. Expansion Joint Filler:

1. Joint fill shall be a preformed non-extruded resilient filler, saturated with bituminous materials and conforming to ASTM D 1751. Products shall be equivalent to Burke "Fiber Expansion Joint", W.R. Meadows "Fibrated Expansion Joint Filler", or approved equal.

F. Concrete Sealer:

1. Cure and Seal, as manufactured by the Euclid Chemical Company "Aqua-Cure VOX", Sonneborn "Kure-N-Seal WB", Burke "Spartan-Cote",W.R. Meadows "Intex" or approved equal conforming to ASTM C-309, Type I, Class B requirements, and conforming to State of California Air Resources Board VOC Regulations.

G. Concrete Hardener/Sealer:

1. Clear, water soluble, sprayable in-organic silicate based hardener/sealer or acrylic co-polymer resin. Products shall be equal to Euclid Chemical Company "Eucosil", Burke "Spartan-Cote", Sonneborn "Sonosil", W.R. Meadows "Pena-Lith", or

approved equal and must conform to State of California Air Resources Board VOC Regulations.

H. Concrete Cure:

1. Water based curing compound conforming to ASTM C-309, Type 1, Class A and B, and AASHTO Specification M-148; Type 1, Class A and B requirements, and State of California Air Resources Board VOC Regulations. Product shall be equivalent to Euclid Chemical Company "Kurez VOX", Burke "No. 1127" or "Aqua-Resin Cure", W.R. Meadows "1100 Clear", or approved equal.

I. Non-Shrink Grout: See Specification 05 12 00 Structural and Miscellaneous Steel, Section 2.03 Accessories for steel plates.

J. Water:

1. Potable, clean and free from injurious amounts of oil, acids, alkali, organic matter and other deleterious substances; suitable for domestic consumption.

K. Sand:

1. Clean, dry, well graded.

L. Admixtures: All admixtures shall be used in strict accordance with the manufacturer's recommendations. Admixtures containing calcium chlorides or other accelerators shall not be used without the approval of the Architect/Engineer and the Owner's Testing Laboratory.

1. Water Reducing

a. ASTM C494 Type D - for use in hot weather.

b. ASTM C494 Type A - for use in cool weather.

2. Air Entraining

a. Conform to ASTM C 260.

3. Fly Ash

a. Conform to ASTM C 618

4. Mid-Range Water-Reducers

a. Master Builders “Polyheed” or approved equal.

M. Slurry: Same proportion of cement to fine aggregates used in the regular concrete mix (i.e. only coarse aggregate omitted); well mixed with water to produce a thick consistency.

N. Non-shrink Grout: non-metallic, flowable Type "713" or "928" by Master Builders or approved equal.

1. Metallic grout equivalent to Master Builders "Embeco" may be used only where covered by earth, concrete, or masonry.

2. Acceptance by Architect required before using.

2.04 ACCESSORIES

A. Bonding Agent: ASTM C 1059, Type II acrylic non-redispersable type.

1. Bonding Agent: Sonneborn "Sonobond"; the Euclid Chemical Company "Euco-Weld"; Larsen Products Corp., "Weld-Crete" or approved equivalent.

B. Epoxy Bonding System: ASTM C 881, type as required by project conditions.

C. Moisture-Retaining Cover: ASTM C 171, type 1.

D. Slab on Grade Vapor Retarder

1. Vapor Barrier must have the following qualities

a. 15 mil thickness minimum

b. WVTR less than 0.008 as tested by ASTM F1249

c. Puncture Resistance: 2266 grams as tested by ASTM D1709

d. Tensile Strength: 70.6 pounds per inch as tested by ASTM D882

e. ASTM E 1745 Class A (Plastics)

2. Vapor Retarder Products

a. Stego Wrap Vapor Barrier by STEGO INDUSTRIES LLC. or approved equal.

b. W.R. Meadows Permintor Membrane or approved equal.

c. Underseal Underslab by Polyguard or approved equal.

3. Vapor Retarder Tape

a. Water Vapor Transmission Rate :ASTM E 96, 0.3 perms or lower

b. Minimum 8-mils thick

c. Minimum 4 inches wide

d. Manufactured from High Density Polyethylene

e. Pressure Sensitive Adhesive

E. Evaporation Reducer: By approved submittal.

F. Permeability Reducer: Use only where specifically referred to by specification.

2.05 JOINT DEVICES AND MATERIALS

A. Waterstops: Resilient type, COE CRD-C513.

B. Expansion Joint Filler: ASTM D 1751, Non-extruding, resilient asphalt impregnated fiberboard or felt, 3/8 inch thick and 4 inches deep; tongue and groove profile.

C. Joint Filler: ASTM D 2475, Felt.

D. Sealants: As specified in Section 07 92 00 Joint Sealants.

E. Slab Joint Sealant: Compatible with floor finishes specified in related sections.

2.06 CONCRETE MIXES

A. General Requirements for Mix Design and Submittal:

1. Mix design(s) for all structural classes of concrete to be prepared by qualified Civil Engineer. Allow for time necessary to do trial batch testing when required.

2. Certification of Mix Design: Preparer to certify in writing that mix design meets:

a. Requirements of the specifications for concrete durability and quality.

b. Requirements of the California Building Code and ACI 318, Chapter 26 including a historical background for designs based on field experience.

3. Clearly note on mix designs with specified maximum WCR if design permits addition of water on site, or clearly identify in the mix design that no water is to be added on site.

B. Proportioning - General: The following provisions apply to all Mix Designs:

1. Proportion concrete mixes to produce concrete of required average strength (as defined by the California Building Code, Chapter 19A and ACI 318.

2. Select aggregate size and type to produce dense, uniform concrete with low to moderate shrinkage, free from rock pockets, honeycomb and other irregularities.

3. Cement Content: Minimum cement content indicates minimum sacks of cementitious material. Increasing cement content to increase early strengths or to achieve specified WCR while maintaining water content is discouraged in order to minimize effects of shrinkage.

a. Substitution of Fly Ash for Portland cement on an equivalent weight basis up to 15% replacement is permitted without special review. Replacement in excess of 15% is encouraged as part of a specified mix design that has been submitted for review.

b. Substitution requests not specified must be approved by the Engineer.

4. Water Content: Mix designs with a specified maximum Water Cement Ratio (WCR) may be designed with a lower WCR than specified in order to allow addition of water at the site. Batch plant to site travel time is to be accounted for.

5. Concrete Strength: Establish required average strength for each type of concrete on the basis of field experience or trial mixtures, as specified in ACI 301 and this section.

6. Placement Options: Mix Designs may, at the Contractor's option, be designed for either pump or conventional placement with aggregate size, slumps, etc. to be maintained as specified in this section.

C. Proportioning Normal Weight Concrete: Comply with ACI 211.1 recommendations and this section.

D. Proportioning Structural Lightweight Concrete: Comply with ACI 211.2 recommendations and this section.

E. Special mix design requirements for interior concrete floor slabs on grade to receive floor coverings shall be made to reduce permeability of concrete.

F. Type A Concrete

1. Strength: 3000 lbs. per square inch minimum at 28 days.

2. Maximum Aggregate Size: 1-1/2 inch.

3. Cement Content: As determined by mix design (ACI 318 Chapter 26).

4. 5.0 sacks per yard minimum.

5. Maximum Water to Cement Ratio: 0.45.

6. Admixture: Water Reducing.

7. Weight: 145 lbs. per cubic foot.

8. Use: Unexposed foundation concrete except as otherwise specified. At Contractor's option, Type B concrete may be substituted for this.

G. Type B Concrete

1. Strength: 3500 lbs. per square inch minimum at 28 days.

2. Maximum Aggregate Size: 1 inch.

3. Minimum Cement Content: As determined by mix design. (ACI 318 Chapter 26) 5.5 sacks per yard minimum.

4. Maximum Water to Cement Ratio: 0.45.

5. Admixture: Water reducing.

6. Weight: 145 lbs. per cubic foot.

7. Use: Building slab on grade.

8. Maximum Fly Ash content as a percentage of total cementitious material: 15%.

H. Type C-1 Concrete

1. Strength: 4000 lbs. per square inch minimum at 28 days.

2. Maximum Aggregate Size: 1 inch.

3. Minimum Cement Content: As required by mix design (ACI 318 Chapter 26).

4. 6.5 sacks per yard minimum.

5. Maximum Water to Cement Ratio: 0.45

6. Admixture: Water reducing.

7. Weight:145 lbs. per cubic foot.

8. Use: Slab on grade at auto lift area.

I. Type C-2 Concrete

1. Strength: 4500 lbs. per square inch minimum at 28 days.

2. Maximum Aggregate Size: 1 ½ inch.

3. Minimum Cement Content: As required by mix design (ACI 318 Chapter 26).

4. 6.5 sacks per yard minimum.

5. Maximum Water to Cement Ratio: 0.45

6. Admixture: Water reducing.

7. Weight:145 lbs. per cubic foot.

8. Use: Exposed and unexposed foundations at solar canopies.

J. Type D Concrete

1. Strength: 2500 lbs. per square inch minimum at 28 days.

2. Maximum Aggregate Size: 1 inch.

3. Minimum Cement Content: 5 sacks per cubic yard.

4. Maximum Water to Cement Ratio: 0.60.

5. Admixture: Water reducing.

6. Weight: 145 lbs. per cubic foot.

7. Use: Concrete sidewalks, mechanical and electrical pads, miscellaneous non-structural slabs on grade.

2.07 MIXING CONCRETE

A. Consistency of Concrete: Concrete slump, measured in accordance with ASTM C 143.

B. Mix Design:

1. Initial mix design and mix proportions shall be prepared and determined for all concrete in accordance with ACI 318 Chapter 26.

C. Mixing:

1. Equipment: All concrete shall be machine mixed. Provide adequate equipment and facilities for accurate measurement and control of materials.

2. Method of Mixing:

a. Transit Mixing: Comply with ASTM C 94. Ready mixed concrete shall be used throughout, except as specified below.

b. On-Site Mixing: Use only if method of storing material, mixing of material and type of mixing equipment is approved in writing by the Structural Engineer of Record. Approval of site mixing does not relieve Contractor of any other requirements of Specifications.

c. Mixing shall be in accordance with ACI 318 Chapter 26.

D. Batch final proportions in accordance with approved mix designs. All adjustments to approved proportions, for whatever reason, shall be reviewed by the Architect / Engineer prior to use.

E. Batch and mix concrete in accordance with ASTM C-94, at an established plant.

2.08 SOURCE QUALITY CONTROL

A. Services by independent Testing Agency:

1. Test aggregates per CBC, Section 1903A and 1705A.3.2.

2. Test cement per CBC Section 1903A and 1705A.3.2.

3. Batch Plant inspection is required. See requirements of CBC Section 1705A.3.3.

4. Batch Plant Certificates: Obtain the weigh master's Batch Plant Certificate at arrival of truck at the site. See requirements of CBC Section 1705A.3.3.1.

2.09 FLOOR LEVELING AND FILL MATERIALS

A. Epoxy Concrete Mortar: Floor leveling, non-shrink trowel applied epoxy concrete mortar; TPM 115 General Polymers Corp., A-H Emery Epoxy Topping #170 Anti-Hydro Corp., or approved equal, where areas to fill are less than 1/4 inch thick.

B. Concrete Mortar: Floor leveling, patching and repair, non-shrink trowel applied concrete mortar; Master Builders EMBECO 411-A, Euclid EUCO, or approved equal, where areas of fill are greater than 1/4 inch thick.

C. 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. Material shall be equal to Quickrete No. 1249, Ardex V-800/K-55, Mapei "Ultra/Flex" or approved equal.

PART 3 - EXECUTION

3.01 EXAMINATION

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

B. Verify work of other sections is complete and tested as required before proceeding.

3.02 PREPARATION

A. Observation, Inspection and Testing:

1. Architect/Engineer: Notify before each concrete placement, for observation and review of reinforcing, forms, and other work prior to placement of concrete.
2. Testing Agency: Notify before each placement for inspection and testing.

B. Placement Records: Contractor shall maintain records of time, temperature and date of concrete placement including mix design and location in the structure. Retain records until completion of the contract. Make available for review by Testing Agency and Architect/Engineer.

C. Clean and Prepare site and formwork.

D. Different types of concrete shall not be at the job site at the same time.

3.03 PIPES AND CONDUITS IN CONCRETE

A. Slabs-On-Grade:

1. Do not exceed maximum pipe or conduit diameter, as indicated on the construction documents, embedded within the specified slab thickness.
2. Do not stack or abut pipes, maintain minimum clearance and spacing, as indicated on the construction documents.

B. Sleeving and Wrapping:

1. Foundations and Slabs or Curbs: Sleeve or wrap all individual pipe and conduit penetrations

   a. Sleeves: Provide minimum clear all around to reinforcing.

   b. Wrapped pipes Provide sheet foam with minimum wraps.

C. Space groups of pipes/conduits to meet minimum requirements as indicated on the construction documents.

3.04 CONCRETE PLACEMENT

A. Before any concrete is placed, the following items of work shall have been completed in the area of placing.

1. Forms shall have been erected, adequately braced, cleaned, sealed, lubricated if required, and bulkheaded where placing is to stop.
2. Any wood forms other than plywood shall be thoroughly water soaked before placing any concrete. The wetting of forms shall be started at least 12 hours before concreting.

3. Reinforcing steel shall have been placed, tied and supported.
4. Embedded work of all trades shall be in place in the forms and adequately tied and braced.
5. 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.
6. Reinforcing steel, at the time the concrete is placed around it, shall be cleaned of scale, mill scale or other contaminants that will destroy or reduce bond.
7. 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.
8. 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.
9. 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. Notify Architect and State's Inspector 48 hours in advance of concrete pour.

B. Placement - General: Placement, once started, shall be carried on as a continuous operation until section of approved size and shape is completed.

1. Interruptions: Shut down placement operations and dispose of all remaining mixed concrete and concrete in hoppers or mixers following interruption in placement.

C. Consolidation:

1. Consolidate all concrete thoroughly during placement with high-speed mechanical vibrators and other suitable tools.

3.05 CONCRETE SLABS ON GRADE

A. Exterior concrete slabs on grade shall be poured as required under this Section. Base shall be accurately leveled and compacted prior to placing of concrete.

B. Typically, interior slabs on grade shall be poured over a vapor barrier and over a minimum of four (4 inch) inches, unless otherwise indicated, of compacted crushed rock.

C. If sand is indicated on the structural drawings, place over the vapor barrier, otherwise, provide no sand layer.

3.06 VAPOR BARRIER AND RETARDER

A. Install vapor barrier as specified and per manufacturer's recommendations.

B. Vapor Retarder installation shall be in accordance with manufacturer's instructions and ASTM E 1643.

3.07 CONCRETE JOINTS

A. Structural Joints (Construction/Cold Joints):

1. Locate joints only where shown and as specified on construction documents.

2. 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. See drawings for doweling and required keys.

B. Expansion/Construction Joints (Dowel Joints and Control Joints):

1. Exterior Concrete Paving (walkways, patios) and other non-structural concrete flatwork at grade as specified.

2. Interior and Exterior Floor Slabs at Grade: Provide dowel joints or control joints at less than maximum dimension specified.

3. Unless otherwise indicated, use 3/8 inch thick expansion joint filler.

C. Joint Types:

1. Dowel Joint: A keyed joint with smooth dowels passing through to allow unrestricted movement due to contraction and expansion. Joints are as shown.

2. Control Joint(s): Shrinkage crack control joints as shown.

a. Joints shall be in locations indicated on Drawings, or as directed by the Structural Engineer of Record.

D. Score markings on exterior slabs on grade shall be marked slabs into rectangles of not less than 12 square feet nor more than 20 square feet using a scoring tool which will leave edges of score markings rounded.

3.08 FLATWORK

A. General Requirements for All Concrete Formed & Finished Flat:

1. Edge Forms and Screeds: Set accurately to produce indicated design elevations and contours in the finished surface, edge forms sufficiently strong to support screed type proposed.

2. Jointing: Located and detailed as indicated.

3. Consolidation: Concrete in slabs shall be thoroughly consolidated.

3.09 FORMED SURFACES

A. Form all concrete members level and plumb, except as specifically indicated.

1. Comply with tolerances specified in ACI 301 Chapter 4 and this specification, except that maximum permissible deviation is 1/4 inch end-to-end for any single member.

B. Cambers: Provide all cambers indicated in the formwork construction.

3.10 CONCRETE FINISHES

A. Flatwork Finishing:

1. Perform with experienced operators.

2. Finish surfaces monolithically. Establish uniform slopes or level grades. Maintain full design thickness.

3. In areas with floor drains, maintain design floor elevation at walls; slope surfaces uniformly to drains, minimum pitch as possible. 1:50 max.

B. Other Concrete: Provide as required to achieve appearance indicated in the FDP and other sections when applicable.

3.11 PATCHING

A. Formed Surfaces:

1. Promptly upon removal of contact forms and after concrete surfaces have been inspected, form ties shall be removed and all necessary patching and pointing shall be expertly done.

2. 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.

3. Tie holes shall be cleaned, dampened and filled solid with patching mortar or cement plugs of an approved variety.

B. Slabs on Grade:

1. After entire slab is finished, shrinkage cracks that may appear shall be patched as follows:

2. 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.

3. Where slab is exposed and appearance is important, unsightly cracks shall be repaired in a manner satisfactory in appearance to Architect and the State. If this cannot be accomplished, concrete shall be considered defective.

4. Where slab is polished, cracks shall be filled with an epoxy material compatible with the grinding and polishing process and of a consistent color and gloss when work is complete.

3.12 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, exposed reinforcing to extent that strength, durability, or appearance is adversely affected.

3. Concrete significantly out of place, line, or level.

4. Concrete not containing the required embedded items.

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 and State's Inspector.

b. Cost of core sampling and testing will be paid for by the Contractor.

c. "85 percent" reduction in ACI 318 Chapter 26.12.4.1 (d) 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 and State's Inspector, 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 State.

E. No repair work shall begin until procedure has been reviewed by the Architect, State's Inspector, and Structural Engineer.

3.13 TOLERANCES

A. Minimum Flatwork Tolerances: Measure flatness of slabs within 48 hours after slab installation in accordance with ACI 302.1R and ASTM E1155 and to achieve the FF and FL tolerances specified.

B. Formed Surface Tolerances:

1. Permanently Exposed Joints and Surfaces: Provide maximum differential height within two feet of, and across construction joints of 1/16 inch.

2. Vertical Elevations: Per elevations established for project.

3.14 SEPARATE FLOOR TOPPINGS

A. Prior to placing floor topping, roughen substrate concrete surface and remove deleterious material.

3.15 CONCRETE CURING

A. Curing - General: Cure in accordance with ACI 308R. Maintain concrete water content for proper hydration and minimize temperature variations. Begin curing immediately following finishing.

3.16 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.

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.

3.17 GROUTING AND DRY PACK

A. Set steel plates on concrete or masonry with grout bed, completely fill all voids; thoroughly compact in place.

B. Bolts or inserts dry packed or grouted in place shall cure before tensioning.

3.18 FIELD QUALITY CONTROL

A. Testing and Inspections by Independent Testing Agency: Provide verification and inspection of concrete per CBC Table 1705A.3. Provide written reports to the Structural Engineer, Architect, Contractor and State's Representative.

3.19 ADJUSTING

A. Inspect all concrete surfaces immediately upon formwork removal. Notify Architect/Engineer of identified minor defects. Repair all minor defects as directed.

3.20 DEFECTIVE CONCRETE

A. Concrete not conforming to required compressive strength, lines, details, dimensions, tolerances, finishes or specified requirements; as determined by the Architect/Engineer.

3.21 CLEANING

A. Maintain site free of debris and rubbish. Remove all materials and apparatus from the premises and streets at completion of work. Remove all drippings, leave the entire work clean and free of debris.

B. Slabs to Receive Floor Finishes Specified in other sections: Remove non-compatible cure/sealers or other foreign material(s) which may affect bonding of subsequent finishes. Leave in condition to receive work of related sections.

3.22 PROTECTION

A. Protect completed work from damage until project is complete and accepted by Owner.

B. Construction Loads: Submit engineering analysis for equipment.

END OF SECTION

SECTION 13 34 00

COMMUNICATIONS TOWER

PART 1 - GENERAL

1.01 DESCRIPTION

A. Work Included:

1. Self-Supporting Communications Tower and foundation.
2. Self-Supporting Feedline (waveguide) bridge and foundation.
3. Federal Aviation Administration (FAA) Permits, when applicable.

B. Related Documents:

1. Section 03 30 00: Cast-in-Place Concrete
2. Section 03 21 00: Reinforcing Steel

C. Work Included Elsewhere in RFP:

1. Federal Communications Commission (FCC) and Federal Aviation Administration (FAA) submittals and permits. (Contractor is responsible to apply for, coordinate, pay for and obtain any and all required approvals, permits, registrations, etc., unless otherwise noted).

1.02 INFORMATIONAL SUBMITTALS - DESIGN

A. Provide submittals in accordance with Section 01 33 00.

1. All submittals shall be submitted as an informational submittal to the Department of General Services (DGS) and separately for review and approval directly to the California Division of the State Architect (DSA). The Contractor shall pay for all applicable DSA review fees. CHP/DGS acceptance and DSA approval shall be obtained prior to the start of any factory tower fabrication.

B. Provide a complete submittal package for the tower design.

C. Each tower design submittal shall include the following:

1. Calculations. Provide all calculations in hard copy with detailed table of contents listing all calculations. Logically organize all calculations. The design criteria, design assumptions, design calculations, software input and output data and manufacturers cut sheets shall be included.
   a. Provide Adobe Acrobat PDF indexed file of the calculations including cover sheet, table of contents, and calculations. Provide one single PDF file.
2. Drawings – Design and Installation. Provide three sets of full size hard copies, stamped and signed by a California Structural Engineer for CHP/DGS review. Quantity for DSA as per DSA requirements.

SECTION 03 35 00

CONCRETE FLOOR SEALER

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

A. Volume 1 – Contracting Requirements and Division-01 General Requirements apply to the work of this section.

1.02 SCOPE

A. Provide concrete floor sealer on housekeeping pads, mechanical and electrical rooms, and on floors as indicated on the Room Finish Schedule.

1.03 Related Documents

A. Cast-In-Place Concrete: Section 03 30 00

B. Polished Concrete Flooring: Section 03 35 23

C. Alkalinity & Vapor Control: Section 03 39 50

1.04 SUMMARY

A. This section includes the following:
   1. Concrete Floor Sealers

1.05 ACTION SUBMITTALS

A. Mockup panel for concrete sealer.

1.06 INFORMATIONAL SUBMITTALS

A. Product Data

   1. Submit manufacturer's specifications for each product specified, including physical properties, performance properties, and testing reports. Each individual component of the system will be evaluated on the basis of these standards. For any of the tests not listed in the manufacturer's standard nationally published data, the manufacturer must supply the missing data from an independent test laboratory tested according to the referenced standard.

B. Installation Instructions

C. Maintenance Data

D. Record Drawings

E. Product Warranty

1.07 QUALITY ASSURANCE

A. Installer Qualifications

1. Installation shall be performed by a concrete floor sealer specialist with skilled mechanics having not less than three (3) years of satisfactory experience in the application of the type and complexity of system as specified in this section. The concrete floor sealer specialist shall be approved in writing by the manufacturer of the concrete floor sealer.

B. Manufacturer Qualifications

1. Materials to be obtained from a single manufacturer.

C. Performance

1. Non-toxic, non-combustible, and non-flammable. Shall not harm lungs or hands. Shall comply with all V.O.C. regulations in effect at the time of manufacture.

a. Technical Properties: Materials to be colorless, transparent, penetrating liquid containing no silicones and be highly resistant to oils, greases and acids.

2. Abrasion – Taber Abrasion Test: 30.7% increase in abrasion resistance.

3. Bonding – per ASTM D3359: 17% increase in epoxy adhesion. No change for polyurethane adhesion.

4. Curing – 94% or greater moisture loss from untreated samples during critical, initial 24 hour curing period.

5. Hardening – per ASTM C42: 40% increase in compressive strength at 7 days, 38% increase at 28 days over untreated samples. ASTM C805, Schmidt hammer: 13.3% increased impact resistance.

6. Permeability – The seepage rate using a 7 inch head of water on a 4.91 square inch area treated was 0.0083cc per hour.

7. Weathering – per ASTM G151: Ultraviolet light and water spray exposure had no adverse effect.

8. Concrete used as finish floor is required to be slip-resistant (per 11B-302.1).

D. Furnish manufacturer's standard warranty of the concrete floor sealer for a period of twenty (20) years following Acceptance of the work.

PART 2 - PRODUCTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. "Ashford Formula" by Curecrete Chemical Company

2. “Seal Hard” by L & M Construction Chemicals

3. “Euco Diamond Hard” by The Euclid Chemical Company

4. Or approved equal.

PART 3 - EXECUTION

A. Installation

1. Mechanically clean the concrete to remove contaminants, form oils, bond breakers, and staining from the wet cure operation. All cleaning compounds shall be removed in their entirety and the concrete surface shall be neutralized.

2. First Application

a. As soon as possible after curing cover removal, spray product with a low pressure sprayer at a rate of 200-250 square feet per gallon.

b. Keep the entire surface wet for 30 to 40 minutes by re-spraying dry spots or moving material from wet areas to dry areas with nylon push brooms.

c. When the wet product becomes slippery underfoot, lightly sprinkle the surface with water to aid penetration and prevent surface drying.

d. As the product begins to dry into the surface and again becomes slippery underfoot, flush the surface with water and squeegee the surface dry, removing all excess product, water, alkali and other impurities from the surface.

e. Coordinate with manufacturer for application requirements at the access flooring areas.

3. Finish Application

a. Apply sealer with a low pressure sprayer or drop sealer with a floor scrubbing machine at 50 – 600 square feet per gallon.

b. Lambs wool or fine bristle broom the sealer evenly across the concrete surface or use a squeegee on the floor scrubbing machine to evenly spread a thin film.

END OF SECTION

SECTION 04 72 00

CAST STONE MASONRY

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

A. Volume 1 – Contracting Requirements and Division-01 General Requirements apply to the work of this section.

1.02 SCOPE

A. Provide all materials, labor and accessories as required and specified for complete cast Stone Masonry Trim Installation for Masonry Walls.

1.03 RELATED DOCUMENTS

A. Reinforcing Steel: Section 03 21 00

B. Cast-In-Place Concrete: Section03 30 00

C. Mortar and Grout: Section04 05 00

D. Concrete Unit Masonry: Section 04 20 00

1.04 SUMMARY

A. This section Includes the following:

1. Cast stone trim (i.e. units) including the following:

   a. Wall caps.

   b. Pilaster caps.

   c. Column caps.

   d. Window sills.

1.05 ACTION SUBMITTALS

A. Samples for Initial Selection: For colored mortar coordinate with Section 04 05 00.

B. Samples for Verification:

1. For each color and texture of cast stone unit required, 10 inches square in size.

2. For colored mortar. Make Samples using same sand and mortar ingredients to be used on Project. Refer to Section 04 05 00.

C. Full-Size Samples: For each color texture and shape of cast stone unit required.

1. Make available for State's review at Project site.

2. Make Samples from materials to be used for units used on Project immediately before beginning production of units for Project.

3. State approved Samples may be installed in the Work.

1.06 INFORMATION SUBMITTALS

A. Qualification Data: For manufacturer and testing agency.

1. Include copies of material test reports for completed projects, indicating compliance of cast stone with ASTM C 1364.

B. Material Test Reports: For each mix required to produce cast stone, based on testing according to ASTM C 1364, including test for resistance to freezing and thawing.

1. Provide test reports based on testing within previous two years.

C. Product Data: For each type of product indicated.

1. For cast stone units, include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

D. Shop Drawings: Show fabrication and installation details for cast stone units. Include dimensions, details of reinforcement and anchorages if any, and indication of finished faces.

1. Include building elevations showing layout of units and locations of joints and anchors.

1.07 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer of cast stone units similar to those indicated for this Project that has sufficient production capacity to manufacture required units, and is a plant certified by the Architectural Precast Association.

B. All tests shall be performed by a DSA approved laboratory as specified in pertinent sections of Division 01 and CBC Chapters 22A and 21A.

C. Source Limitations for Cast Stone Units: Obtain cast stone units through single source from single manufacturer.

D. Source Limitations for Mortar Materials: Obtain mortar ingredients of a uniform quality, including color, from one manufacturer for each cementitious component and from one source or producer for each aggregate.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Coordinate delivery of cast stone units with concrete unit masonry work to avoid delaying the Work and to minimize the need for on-site storage.

B. Pack, handle, and ship cast stone units in suitable packs or pallets.

1. Lift with wide-belt slings; do not use wire rope or ropes that might cause staining. Move cast stone units, if required, using dollies with wood supports.

2. Store cast stone units on wood skids or pallets with nonstaining, waterproof covers, securely tied. Arrange to distribute weight evenly and to prevent damage to units. Ventilate under covers to prevent condensation.

C. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.

D. Store mortar aggregates where grading and other required characteristics can be maintained and contamination can be avoided.

1.09 PROJECT CONDITIONS

A. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Comply with cold-weather construction requirements in TMS 602-16/ACI 530.1-16/ASCE 6-16.

1. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is 40 degrees F and above and will remain so until cast stone has dried, but no fewer than seven days after completing cleaning.

B. Hot-Weather Requirements: Comply with hot-weather construction requirements in TMS 602-16/ACI 530.1-16/ASCE 6-16.

PART 2 - PRODUCTS

2.01 CAST STONE MATERIALS

A. General: Comply with ASTM C 1364 and the following:

B. Portland Cement: ASTM C 150, Type I or Type III, containing not more than 0.60 percent total alkali when tested according to ASTM C 114. Provide natural color or white cement as required to produce cast stone color indicated.

C. Coarse Aggregates: Granite, quartz, or limestone complying with ASTM C 33; gradation and colors as needed to produce required cast stone textures and colors.

D. Fine Aggregates: Natural sand or crushed stone complying with ASTM C 33, gradation and colors as needed to produce required cast stone textures and colors.

E. Color Pigment: ASTM C 979, synthetic mineral-oxide pigments or colored water-reducing admixtures; color stable, free of carbon black, nonfading, and resistant to lime and other alkalis.

F. Admixtures: Use only admixtures specified or approved in writing by Architect.

1. Do not use admixtures that contain more than 0.1 percent water-soluble chloride ions by mass of cementitious materials. Do not use admixtures containing calcium chloride.

2. Use only admixtures that are certified by manufacturer to be compatible with cement and other admixtures used.

3. Air-Entraining Admixture: ASTM C 260. Add to mixes for units exposed to the exterior at manufacturer's prescribed rate to result in an air content of 4 to 6 percent, except do not add to zero-slump concrete mixes.

4. Water-Reducing Admixture: ASTM C 494, Type A.

5. Water-Reducing, Retarding Admixture: ASTM C 494, Type D.

6. Water-Reducing, Accelerating Admixture: ASTM C 494, Type E.

G. Reinforcement: Deformed steel bars complying with ASTM A 615, Grade 60. Use galvanized or epoxy-coated reinforcement when covered with less than 1-1/2 inches of cast stone material. Coordinate with Section 03 21 00.

1. Epoxy Coating: ASTM A 775.

2. Galvanized Coating: ASTM A 767.

H. Embedded Anchors and Other Inserts: Fabricated from steel complying with ASTM A 36, and hot-dip galvanized to comply with ASTM A 123.

2.02 CAST STONE UNITS

A. Manufacturers: Subject to compliance with requirements.

B. Provide cast stone units complying with ASTM C 1364 using either the vibrant dry tamp or wet-cast method.

1. Provide units that are resistant to freezing and thawing as determined by laboratory testing according to ASTM C 666, Procedure A, as modified by ASTM C 1364.

C. Fabricate cast stone units with sharp arris and accurately reproduced details, with indicated texture on all exposed surfaces unless otherwise indicated.

1. Slope exposed horizontal surfaces 1:12 to drain unless otherwise indicated.

2. Provide drips on projecting elements unless otherwise indicated.

D. Fabrication Tolerances for cast stone units:

1. Variation in Cross Section: Do not vary from indicated dimensions by more than 1/8 inch.

2. Variation in Length: Do not vary from indicated dimensions by more than 1/360 of the length of unit or 1/8 inch, whichever is greater, but in no case by more than 1/4 inch.

3. Warp, Bow, and Twist: Not to exceed 1/360 of the length of unit or 1/8 inch, whichever is greater.

4. Location of Grooves, False Joints, Holes, Anchorages, and Similar Features: Do not vary from indicated position by more than 1/8 inch on formed surfaces of units and 3/8 inch on unformed surfaces.

E. Cure cast stone units as follows:

1. Cure cast stone units in enclosed moist curing room at 95 to 100 percent relative humidity and temperature of 100 deg F for 12 hours or 70 deg F for 16 hours.

2. Keep cast stone units damp and continue curing to comply with one of the following:

a. No fewer than five days at mean daily temperature of 70 deg F or above.

b. No fewer than six days at mean daily temperature of 60 deg F or above.

c. No fewer than seven days at mean daily temperature of 50 deg F or above.

d. No fewer than eight days at mean daily temperature of 45 deg F or above.

F. Acid etch cast stone units after curing to remove cement film from surfaces to be exposed to view.

G. Colors and Textures: As selected by State from manufacturer's full range.

2.03 MORTAR MATERIALS

A. Provide mortar materials that comply with Section 04 05 00 Mortar and Grout unless otherwise indicated in this Section.

B. Portland Cement-Lime Mix: Packaged blend of portland cement and hydrated lime containing no other ingredients.

C. Masonry Cement: ASTM C 91.

D. Mortar Cement: ASTM C 1329.

E. Mortar Pigments: Natural and synthetic iron oxides and chromium oxides, compounded for use in mortar mixes and complying with ASTM C 979. Use only pigments with a record of satisfactory performance in masonry mortar.

F. Colored Cement Product: Packaged blend made from portland cement and hydrated lime and mortar pigments, all complying with specified requirements and containing no other ingredients.

1. Formulate blend as required to produce color indicated or, if not indicated, as selected from manufacturer's standard colors.

2. Pigments shall not exceed 10 percent of portland cement by weight.

G. Aggregate for Mortar: ASTM C 144.

1. For mortar that is exposed to view, use washed aggregate consisting of natural sand or crushed stone.

2. For joints less than 1/4 inch thick, use aggregate graded with 100 percent passing the No. 16 sieve.

3. Colored-Mortar Aggregates: Natural sand or crushed stone of color necessary to produce required mortar color.

2.04 ACCESSORIES

A. Anchors: Type and size indicated, fabricated from steel complying with ASTM A 36, and hot-dip galvanized to comply with ASTM A 123.

B. Dowels: 1/2-inch diameter, round bars, fabricated from steel complying with ASTM A 36, and hot-dip galvanized to comply with ASTM A 123.

C. Proprietary Acidic Cleaner: Manufacturer's standard-strength cleaner designed for removing mortar/grout stains, efflorescence, and other new construction stains from new masonry without discoloring or damaging masonry surfaces. Use product expressly approved for intended use by cast stone manufacturer and expressly approved by cleaner manufacturer for use on cast stone and adjacent masonry materials.

2.05 MORTAR MIXES

A. Comply with requirements in Section 04 05 00 Mortar and Grout for mortar mixes unless otherwise indicated in this section.

B. Do not use admixtures including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures unless otherwise indicated.

1. Do not use calcium chloride in mortar or grout.

2. Use portland cement-lime mortar unless otherwise indicated.

C. Comply with ASTM C 270, Proportion Specification.

1. For setting mortar, use Type S.

2. For pointing mortar, use Type N.

D. Pigmented Mortar: Use colored cement product.

1. Pigments shall not exceed 10 percent of portland cement by weight.

2. Mix to match State's sample.

3. Application: Use pigmented mortar for exposed mortar joints.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 SETTING CAST STONE UNITS IN MORTAR

A. Install cast stone units to comply with requirements in Section 04 20 00 Concrete Unit Masonry.

B. Set cast stone units as indicated on Drawings. Set cast stone units accurately in locations indicated with edges and faces aligned according to established relationships and indicated tolerances.

1. Install anchors, supports, fasteners, and other attachments indicated or necessary to secure units in place.

2. Coordinate installation of cast stone units with installation of flashing specified in other Sections.

C. Wet joint surfaces thoroughly before applying mortar or setting in mortar.

D. Set cast stone units in full bed of mortar with full head joints unless otherwise indicated.

1. Set units with joints 1/4 to 3/8 inch wide unless otherwise indicated.

2. Build anchors and ties into mortar joints as units are set.

3. Fill dowel holes and anchor slots with mortar.

4. Fill collar joints solid as units are set.

5. Build concealed flashing into mortar joints as units are set.

6. Keep head joints in coping and other units with exposed horizontal surfaces open to receive sealant.

7. Keep joints at shelf angles open to receive sealant.

E. Rake out joints for pointing with mortar to depths of not less than 3/4 inch. Rake joints to uniform depths with square bottoms and clean sides. Scrub faces of units to remove excess mortar as joints are raked.

F. Point mortar joints by placing and compacting mortar in layers not greater than 3/8 inch. Compact each layer thoroughly and allow it to become thumbprint hard before applying next layer.

G. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness unless otherwise indicated.

H. Provide sealant joints at copings and other horizontal surfaces, at expansion, control, and pressure-relieving joints, and at locations indicated.

1. Keep joints free of mortar and other rigid materials.

2. Build in compressible foam-plastic joint fillers where indicated.

3. Form joint of width indicated, but not less than 3/8 inch.

4. Prime cast stone surfaces to receive sealant and install compressible backer rod in joints before applying sealant unless otherwise indicated.

5. Prepare and apply sealant of type and at locations indicated to comply with applicable requirements in Section 07 92 00 "Joint Sealants."

3.03 SETTING ANCHORED CAST STONE UNITS WITH SEALANT-FILLED JOINTS

A. Set cast stone units as indicated on Drawings. Set cast stone units accurately in locations indicated with edges and faces aligned according to established relationships and indicated tolerances.

1. Install anchors, supports, fasteners, and other attachments indicated or necessary to secure units in place.

2. Shim and adjust anchors, supports, and accessories to set cast stone in locations indicated with uniform joints.

B. Keep cavities open where unfilled space is indicated between back of cast stone units and backup wall; do not fill cavities with mortar or grout.

C. Fill anchor holes with sealant.

1. Where dowel holes occur at pressure-relieving joints, provide compressible material at ends of dowels.

D. Set cast stone units supported on clip or continuous angles on resilient setting shims. Use material of thickness required to maintain uniform joint widths. Hold shims back from face of cast stone a distance at least equal to width of joint.

E. Keep joints free of mortar and other rigid materials. Remove temporary shims and spacers from joints after anchors and supports are secured in place and cast stone

units are anchored. Do not begin sealant installation until temporary shims and spacers are removed.

1. Form open joint of width indicated, but not less than 3/8 inch.

F. In joints before applying sealant unless otherwise indicated.

G. Prepare and apply sealant of type and at locations indicated to comply with applicable requirements in Section 07 92 00 "Joint Sealants."

3.04 INSTALLATION TOLERANCES

A. Variation from Plumb: Do not exceed 1/8 inch in 10 feet maximum.

B. Variation from Level: Do not exceed 1/8 inch in 10 feet maximum.

C. Variation in Joint Width: Do not vary joint thickness more than 1/8 inch in 36 inches or one-fourth of nominal joint width, whichever is less.

D. Variation in Plane between Adjacent Surfaces (Lipping): Do not vary from flush alignment with adjacent units or adjacent surfaces indicated to be flush with units by more than 1/16 inch, except where variation is due to warpage of units within tolerances specified.

3.05 ADJUSTING AND CLEANING

A. Remove and replace stained and otherwise damaged cast stone units and cast stone units not matching approved Samples. Cast stone units may be repaired if methods and results are approved by Architect.

B. Replace cast stone units in a manner that results in cast stone matching approved Samples, complying with other requirements, and showing no evidence of replacement.

C. In-Progress Cleaning: Clean cast stone units as work progresses.

1. Remove mortar fins and smears before tooling joints.

2. Remove excess sealant immediately, including spills, smears, and spatter.

D. Final Cleaning: After mortar is thoroughly set and cured, clean exposed cast stone units as follows:

1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.

2. Test cleaning methods on sample; leave one sample uncleaned for comparison purposes. Obtain Architect's approval of sample cleaning before proceeding with cleaning of cast stone units.

3. Protect adjacent surfaces from contact with cleaner by covering them with liquid strippable masking agent or polyethylene film and waterproof masking tape.

4. Wet surfaces with water before applying cleaners; remove cleaners promptly by rinsing thoroughly with clear water.

5. Clean cast stone units by bucket-and-brush hand-cleaning method described in BIA Technical Notes 20.

6. Clean cast stone units with proprietary acidic cleaner applied according to manufacturer's written instructions.

END OF SECTION

SECTION 05 12 00

STRUCTURAL AND MISCELLANEOUS STEEL

GENERAL

1.01 GENERAL REQUIREMENTS

A. Volume 1 – Contracting Requirements and Division-01 General Requirements apply to the work of this section.

1.02 SCOPE

A. Provide all materials, labor and accessories as required and specified for complete structural and miscellaneous steel installation.

1.03 RELATED DOCUMENTS:

1. Pertinent sections of Division 01 specifying Quality Control and Testing Agency services.

2. Pertinent Sections of other Divisions specifying concrete reinforcement, formwork, concrete, and rough carpentry.

3. Pertinent Sections of other Divisions specifying structural and miscellaneous steel fabrications, steel joist framing, metal decking, cold-formed metal framing.

1.04 SUMMARY

A. This section Includes the following:

1. Structural steel columns, beams, bracing, base plates, bolts, joist hangers, and stud bolts welded to structural steel.

2. Miscellaneous structural steel and connections; fabricated connectors and hangers installed by related sections.

3. Anchor bolts and steel inserts embedded in concrete or masonry, installed by related sections.

4. Fabricated steel items embedded in concrete or masonry installed by related sections.

5. Supervision of anchor bolt setting, leveling and elevations to insure required fit of steel work.

6. Shop priming and field touch-up, galvanizing.

B. Bracing, Shoring, Fabrication and Erection.

1.05 INFORMATIONAL SUBMITTALS

A. Submit shop drawings of all fabrications.

1. Shop drawings shall include complete details and schedules for fabrication and assembly of structural steel members, procedures, and diagrams.

2. Include details of cuts, connections, camber, holes, and other pertinent data. Indicate welds by standard AWS symbols, and show size, length, and type of each weld.

3. Provide setting drawings, templates, and directions for installation of anchor bolts and other anchorages to be installed by others.

4. 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 Contractor. Contractor shall also coordinate and provide dimensions to locate structural steel for window washing supports such as davits, tie-backs, etc.

B. Procedures:

1. Provide weld procedures for both pre-qualified welds and special welds to be submitted to the Owner's Testing Laboratory and the Architect.

2. Provide installation procedure and inspection for direct tension indicator washers detailed in supplemental specifications provided by the manufacturer for approval.

3. Procedures shall be submitted for both shop and field welds

C. Certifications:

1. Quality Control
2. Steel Materials
   a. Manufacturers Mill Certificates
   b. Mill Test Reports
3. Welders Certificates

D. Product Data: Include laboratory test reports and other data to show compliance with specifications (include specified standards). Include certified copies of mill reports covering chemical and physical properties of each type of structural steel.

1.06 QUALITY ASSURANCE

A. For DSA requirements, refer to pertinent sections of Division 01 and CBC Chapter 22A.

B. All tests shall be performed by a DSA approved laboratory as specified in pertinent sections of Division 01,CBC Chapters 17A and 22A, and the approved form DSA-103.

C. Certification and Identification of Materials and Uses.

1. Provide DSA approved laboratory with access to fabrication plant to facilitate inspection of steel. Provide notification of commencement and duration of shop fabrication in sufficient time to allow inspection and all material identification/test information listed below.

    a. Test all steel as required by ASTM A6.

    b. Provide manufacturer's Mill Test Reports for all materials. Indicate structural strength, destructive test analysis and non-destructive test analysis

2. Manufacturer's Mill Certificate: Certify that products meet or exceed specified requirements.

3. Welders Certificates: Certify welders employed on the Work, verifying AWS qualification.

D. Testing and Inspection:

1. DSA statement of structural tests and special inspections (DSA-103) shall be prepared by the registered design professional in responsible charge.

2. Welding Inspection:

    a. If shop or field welding inspection is indicated on the structural drawings or required by the applicable referenced standards, shop and field welded operations shall be inspected in accordance with AISC 360 by a qualified welding inspector employed by the Testing Laboratory. Such inspector will be a person trained and thoroughly experienced in inspection of welds. The inspector's ability to distinguish between sound and unsound welding will be reliably established

    b. The welding inspector will make a systematic record of all welds. This record shall include:

        1) Identification marks of welders.

        2) List of defective welds.

        3) Manner of correction of defects.

    c. The welding inspector will check the material, equipment and procedure, as well as the welds. He will also check the ability of the welder. He will furnish the Architect with a report, duly verified by him that the welding which is required to be inspected is proper, and has been done in conformity with the Contract Documents, and that he has used all means to determine the quality of the welds.

    d. All full penetration groove welds will be subject to ultrasonic testing, as per AWS D1.1. All defective welds shall be repaired and retested with ultrasonic equipment at the Contractor's expense.

e. 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.

f. 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.

g. The ultrasonic instrumentation will be calibrated by the technician to evaluate the quality of the welds in accordance with AWS D1.1.

h. 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.

i. 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.

j. End-welded studs shall be sampled, tested, and inspected per the requirements of AWS D1.1.

3. High Strength Bolting Tests and Inspection:

a. Furnish certified test reports for each lot of bolts in accordance with ASTM A325 and A490. Install bolts under the supervision of a qualified inspector in accordance with, Research Council "Specifications for Structural Joints using ASTM A325 or A490 Bolts".

b. 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.

c. While the work is in progress, the Inspector shall determine that the requirements of this Specification are met in the work. The Inspector shall observe the calibration procedures and shall monitor the installation of bolts to determine that all plies of connected material have been drawn together and that the selected procedure is properly used to tighten all bolts.

1) In addition to the requirement of the foregoing paragraph, for all connections specified to be slip critical (SC), the Inspector shall assure that the specified procedure was followed to achieve the pretension specified in the AISC. The pretension shall be verified by the inspector for these bolts.

2) Bolts in connections identified as not being slip-critical nor subject to direct tension need not be inspected for bolt tension other than to ensure that the piles of the connected elements have been brought into snug contact.

E. The approved laboratory shall review all submittals and testing of materials per Chapters 17A and 22A of the CBC.

PART 2 - PRODUCTS

2.01 PRODUCT HANDLING

A. Store materials to permit easy access for inspection and identification. Keep steel members off the ground, using pallets, platforms, or other supports. Protect steel members and packaged materials from erosion and deterioration.

B. Do not store materials on structure in a manner that might cause distortion or damage to members or supporting structures. Repair or replace damaged materials or structures as directed.

2.02 MATERIALS

A. Structural Steel W Shapes: ASTM A 992 Grade 50.

B. Structural Steel Plates and Channels ASTM A36 unless indicated otherwise.

C. Angles, plates and bars: ASTM A36 unless indicated otherwise on drawings.

D. Channels and other rolled shapes: ASTM A36 unless indicated otherwise on drawings.

E. AISC group 4 and 5 shapes and plates greater than 2 inches thick: ASTM A36 and/or ASTM A572 Grade 50 with supplementary requirements S91 Fine Austenitic Grain Size and S5 Charpy V-Notch Impact Test. 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° F.

F. HSS (Hollow Structural Sections – formerly SSP & TS):

1. Round: ASTM A-500, Grade C.

2. Rectangular or Square: ASTM A500, Grade C.

G. Cold-Formed Steel Tubing: ASTM A500, Grade B.

H. Steel Pipe: ASTM A53, Type E or S, Grade B.

I. Machine Bolts and Washers: Bearing and Shear connections (denoted as “MB”); ASTM A307. Provide hot-dipped galvanized finish at all connection where steel is required to be galvanized.

J. Anchor Bolts/Rods: ASTM A307 or ASTM A36. All anchor bolts cast in concrete or masonry shall be headed bolts with cut threads conforming to ASTM F1554 grade 36, 55 or 105.

K. High Strength Bolts, Nuts and Washers: Install in accordance with requirements for A325 and A490 slip critical and snug tight conditions as indicated on drawings. Install high strength bolts with snug tight type connections with threads included in shear plane except as otherwise noted. Install hardened washers in conformance with AISC Specifications.

L. Headed Stud-Type Shear Connectors: ASTM A108 Grade 1015 or 1020 Cold-finished carbon steel with dimensions complying with AISC Specifications.

Ultimate Tensile strength, 65,000 psi.

Elongation in 2 inches, 20 percent

Reduction of area, 50 percent.

M. Provide hexagonal heads and nuts for all connections per ASTM A563, Appendix Table X1.1.

N. Electrodes for Welding: Comply with AWS Code, E70 Series minimum. Fabricator to select proper electrodes according to weld procedures as submitted.

O. Powder Driven 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 approved equal.

P. Expansion Bolts: Hilti Fastening Systems “Kwik-Bolt TZ2 Concrete Expansion Anchors” to concrete or approved equal; Hilti Fastening Systems “Kwik-Bolt 3 Masonry Expansion Anchors” to masonry or approved equal.

Q. Arc-Welding Electrodes: AWS Standards E70 or equivalent, except no E70T-4 allowed.

R. Other Welding Materials: AWS D1.1; type required for materials being welded.

S. Utilize material with highest level of recycled content as practical.

2.03 ACCESSORIES

A. Grout: ASTM C 1107, Non-shrink, non-metallic aggregate type, capable of developing minimum compressive strength of 7,000 psi at 28 days.

B. Building Structural Steel Primers:

1. All paints shall meet the California Air Resources Board Standards and be compatible with finish coats specified in other sections. Follow manufacturers printed instructions and application of coats.

2. Type A Material: Modified Alkyd type.

3. Type B Material: Organic Zinc-rich Urethane.

4. Type C Material: MIO-Zinc Filled Primer.

a. Color to be selected by owner.

C. Galvanizing: ASTM A153, and A123.

D. Touch-Up Primer for Galvanized Surfaces: Type B primer.

2.04 FABRICATION

E. Fabricate as specified.

2.05 FINISHES

A. Finish paint Material: Aliphatic Acrylic Polyurethane, Series 73 which meets the accelerated weathering requirements of SSPC Paint Standard 36.

B. Prepare and finish structural component surfaces as specified.

C. Galvanize structural steel members exposed to weather and not finish painted, or as otherwise indicated to receive galvanizing, to comply with ASTM A123. Galvanize iron and steel hardware to comply with ASTM A153.

D. Do not finish work until inspection is complete and work approved by Testing Agency.

2.06 SOURCE QUALITY CONTROL

A. A DSA approved laboratory shall perform source quality control tests and submit reports, as specified in pertinent sections of Division 01 and Chapters 17A and 22A of the CBC.

B. Steel Materials Testing:

1. Unidentified steel - General: A DSA approved laboratory shall test all structural shapes. In addition, test to verify Fy and Fu values when engineering requirements exceed Fy = 25 ksi for design.

2. No testing is required for Materials identified in accordance with CBC Chapter 17A (heat number, grade stencil, etc.).

C. Shop Welding Inspection:

1. The DSA approved laboratory shall inspect and certify all structural welds, unless the fabricating shop has been accredited in conformance with CBC requirements.

D. Bolts, Nuts and Washers: Provide samples to DSA approved laboratory for required testing,

PART 3 - EXECUTION

3.01 EXAMINATION

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

3.02 FABRICATION

A. Shop Fabrication and Assembly: Fabricate and assemble structural assemblies in shop to greatest extent possible. Fabricate items of structural steel in accordance with AISC Specifications and as indicated on final shop drawings. Provide camber in structural members where indicated to provide the flattest floor possible. The contractor shall coordinate member tolerances with finishes.

B. Unless noted otherwise, make holes 1/16 inches larger than nominal bolt diameter.

3.03 HIGH STRENGTH BOLTS

A. Installation and Tightening:

1. Handling and Storage of Fasteners: Fasteners shall be protected from dirt and moisture at the job site. Only as many fasteners as are anticipated to be installed and tightened during a work shift shall be taken from protected storage. Fasteners not used shall be returned to protected storage at the end of the shift. Fasteners shall not be cleaned of lubricant that is present in as-delivered condition.

2. 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.

3. 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.

4. 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.

5. Mark bolts that have been completely tightened with an identifying symbol.

3.04 WELDING

A. General: Quality of materials and design and fabrication of all welded connections shall conform to AISC "Specification for Structural Steel Buildings," "AWS Code for Welding in Building Construction," “AWS D1.8 Seismic Supplement” and requirements of this section.

B. 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 of record.

C. Qualification of Welders:

1. Structural steel welding: Manual and automatic welds for structural steel construction shall be made only by operators who have been previous qualified by tests, as prescribed in AWS D1.1 to perform type of work required.

D. Control cooling process after weld is complete by either step down post heat or thermal blankets as determined by procedures and prequalification.

E. 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.

3.05 ERECTION

A. Erect structural steel in compliance with AISC "Code of Standard Practice for Steel Buildings and Bridges".

B. Do not make final connections until structure is aligned to meet specified tolerances.

3.06 ERECTION TOLERANCES

A. Structural steel erection: Comply with AISC "Specification for the Structural Steel Buildings", latest edition.

B. Maximum variation from plumb: 1/4 inch per story, non-cumulative.

C. Maximum offset from true alignment: 1/4 inch.

3.07 FIELD QUALITY CONTROL

A. The independent Testing Agency will perform field quality control tests, as specified in pertinent sections of Division 01.

3.08 ADJUSTING

A. Replace defective or damaged work which cannot be corrected in the field with new work, or return defective items to the shop for repair.

B. Architect/Engineer shall review and approve method of correction for the repair or replacement of damaged, defective, or missing work.

3.09 CLEANING AND PROTECTION

A. Clean all surfaces upon completion of erection, leave free of grime and dirt.

B. Protect work from damage by subsequent operations.

END OF SECTION

SECTION 04 05 00

MORTAR AND GROUT

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

A. Volume 1 – Contracting Requirements and Division-01 General Requirements apply to the work of this section.

1.02 SCOPE

A. Provide all materials, labor and accessories as required and specified for complete mortar and grout installation in masonry walls.

1.03 RELATED DOCUMENTS

A. Cast-In-Place Concrete: Section 03 30 00.

B. Concrete Unit Masonry: Section 04 20 00.

C. Reinforcing Steel: Section 03 21 00.

1.04 SUMMARY

A. This Section includes the following:

1. Mortar
2. Grout

1.05 ACTION SUBMITTALS

A. Proposed mortar color for review by the state.

1.06 INFORMATIONAL SUBMITTALS

A. Qualification Data: For manufacturer

B. Product Certificates: For each type of product, signed by product manufacturer.

C. Mix design for mortar and grout shall be submitted for review.

D. Supplier's certificates indicating materials comply with the specifications below. They shall include but are not necessarily limited to:

1. Aggregates
2. Cement
3. Admixtures

1.07 QUALITY ASSURANCE

A. Standards and References: (Latest Edition unless otherwise noted)

1. ASTM C144 Aggregate for Masonry Mortar.

2. ASTM C150 Portland Cement.

3. ASTM C207 Hydrated Lime for Masonry Purposes.

4. ASTM C270 Mortar for Unit Masonry.

5. ASTM C404 Aggregates for Masonry Grout.

6. ASTM C476 Grout for Masonry.

7. ASTM C1019 Test Method for Sampling and Testing Grout.

8. California Building Code (CBC), Section 2103A.

9. Building Code Requirements (TMS 402/ACI 530/ASCE 5) and Specifications (TMS 602/ACI 530.1/ASCE 6) for Masonry Structures (MSJC Code).

B. Testing and Inspections:

1. DSA statement of structural tests and special inspections (DSA-103) shall be prepared by the registered design professional in responsible charge.

2. Mortar and Grout Tests: At the beginning of Masonry Work, at least 1 test sample each of mortar and grout shall be taken on 3 successive working days, then once per week with at least one sample taken for each 5000 square feet of wall area, or fraction thereof.

a. Test specimens shall be made in accordance with ASTM C1019 for grout and ASTM C780 for mortar.

b. Test specimens shall be continuously stored in moist air until tested.

C. The DSA approved laboratory shall review all submittals and testing materials per Chapters 17A & 21A of the CBC.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Cement: ASTM C 150, Type I or II or V if in contact with soil, low alkali; natural gray.

B. Hydrated Lime: ASTM C 207, Type S.

C. Quicklime: ASTM C 5.

D. Lime Putty: Made from hydrated lime or quicklime.

1. If made from quicklime, other than processed pulverized quicklime, slake lime and then screen through a No. 16 mesh sieve. Before using, store and protect slaked and screened lime putty for not less than 10 days.

2. Processed pulverized quicklime shall be slaked for not less than 48 hours, and shall be cool when used.

3. Lime putty prepared from hydrated lime may be used immediately after mixing.

4. Lime putty prepared from quicklime or pulverized quicklime shall have a plasticity figure, after slaking and screening, of not less than 200, and shall weigh not less than 83 lbs. per cubic foot. Lime putty prepared from hydrated lime shall conform to ASTM C 207, Type S.

E. Aggregate:

1. For Mortar: ASTM C144.

2. For Grout: ASTM C404.

F. Admixture: “Sika Grout Aid” or equivalent.

G. Water: Suitable for domestic consumption.

2.02 MORTAR

A. Mortar shall be Cement-lime, Type S, and shall conform to CBC Section 2103A.2.

B. Mortar shall be made with admixtures that are proportioned, added and mixed in strict accordance with manufacturer's directions.

C. Mortar mix shall be proportioned by volume; one part portland cement, not less than 1/4 part nor more than ½ part lime putty, and sand totaling not less than 2-1/4 nor more than 3 times sum of volumes of cement and lime used.

1. Total clay content shall not exceed 2% of sand content or 6% of cement content.

D. Mortar Pigments: Natural and synthetic iron oxides and chromium oxides, compounded for use in mortar mixes and complying with ASTM C 979. Use only pigments with a record of satisfactory performance in masonry mortar.

E. Aggregate for Mortar: ASTM C 144.

1. For mortar that is exposed to view, use washed aggregate consisting of natural sand or crushed stone.

2. For joints less than 1/4 inch thick, use aggregate graded with 100 percent passing the No. 16 sieve.

3. White-Mortar Aggregates: Natural white sand or crushed white stone.

4. Colored-Mortar Aggregates: Natural sand or crushed stone of color necessary to produce required mortar color.

F. Water-Repellent Admixture: Liquid water-repellent mortar admixture intended for use with CMUs containing integral water repellent by same manufacturer.

2.03 GROUT

A. Grout shall have a 28-day compressive strength of 2000 psi or f'm, whichever is greater. Proportion by volume, and with sufficient water to produce consistency for pouring without segregation so that grout will flow into masonry joints. Grout shall conform to CBC Section 2103A and ASTM C476.

B. Fine Grout:

1. Fine grout shall be used for all grout spaces less than 3" wide.

C. Coarse Grout:

1. Coarse grout shall be used in grout spaces 3" wide or more.

D. Add "Sika Grout Aid" admixture to grout at the rate of 1 pound per 100 pounds cementitious material.

PART 3 - PART 3 - EXECUTION

3.01 MIXING MORTAR AND GROUT

A. Accurately measure materials in suitably calibrated devices; shovel measurements are not acceptable. Each 94lb. sack of portland cement will be considered as 1 cubic foot.

B. 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.

C. Use mixers of at least 1 sack capacity; batches requiring fractional sacks will not be permitted unless cement is weighed for each batch.

3.02 GROUTING PROCEDURES

A. Specified under Sections 04 20 00.

3.03 RETEMPERING

A. When necessary to retemper mortar, add water and remix; retempering by dashing water over mortar will not be permitted.

B. Any mortar which is unused within 30 minutes after initial mixing and any mortar that has begun to set shall not be used.

3.04 DEFECTIVE MORTAR OR GROUT

A. Should the strength of mortar or grout fall below that specified, remainder of Work shall be adjusted to reach required strength. Work in place representing inferior grout and 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 and State's Inspector.

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 the State.

C. Costs relative to taking and testing of core samples and patching core holes shall be borne by Contractor.

END OF SECTION

SECTION 04 20 00

CONCRETE UNIT MASONRY

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

A. Volume 1 – Contracting Requirements and Division-01 General Requirements apply to the work of this section.

1.02 SCOPE

A. Furnish and install all concrete unit masonry, reinforcement, and all required accessories and materials as shown on the Drawings and specified here.

1. Cooperate with other trades for embedded items, furnished under those sections and installed here.

2. Supervise setting of dowels for masonry furnished and installed under Section 03 21 00, Reinforcing Steel.

1.03 Related Documents

A. Cast-In-Place Concrete: Section 03 30 00.

B. Mortar and Grout: Section 04 05 00.

C. Reinforcing Steel: Section 03 21 00.

D. Cast Stone Masonry: Section 04 72 00

E. Water Repellents: Section 07 19 00

1.04 SUMMARY

A. This section Includes the following:

1. Concrete masonry units.

2. Decorative concrete masonry units.

3. Masonry joint reinforcement.

4. Ties and anchors.

5. Embedded flashing.

6. Miscellaneous masonry accessories.

7. Cavity-wall insulation.

1.05 ACTION SUBMITTALS

A. Samples for Initial Selection:

1. Decorative CMUs, in the form of small-scale units.

2. Colored mortar. Make Samples using same sand and mortar ingredients to be used on Project. Coordinate with Section 04 05 00 Mortar and Grout.

B. Samples for Verification: For each type and color of the following:

1. Decorative CMUs.

2. Colored mortar. Make Samples using same sand and mortar ingredients to be used on Project. Coordinate with Section 04 05 00 Mortar and Grout.

1.06 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing agency.

B. Material Certificates: For each type and size of the following:

1. Masonry units.

a. Include material test reports substantiating compliance with requirements.

2. Cementitious materials. See Section 04 05 00 Mortar and Grout.

3. Preblended, dry mortar mixes. Include description of type and proportions of ingredients. See Section 04 05 00 Mortar and Grout.

4. Grout mixes. Include description of type and proportions of ingredients. See Section 04 05 00 Mortar and Grout.

5. Reinforcing bars. See Section 03 21 00 Reinforcing Steel.

6. Joint reinforcement.

7. Anchors, ties, and metal accessories.

C. Mix Designs: For each type of mortar and grout. See Section 04 05 00 Mortar and Grout. Include description of type and proportions of ingredients.

D. Statement of Compressive Strength of Masonry: For each combination of masonry unit type and mortar type, provide statement of average net-area compressive strength of masonry units, mortar type, and resulting net-area compressive strength of masonry determined according to Tables 1 and 2 in TMS 602/ACI 530.1/ASCE 6.

E. Cold-Weather and Hot Weather Procedures: Detailed description of methods, materials, and equipment to be used to comply with requirements.

F. Product Data: For each type of product indicated.

G. Shop Drawings: For the following:

1. Masonry Units: Show sizes, profiles, coursing, and locations of special shapes.

2. Reinforcing Steel: Detail bending and placement of unit masonry reinforcing bars. Comply with ACI 315, "Details and Detailing of Concrete Reinforcement. Coordinate with Section 03 21 00 Reinforcing Wall.

3. Fabricated Flashing: Detail corner units, end-dam units, and other special applications.

H. Accessories embedded in masonry.

1.07 QUALITY ASSURANCE

A. Testing and Inspection:

1. DSA statement of structural tests and special inspections (DSA-103) shall be prepared by the registered design professional in responsible charge.

B. Source Limitations for Masonry Units: Obtain exposed masonry units of a uniform texture and color, or a uniform blend within the ranges accepted for these characteristics, from single source from single manufacturer for each product required.

C. Source Limitations for Mortar Materials: Obtain mortar ingredients of a uniform quality, including color for exposed masonry, from single manufacturer for each cementitious component and from single source or producer for each aggregate. See section 04 05 00 Mortar and Grout.

D. Masonry Standard: Comply with TMS 602/ACI 530.1/ASCE 6 unless modified by requirements in the Contract Documents.

E. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

1. Build mockup of typical wall area.

a. Include a sealant-filled joint at least 16 inches long in exterior wall mockup.

b. Include lower corner of window opening at upper corner of exterior wall mockup. Make opening approximately 12 inches wide by 16 inches high.

2. Clean one-half exposed faces of mockups with masonry cleaner as indicated.

3. Protect accepted mockups from the elements with weather-resistant membrane.

4. Approval of mockups is for color, texture, and blending of masonry units; relationship of mortar and sealant colors to masonry unit colors; tooling of joints; and aesthetic qualities of workmanship.

a. Approval of mockups is also for other material and construction qualities specifically approved by Architect in writing.

b. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless such deviations are specifically approved by Architect in writing.

5. Approved mockups may become part of the completed Work if undisturbed at time of acceptance of the work.

F. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination."

G. Preconstruction Testing Service: Owner will engage a qualified independent testing agency to perform preconstruction testing indicated below. Retesting of materials that fail to comply with specified requirements shall be done at Contractor's expense.

1. Concrete Masonry Unit Test: For each type of unit required, according to ASTM C 140 for compressive strength.

H. The DSA approved laboratory shall review all submittals and testing of materials per Chapters 17A and 21A of the CBC.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Store masonry units on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied. If units become wet, do not install until they are dry.

B. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.

C. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.

D. Deliver preblended, dry mortar mix in moisture-resistant containers designed for use with dispensing silos. Store preblended, dry mortar mix in delivery containers on elevated platforms, under cover, and in a dry location or in covered weatherproof dispensing silos.

E. Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.

1.09 PROJECT CONDITIONS

A. Protection of Masonry: During construction, cover tops of walls, projections, and sills with waterproof sheeting at end of each day's work. Cover partially completed masonry when construction is not in progress.

1. Extend cover a minimum of 24 inches down both sides of walls and hold cover securely in place.

B. Do not apply uniform floor or roof loads for at least 12 hours and concentrated loads for at least three days after building masonry walls or columns.

C. Stain Prevention: Prevent grout, mortar, and soil from staining the face of masonry to be left exposed or painted. Immediately remove grout, mortar, and soil that come in contact with such masonry.

1. Protect base of walls from rain-splashed mud and from mortar splatter by spreading coverings on ground and over wall surface.

2. Protect sills, ledges, and projections from mortar droppings.

3. Protect surfaces of window and door frames, as well as similar products with painted and integral finishes, from mortar droppings.

4. Turn scaffold boards near the wall on edge at the end of each day to prevent rain from splashing mortar and dirt onto completed masonry.

D. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace unit masonry damaged by frost or by freezing conditions. Comply with cold-weather construction requirements contained in TMS 602/ACI 530.1/ASCE 6.

1. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is 40 deg F and higher and will remain so until masonry has dried, but not less than seven days after completing cleaning.

E. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in TMS 602/ACI 530.1/ASCE 6.

PART 2 - PRODUCTS

2.01 MASONRY UNITS, GENERAL

A. Defective Units: Referenced masonry unit standards may allow a certain percentage of units to contain chips, cracks, or other defects exceeding limits stated in the standard. Do not use units where such defects will be exposed in the completed Work.

B. Fire-Resistance Ratings: Where indicated, provide units that comply with requirements for fire-resistance ratings indicated as determined by testing according to ASTM E 119, by equivalent masonry thickness, or by other means, as acceptable to authorities having jurisdiction.

2.02 CONCRETE MASONRY UNITS

A. Shapes: Provide shapes indicated and as follows, with exposed surfaces matching exposed faces of adjacent units unless otherwise indicated.

1. Provide special shapes for lintels, corners, jambs, sashes, movement joints, headers, bonding, and other special conditions.

B. Integral Water Repellent: Provide units made with integral water repellent.

1. Integral Water Repellent: Liquid polymeric, integral water-repellent admixture that does not reduce flexural bond strength. Units made with integral water repellent, when tested according to ASTM E 514 as a wall assembly made with mortar containing integral water-repellent manufacturer's mortar additive, with test period extended to 24 hours, shall show no visible water or leaks on the back of test specimen.

    a. Products: Subject to compliance with requirements, provide the following available products that may be incorporated into the Work include, but are not limited to, the following:

        1) ACM Chemistries; RainBloc..

        2) BASF Aktiengesellschaft; Rheopel Plus.

        3) Grace Construction Products, W. R. Grace & Co. - Conn.; Dry-Block.

        4) CA Approved equal

C. CMUs: ASTM C 90.

1. For utility non-visual areas.

2. Weight: Medium weight

3. Twenty-eight-day compressive strength of 2000 pounds per square inch.

D. Decorative CMUs: ASTM C 90.

1. Standard pattern, split-face and ground face finish. For all building exteriors.

2. Weight: Medium weight

3. Twenty-eight-day compressive strength of 2000 pounds per square inch.

4. 8" wide by 8" high x 16" long unless specified otherwise.

5. 8” wide by 8” high x 16” long scored to 8” x 8” unless specified otherwise.

6. All units exposed to view shall be split face, ground face or precision face with integral color to be selected by state from manufacturer’s full range.

7. All concealed faces shall be precision faced.

2.03 MORTAR AND GROUT MATERIALS

A. For Mortar and Grout Materials, see Section 04 05 00.

B. Mortar Pigments: Natural and synthetic iron oxides and chromium oxides, compounded for use in mortar mixes and complying with ASTM C 979. Use only pigments with a record of satisfactory performance in masonry mortar.

C. Aggregate for Mortar: ASTM C 144.

1. For mortar that is exposed to view, use washed aggregate consisting of natural sand or crushed stone.

2. For joints less than 1/4 inch thick, use aggregate graded with 100 percent passing the No. 16 sieve.

3. White-Mortar Aggregates: Natural white sand or crushed white stone.

4. Colored-Mortar Aggregates: Natural sand or crushed stone of color necessary to produce required mortar color.

D. Water-Repellent Admixture: Liquid water-repellent mortar admixture intended for use with CMUs containing integral water repellent by same manufacturer.

2.04 REINFORCEMENT

A. See Section 03 21 00 unless indicated otherwise in this section.

B. Masonry Joint Reinforcement, General: ASTM A 951.

1. Interior Walls: Hot-dip galvanized, carbon steel.

2. Exterior Walls: Hot-dip galvanized steel.

3. Spacing of Cross Rods, Tabs, and Cross Ties: Not more than 16 inches o.c.

4. Provide in lengths of not less than 10 feet.

2.05 TIES AND ANCHORS

A. Materials: Provide ties and anchors specified in this article that are made from materials that comply with the following unless otherwise indicated.

1. Mill-Galvanized, Carbon-Steel Wire: ASTM A 82; with ASTM A 641, Class 1 coating.

2. Hot-Dip Galvanized, Carbon-Steel Wire: ASTM A 82; with ASTM A 153, Class B-2 coating.

3. Stainless-Steel Wire: ASTM A 580, Type 304.

4. Steel Sheet, Galvanized after Fabrication: ASTM A 1008, Commercial Steel, with ASTM A 153, Class B coating.

B. Adjustable Anchors for Connecting to Structural Steel Framing: Provide anchors that allow vertical or horizontal adjustment but resist tension and compression forces perpendicular to plane of wall.

C. Anchor Bolts: steel bolts complying with ASTM A 307, Grade A; hot-dip galvanized to comply with ASTM A 153, Class C unless indicated otherwise in construction documents.

2.06 MASONRY CLEANERS

A. Proprietary Acidic Cleaner: Manufacturer's standard-strength cleaner designed for removing mortar/grout stains, efflorescence, and other new construction stains from new masonry without discoloring or damaging masonry surfaces. Use product expressly approved for intended use by cleaner manufacturer and manufacturer of masonry units being cleaned.

2.07 MORTAR AND GROUT MIXES

A. For Mortar and Grout, refer to Section 04 05 00.

PART 3 - EXECUTION

3.01 EXAMINATION

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

1. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of work.

2. Verify that foundations are within tolerances specified.

a. And foundation surface are level to permit bed joint with range of 1/4 to 3/4 inch.

b. And edge are true to line to permit projection of masonry to less than 1/4-inch.

3. Verify that reinforcing dowels are properly placed.

a. And projecting dowels are free from loose scale, dirt, concrete, or other bond-inhibiting substances and properly located.

B. Before installation, examine rough-in and built-in construction for piping systems to verify actual locations of piping connections.

C. Do not begin work before unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Clean concrete surfaces to receive masonry. Remove latence 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 Division 3 Concrete specifications.

3.03 INSTALLATION, GENERAL

A. Thickness: Build cavity and composite walls and other masonry construction to full thickness shown. Build single-wythe walls to actual widths of masonry units, using units of widths indicated.

B. Build chases and recesses to accommodate items specified in this and other Sections.

C. Leave openings for equipment to be installed before completing masonry. After installing equipment, complete masonry to match the construction immediately adjacent to opening.

D. Use full-size units without cutting if possible. If cutting is required to provide a continuous pattern or to fit adjoining construction, cut units with motor-driven saws; provide clean, sharp, unchipped edges. Allow units to dry before laying unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.

E. Select and arrange units for exposed unit masonry to produce a uniform blend of colors and textures.

   1. Mix units from several pallets or cubes as they are placed.

F. Matching Existing Masonry: Match coursing, bonding, color, and texture of existing masonry.

G. Wetting of Brick when necessary: Wet brick before laying if initial rate of absorption exceeds 30 g/30 sq. in. per minute when tested per ASTM C 67. Allow units to absorb water so they are damp but not wet at time of laying.

3.04 TOLERANCES

A. Dimensions and Locations of Elements:

   1. For dimensions in cross section or elevation do not vary by more than plus 1/2 inch or minus 1/4 inch.

   2. For location of elements in plan do not vary from that indicated by more than plus or minus 1/2 inch.

   3. For location of elements in elevation do not vary from that indicated by more than plus or minus 1/4 inch in a story height or 1/2 inch total.

   4. Variation from Unit to Adjacent Unit: 1/32-inch max

   5. Variation from Plane of Wall: ¼-inch in 10 feet.

   6. Variation from Plumb: ¼-inch

   7. Variation from Level Coursing: 1/8-inch in 3 feet, ¼-inch in 10 feet, ½-inch maximum.

   8. Variation in joint thickness: 1/8-inch in 3 feet.

B. Lines and Levels:

1. For bed joints and top surfaces of bearing walls do not vary from level by more than 1/4 inch in 10 feet, or 1/2 inch maximum.

2. For conspicuous horizontal lines, such as lintels, sills, parapets, and reveals, do not vary from level by more than 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 1/2 inch maximum.

3. For vertical lines and surfaces do not vary from plumb by more than 1/4 inch in 10 feet, 3/8 inch in 20 feet, or 1/2 inch maximum.

4. For conspicuous vertical lines, such as external corners, door jambs, reveals, and expansion and control joints, do not vary from plumb by more than 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 1/2 inch maximum.

5. For lines and surfaces do not vary from straight by more than 1/4 inch in 10 feet, 3/8 inch in 20 feet, or 1/2 inch maximum.

6. For vertical alignment of exposed head joints, do not vary from plumb by more than 1/4 inch in 10 feet, or 1/2 inch maximum.

C. Joints:

1. Horizontal and vertical joints at masonry units shall be 3/8-inch wide.

2. Tool exposed interior and exterior joints and concealed exterior joints to produce a dense slightly concave surface that is well bonded to unit at edges. Tool joints behind room base, switches, and outlet plates to produce a smooth dense joint flush with the face of adjacent masonry units, where occurring on the job. Cut joints flush on concealed interior surfaces and surfaces to be plastered.

3. For bed joints, do not vary from thickness indicated by more than plus or minus 1/8 inch, with a maximum thickness limited to 1/2 inch.

4. For exposed bed joints, do not vary from bed-joint thickness of adjacent courses by more than 1/8 inch.

5. For head and collar joints, do not vary from thickness indicated by more than plus 3/8 inch or minus 1/4 inch.

6. For exposed head joints, do not vary from thickness indicated by more than plus or minus 1/8 inch. Do not vary from adjacent bed-joint and head-joint thickness by more than 1/8 inch.

7. For exposed bed joints and head joints of stacked bond, do not vary from a straight line by more than 1/16 inch from one masonry unit to the next.

3.05 LAYING MASONRY WALLS

A. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint thicknesses and for accurate location of openings, movement-type joints, returns, and

offsets. Avoid using less-than-half-size units, particularly at corners, jambs, and, where possible, at other locations.

B. Bond Pattern for Exposed Masonry: Unless otherwise indicated, lay exposed masonry in running bond. Do not use units with less than nominal 4-inch horizontal face dimensions at corners or jambs.

C. Lay concealed masonry with all units in a wythe in running bond or bonded by lapping not less than 4-inches. Bond and interlock each course of each wythe at corners. Do not use units with less than nominal 4-inch horizontal face dimensions at corners or jambs.

D. Stopping and Resuming Work: Stop work by racking back units in each course from those in course below; do not tooth. When resuming work, clean masonry surfaces that are to receive mortar, remove loose masonry units and mortar, and wet brick if required before laying fresh masonry.

E. Built-in Work: As construction progresses, build in items specified in this and other Sections. Fill in solidly with masonry around built-in items.

F. Fill space between steel frames and masonry solidly with mortar unless otherwise indicated.

G. Where built-in items are to be embedded in cores of hollow masonry units, place a layer of metal lath, wire mesh, or plastic mesh in the joint below and rod mortar or grout into core.

H. Fill cores in hollow CMUs with grout 24 inches under bearing plates, beams, lintels, posts, and similar items unless otherwise indicated on construction documents.

3.06 MORTAR BEDDING AND JOINTING

A. Lay CMU's as follows:

1. With face shells fully bedded in mortar and with head joints of depth equal to bed joints.

2. With webs fully bedded in mortar in all courses of piers, columns, and pilasters.

3. With webs fully bedded in mortar in grouted masonry, including starting course on footings.

4. With entire units, including areas under cells, fully bedded in mortar at starting course on footings where cells are not grouted.

B. Lay solid masonry units with completely filled bed and head joints; butter ends with sufficient mortar to fill head joints and shove into place. Do not deeply furrow bed joints or slush head joints.

C. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness unless otherwise indicated.

D. Cut joints flush for masonry walls to receive plaster or other direct-applied finishes (other than paint) unless otherwise indicated.

E. Corners: Provide interlocking masonry unit bond in each wythe and course at corners unless otherwise indicated.

F. Intersecting and Abutting Walls: Unless vertical expansion or control joints are shown at juncture, bond walls together as follows:

3.07 GROUTING

A. General Requirements:

1. All cells shall be grouted solid.

2. Use low lift or high lift grouting at Contractor's option.

B. Low Lift Grouting:

1. Conform to requirements of CBC Section 2104A.1.3.1.1.2.2.

C. High Lift Grouting:

1. Conform to requirements of CBC Section 2104A.1.3.1.1.2.3.

3.08 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. Avoid cutting and patching.

3.09 ANCHORING MASONRY TO STRUCTURAL STEEL AND CONCRETE

A. Anchor masonry to structural steel and concrete where masonry abuts or faces structural steel or concrete.

3.10 CONTROL AND EXPANSION JOINTS

A. General: Install control and expansion joint materials in unit masonry as masonry progresses. Do not allow materials to span control and expansion joints without provision to allow for in-plane wall or partition movement.

3.11 LINTELS

A. Install steel lintels where required and as shown on construction documents.

B. Install masonry lintels where required and as shown on construction documents.

3.12 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.

3.13 REINFORCED UNIT MASONRY INSTALLATION

A. Temporary Formwork and Shores: Construct formwork and shores as needed to support reinforced masonry elements during construction.

1. Construct formwork to provide shape, line, and dimensions of completed masonry as indicated. Make forms sufficiently tight to prevent leakage of mortar and grout. Brace, tie, and support forms to maintain position and shape during construction and curing of reinforced masonry.

2. Do not remove forms and shores until reinforced masonry members have hardened sufficiently to carry their own weight and other loads that may be placed on them during construction.

B. Placing Reinforcement: Comply with requirements in TMS 602/ACI 530.1/ASCE 6.

C. Grouting: Do not place grout until entire height of masonry to be grouted has attained enough strength to resist grout pressure.

1. Comply with requirements in TMS 602/ACI 530.1/ASCE 6 for cleanouts and for grout placement, including minimum grout space and maximum pour height.

3.14 TESTS AND INSPECTIONS

A. A testing program is required prior to start of construction. Testing program to be done in compliance with DSA Form DSA-103 Statement of Structural Tests and Special Inspections; CBC (latest edition) and in collaboration with the Testing Laboratory, design team, contractor and owner.

3.15 FIELD QUALITY CONTROL

A. Testing and Inspecting: Owner will engage special inspectors to perform tests and inspections and prepare reports. Allow inspectors access to scaffolding and work areas, as needed to perform tests and inspections. Retesting of materials that fail to comply with specified requirements shall be done at Contractor's expense.

1. 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.

2. Test three sample units prior to construction. Test also three sample units during construction for every 5,000 square feet of wall area.

3. Units will be tested for compressive strength on both the net and gross area per ASTM C140.

4. Units will be tested for linear drying shrinkage per ASTM C426.

5. A special inspector shall be employed per CBC Section 1705A.4 to inspect the placement of all units, placement of all reinforcing steel, during all grouting operations and during taking of all test specimens.

6. Core Testing: Not less than two cores per 5,000 square feet of floor area or wall area, whichever is greater and at least two cores from each building or structure. Core in locations approved by the Architect and test per CBC Section 2105A.4. Repair holes as directed by the Architect.

7. See Section 03 21 00 for reinforcing steel tests and inspections.

B. Inspections: Special inspections according to CBC and/or DSA.

1. Begin masonry construction only after inspectors have verified proportions of site-prepared mortar.

2. Place grout only after inspectors have verified compliance of grout spaces and of grades, sizes, and locations of reinforcement.

3. Place grout only after inspectors have verified proportions of site-prepared grout.

C. Mortar Aggregate Ratio Test (Proportion Specification): For each mix provided, according to ASTM C 780.

D. Mortar Test (Property Specification): For each mix provided, according to ASTM C 780.

E. Grout Test (Compressive Strength): For each mix provided, according to ASTM C 1019.

3.16 REPAIRING, POINTING, AND CLEANING

A. Remove and replace masonry units that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Install new units to match adjoining units; install in fresh mortar, pointed to eliminate evidence of replacement.

B. Pointing: During the tooling of joints, enlarge voids and holes, except weep holes, and completely fill with mortar. Point up joints, including corners, openings, and adjacent construction, to provide a neat, uniform appearance. Prepare joints for sealant application, where indicated.

C. In-Progress Cleaning: Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears before tooling joints.

D. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry as follows:

1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.

2. Test cleaning methods on sample wall panel; leave one-half of panel uncleaned for comparison purposes. Obtain Architect's approval of sample cleaning before proceeding with cleaning of masonry.

3. Protect adjacent stone and nonmasonry surfaces from contact with cleaner by covering them with liquid strippable masking agent or polyethylene film and waterproof masking tape.

4. Wet wall surfaces with water before applying cleaners; remove cleaners promptly by rinsing surfaces thoroughly with clear water.

5. Clean masonry with a proprietary acidic cleaner applied according to manufacturer's written instructions.

6. Clean concrete masonry by cleaning method indicated in NCMA TEK 8-2A applicable to type of stain on exposed surfaces.

3.17 MASONRY WASTE DISPOSAL

A. Salvageable Materials: Unless otherwise indicated, excess masonry materials are Contractor's property. At completion of unit masonry work, remove from Project site.

B. Waste Disposal as Fill Material (when approved by engineer): Dispose of clean masonry waste, including excess or soil-contaminated sand, waste mortar, and broken masonry units, by crushing and mixing with fill material as fill is placed.

1. Crush masonry waste to less than 4 inches in each dimension.

2. Mix masonry waste with at least two parts of specified fill material for each part of masonry waste.

3. Do not dispose of masonry waste as fill within 18 inches of finished grade.

C. Excess Masonry Waste: Remove excess clean masonry waste that cannot be used as fill, as described above, and other masonry waste, and legally dispose of off Owner's property.

END OF SECTION

SECTION 05 12 13

ARCHITECTURALLY EXPOSED STRUCTURAL STEEL

PART 1 - GENERAL

1.01 SUMMARY

A. Work Included: Architecturally exposed structural steel, complete, as shown and specified.

B. Work Specified Elsewhere:

1. Finish Painting in the Field: Section 09 90 00.

C. Other Applicable Sections: Work of this Section is governed by applicable provisions of the following Sections:

1. Section 05 12 00 Structural Steel.

1.02 REFERENCE STANDARDS (Latest Edition unless otherwise noted.)

A. American Institute of Steel Construction (AISC) 303-16:

1. Code of Standard Practice for Steel Buildings and Bridges, Section 10.

B. The Society for Protective Coatings (SSPC):

1. SSPC Painting Manual, Volume 2

1.03 SUBMITTALS

A. Product Date, Shop Drawings, and Certificates: As specified in Section 05 12 00.

B. All members designated as AESS shall be clearly identified to a Category, either AESS 1, 2, 3, 4 or C, in the approval documents. Tack welds, temporary braces, backing and fixtures used in fabrication of AESS shall be shown in the fabrication documents. Architecturally sensitive connection details shall be submitted for approval by the owner's designated representative for design prior to completion of the approval documents.

1.04 PRODUCT HANDLING

A. Delivery: Use special care in unloading items to protect surfaces and to prevent distortion and other damage.

B. Storage: Under cover and off ground.

C. Protection: Protect items until erected and accepted.

PART 2 - PRODUCTS

2.01 MATERIAL

A. General: Provide AESS material and finishes per AISC 303 in the categories indicated for structural steel as indicated AESS on the Architectural Drawings.

B. ENGINEER NOTE: SUGGEST TO ARCHITECT THAT THE FOLLOWING CHART TAKEN FROM AISC 303 BE USED AS A STARTING POINT FOR SPECIFYING

C. DEFAULT DESIGN TABLE

Member or Component	**AESS C**	**AESS 4**	**AESS 3**	**AESS 2**	**AESS 1**	**Non-AESS**
Typical - Not exposed to view						X
Basic Elements exposed to view					X	
Featured elements exposed to view from more than 20ft				X		
Featured elements exposed to view from less than 20ft			X			
Showcase elements with special edge treatment - identified by architect		X				
Custom elements - identified by architect	X					

D. Quality: Per ASTM Standards, unless higher standard indicated in AISC 303 for the AESS category indicated.

E. Tubes and Pipes: per AISC 303, Section 10.4.12

F. Comply with more stringent requirements of Section 05 12 00 and this Section.

G. See AISC 303, Table 10.1 for complete description of preparation work to be performed for each category of AESS.

2.02 FABRICATION

A. General: Comply with more stringent requirements of Section 05 12 00 and Reference Standards, except as follows.

B. Connections: Fabricate shear plates and beam flanges and webs at connections as shown.

C. Bolts: Hexagonal head.

D. Welds: Grind and polish every weld smooth and uniform, unless otherwise noted. Grind butt welds and welds at external corners flush and smooth. Completely remove back-up bars, weld spatter, and run-off tabs where exposed to view. Fill web cutouts at backup bars. Weld show-through not acceptable.

E. Marks: Manufacturer's names and identification marks not permitted on exposed surfaces. Do not apply erection marks, symbols, or painted notes to exposed surfaces.

2.03 SHOP PAINTING

A. General: Prepare surfaces and apply materials to concealed and exposed surfaces per coating system manufacturer's recommendations. Coordinate prime coat with body and finish coats.

B. Surface Preparation:

1. Steel: Remove oil and grease with volatile solvents per SSPC SP-1 and commercial blast clean per SSPC SP-6/NACE No. 3. Apply prime coat before rust bloom appears, but not more than 8 hours after cleaning.

2. Stainless Steel: Remove oil and grease with volatile solvents per SSPC SP-1 and scarify surfaces.

A. Exterior Work:

1. Prime Coat: Tnemec Co. Inc.'s 94H20 Tneme-Zinc, or approved equal; zinc-rich urethane with not less than 80 percent zinc in dried film; at 2.5 to 3.5 mils dry film thickness.

2. Body and Finish Coats: Concealed and exposed surfaces; polyaspartic urethane enamel coating system as specified under Section 09 90 00.

D. Interior Work:

1. Prime Coat:

a. Shop Applied: Tnemec Co. Inc.'s Series 27WB Epoxy Coating, or Engineer approved equal, applied at 4.0 to 5.0 mils dry film thickness.

2. Finish Coats: As specified under Section 09 90 00.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verification of Conditions: Before staring work, examine adjoining work on which execution is in any way dependant for workmanship and fit. Give written notification of any existing deficiencies detrimental to proper and timely installation of work under this Section. Do not proceed until conditions are satisfactory.

3.02 ERECTION

A. General: As specified under Section 05 12 00.

3.03 CONNECTIONS

A. General: As specified under Section 05 12 00, except as modified under Paragraph Fabrication of this Section.

B. Bolts: Orient heads in same direction.

3.04 FIELD QUALITY CONTROL

A. General: As specified under Section 05 12 00.

3.05 FIELD TOUCH-UP OF SHOP PAINTED SURFACES

A. General: As specified under Section 05 12 00 except, at Contractor's option, preparation for tough-up by SSPC-SP-11 may be substituted for SSPC-SP-6.

END OF SECTION

SECTION 05 21 00

STEEL JOIST FRAMING

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

A. Volume 1 – Contracting Requirements and Division-01 General Requirements apply to the work of this section.

1.02 SCOPE

A. Provide all materials, labor, and accessories as required and specified for complete open web steel joist framing installation.

1.03 RELATED DOCUMENTS

A. Cast-in-Place Concrete: Section 03 30 00

B. Concrete Unit Masonry: Section 04 20 00

C. Structural and Miscellaneous Steel: Section 05 12 00

1.04 SUMMARY

A. This section Includes the following:

1. K-series steel joists.

2. K-series steel joist substitutes.

3. LH- series long-span steel joists.

4. Joist accessories.

B. SJI's "Specifications": Steel Joist Institute's "Standard Specifications, Load Tables and Weight Tables for Steel Joists and Joist Girders."

C. Special Joists: Steel joists or joist girders requiring modification by manufacturer to support non-uniform, unequal, or special loading conditions that invalidate load tables in SJI's "Specifications."

1.05 ACTION SUBMITTALS

A. None

1.06 INFORMATIONAL SUBMITTALS

A. Shop Drawings:

1. Include layout, designation, number, type, location, and spacing of joists.

2. Include joining and anchorage details, bracing, bridging, and joist accessories; splice and connection locations and details; and attachments to other construction.

3. Indicate locations and details of bearing plates to be embedded in other construction.

B. Comprehensive engineering analysis of joists signed and sealed by the qualified professional engineer responsible for its preparation. Prepare submittals according to DSA IR 22-3.13.

C. Product Data: For each type of joist, accessory, and product.

D. Certifications:

1. Quality Control

2. Steel Joist Institute (SJI)

3. Certified as an approved fabricator.

4. Steel Materials

a. Mill Test Reports

E. Welders Certificates

F. Samples of color finish at exposed locations

G. Maintenance Data

1.07 QUALITY ASSURANCE

A. Manufacturer Qualifications: A manufacturer certified by SJI to manufacture joists complying with applicable standard specifications and load tables in SJI's "Specifications**",** DSA IR 22-3.13 and CBC Chapter 22A.

1. Manufacturer's responsibilities include providing professional engineering services for designing special joists to comply with performance requirements.

B. Welding Qualifications: Qualify shop and field-welding procedures and personnel according to AWS D1.1, "Structural Welding Code – Steel".

C. Testing and Inspection:

1. DSA statement of structural tests and special inspections (DSA-103) shall be prepared by the registered design professional in responsible charge.

D. The DSA approved laboratory shall review all submittals and testing of materials per Chapters 17A and 22A of the CBC.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle joists as recommended in SJI's "Specifications**."**

B. Protect joists from corrosion, deformation, and other damage during delivery, storage, and handling.

1.09 SEQUENCING

A. Deliver steel bearing plates to be built into masonry construction as required by design.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Structural Performance: Provide special joists and connections capable of withstanding design loads indicated in the CBC.

B. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of pre-consumer recycled content not less than 50 percent.

2.02 K-SERIES STEEL JOISTS

A. Manufacture steel joists of type indicated according to "Standard Specifications for Open Web Steel Joists, K-Series" in SJI's "Specifications," with steel-angle top- and bottom-chord members, underslung ends, and parallel top chord.

1. Joist Type: K-series steel joists.

B. Steel Joist Substitutes: Manufacture according to "Standard Specifications for Open Web Steel Joists, K-Series" in SJI's "Specifications," with steel-angle or -channel members.

C. Top-Chord Extensions: Extend top chords of joists with SJI's Type S top-chord extensions where indicated, complying with SJI's "Specifications."

D. Extended Ends: Extend bearing ends of joists with SJI's Type R extended ends where indicated, complying with SJI's "Specifications."

E. Camber joists according to SJI's "Specifications."

F. Coordinate equip bearing ends of joists with manufacturer's requirements for beveled ends or sloped shoes if joist slope requires it for proper installation.

2.03 LONG-SPAN STEEL JOISTS

A. Manufacture steel joists according to "Standard Specifications for Longspan Steel Joists, LH-Series in SJI's "Specifications," with steel-angle top- and bottom-chord members; of joist type and end and top-chord arrangements as indicated.

1. Joist Type: LH-series steel joists**.**

2. End Arrangement: Square.

3. Top-Chord Arrangement: Sloped top chord.

B. Camber long-span steel joists according to SJI's "Specifications."

C. Coordinate equip bearing ends of joists with manufacturer's requirements for beveled ends or sloped shoes if joist slope requires it for proper installation.

2.04 COMPOSITE STEEL JOISTS

A. Manufacture steel joists according to "Standard Specifications for Composite Steel Joists, CJ-Series" in SJI's "Standard Specifications for Composite Steel Joists, Weight Tables and Bridging Tables, Code of Standard Practice," with steel-angle top- and bottom-chord members and parallel top chord, and with square ends.

2.05 PRIMERS

A. Low-Emitting Materials: Paints and coatings shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

B. Primer: SSPC-Paint 15, or manufacturer's standard shop primer complying with performance requirements in SSPC-Paint 15.

C. Primer: Provide shop primer that complies with Section 09 91 13 "Exterior Painting"

2.06 JOIST ACCESSORIES

A. Bridging: Provide bridging anchors and number of rows of diagonal bridging of material, size, and type required by SJI's "Specifications" for type of joist, chord size, spacing, and span. Furnish additional erection bridging if required for stability.

B. Bridging: Schematically indicated. Detail and fabricate according to SJI's "Specifications." Furnish additional erection bridging if required for stability.

C. Bridging: Fabricate as indicated and according to SJI's "Specifications**."** Furnish additional erection bridging if required for stability.

D. Fabricate steel bearing plates from ASTM A 36 steel with integral anchorages of sizes and thicknesses indicated. Steel bearing plates with integral anchorages are specified in Section 05 50 00 "Metal Fabrications."

E. Furnish ceiling extensions, either extended bottom-chord elements or a separate extension unit of enough strength to support ceiling construction. Extend ends to within 1/2 inch of finished wall surface unless otherwise indicated.

F. Carbon-Steel Bolts and Threaded Fasteners: ASTM A 307, Grade A carbon-steel, hex-head bolts and threaded fasteners; carbon-steel nuts; and flat, unhardened steel washers.

1. Finish: Plain, uncoated.

G. High-Strength Bolts, Nuts, and Washers: ASTM A 325, Type 1, heavy hex steel structural bolts; ASTM A 563 heavy hex carbon-steel nuts; and ASTM F 436 hardened carbon-steel washers.

1. Finish: Plain.

H. Welding Electrodes: Comply with AWS standards.

I. Furnish miscellaneous accessories including splice plates and bolts required by joist manufacturer to complete joist assembly.

2.07 CLEANING AND SHOP PAINTING

A. Clean and remove loose scale, heavy rust, and other foreign materials from fabricated joists and accessories by hand-tool cleaning, SSPC-SP 2.

B. Do not prime paint joists and accessories to receive sprayed fire-resistive materials.

C. Apply one coat of shop primer to joists and joist accessories to be primed to provide a continuous, dry paint film not less than 1 mil thick.

D. Shop priming of joists and joist accessories is specified in Section 09 91 13 "Exterior Painting".

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine supporting substrates, embedded bearing plates, and abutting structural framing for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Do not install joists until supporting construction is in place and secured.

B. Install joists and accessories plumb, square, and true to line; securely fasten to supporting construction according to SJI's "Specifications," joist manufacturer's written recommendations, and requirements in this Section.

C. Field weld joists to supporting steel and framework. Coordinate welding sequence and procedure with placement of joists. Comply with AWS requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.

D. Bolt joists to supporting steel framework using carbon-steel bolts.

E. Bolt joists to supporting steel framework using high-strength structural bolts. Comply with Research Council on Structural Connection's "Specification for Structural Joints Using ASTM A 325 or ASTM A 490 Bolts" for high-strength structural bolt installation and tightening requirements.

F. Install and connect bridging concurrently with joist erection, before construction loads are applied. Anchor ends of bridging lines at top and bottom chords if terminating at walls or beams.

3.03 FIELD QUALITY CONTROL

A. Testing Agency: The State will engage a qualified independent testing and inspecting laboratory to inspect field welds and bolted connections and to perform field tests and inspections and prepare test and inspection reports.

B. Visually inspect field welds according to AWS D1.1.

1. In addition to visual inspection, test field welds according to AWS D1.1 and the following procedures, as applicable:

a. Liquid Penetrant Inspection: ASTM E165.

b. Magnetic Particle Inspection: ASTM E709.

c. Ultrasonic Testing: ASTM E164.

d. Radiographic Testing: ASTM E94.

C. Visually inspect bolted connections.

D. Correct deficiencies in Work that test and inspection reports have indicated are not in compliance with specified requirements.

E. Perform additional testing to determine compliance of corrected Work with specified requirements.

3.04 PROTECTION

A. Repair damaged galvanized coatings on galvanized items with galvanized repair paint according to ASTM A 780 and manufacturer's written instructions.

B. Touchup Painting: After installation, promptly clean, prepare, and prime or reprime field connections, rust spots, and abraded surfaces of prime-painted joists**,** bearing plates**,** abutting structural steel**,** and accessories.

1. Clean and prepare surfaces by hand-tool cleaning according to SSPC-SP 2, or power-tool cleaning according to SSPC-SP 3.

2. Apply a compatible primer of same type as primer used on adjacent surfaces.

C. Touchup Painting: Cleaning and touchup painting are specified in Section 09 91 13 "Exterior Painting"**.**

D. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure that joists and accessories are without damage or deterioration at time of acceptance of the work.

END OF SECTION

SECTION 05 12 00

STRUCTURAL AND MISCELLANEOUS STEEL

GENERAL

1.01 GENERAL REQUIREMENTS

A. Volume 1 – Contracting Requirements and Division-01 General Requirements apply to the work of this section.

1.02 SCOPE

A. Provide all materials, labor and accessories as required and specified for complete structural and miscellaneous steel installation.

1.03 RELATED DOCUMENTS:

1. Pertinent sections of Division 01 specifying Quality Control and Testing Agency services.

2. Pertinent Sections of other Divisions specifying concrete reinforcement, formwork, concrete, and rough carpentry.

3. Pertinent Sections of other Divisions specifying structural and miscellaneous steel fabrications, steel joist framing, metal decking, cold-formed metal framing.

1.04 SUMMARY

A. This section Includes the following:

1. Structural steel columns, beams, bracing, base plates, bolts, joist hangers, and stud bolts welded to structural steel.

2. Miscellaneous structural steel and connections; fabricated connectors and hangers installed by related sections.

3. Anchor bolts and steel inserts embedded in concrete or masonry, installed by related sections.

4. Fabricated steel items embedded in concrete or masonry installed by related sections.

5. Supervision of anchor bolt setting, leveling and elevations to insure required fit of steel work.

6. Shop priming and field touch-up, galvanizing.

B. Bracing, Shoring, Fabrication and Erection.

1.05 INFORMATIONAL SUBMITTALS

A. Submit shop drawings of all fabrications.

1. Shop drawings shall include complete details and schedules for fabrication and assembly of structural steel members, procedures, and diagrams.

2. Include details of cuts, connections, camber, holes, and other pertinent data. Indicate welds by standard AWS symbols, and show size, length, and type of each weld.

3. Provide setting drawings, templates, and directions for installation of anchor bolts and other anchorages to be installed by others.

4. 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 Contractor. Contractor shall also coordinate and provide dimensions to locate structural steel for window washing supports such as davits, tie-backs, etc.

B. Procedures:

1. Provide weld procedures for both pre-qualified welds and special welds to be submitted to the Owner's Testing Laboratory and the Architect.

2. Provide installation procedure and inspection for direct tension indicator washers detailed in supplemental specifications provided by the manufacturer for approval.

3. Procedures shall be submitted for both shop and field welds

C. Certifications:

1. Quality Control
2. Steel Materials
   a. Manufacturers Mill Certificates
   b. Mill Test Reports
3. Welders Certificates

D. Product Data: Include laboratory test reports and other data to show compliance with specifications (include specified standards). Include certified copies of mill reports covering chemical and physical properties of each type of structural steel.

1.06 QUALITY ASSURANCE

A. For DSA requirements, refer to pertinent sections of Division 01 and CBC Chapter 22A.

B. All tests shall be performed by a DSA approved laboratory as specified in pertinent sections of Division 01,CBC Chapters 17A and 22A, and the approved form DSA-103.

C. Certification and Identification of Materials and Uses.

1. Provide DSA approved laboratory with access to fabrication plant to facilitate inspection of steel. Provide notification of commencement and duration of shop fabrication in sufficient time to allow inspection and all material identification/test information listed below.

    a. Test all steel as required by ASTM A6.

    b. Provide manufacturer's Mill Test Reports for all materials. Indicate structural strength, destructive test analysis and non-destructive test analysis

2. Manufacturer's Mill Certificate: Certify that products meet or exceed specified requirements.

3. Welders Certificates: Certify welders employed on the Work, verifying AWS qualification.

D. Testing and Inspection:

1. DSA statement of structural tests and special inspections (DSA-103) shall be prepared by the registered design professional in responsible charge.

2. Welding Inspection:

    a. If shop or field welding inspection is indicated on the structural drawings or required by the applicable referenced standards, shop and field welded operations shall be inspected in accordance with AISC 360 by a qualified welding inspector employed by the Testing Laboratory. Such inspector will be a person trained and thoroughly experienced in inspection of welds. The inspector's ability to distinguish between sound and unsound welding will be reliably established

    b. The welding inspector will make a systematic record of all welds. This record shall include:

        1) Identification marks of welders.

        2) List of defective welds.

        3) Manner of correction of defects.

    c. The welding inspector will check the material, equipment and procedure, as well as the welds. He will also check the ability of the welder. He will furnish the Architect with a report, duly verified by him that the welding which is required to be inspected is proper, and has been done in conformity with the Contract Documents, and that he has used all means to determine the quality of the welds.

    d. All full penetration groove welds will be subject to ultrasonic testing, as per AWS D1.1. All defective welds shall be repaired and retested with ultrasonic equipment at the Contractor's expense.

e. 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.

f. 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.

g. The ultrasonic instrumentation will be calibrated by the technician to evaluate the quality of the welds in accordance with AWS D1.1.

h. 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.

i. 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.

j. End-welded studs shall be sampled, tested, and inspected per the requirements of AWS D1.1.

3. High Strength Bolting Tests and Inspection:

a. Furnish certified test reports for each lot of bolts in accordance with ASTM A325 and A490. Install bolts under the supervision of a qualified inspector in accordance with, Research Council "Specifications for Structural Joints using ASTM A325 or A490 Bolts".

b. 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.

c. While the work is in progress, the Inspector shall determine that the requirements of this Specification are met in the work. The Inspector shall observe the calibration procedures and shall monitor the installation of bolts to determine that all plies of connected material have been drawn together and that the selected procedure is properly used to tighten all bolts.

1) In addition to the requirement of the foregoing paragraph, for all connections specified to be slip critical (SC), the Inspector shall assure that the specified procedure was followed to achieve the pretension specified in the AISC. The pretension shall be verified by the inspector for these bolts.

2) Bolts in connections identified as not being slip-critical nor subject to direct tension need not be inspected for bolt tension other than to ensure that the piles of the connected elements have been brought into snug contact.

E. The approved laboratory shall review all submittals and testing of materials per Chapters 17A and 22A of the CBC.

PART 2 - PRODUCTS

2.01 PRODUCT HANDLING

A. Store materials to permit easy access for inspection and identification. Keep steel members off the ground, using pallets, platforms, or other supports. Protect steel members and packaged materials from erosion and deterioration.

B. Do not store materials on structure in a manner that might cause distortion or damage to members or supporting structures. Repair or replace damaged materials or structures as directed.

2.02 MATERIALS

A. Structural Steel W Shapes: ASTM A 992 Grade 50.

B. Structural Steel Plates and Channels ASTM A36 unless indicated otherwise.

C. Angles, plates and bars: ASTM A36 unless indicated otherwise on drawings.

D. Channels and other rolled shapes: ASTM A36 unless indicated otherwise on drawings.

E. AISC group 4 and 5 shapes and plates greater than 2 inches thick: ASTM A36 and/or ASTM A572 Grade 50 with supplementary requirements S91 Fine Austenitic Grain Size and S5 Charpy V-Notch Impact Test. 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° F.

F. HSS (Hollow Structural Sections – formerly SSP & TS):

1. Round: ASTM A-500, Grade C.

2. Rectangular or Square: ASTM A500, Grade C.

G. Cold-Formed Steel Tubing: ASTM A500, Grade B.

H. Steel Pipe: ASTM A53, Type E or S, Grade B.

I. Machine Bolts and Washers: Bearing and Shear connections (denoted as “MB”); ASTM A307. Provide hot-dipped galvanized finish at all connection where steel is required to be galvanized.

J. Anchor Bolts/Rods: ASTM A307 or ASTM A36. All anchor bolts cast in concrete or masonry shall be headed bolts with cut threads conforming to ASTM F1554 grade 36, 55 or 105.

K. High Strength Bolts, Nuts and Washers: Install in accordance with requirements for A325 and A490 slip critical and snug tight conditions as indicated on drawings. Install high strength bolts with snug tight type connections with threads included in shear plane except as otherwise noted. Install hardened washers in conformance with AISC Specifications.

L. Headed Stud-Type Shear Connectors: ASTM A108 Grade 1015 or 1020 Cold-finished carbon steel with dimensions complying with AISC Specifications.

Ultimate Tensile strength, 65,000 psi.

Elongation in 2 inches, 20 percent

Reduction of area, 50 percent.

M. Provide hexagonal heads and nuts for all connections per ASTM A563, Appendix Table X1.1.

N. Electrodes for Welding: Comply with AWS Code, E70 Series minimum. Fabricator to select proper electrodes according to weld procedures as submitted.

O. Powder Driven 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 approved equal.

P. Expansion Bolts: Hilti Fastening Systems “Kwik-Bolt TZ2 Concrete Expansion Anchors” to concrete or approved equal; Hilti Fastening Systems “Kwik-Bolt 3 Masonry Expansion Anchors” to masonry or approved equal.

Q. Arc-Welding Electrodes: AWS Standards E70 or equivalent, except no E70T-4 allowed.

R. Other Welding Materials: AWS D1.1; type required for materials being welded.

S. Utilize material with highest level of recycled content as practical.

2.03 ACCESSORIES

A. Grout: ASTM C 1107, Non-shrink, non-metallic aggregate type, capable of developing minimum compressive strength of 7,000 psi at 28 days.

B. Building Structural Steel Primers:

1. All paints shall meet the California Air Resources Board Standards and be compatible with finish coats specified in other sections. Follow manufacturers printed instructions and application of coats.

2. Type A Material: Modified Alkyd type.

3. Type B Material: Organic Zinc-rich Urethane.

4. Type C Material: MIO-Zinc Filled Primer.

a. Color to be selected by owner.

C. Galvanizing: ASTM A153, and A123.

D. Touch-Up Primer for Galvanized Surfaces: Type B primer.

2.04 FABRICATION

E. Fabricate as specified.

2.05 FINISHES

A. Finish paint Material: Aliphatic Acrylic Polyurethane, Series 73 which meets the accelerated weathering requirements of SSPC Paint Standard 36.

B. Prepare and finish structural component surfaces as specified.

C. Galvanize structural steel members exposed to weather and not finish painted, or as otherwise indicated to receive galvanizing, to comply with ASTM A123. Galvanize iron and steel hardware to comply with ASTM A153.

D. Do not finish work until inspection is complete and work approved by Testing Agency.

2.06 SOURCE QUALITY CONTROL

A. A DSA approved laboratory shall perform source quality control tests and submit reports, as specified in pertinent sections of Division 01 and Chapters 17A and 22A of the CBC.

B. Steel Materials Testing:

1. Unidentified steel - General: A DSA approved laboratory shall test all structural shapes. In addition, test to verify Fy and Fu values when engineering requirements exceed Fy = 25 ksi for design.

2. No testing is required for Materials identified in accordance with CBC Chapter 17A (heat number, grade stencil, etc.).

C. Shop Welding Inspection:

1. The DSA approved laboratory shall inspect and certify all structural welds, unless the fabricating shop has been accredited in conformance with CBC requirements.

D. Bolts, Nuts and Washers: Provide samples to DSA approved laboratory for required testing,

PART 3 - EXECUTION

3.01 EXAMINATION

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

3.02 FABRICATION

A. Shop Fabrication and Assembly: Fabricate and assemble structural assemblies in shop to greatest extent possible. Fabricate items of structural steel in accordance with AISC Specifications and as indicated on final shop drawings. Provide camber in structural members where indicated to provide the flattest floor possible. The contractor shall coordinate member tolerances with finishes.

B. Unless noted otherwise, make holes 1/16 inches larger than nominal bolt diameter.

3.03 HIGH STRENGTH BOLTS

A. Installation and Tightening:

1. Handling and Storage of Fasteners: Fasteners shall be protected from dirt and moisture at the job site. Only as many fasteners as are anticipated to be installed and tightened during a work shift shall be taken from protected storage. Fasteners not used shall be returned to protected storage at the end of the shift. Fasteners shall not be cleaned of lubricant that is present in as-delivered condition.

2. 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.

3. 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.

4. 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.

5. Mark bolts that have been completely tightened with an identifying symbol.

3.04 WELDING

A. General: Quality of materials and design and fabrication of all welded connections shall conform to AISC "Specification for Structural Steel Buildings," "AWS Code for Welding in Building Construction," “AWS D1.8 Seismic Supplement” and requirements of this section.

B. 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 of record.

C. Qualification of Welders:

1. Structural steel welding: Manual and automatic welds for structural steel construction shall be made only by operators who have been previous qualified by tests, as prescribed in AWS D1.1 to perform type of work required.

D. Control cooling process after weld is complete by either step down post heat or thermal blankets as determined by procedures and prequalification.

E. 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.

3.05 ERECTION

A. Erect structural steel in compliance with AISC "Code of Standard Practice for Steel Buildings and Bridges".

B. Do not make final connections until structure is aligned to meet specified tolerances.

3.06 ERECTION TOLERANCES

A. Structural steel erection: Comply with AISC "Specification for the Structural Steel Buildings", latest edition.

B. Maximum variation from plumb: 1/4 inch per story, non-cumulative.

C. Maximum offset from true alignment: 1/4 inch.

3.07 FIELD QUALITY CONTROL

A. The independent Testing Agency will perform field quality control tests, as specified in pertinent sections of Division 01.

3.08 ADJUSTING

A. Replace defective or damaged work which cannot be corrected in the field with new work, or return defective items to the shop for repair.

B. Architect/Engineer shall review and approve method of correction for the repair or replacement of damaged, defective, or missing work.

3.09 CLEANING AND PROTECTION

A. Clean all surfaces upon completion of erection, leave free of grime and dirt.

B. Protect work from damage by subsequent operations.

END OF SECTION

SECTION 05 30 00

METAL DECKING

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

A. Volume 1 – Contracting Requirements and Division-01 General Requirements apply to the work of this section.

1.02 SCOPE

A. Provide all materials, labor and accessories as required and specified for complete metal decking installation.

1.03 RELATED DOCUMENTS

A. Structural and Miscellaneous Steel: Section 05 12 00.

B. Metal Fabrications: Section 05 50 00.

C. Holes for Mechanical and Electrical Work: Divisions 21, 22, 23, and 26.

1. Cutting and reinforcing of holes for plumbing and electrical conduits shall be part of this work providing holes are located by the mechanical and electrical contractors prior to or during installation. Cutting and reinforcing of holes after installation shall be the responsibility of those trades requiring them.

2. Miscellaneous connection requirements for Mechanical and Electrical Work: Divisions 21, 22, 23, and 26.

1.04 SUMMARY

A. This section Includes the following:

1. Metal decking

B. Furnish all design and other services, material, labor and equipment as necessary for the fabrication, erection and completion of all metal decking, including all bracing and shoring required for erection, miscellaneous metal, and related work. Factory Mutual (FM) – Metal roof deck profiles shall be in conformance with FM where applicable.

C. Metal Decking is to be attached to the structural frame in conformance with AWS D1.1 and D1.3 “Specification for Welding Sheet Steel in Structures.”

1.05 ACTION SUBMITTALS

A. None

1.06 INFORMATIONAL SUBMITTALS

A. Shop drawings:

1. Prior to fabrication, prepare shop drawings for work under this section and submit to Architect. Shop drawings are to include deck layout, deck type and gauge, framing and support of openings, dimensions and sections, details of accessories and type and location of welds.

B. Product Data

1. Manufacturer's specifications for each Deck Type. Provide manufacturer’s product literature and relevant approvals

C. Certifications:

1. Steel Materials

a. Manufactures Mill Certificate

b. Mill Test Reports

D. Welders Certificates

E. Samples of color finish at exposed locations.

F. Maintenance Data

G. Test Reports

1.07 INFORMATIONAL SUBMITTALS

A. Manufacturer shall provide affidavits of approval by the International Code Council Evaluation Service (ICC-ES) for the metal decking shapes proposed.

1.08 QUALITY ASSURANCE

A. American Iron and Steel Institute (AISI). Specification for the Design of Cold - Formed Steel Structural Members. Specifically section properties.

B. American Welding Society (AWS): AWS D-1.3 "Structural Welding Code - Sheet Steel".

C. IAPMO UES Report No. 2018, 0161, and 0329.

D. California Building Code, California Code and Regulations, Title 24, (CBC) Chapters 17A and 22A. Latest Edition.

E. Steel Deck Institute (SDI) – Metal roof deck profiles shall be in conformance with SDI standards.

F. Testing and Inspection:

1. DSA statement of structural tests and special inspections (DSA-103) shall be prepared by the registered design professional in responsible charge.

G. The DSA approved laboratory shall review all submittals and testing of materials per Chapters 17A and 22A of the CBC.

1.09 DELIVERY, STORAGE AND HANDLING PRODUCTS

A. Protect decking with coverings while in transit and while stored at site.

1. Allow adequate air movement beneath coverings.

2. Provide blocking under stored decking to:

a. Provide sloped drainage.

b. Keep decking off ground.

PART 2 - PRODUCTS

2.01 GENERAL

A. Acceptable Manufacturers include but are not limited to the following:

1. ASC Steel Deck.

2. Verco Manufacturing Co.

3. Manufacturers of materials are indicated to set a standard for design and product performances.

4. Subject to the requirements of Division 1, products of manufacturers not indicated may be proposed for substitution, provided that they are equal in design, product performance and warranty to the products specified and have a valid evaluation report.

5. The burden of proof of equality of proposed products is on the Contractor.

2.02 MATERIALS

A. Materials shall comply with one or more of the following:

1. ASTM A653, Grade SS.

2. ASTM A924, G-60 or G-90.

B. Provide deck of type and gage designed by engineer. Deck units and all necessary items shall be formed from steel sheets conforming to ASTM-A653, structural quality. The steel sheets shall have received, before being formed, a metal protective coating of

Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed), conforming to ASTM-A653 Class G60 coating.

C. Roof Deck:

1. Type and Size: minimum 1-1/2 –inch, 18 gage, wide rib with nesting type side lap.

D. Provide deck sections, type and gage per the engineers design. Other manufacturers producing deck complying with the project specifications, and having equivalent properties and dimensions will be subject to the Architect's review upon submission of substantiating data, and may be used only if equivalent to deck sections specified, in the Architect's opinion.

E. All deck units shall be approved by International Code Council Evaluation Service (ICC-ES) for use as a diaphragm.

1. Diaphragm shear capacities shall be comparable (within 5%) to those listed on the drawings for the deck, welding, and spans indicated.

F. Welding rods: E60XX minimum.

2.03 FABRICATION

A. Fabricate to obtain continuity over as many spans as practicable.

B. Form members to manufacturer's standard shapes meeting design criteria.

C. Prime un-galvanized steel.

PART 3 - EXECUTION

3.01 ERECTION

A. General:

1. Erect decking and weld to supports in accordance with manufacturer's specifications and as specified by the structural engineer.

2. Field cutting of openings through the deck shall be less than 16 square feet in area. Perform skew cutting in the field.

3. Touch up damaged galvanized areas with a zinc rich paint meeting ASTM D520.

B. Roof Deck:

1. Anchoring: Anchor deck to all steel supporting members as specified by the structural engineer.

2. Side Laps: Fasten as specified by the structural engineer.

3. Side Termination of Roof Deck: At edges of roof and at openings in roof deck where a structural steel supporting member occurs, the bottom of a flute shall occur and bear on one of the following:

   a. Supporting steel member.

   b. A Channel Shaped Member:

      1) Connected to both the metal deck and the steel supporting member below with the same connection type as specified by the structural engineer for anchoring deck to structural members.

      2) The channel depth shall match the metal roof deck depth.

      3) The length of the horizontal legs of the channel shall be as required to obtain bearing.

4. Span Direction Changes of Roof Deck: Where (if occurs) roof deck changes direction of span, and there is no provision in the structure for an expansion joint, reinforce the discontinuity at the joint as specified by the structural engineer.

C. Inspection:

1. Examine areas to receive work specified. Do not begin work until underlying work is complete, all required inspections have been made, and all conditions which might prevent proper installation or impair performance of work have been corrected.

D. Erection:

1. Deck shall be laid true to line and shall be without deformations, creases, wrinkles or noticeable defects.

3.02 DEFECTIVE WORK AND MATERIALS

A. Work found to be defective, deformed or damaged shall be immediately removed and/or replaced at no cost to the State.

3.03 TOUCH UP AND CLEANING

A. All welds and abrasions on deck surfaces not covered by concrete shall be touched up using a zinc dust-zinc oxide primer.

B. Burn spots on supporting exposed steel shall be touched up with same primer as used on adjacent surface.

C. Clean surfaces of installed deck by effective means to receive sprayed-on fireproofing or finish painting.

D. Prior to acceptance of the work of this section, thoroughly clean deck and affected areas.

END OF SECTION

SECTION 05 40 00

COLD-FORMED METAL FRAMING

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

A. Volume 1 – Contracting Requirements and Division-01 General Requirements apply to the work of this section.

1.02 SCOPE

A. Provide all materials labor and accessories as required and specified for complete cold-formed metal framing installation.

1.03 RELATED DOCUMENTS

A. Pertinent Sections of Division 01 Specifying Quality Control and Testing Agency Sections.

B. Pertinent Sections of Division 05 Specifying Structural Steel.

1.04 SUMMARY

A. This section Includes the following:

1. Cold-formed metal framing.

2. All design and other services, material, labor and equipment as necessary for the fabrication, erection and completion of all cold formed metal framing including all bracing and shoring required for erection, miscellaneous metal, and related work.

1.05 ACTION SUBMITTALS

A. None

1.06 INFORMATIONAL SUBMITTALS

A. ICC-ES report.

B. Mill certificates verifying steel properties.

C. Shop drawings

D. Structural calculations

E. Product Data:

1. Manufacturers catalog with sizes to be used indicated

1.07 QUALITY ASSURANCE

A. Specification for the Design of Cold-Formed Steel Structural Members American Iron and Steel Institute.

B. Cold-Formed Steel Design Manual, latest edition, American Iron and Steel Institute.

C. California Building Code, California Code and Regulations, Title 24, (CBC) Chapter 22A.

D. American Society for Testing and Materials (ASTM).

E. American Welding Society (AWS)..

F. Federal Specifications (FS)

1. TT-P-664C(1), Primer Coating, Synthetic, Rust-inhibiting, Lacquer-resisting.

G. Erector Qualifications:

1. Welders Qualified in accordance AWS D1.3.

H. Cold form carbon and low alloy steel used for structural purposes shall be identified per CBC Section 2203A.3.

I. Welding inspections shall conform to AWS D1.3.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Protect metal framing units from rusting and damage.

B. Deliver to Project site in manufacturer's unopened containers or bundles, identified with name, brand, type and grade.

C. Store off ground in a dry ventilated space or protect with suitable waterproof covering.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Members of the Steel Stud Manufacturer’s Association (SSMA)with products meeting all the requirements of ICC-ESR-3064P, or equal.

2.02 METAL FRAMING

A. All stud and/or joist framing members shall be of the type, size as specified by engineer.

B. All runner and end tracks, bridging and non-load bearing studs shall be of the type, size as specified by engineer.

C. Material and Finishes

1. All 14 and 16 gage steel studs and steel joists or headers to joist shall be formed from steel that corresponds to the requirements of the following standards with a minimum yield of 50,000 psi with highest level of recycled content as practical:

    a. 54 Mils (16 Gauge) and Thicker: Fabricate metal framing components of structural quality (SQ) steel sheet with a minimum yield point of 50,000-psi; conforming to ASTM A653, SS Grade 50, Class 1 or 3 or ASTM A1011, SS Grade 50.

2. All 12, 14 and 16 gage track and bridging shall be formed from steel that corresponds to the requirements of the following Standards with a minimum yield of 50,000 psi:

    a. 54 Mils (16 Gauge) and Thicker: Fabricate metal framing components of structural quality (SQ) steel sheet with a minimum yield point of 50,000-psi; conforming to ASTM A653, SS Grade 50, Class 1 or 3 or ASTM A1011, SS Grade 50.

3. All 18 and 20 gage steel studs, joists, track, bridging and accessories shall be formed from steel that corresponds to the requirements of the following Standards with a minimum yield of 33,000 psi:

    a. Painted Material - ASTM A1008, Grade C.

    b. 43 Mils (18 Gauge) and Thinner: Fabricate metal framing components of structural quality (SQ) steel sheet with a minimum yield point of 33,000-psi; conforming to ASTM A653, SS Grade 33 or ASTM A1011 SS Grade 33)

4. All stud and joist components shall be formed from steel having a G-60 galvanized coating or shall be primed with paint meeting the performance requirements TT-P-636C.

    a. Primer: FS TT-P-664, Composition G - General Use.

D. Welding Electrodes: E60XX.

E. Galvanizing Repair Paint: High zinc-dust content paint for repair of galvanized surfaces damaged by welding.

F. Material Thickness: All sections are to be roll formed in various depths with the following minimum bare metal thicknesses:

Minimum Thick-ness (inch)	Minimum Design Thickness (inch)	Gauge	Mils
0.0329	0.0346	20	33
0.0428	0.0451	18	43
0.0538	0.0566	16	54
0.0677	0.0713	14	68
0.0966	0.1017	12	97
0.1180	0.1240	10	118

G. Welding Electrodes: AWS A5.1 E 6013 Rods, AWS A5.18 (Gas Metal Arc).

H. Screws: IFI-113 - "Steel self-drilling tapping screws"

I. Fasteners: Cold-formed metal framing manufacturer's standard and/or standard machine bolts per ASTM A307.

J. Accessories: Cold-formed metal framing manufacturer's standard.

2.03 FABRICATION

A. Form members to manufacturer's standard shapes meeting design criteria.

B. Prime un-galvanized steel.

PART 3 - EXECUTION

3.01 ERECTION

A. Install metal framing systems in accordance with the engineered drawings. Where drawings conflict with manufacturer’s recommendations, the Structural Drawings will govern.

B. Connect members together by welding and/or fasteners.

C. Wall system shall provide for movement of components without damage, failure of joint seals, undue stress on fasteners, or other detrimental effects when subject to seasonal or cyclic day/night temperatures.

D. Wall system shall accommodate construction tolerances, deflection of building structural members, and clearances of intended openings.

E. Perform welding in accordance with AWS D1.3.

F. Remove erection bolts and screws used in welded construction.

3.02 DEFECTIVE WORK AND MATERIALS

A. Work found to be defective, missing or damaged shall be immediately replaced with proper work.

3.03 CLEANING

A. After erection, all surfaces shall be cleaned and left free of all grime and dirt.

END OF SECTION

SECTION 05 50 00

METAL FABRICATIONS

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

A. Volume 1 – Contracting Requirements and Division-01 General Requirements apply to the work of this section.

1.02 SCOPE

A. Provide all materials, labor and accessories as required and specified for complete metal fabrication installation.

1.03 RELATED DOCUMENTS

A. Structural Steel: Section 05 12 00

1.04 SUMMARY

A. This Section includes the following:

1. Steel framing and supports for floor mounted overhead braced toilet compartments.
2. Steel framing and supports for countertops.
3. Steel framing and supports for mechanical and electrical equipment.
4. Steel framing and supports for applications where framing and supports are not specified in other sections.
5. Loose bearing and leveling plates for applications where they are not specified in other sections.
6. Support steel for PMA Dummy.
7. Steel for ladder for roof access hatch.

1.05 ACTION SUBMITTALS

A. Grout

B. Color charts for initial color selection.

C. Samples of color for final selection.

1.06 INFORMATIONAL SUBMITTALS

A. Mill Certificates: Signed by manufacturers of stainless-steel certifying that products furnished comply with requirements.

B. Welding certificates.

C. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers certifying that shop primers are compatible with topcoats.

D. Shop Drawings:

1. Prior to fabrication, prepare shop drawings for work under this section. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items.

2. Provide structural calculations by qualified professional engineer for steel framing and supports.

E. Product Data:

1. Bicycle Racks

2. Metal Sun Screens

3. Paint Products

F. Product samples if requested by the State or Architect.

G. Maintenance Data

1.07 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code - Steel."

B. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1, "Structural Welding Code - Steel."

2. AWS D1.2, "Structural Welding Code - Aluminum."

3. AWS D1.6, "Structural Welding Code - Stainless Steel."

1.08 PROJECT CONDITIONS

A. Field Measurements: Verify actual locations of walls and other construction contiguous with metal fabrications by field measurements before fabrication.

1.09 COORDINATION

A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.

B. Coordinate installation of anchorages and steel weld plates and angles for casting into concrete. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

2.02 METALS

A. Metal Surfaces, General: Provide materials with smooth, flat surfaces without blemishes.

B. Ferrous Metals:

1. Steel Plates, Shapes, and Bars: ASTM A36.

2. Stainless Steel Bars and Shapes: ASTM A276, Type 304.

3. Rolled Steel Floor Plate: ASTM A786, rolled form plate complying with ASTMA36 or ASTM A283, Grade C or D.

4. Rolled Stainless Steel Floor Plate: ASTM A793.

5. Steel Tubing: ASTM A500 Grade C, cold formed steel tubing.

6. Steel Pipe: ASTM A53 Type E or S, Grade B, standard weight (Schedule 40), unless another weight is indicated or required by structural loads.

7. Slotted Channel Framing: Cold formed metal channels complying with MFMA-3, 1-5/8 by 1-5/8 inches. Channels made from galvanized steel complying with ASTM A653, structural steel, Grade 33, with G90 coating; 0.079 inch nominal thickness.

8. Cast Iron: ASTM A48, Class 30, unless another class is indicated or required by structural loads.

C. Non-ferrous Metals:

1. Aluminum Extrusions: ASTM B221, alloy 6063-T6.

2. Aluminum Alloy Rolled Tread Plate: ASTM B632, alloy 6061-T6.

3. Aluminum Castings: ASTM B26, alloy 443.0-F.

2.03 FASTENERS

A. General: Type 304 stainless steel fasteners for exterior use and zinc plated fasteners with coating complying with ASTM B633, Class Fe/Zn5, at exterior walls. Provide stainless steel fasteners for fastening aluminum. Select fasteners for type, grade, and class required.

B. Cast-in-Place Anchors in Concrete: Threaded or wedge type; galvanized ferrous castings, either ASTM A47 malleable iron or ASTM A27 cast steel. Provide bolts, washers, and shims as needed, hot dip galvanized per ASTM A153.

2.04 MISCELLANEOUS MATERIALS

A. Universal Shop Primer: Fast curing, lead and chromate free, universal modified alkyd primer complying with MPI #79.

B. Galvanizing Repair Paint: SSPC-Paint 20, high zinc duct content paint for re-galvanizing welds in steel.

C. Non-shrink, Non-metallic Grout: Factory packaged, non-staining, non-corrosive, non-gaseous grout complying with ASTM C1107.

D. Concrete Materials and Properties: Comply with requirements in Section 03 30 00 “Cast-in-Place Concrete” for normal weight, air entrained, ready mix concrete with a minimum 28 day compressive strength of 3000 psi, unless otherwise indicated.

2.05 FABRICATION

A. General: Preassemble items in the shop to greatest extent possible. Use connections that maintain structural value of joined pieces.

1. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges. Remove sharp or rough areas on exposed surfaces.

2. Weld corners and seams continuously. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals. Obtain fusion without undercut or overlap. Remove welding flux immediately. Finish exposed welds smooth and blended.

3. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners where possible. Locate joints where least conspicuous.

4. Fabricate seams and other connections that will be exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.

5. Where units are indicated to be cast into concrete or built into masonry, equip with integrally welded steel strap anchors, not less than 24 inches o.c.

B. Miscellaneous Framing and Supports: Provide steel framing and supports not specified in other sections as needed to complete the work. Fabricate units from steel shapes,

plates, and bars of welded construction. Cut, drill, and tap units to receive hardware, hangers, and similar items.

1. Fabricate steel girders for wood frame construction from continuous steel shapes. Where wood nailers are attached to girders with bolts or lag screws; drill holes at 24 inches on center.

2. Fabricate steel pipe columns for supporting wood frame construction with steel baseplates and top plates welded to pipe with fillet welds the same size as pipe wall thickness.

C. Miscellaneous Steel Trim: Fabricate units from steel shapes, plates, and bars of profiles shown with continuously welded joints and smooth exposed edges. Miter corners and use concealed field splices where possible. Provide cutouts, fittings, and anchorages as needed to coordinate assembly and installation with other work.

1. Exterior Miscellaneous Steel Trim: Galvanize.

2.06 FINISHES

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes. Finish metal fabrications after assembly.

B. Steel and Iron Finishes:

1. Hot-dip galvanized items to comply with ASTM A123 or ASTM A153 as applicable. Hot-dip galvanize:

a. Items exposed to outside air.

b. Items installed in unconditioned interior spaces.

c. Items specifically noted to receive galvanized finish.

2. Preparation for Shop Priming: Prepare uncoated ferrous metal surfaces to comply with requirements indicated below for environmental exposure conditions of installed metal fabrications.

3. Shop Priming: Apply shop primer to uncoated surfaces of metal fabrications, except those with galvanized finishes and those to be embedded in concrete, sprayed-on fireproofing, or masonry, to comply with SSPC-PA 1, "Paint Application Specification No.1: Shop, Field, and Maintenance Painting", for shop painting.

PART 3 - EXECUTION

3.01 INSTALLATION, GENERAL

A. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.

B. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.

C. Field Welding: Comply with the following requirements:

D. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.

E. Obtain fusion without undercut or overlap.

F. Remove welding flux immediately.

G. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

H. Fastening to In-Place Construction: Provide anchorage devices and fasteners where metal fabrications are required to be fastened to in-place construction. Provide threaded fasteners for use with concrete and masonry inserts, toggle bolts, through bolts, lag screws, wood screws, and other connectors.

I. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.

J. Corrosion Protection: Coat concealed surfaces of aluminum that will come into contact with grout, concrete, masonry, wood, or dissimilar metals with the following:

K. Cast Aluminum: Heavy coat of bituminous paint.

L. Extruded Aluminum: Two coats of clear lacquer.

3.02 INSTALLING MISCELLANEOUS FRAMING AND SUPPORTS

A. General: Install framing and supports to comply with requirements of items being supported, including manufacturers' written instructions and requirements.

B. Anchor supports for operable partitions securely to and rigidly brace from building structure.

C. Support steel girders on solid grouted masonry, concrete or steel pipe columns. Secure girders with anchor bolts embedded in grouted masonry or concrete or with bolts through top plates of pipe columns.

D. Where grout space under bearing plates is indicated for girders supported on concrete or masonry, install as specified in "Installing Bearing and Leveling Plates" Article.

E. Install pipe columns on concrete footings with grouted baseplates. Position and grout column baseplates as specified in "Installing Bearing and Leveling Plates" Article.

F. Grout baseplates of columns supporting steel girders after girders are installed and leveled.

3.03 INSTALLING BEARING AND LEVELING PLATES

A. Clean concrete and masonry bearing surfaces of bond-reducing materials, and roughen to improve bond to surfaces. Clean bottom surface of plates.

B. Set bearing and leveling plates on wedges, shims, or leveling nuts. After bearing members have been positioned and plumbed, tighten anchor bolts. Do not remove wedges or shims, but if protruding, cut off flush with edge of bearing plate before packing with grout.

C. Use non-shrink grout, either metallic or nonmetallic, in concealed locations where not exposed to moisture; use non-shrink, nonmetallic grout in exposed locations unless otherwise indicated.

D. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

3.04 ADJUSTING AND CLEANING

A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas. Paint uncoated and abraded areas with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.

1. Apply by brush or spray to provide a minimum 2.0-mil (0.05-mm) dry film thickness.

B. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.

END OF SECTION

SECTION 11 11 00

VEHICLE SERVICE EQUIPMENT

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes.

1. Vehicular Lift.
2. Vehicle Exhaust Extraction system.
3. Vehicle Service Delivery Systems:
   a. Water and Compressed Air.
4. Overhead Electrical Cord Retracting Reels.
5. Parts Washing Tank.
6. Tire Storage Rack.
7. Industrial Storage Shelves.
8. Waste Oil Containment Tank.
9. Air Compressor (refer to Section 22 15 19).
10. Technicians Work Bench.
11. Windshield Service Center (at Vehicle Fueling Area)
12. Vehicle Fluid Delivery System (at Vehicle Fueling Area)

B. Volume 1 - Contracting Requirements, and Division -01 General Requirements apply to the Work of this Section.

1.02 ACTION SUBMITTALS

A. Submit under provisions of Section 01 33 00.

B. Product Data: For each type of product indicated. Include the following:

1. Manufacturer's model number.
2. Accessories and components that will be included for Project.
3. Clearance requirements for access and maintenance.

4. Utility service connections for water, drainage, power, and fuel; include roughing-in dimensions.

1.03 INFORMATIONAL SUBMITTALS

A. Operation Instructions and Maintenance Data.

1.04 COORDINATION

A. Coordinate equipment layout and installation with other work, including layout and installation of lighting fixtures, HVAC equipment, and fire-suppression system components.

B. Coordinate locations and requirements of utility service connections.

C. Coordinate sizes, locations, and requirements of the following:

1. Overhead equipment supports.

2. Equipment bases.

1.05 RELATED REQUIREMENTS

A. Anchorage requirements per Chapter 13 of ASCE 7-16.

1.06 AIDS TO USE

A. All record documentation, Operation and Maintenance Data and training shall be provided in accordance with Division 1 – General Requirements.

B. Upon completion, the Contractor shall provide:

1. Manuals of operating and maintenance literature, pursuant to the requirements of the General Conditions.

2. Contractor to provide training for the CHP personnel in the operation, upkeep and basic maintenance of the system, pursuant to the requirements of the General Conditions.

PART 2 - PRODUCTS

2.01 MATERIALS

A. The Basis of Design products listed are for reference only. CONTRACTOR's have the option to submit an equal product that provides similar quality. Other manufactures exist that can be priced during the proposal period that the CONTRACTOR finds to be equal.

B. Vehicle Lift: Standard two-post hydraulic vehicle lift designed for passenger automobiles and light trucks. Provide complete operational system with required hardware and fittings.

1. Basis of Design: Mohawk (Model LMF-12), BendPak or approved equal.

2. Description:

    a. Capacity: Minimum 12,000 lbs.

    b. Speed of Rise: Maximum 60 seconds minimum from floor to full height.

    c. Lifting Height: 77 inches minimum. The dimension is measured from the floor to underneath the swing arm when the lift is at full height.

3. The lift equipment shall conform to the safety requirements of ASNI/ALI ALCTV, Standard for Automotive Lifts – Safety Requirements for Construction, Testing and Validation.

4. The lift shall be certified by the Automotive Lift Institute. A copy of the listing certification shall be supplied as part of the acceptance.

5. The equipment must be supplied with all ANSI, ALI/ETL Safety Decals. Decals shall be permanently placed on the Lift in clear view for the operator.

6. Lifting Columns (twin post): Each column will be approximately 19-inches wide by 9-inches deep and constructed of approx. 3/4-inch steel. Each column base plate will be made from 3/4-inch thick Grade A36 steel plates, minimum. Base plate size shall be as required per structural calculations.

7. Locks: Provide arm restraint system that engages when the lift is raised and disengage when the lift is fully lowered. Shall have gravity activated locks in each column that works independently of each other and shall start locking at a minimum of approx. five inches off the floor. The mechanical locks in each column will engage every 3-5 inches (approximate) to full lifting height. Each individual locking device shall be capable of supporting the entire rated load of the lifting leg.

8. Carriage Assembly: Each column will have a carriage constructed of approximately 3/4-inch steel plates joined to a backer plate. The carriage assembly will roll up and down in columns on eight double sealed self-lubricating steel ball bearing rollers per carriage. Plastic or nylon slide blocks and bushing type rollers are not acceptable. Carriage assembly wear surfaces shall be completely sealed and self-lubricating. The carriage will be lifted by 1 3/4-inch wide leaf chain (minimum) rolling over two double sealed self-lubricating chain bearings.

9. Lifting Arms: Minimum height from floor to top of lifting pad is approximately 3 to 4 inches, constructed of structural tubing with a tensile strength of 75,000 PSI and yield strength of 60,000 PSI minimum. Lifting arms will have a closed reach of 35-40-inch and an open reach of 53-56 inches. Asymmetrical lift arms are not acceptable. Lifting arms will be equipped with arm restraints that operate automatically. Load Capacity per Arm: 2,500 lb minimum.

10. Lifting Dimensions: Column height shall be approx. 100 to 104-inches maximum. Width between columns shall be approx. 10 feet standard. Width between lifting arms shall be approx. 103 to 106, adjustable for wider vehicles.

11. Hydraulics: The lift shall incorporate a master / slave hydraulic system which synchronizes elevations during both raising and lowering operations with the most adverse rated load placed on the lift the lift shall come equipped with fully automatic leveling control and manual over-ride as a backup. Chain or cable equalized lifts are not acceptable. Internal hydraulic safeties on both cylinders shall detect main-side to offside pressure differentials of less than 200 lbs. should the lifts pressure change or an imbalance condition occur for any reason, the lift will hydraulically lock on both sides.

    a. Hydraulic cylinders will be made of chrome rod.

    b. Full load working pressure will be a maximum of 2,300 PSI.

    c. Cylinder packing consists of dynamic piston T-Seals, two back up rings, two static o-rings, rod wiper and rod T-seals.

    d. Lift will be equipped with external hydraulic safeties consisting of velocity fuses mounted on each cylinder which hydraulically lock in the event of a leak.

    e. Seamless stainless steel hydraulic tubing with a burst rating of 14,000 PSI minimum.

    f. All hydraulic fittings will be standard JIC or O-ring boss fittings.

12. Power Unit: Electric/hydraulic power unit will be an electric motor with 4 HP, 208V/230V 1 phase, 60 Hz. The hydraulic pump consists of a steel oil reservoir, suction strainer, hydraulic gear pump and valving.

13. Quality Assurance: The manufacturer must be a firm regularly engaged in eh design and manufacturing of the type of equipment specified herein for a minimum of five years. The equipment being offered must be a model that has been in the production for a minimum of five years.

14. Installation: The lift equipment must be installed in accordance with ANSI/ALI ALIS-2009 Standard for Automotive Lifts – Safety Requirements for Installation and Service.

15. Warranty: Standard warranty on all structural components and power unit warranty is a full five years.

16. Product Literature:

    a. The lift equipment must be supplied with ANSI/ALI ALOIM Standard for Automotive Lifts – Safety Requirements for Operation, Inspection and Maintenance information.

    b. ANSI/ALI Lifting it right booklet (ALI Standard #ALI-SM).

    c. ANSI/ALI Lifting point guide booklet (ALI Standard #ALI/LP-Guide).

    d. ANSI/ALI Safety decals affixed to lift.

C. Vehicle Exhaust Extraction System: The vehicle exhaust extraction system shall consist of a complete motorized hose reel and a motorized exhaust system.

1. Basis of Design: Monoxivent 9000 with 4000 series 6” diameter hose, Nederman 865 or approved equal.

2. Hose Reel: The hose reel side mounting support frame shall be constructed of approx. 11 gauge cold rolled steel. The hose reel shall have a hose to drum connection fitting allowing connection of hose.

3. Hose Drum: Shall be constructed of approx. 16 gauge cold rolled steel. The drum shall be formed and rolled to an approx. 18" diameter. The hose reel drum shall also be supplied with a hose tracking bar to guide the hose during recoiling function.

4. Drum end flanges: Shall be constructed of approx. 16 gauge cold rolled steel.

5. Side Fitting: The side discharge fitting is a complete bearing fitting and allows for the connection of approx. 6" diameter discharge duct.

6. Motor for Reel: Shall be a direct drive planetary gear function motor - asynchronous, totally enclosed.

   a. Shall be single phase 220 V, 60 hz, with built in start run capacitor, built in brake, built in Up/Down limit control knobs, anti-corrosion coating and manual override.

   b. Motor unit shall be supplied with double pole spring rocker switch Up/Down function and automatically returns to center, which is neutral position. Switch also supplied with Switch Plate and can be wall or column mounted. The motor shall be equipped with a manual override.

7. Exhaust Blower Motor: The blower housing and wheel are spark-proof and constructed of aluminum. The wheel is of a radial type. The motor shall be a totally enclosed fan Cooled 220v / 1 Phase / 20 amp UL and CSA rated.

   a. Blower fan shall be sized to remove exhaust from vehicles that test at 3,000 rpm. Fan to provide at least 550 cfm airflow.

8. Finish: The entire hose reel shall be protected by polyester powder coating for longevity and to resist corrosion.

9. Tail-pipe adapters for passenger cars, light duty trucks and Vans, including dual tailpipe adaptors (Y adaptor Kit).

D. Vehicle Fluid Delivery Systems: Shall include reels, reel hoses, compressed air, air lines, regulators, lubricators, piping, valves and pumps as required for a complete system. Reels shall be installed above the Vehicle Lifts. Contractor shall engineer the structure above to receive direct mounting of overhead reels.

1. Manufacturer shall be accredited under ANSI-ASQ National Accreditation Board (ANAB) for:

a. ISO 9001 quality management systems (QMS) accredited.

b. ISO 14001 environmental management systems (EMS) accredited.

2. Basis of Design: Graco / Reelcraft or approved equal.

3. Overhead Retractable Reels Basis of Design: Graco XD Series, Reelcraft D80000 series or approved equal.

a. Heavy Duty dual pedestal frame.

b. Separate Reels for the following:

1) Compressed Air.

2) Water.

c. Graco Model HSL25B / Reelcraft DP7650 OLP or approved equal.

1) Air/Water.

a) 300 PSI.

b) 3/8” ID hose by 50’ long.

c) Inlet 1/2”, Outlet 3/8”

E. Overhead Electrical Cord Retracting Reels:

1) Basis of Design: Reelcraft Model L4545 123 7A or approved equal.

a) 3 conductor, 12AWG, 125 AC, 20 AMP.

b) 45’ Cord with GFCI Duplex Outlet Box.

F. Parts Washing Tank (Armory Room):

1. Basis of Design: CleanMaster #CM200 (Armory) or approved equal products.

a. CleanMaster #CM200

1) 30 Gal. Tank Free Standing Parts Washer.

2) 35 1/4” L. x 24 1/2” W. x 35 1/8” H.

3) 18 gauge steel construction.

4) 205GPH@1Ft, Voltage 120V/60Hz grounded.

5) Powder Coated Steel Construction, For Use With mineral spirits, petroleum-based solvents, Standards UL Pump, Includes Large Components Shelf and Small Parts Tray.

G. Tire Storage Rack (New and Used Tire Storage):

1. Heavy Duty Steel Tire Rack.

   a. Tire capacity – See Volume 2 – Facility Design Program.

   b. 96” wide by 18” deep by 72” high.

   c. Single entry, three levels.

   d. Formed horizontal beams, adjustable. Beam design shall provide a flat surface area where tire contacts beam to reduce tire fatigue and deformity.

   e. Boltless design with 12-gauge beam connectors.

   f. Cross braced for added strength.

   g. 14-gauge steel uprights 1-3/4" x 1-3/4".

   h. Gray powder coat finish.

H. Industrial Storage Shelves :

1. Basis of Design: Lyons Industrial shelving or approved equal.

2. Bulk Storage Heavy Duty Rack (Part Storage Room):

   a. 48”W x 24”D x 84”H.

   b. (6) shelves, (4) adjustable and (2) stationary, top and bottom with1,000 lb. per shelf load capacity.

   c. Powder coated painted finish.

3. Full Height Storage Cabinets (Tool Storage and Work Area).

   a. Heavy Duty Units.

   b. 36”W x 24”D x 82”H.

   c. (4) Adjustable shelves with1,000 lb. per shelf load capacity.

   d. Lockable pair of metal doors.

   e. Powder coated painted finish.

I. Waste Oil Containment Tank:

1. Complies with the latest EPA and NFPA 30 standards for waste oil storage containers
2. Steel Double wall UL rated 142
3. Corrosion resistant exterior coating
4. 250 gallon capacity
5. 7 gallon spill box
6. 2 lifting lugs
7. Moveable by forklift
8. Tank Level Monitor by Graco model 256285 or approved equal

J. Air Compressor (Air Compressor Room):

1. Refer to Section 221519.

K. Technician Work Bench (Tool Storage Work Area & Service Equip. Area):

1. Basis of Design: Burroughs Corp., Series 120 or approved equal.
2. Heavy Duty units.
3. 72”W x 28”D x 34”H.
4. Stainless Steel Top.
5. Powder Coated Painted Finish for frame and legs.

L. Windshield Service Center (at Vehicle Fueling area):

1. Basis of Design: DCI or approved equal.
2. Large 25-gallon trash capacity.
3. Lift-off trash lid.
4. Shall include one squeegee and removable water bucket.
5. Accommodates folded towels.
6. Molded from high-density polyethylene
7. Size: 30 H x 18-1/2" W x 19" D.
8. Color: Black.

M. Vehicle Fluid Delivery System (at Vehicle Fueling Area): Shall include pedestal, reels, reel hoses, compressed air, air lines, regulators, lubricators, piping, valves and pumps as required for a complete system. Pedestal shall be installed near the fuel pumps.

1. Basis of Design: Duro Reel Technology Hose Guardian or approved equal.

2. Pedestal Retractable Reels Basis of Design: Hose Guardian 50-31 or approved equal.

   a. Heavy cast aluminum base with heavy stainless steel shroud.

   b. Separate Reels for the following:

      1) Compressed Air.

      2) Water.

END OF SECTION

SECTION 11 11 26

VEHICLE WASHING EQUIPMENT

PART 1 - GENERAL

1.01 SUMMARY

A. Volume 1 - Contracting Requirements, and Division -01 General Requirements apply to the Work of this Section.

B. Wash waters generated from the vehicle washing equipment shall be addressed per the local Stormwater Quality Control Standards for New Development and Redevelopment, State of California's water control requirements, and other governing codes and regulations.

C. This Section includes the following:

1. Vehicle wash system and accessories.

2. Wash-water recycling system.

1.02 ACTION SUBMITTALS

A. Submit under provisions of Section 01 33 00.

1. Product Data for all equipment.

1.03 INFORMATIONAL SUBMITTALS

A. Operation Instructions and Maintenance Data.

B. Other as specified.

1.04 RELATED REQUIREMENTS

A. Anchorage requirements per Chapter 13 of ASCE 7-16.

PART 2 - PRODUCTS

2.01 PRESSURE WASHER SYSTEM

A. Provide a space conservative stack system with all-welded stainless-steel construction (frames, tanks and panels); compact, self-contained, pre-plumbed and pre-wired; single or three-phase; 5-hp motors with pumps; high- and low-pressure systems (soap, foam brush, and rinse) in the same unit; simple maintenance; all bay equipment included in car wash package.

B. Basis of Design D & S Carwash Equipment Modular System, Dultmeier Car Wash cleaning systems, Hotsy or approved equal. Please note that electrical components not

protected by NEMA 4 enclosures will need to be shielded from direct water spray by a building wall.

C. Pressure Wash System:

1. High-pressure soap.

2. Foam brush.

3. Cold water rinse.

D. Bay Accessories:

1. Stainless Steel 360 degree boom dual.

2. Bay manifold.

3. Foaming brush, wand hose.

4. Stainless steel wand holder.

5. Hose.

2.02 WASH-WATER RECYCLE SYSTEM

A. Basis of Design: Water Maze's EC2-20A, Mi-T-M BIO-15-030 or approved equal.

B. CONTRACTOR shall provide, install a complete water recycling management system. The system shall treat wash water and other industrial waste water that contains suspended solids, emulsified oils, and heavy metals. This system shall utilize a water treatment technology and chemical flocculation to process and remove elements from the waste water. The water shall be processed and discharged to sewer (unless prohibited by the AHJ) or held for recycle.

C. Wash-water recycling system shall be an Advanced Bio Remediation (ABS) system or and Advanced Electro-coagulation (EC) system.

END OF SECTION

SECTION 11 20 00

COMMERCIAL EQUIPMENT

PART 1 - GENERAL

1.01 SUMMARY

A. This Section includes:

1. Evidence Refrigerator.
2. Evidence Drying Cabinet.
3. Defibrillator.
4. Ice Machine and Filter.
5. Gun Safe
6. Peg Board Panel
7. Floor Exercise Mats

B. Volume 1 - Contracting Requirements, and Division -01 General Requirements apply to the Work of this Section.

1.02 RELATED REQUIREMENTS

A. Anchorage requirements per Chapter 13 of ASCE 7-16.

1.03 ACTION SUBMITTALS

A. Submit under the provisions of Section 01 33 00.

B. Product Data: For each type of product indicated. Include the following:

1. Manufacturer's model number.
2. Accessories and components that will be included for Project.
3. Clearance requirements for access and maintenance.
4. Utility service connections for water, drainage, and power; include roughing-in dimensions.

C. Samples for Selection: For units with factory-applied color finishes.

D. Samples for Verification: For each factory-applied color finish required, in manufacturer's standard sizes.

1.04 INFORMATIONAL SUBMITTALS

A. Shop Drawings: For fabricated equipment. Include plans, elevations, sections, roughing-in dimensions, fabrication details, utility service requirements, and attachments to other work.

B. Coordination Drawings:

1. Indicate locations of commercial equipment and connections to utilities.
2. Key equipment using same designations.
3. Include plans and elevations; clearance requirements for equipment access and maintenance; details of equipment supports; and utility service characteristics.
4. Include details of seismic bracing for equipment.

C. Warranty: Samples of special warranty.

D. Closeout Submittals

1. Operation and Maintenance Data: For commercial equipment to include in emergency, operation, and maintenance manuals.

a. Product Schedule: For each commercial equipment item, include the following:

1. Manufacturer's name and model number.

2. List of factory-authorized service agencies including addresses and telephone numbers.

1.05 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.06 AIDS TO USE

A. All record documentation, Operation and Maintenance Data and training shall be provided in accordance with Division 1 – General Requirements.

B. Upon completion, the Contractor shall provide:

1. Manuals of operating and maintenance literature, pursuant to the requirements of the General Conditions.

2. Contractor to provide training for the CHP personnel in the operation, upkeep and basic maintenance of the system, pursuant to the requirements of the General Conditions.

PART 2 - PRODUCTS

2.01 The Basis of Design products listed are for reference only. CONTRACTOR shall have the option to submit an equal product that provides similar quality. Other manufacturers exist that can be priced during the proposal period that the CONTRACTOR finds to be equal.

2.02 EQUIPMENT

A. EVIDENCE REFRIGERATOR:

1. Basis of Design Product: True Food Service Equipment, Inc., Model TS-35, or a comparable product by one of the following:
   a. DSM Refrigerated Evidence Storage Lockers.
   b. Sentinel Refrigerator Locker.
   c. Equal approved by the State.
2. Type: Freestanding, two-door refrigerator.
3. Storage Capacity: 35 cu. ft., 6 heavy duty PVC coated shelves.
4. Construction: Stainless steel interior and exterior front, sides and doors.
5. Electrical requirements: 115/60/1.
6. Alarm system to notify authorized personnel of any significant temperature variance. Shall connect to visual alarm in common hallway.

B. DRYING CABINET

1. Basis of Design Product: DSM Law Enforcement Products, Drying Cabinet, or a comparable product by one of the following:
   a. Misonix Evidence Drying Cabinet.
   b. AirClean Systems 'DrySafe' Evidence Drying Cabinet.
   c. Equal approved by the State.
2. Type: Freestanding, two door drying cabinet.
3. Construction: Stainless steel interior and exterior.
4. Filtered 8" I.D. top exhaust duct.
5. Provide the manufacturer's standard legs / clips for permanent seismic installation.

C. DEFIBRILLATOR

1. Automated external defibrillator, Phillips HeartStart FR2 (or equal).
2. CPR kit.
3. Wall cabinet.
4. Carry case.
5. AED signage.
6. 2-pair adult electrode pads.
7. Battery.
8. Users Manual.
9. Quantity:
   a. Provide 1 defibrillator for every 10,000 square feet of Area Office and at least 1 in the Auto Tech Area.

D. ICE MACHINE

1. Basis of Design Product: Manitowoc, Scotsman, Ice-O-Matic (or equal).
   a. Manitowoc iT-1500 Ice Machine.
   b. Half-Dice cube style, air cooled, self-contained condenser, 1,800 lbs. production/24 hrs.
   c. D-970 Bin, 710 lbs. capacity.
   d. AR-PRE Filter plus AR-40000 filter.
   e. Include replacement filters for PRE and AR units (case each).

f. Automatic Cleaning System (integral with manufacture).
g. Slim Inhibitor Sachet.

E. GUN SAFE

1. Basis of Design Product Superior Safe Co. – Regal Gun Safe SR-35 or approved equal
2. Exterior skin 11 gauge steel minimum, 3/16” at door.
3. 75 minute fire rated at 1500 Degrees Fahrenheit (Certified 60minutes)
4. Electronic Lock – UL Group II with 14 active 1 ¼” Bolts
5. Interior volume 25 cubic feet
6. Velour lined interior with high capacity gun rack

F. PEG BOARD PANEL
1. Basis of Design - Alligator Board or approved equal.
2. Panel size:16-inch H. x 5/8-inch D. x 32-inch or 48-inch L. 20 gauge minimum
3. Panel Material: Powder Coated steel with formed edges.
4. Holes: 1-inch o.c. each way, sized to accommodate ¼-inch pegs
5. Pegs: ¼-inch chrome plated steel, provide (1) peg per 6 square inches of panel.
6. Warrantee: 5-years.

G. FLOOR EXERCISE MATS
1. Basis of Design: Matts as manufactured by Rubber Flooring Inc., Redman, Tiffin, or Dollamur
2. Mat Construction: 2-inch thick folding mats with 18 oz. vinyl coated nylon covering over 2” crosslinked polyethylene closed cell foam (2 lb. density) all four edges equipped with Velcro fasteners.
3. Color as selected by the State form the manufacturers full color selection.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install commercial equipment level and plumb, according to manufacturer's written instructions.

1. Connect equipment to utilities.
2. Provide cutouts in equipment, neatly formed, where required to run service lines through equipment to make final connections.

B. Install equipment with access and maintenance clearances that comply with manufacturer's written installation instructions and with requirements of authorities having jurisdiction.

3.02 CLEANING AND PROTECTING

A. After completing installation of equipment, repair damaged finishes.

B. Clean and adjust equipment as required to produce ready-for-use condition.

C. Protect equipment from damage during remainder of the construction period.

END OF SECTION

SECTION 11 31 00

RESIDENTIAL APPLIANCES

PART 1 - GENERAL

1.01 SUMMARY

A. This Section includes the following:

1. Cooking equipment including ranges and microwave ovens.
2. Residential Appliances:
   a. Range, Drop-in.
   b. Venting hood.
   c. Microwave Oven
   d. Refrigerator / Freezer.
   e. Below counter refrigerator.

B. Volume 1 - Contracting Requirements, and Division -01 General Requirements apply to the Work of this Section.

1.02 QUALITY ASSURANCE

A. Source Limitations: Obtain residential appliances from single source, when applicable.

B. Installer Qualifications: An employer of workers trained and approved by manufacturer for installation and maintenance of units required for this Project.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

D. Residential Appliances: Comply with NAECA standards.

E. Energy Ratings: Provide appliances that qualify for the EPA/DOE ENERGY STAR product labeling program.

F. ADA Compliant.

1.03 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer of each appliance specified agrees to repair or replace residential appliances or components that fail in materials or workmanship within specified warranty period.

1. Electric Range: Five year limited warranty for in-home service on surface burner elements.
2. Microwave Oven: Five year limited warranty for defects in the magnetron tube.

3. Refrigerator / Freezer: Five year limited warranty for in-home service on the sealed refrigeration system.

1.04 ACTION SUBMITTALS

A. Submit under provisions of Section 01 33 00.

1. Product data for each equipment listed.
2. Samples of color for final selection.

1.05 INFORMATIONAL SUBMITTALS

A. Operation Instructions.

B. Special Warranty.

C. Maintenance Data.

D. Closeout Submittals

1. Operation and Maintenance Data: For each residential appliance to include in operation and maintenance manuals.

1.06 AIDS TO USE

A. All record documentation, Operation and Maintenance Data and training shall be provided in accordance with Division 1 – General Requirements.

B. Upon completion, the Contractor shall provide:

1. Manuals of operating and maintenance literature, pursuant to the requirements of the General Conditions.

2. Contractor to provide training for the CHP personnel in the operation, upkeep and basic maintenance of the system, pursuant to the requirements of the General Conditions.

PART 2 - PRODUCTS

2.01 The Basis of Design products listed are for reference only. CONTRACTOR shall have the option to submit an equal product that provides similar quality. Other manufacturers exist that can be priced during the proposal period that the CONTRACTOR finds to be equal.

2.02 COOKING APPLIANCES

A. Basis of Design or Equal:

B. Range; Drop in Electric:

1. (Accessible Side Approach – Reach Height).

2. GE, or approved equal.
3. Oven Capacity: 4.4 cu. ft.
4. Style: Smooth top, 4 ribbon.
5. Control Location: Up front.
6. Self-Cleaning.
7. 6/6/9/8 inch Heating Elements.
8. Finish: High Gloss White.
9. Size: 31-1/4”W x 28-1/2”D x 27”H.

C. Venting Hood above Range:

1. ADA compliant (Controlled via side approach accessible switch).
2. Air King, or approved equal.
3. Size: 29-7/8”W x 19-1/2”D x 7-1/2”H.
4. Two speed control fan.
5. Incandescent light.
6. Accessible wall mounted dual rocker switch with plate.
7. Finish: High Gloss White.

D. Microwave Oven

1. Accessible side approach.
2. GE, or approved equal.
3. Style: Countertop.
4. Microwave Watts: 1100W.
5. Power Levels: 10.
6. Turntable glass.
7. Finish: High Gloss White.

2.03 REFRIGERATION APPLIANCES

A. Refrigerator / Freezer:

1. GE. Energy Star, or approved equal.
2. Type: Freestanding, side by side refrigerator / freezer with ice maker and cold water dispenser in door.
3. Storage Capacity: 21.9 cu. ft.
4. Water Filter.
5. Integrated Ice and Water dispenser.
6. Dual Evaporator.
7. Variable Speed Compressor.
8. Finish: High Gloss White front doors, side panels and top.
9. Size Approximate: 33-1/2”W x 33 5/8”D x 69-1/2”H.

B. Refrigerator: (Lactation Room)

1. GE, or approved equal
2. Type: Under counter refrigerator.
3. Storage Capacity: 1.7 cu. ft.
4. Finish: High Gloss White front doors, side panels and top.
5. Size Approximate: 18”W x 19”D x 20”H.

2.04 MISCELLANEOUS APPLIANCES

A. Instant Hot Tank and Water Dispenser combination unit.

1. In-Sink-Erator Model Hot1, or approved equal.
2. Instant, self closing hot valve
3. Adjustable temperature from 160 degree F. to 200 degree F

PART 3 – EXECUTION

3.01 INSTALLATION, GENERAL

A. Built-in Equipment: Securely anchor units to supporting cabinets or countertops with concealed fasteners. Verify that clearances are adequate for proper functioning and rough openings are completely concealed.

B. Freestanding Equipment: Place units in final locations after finishes have been completed in each area. Verify that clearances are adequate to properly operate equipment.

C. Utilities: Refer to Divisions 22 and 26 for plumbing and electrical requirements.

D. Tests and Inspections:

1. Perform visual, mechanical, and electrical inspection and testing for each appliance according to manufacturers' written recommendations. Certify compliance with each manufacturer's appliance performance parameters.
2. Leak Test: After installation, test for leaks. Repair leaks and retest until no leaks exist.
3. Operational Test: After installation, start units to confirm proper operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and components.

E. An appliance will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

END OF SECTION

SECTION 11 52 13

ELECTRONICALLY OPERATED PROJECTION SCREENS

PART 1 - GENERAL

1.01 SUMMARY

A. This Section specifies electronically operated front projection screens and accessories.

B. Volume 1 - Contracting Requirements, and Division -01 General Requirements apply to the Work of this Section.

1.02 RELATED REQUIREMENTS

A. Anchorage requirements per Chapter 13 of ASCE 7-16.

1.03 ACTION SUBMITTALS

A. Submit under the provisions of Section 01 33 00.

B. Product Data: For each type of product indicated.

1.04 INFORMATIONAL SUBMITTALS

A. Shop Drawings: For projection screens. Show layouts and types of projection screens. Include the following:
   1. For electrically operated projection screens and controls:
      a. Location of screen centerline relative to ends of screen case.
      b. Location of wiring connections for electrically operated units.
      c. Location of seams in viewing surfaces.
      d. Drop lengths.
      e. Anchorage details, including connection to supporting structure for suspended units.
      f. Details of juncture of exposed surfaces with adjacent finishes.
      g. Accessories.
      h. Wiring diagrams.

B. Samples for Initial Selection: For finishes of surface-mounted screen cases.

C. Quality Assurance:
   1. Certified test reports showing compliance with specified performance characteristics and physical properties.
   2. Product certifies signed by manufacturer certifying that materials comply with specified performance characteristics, criteria and physical requirements.
   3. Manufacturer's installation instructions.

D. CLOSEOUT SUBMITTALS

1. Maintenance Data: For projection screens to include in maintenance manuals.
2. Operation Instructions.

1.05 WARRANTY

A. Manufacturer's Warranty: Submit, for the State's acceptance, manufacturer's standard warranty document executed by authorized company official.

B. Commencing on date of Acceptance of the Work.

C. Shop Drawings: Indicate dimensions, fabrication and installation details.
1. Include electric wiring diagrams.

1.06 AIDS TO USE

A. All record documentation, Operation and Maintenance Data and training shall be provided in accordance with Division 1 – General Requirements.

B. Upon completion, the Contractor shall provide:

1. Manuals of operating and maintenance literature, pursuant to the requirements of the General Conditions.

2. Contractor to provide training for the CHP personnel in the operation, upkeep and basic maintenance of the system, pursuant to the requirements of the General Conditions.

PART 2 - PRODUCTS

2.01 The Basis of Design products listed are for reference only. Contractor shall have the option to submit an equal product that provides similar quality. Other manufacturers exist that can be priced during the proposal period that the Contractor finds to be equal.

2.02 MANUFACTURERS

A. Ensure manufacturer has minimum of 5 years-experience manufacturing components similar to or exceeding project requirements.
1. Basis of Design: Da-Lite Advantage Deluxe Electrol, or approved equal.

B. Type 2: Ceiling Recessed Electrically Operated Projection Screens.
1. Screen Operation: Electrically operated, UL and ULC listed, retractable, with 2 rigid metal rollers.
2. Motors:
a. Quantity: Per the Facility Design Program.
b. 120V, 60 Hz, 3-wire with ground, with quick connect male plug-in connector permanently lubricated, quick reversal type designed for mounting inside roller.
c. Amperage: 2.4 amps maximum.
d. Include automatic thermal overload protection, integral gears, capacitor and electric brake to prevent coasting.
e. Include preset, adjustable limit switches to automatically stop fabric door and viewing surface in the UP and DOWN position.

f. Housing: Inside metal roller.

C. Controls:
1. Electric Screen Control Switch:
a. Wall mounted, 115V, 60 Hz, 3-position control switch.
b. Junction Box: Internally attached to the screen case.

D. Screen Mounting: Ceiling recessed, UL and plenum rated.
1. Include mounting hardware and roller mounting brackets that adjust to allow centering or offsetting of the screen within the case.

E. Screen Case: Designed to receive mounting hardware and sized to suit projection screen.
1. Extruded aluminum.
a. Case Bottom: Self-trimming with built-in flange and equipped with concealed hinge automatic aluminum closure door for raising and lowering the viewing surface and concealed hinge aluminum access panel.
b. End Caps: Heavy gauge steel.
c. Steel Brackets: Adjustable.
d. Finish: White powder coated.

F. Screen Size:
1. 69” H x 92” W screen location(s) per Facility Design Program.
2. 105” H x 140” W screens location(s) per Facility Design Program.

G. Non-Tensioned Screen Material:
1. Front projection, flame retardant, mildew resistant fiberglass, black backing with standard black borders, easily cleaned with mild soap and water solution.
2. Bottom of fabric to form a pocket holding a metal rod.
3. Seams: Seamless.

H. Format: Video or NTSC 4:3.
1. Material: Rolled, can be easily cleaned with mild soap and water solution.
2. Acceptable Materials:
a. Matte White.

2.03 ACCESSORIES

A. Include optional NET-200 Ethernet Serial Adapter to allow SCB-200 controlled screen to be controlled over a local area or wide area network.

B. Serial Control Board:
1. SCB-200 RS-232: Built-in with NET-200 Ethernet Serial Adapter.

C. Installation Hardware: Fasteners and other components of type, size and spacing recommended by manufacturer for complete, functional and secure installation of electric screen.

PART 3 - EXECUTION

3.01 INSTALLERS

A. Provide experienced and qualified technicians to install electrically operated projection screens.

3.02 MANUFACTURER'S INSTRUCTIONS

A. Compliance: Comply with manufacturer's written data, including product technical bulletins, product catalog installation instructions, product carton installation instructions and technical data sheets.

3.03 COORDINATION

A. Coordinate electric projection screen placement with other ceiling and wall mounted components.

3.04 INSTALLATION

A. Install electric projection screens in accordance with reviewed shop drawings at locations and heights indicated.

B. Install screen housing and make electrical connections in conjunction with installation of suspended ceiling system.

C. Screen fabric to be permanently attached to roller.
   1. Install viewing surface and drive assembly in housing only after interior construction is substantially complete.

D. Securely install screens plumb and level to supporting substrate.

3.05 FINAL CLEANING

A. Upon completion, remove surplus materials, rubbish, tools and equipment.

END OF SECTION

SECTION 11 52 16

AUDIO VIDEO EQUIPMENT

PART 1 - GENERAL

1.01 RELATED REQUIREMENTS

A. Volume 1 - Contracting Requirements, and Division -01 General Requirements apply to the Work of this Section.

1.02 SUMMARY

A. The work described within this section shall be coordinated and provided as described herein. The Contractor shall review the scope of services described, and within the contract drawings. All required reference, coordination efforts and infrastructure to be included whether shown or implied. It is recommended that the affected subcontractors conduct a pre-construction meeting prior to installation to discuss, review and address all necessary installation requirements for the Audio Visual systems and infrastructure.

B. This section is to describe the work required for the installation of a fully-integrated Audio/Visual (A/V) system within the building. The Contractor shall include all labor and materials required to provide a complete and operational system as defined to properly perform and operate the equipment as it is intended.

C. This Specification, in conjunction with the Drawings, establishes the requirements necessary to achieve the intended performance, installation and functions of the A/V Systems in locations noted.

D. Contractor to provide the services necessary to furnish, install, train, and to provide maintenance support for the A/V Systems including all required peripheral apparatus conforming to acceptable industry standards. All work shall be in accordance with the true intent of these Drawings and Specifications, and as required to leave the A/V Systems complete and in satisfactory operating condition.

E. Verify dimensions and conditions at the job site prior to installation, and perform installation in accordance with these Specifications, Manufacturers recommendations and the latest edition or revision of all applicable building and industry codes and standards.

F. The A/V Systems shall include providing and integrating the following principal systems:

1. A/V Switching.

2. Sound Reinforcement and distribution.

3. A/V Control System and equipment

4. A/V interface equipment and components.

1.03 SCOPE OF WORK

A. Furnish all labor, materials, apparatus, tools, equipment, transportation, temporary construction and special and occasional services to make complete, working audio visual and auxiliary systems. Demonstrate by specified tests that all components and the completed systems meet the specifications.

   1. It shall be the responsibility of the Audio/Visual contractor to coordinate and direct all installation and power requirements with the project electrical contractor prior to submission of bidding for cost and prior to the beginning work for installation.

   2. Audio-Visual system installer to review the contract documents and confirm all power and infrastructure requirements. Any additional installation requirements not shown within the contract documents or specified herein shall be noted and addressed with the appropriate subcontractors prior to bidding. All additional costs associated with the necessity to add power, conduit or interface equipment for proper operation shall be borne by the Contractor.

B. Work Included, but not limited to the following:

   1. All wiring and cabling including patch cabling.

   2. All audio-visual system receptacles and faceplates for interfacing systems.

   3. All equipment and materials.

   4. The support and back-cans for all fixed speakers

   5. The supports for projection equipment.

   6. Cover-plates for outlet and junction boxes.

   7. Extension rings where required to provide a flush surface for cover-plate mounting on finished walls

   8. Engraved nameplates on all boxes, equipment racks and equipment.

   9. Coordination and integration of system controls with motorized projection screens.

   10. Cable television signal distribution (CATV) to all shown equipment from main MATV distribution point.

C. Related Work to be provided by others:

   1. All conduits including device junction boxes and pull-wires are to be furnished and installed. For reference, refer to Division 26 sections.

   2. Safety wires for all fixed system equipment.

   3. The isolated grounding electrode, isolated grounding electrode conductor and other equipment and materials for this isolated ground system are specified, furnished and installed under Division 26.

1.04 ACTION SUBMITTALS

A. Product Data Submittal: The Contractor shall submit for review a complete and final list of all components that are to be furnished. This list shall be in the same order and format as the Specifications and shall include confirming manufacturers' independent test data for each specified item. A brochure and photograph (unless included in the brochure) of each item shall also be furnished.

1.05 INFORMATIONAL SUBMITTALS

A. Prepare complete product and systems shop drawings for proposed Audio/Visual System for review, in accordance with the General Conditions shall include, but not be limited to, the following:

   1. Submission of shop drawings, samples and layouts for all items described herein.

   2. Completion dates for the following tests.

   3. Labels for equipment racks and equipment.

   4. Example of engraved cover plates.

B. Test results shall be submitted for review for the following as specified herein:

   1. Performance tests on completed component sub—assemblies including all racks, consoles and enclosures.

   2. Performance tests on the complete system.

C. Layouts shall be submitted for approval as follows:

   1. Individual Room layouts showing equipment locations and dimensions.

   2. Equipment racks ("AVR"), showing locations, dimensions and connections.

   3. Wiring Diagrams and routing for all equipment and interface

D. Maintenance Data.

E. Operation Instructions.

1.06 QUALITY ASSURANCE

A. Unless otherwise stated, all electrical, electronic and optical equipment shall be products of firms regularly engaged in the manufacture of electrical, electronic or optical equipment. The equipment shall be the latest model or type offered which meets the applicable specifications at the time of the submittal. Discontinued items replaced by newer models or versions are acceptable and shall be noted as "Alternate" in the submittal for review.

B. Quality of workmanship and fabrication of all equipment and components which are custom fabricated shall be comparable to professional equipment produced by specialized manufacturers of the trade involved and shall be verified by observation. Only skilled craftsmen of the profession required shall be utilized for all aspects of the fabrication and installation of the system.

C. All materials and products shall be new and of professional quality designed for the intended use. No used materials shall be installed.

1.07 WARRANTIES

A. All warranties shall be provided in accordance with Division 1 General Requirements.

B. A full one (1) year warranty from the time of system acceptance shall be provided in writing covering all components and systems including materials and workmanship. This obligation is limited to exclude conditions of misuse.

C. The Contractor shall submit, in writing, provision during the warranty period of one year for availability of service personnel within twenty-four (24) hours of call and for exchange of faulty components within seven days. This service requires assurance of commitment by the subcontractors and suppliers of all components.

1.08 AIDS TO USE

A. All record documentation, Operation and Maintenance Data and training shall be provided in accordance with Division 1 – General Requirements.

B. Upon completion, the Contractor shall provide:

1. Manuals of operating and maintenance literature, pursuant to the requirements of the General Conditions.

2. System geographical layout and block diagrams under a plastic cover on the door of the AVR cabinet(s) or Equipment Room(s).

3. Contractor to provide a minimum of eight (8) hours of training for the CHP personnel in the operation, upkeep and basic maintenance of the system.

1.09 MAINTENANCE OF SYSTEM

A. The Contractor shall, for the first year of system operation:

1. Establish and provide an approved maintenance program for all Audio-Visual and Communication systems specified herein.

2. Perform a complete system survey, including critical electronic and optional measurements, on a quarterly basis and provide written summary for review.

1.10 ROOM DESCRIPTION OF THE SYSTEMS

A. General: Contractor shall install all necessary equipment and support infrastructure to provide the systems as described in locations where noted.

   1. Systems shall be provided and installed with all necessary interconnection and wiring for proper function of the equipment as intended.

   2. A requirement noted or inferred in this specification section shall have the same effect as if it were included with all parts.

B. Media Equipment Closet: The Media Equipment Closet shall contain all electronics head end equipment; provide, at minimum matrix switchers, controllers, amplifiers, audio processor, DVD/Blueray/CD player, ALS controller, etc. Equipment shall support all A/V devices listed in this section.

C. Briefing Room: (2) Wall mounted 55” 1080P high definition television units with (1) CATV and (1) HDMI outlet at each (TV provided by State); (1) ceiling mounted HD video projector with (1) HDMI interface and (1) data jack and recessed motorized projection screen; (3) pairs flush ceiling speakers, (3) on each side of partition wall (when applicable), each pair selectable on/off; wall mounted A/V controller; (1) lectern position with mounted touch panel controller, gooseneck microphone, and audio and video inputs; (1) wall mount audio and video input plate; (1) wireless, wearable microphone with lapel clip and transmitter; (1) wireless microphone antenna; (1) IR transmitter for Assisted Listening System (ALS) devices; (4) ALS IR receivers with ear buds (shared between all rooms). Interface motorized projector screen with A/V control processor and wall mounted controller.

D. Conference Room: (1) Wall mounted 55” 1080P high definition television unit with (1) CATV and (1) HDMI outlet (TV provided by the State); (1) ceiling mounted HD video projector with (1) HDMI and (1) data jack and recessed motorized projection screen; (2) pair flush ceiling speakers; wall mounted touch panel A/V controller; (1) audio and video input plate at conference table; (1) wall mount audio and video input plate; (1) wireless, wearable microphone with lapel clip and transmitter; (1) wire- less microphone antenna; (1) IR transmitter for ALS devices; (4) ALS IR receivers with ear buds (shared between all rooms). Interface motorized projector screen with A/V control processor.

E. Captain, Lieutenant, Lobby Break Room: (1) wall mounted 32” 1080P high definition television unit with (1) CATV and (1) HDMI outlet (TV provided by the State).

F. Sergeant’s Office: (1) wall mounted 55” 1080P high definition television unit with (1) CATV and (1) HDMI outlet.

G. Reception Area: (1) wall mounted 32” 1080P high definition television unit with (1) CATV and (1) HDMI outlet (TV provided by State).

H. Special Duty Office: (1) wall mounted 55” 1080P high definition television unit with (1) CATV and (1) HDMI outlet.

I. A/V Network: The Contractor shall utilize the States A/V IP network for proper A/V device and equipment communications, control and operation. Coordinate all IP addresses, LAN ports, VLAN requirements, subnets and integration to other site A/V networks with the States IT specialists.

1.10 CONTRACTOR QUALIFICATIONS

A. The work specified herein and in each of the allied sections shall be accomplished by a single Audio-Visual Systems Specialty Contractor experienced in the design, fabrications, installation, checkout and warranty contract management of systems such as those described in each section. This specialty Contractor shall have complete responsibility for the systems described herein and shall be the single contact point for the State with respect to all work specified herein.

B. The contractor shall, with the bid, in accordance with the Instruction to Bidders, submit at least the following information to verify that the bidder has the necessary experience and qualifications to perform the specified work:

1. A detailed brochure describing its capabilities in terms of facilities, personnel (including the person defined in paragraph 1.11 C, below), experience background, examples of similar installations (at least two projects within the past two years), distribution arrangements with manufacturers and financial capability

2. Information identifying any and all local agents and/or subcontractors who will assist in the work in their role in the project. Identification of sources of labor for all fabrication and installation throughout the duration of the project.

3. Evidence that he has acquired all the necessary licenses and approvals to perform the specified work.

4. Information on how and by whom it will fulfill the requirements of the warranty period.

5. Equipment to be furnished, per Part 2 below.

6. This submittal must justify that the Contractor has the capability to manage and install a project of this size and scope and that he is capable of the necessary business and technical arrangements for this installation and the pursuant warranty service.

C. The Contractor shall have on staff a qualified project engineer. This person shall:

1. Be a university graduate in electrical or electronic engineering or physics, and have at least five (5) years' industry experience with similar electronic specialty systems or other approved educational experience background.

2. Provide all technical liaison between the contractor and States Representative. This shall include participation in meetings and conferences. They will be required to be present at the job site for final observation, approve the operating and maintenance manuals.

3. Be responsible for supervision of all technical work which is part of the contract. This supervision includes, but is not limited to, the following:

    a. Preparation of all construction and as-built drawings from information within the specifications and the drawings. They shall approve and sign all shop drawings.

    b. Supervision of shop fabrication and field installation work to assure conformance with the contract drawings, the specifications and the approved shop drawings to assure workmanship of the highest quality. They shall oversee the testing of all assemblies and sub-assemblies prior to delivery to the job sit. They shall take a leading role in the specified testing of the completed installation to assure that all specification are met. They shall coordinate and be present at the Acceptance of the Work and Final Acceptance observations.

1.11 SUBSTITUTIONS TO SPECIFIED EQUIPMENT

A. The Contractor shall submit for review a complete list of proposed substitutions for approved equipment listed in Part 2, below. The base bid shall include all equipment specified in Part 2 below and any and all other equipment and devices for complete and operational A/V Systems.

B. For all substitutions, the Contractor shall provide manufacturer's independent test data to demonstrate that the proposed alternatives to the approved equipment comply with the specifications. Specifications shall contain at least all information available for the specified product.

C. The Contractor shall submit a description or drawings showing all changes to the Contract Documents that the proposed substitution will require for proper functionality and operation.

D. Proposed substitutions shall not affect dimensions shown on the Contract Documents.

E. Any redesign or construction costs required to integrate the proposed substitution shall be the responsibility of the Contractor.

F. Any proposed substitution shall have no adverse effect on other trades, the construction schedule or specified warranty requirements.

G. The functionality, performance, general appearance and quality of the proposed substitution are equivalent to or superior to those of the specified item.

H. Any change to the Contract (deductive or additive cost) associated with a proposed substitution shall be submitted for review at the time the substitution is proposed and accompanying the substitution request documentation.

PART 2 - PRODUCTS

2.01 GENERAL

A. Unless otherwise stated, all equipment and components shall be products of firms regularly engaged in the manufacture of projection, electronic or curtain equipment and components.

B. All manufacturers' stock equipment and component labeling and console designations will be in English. All system nomenclature, signage and custom labeling pertaining to routine system operation shall be either on the equipment itself or on descriptive drawings, charts or diagrams.

2.02 EQUIPMENT

A. General: The equipment specified in this section is intended to present the major components and performance requirements of the systems and to provide information on the systems to be installed. It is the responsibility of the contractor to determine the exact quantities of equipment and accessories to produce a complete and functional system consistent with the design intent, Construction Drawings and these Specifications. Provide any additional equipment and accessories, devices, materials, labor, and services necessary to complete or perfect all parts of the equipment rooms and spaces, and to ensure that they are in compliance with requirements stated or reasonably inferred by this specification and the Construction Drawings.

B. The State shall be notified of any discontinued equipment and alternate equipment of equal or greater functionality shall be provided to the State for acceptance as replacement device.

C. Following is a list of preferred equipment. Products of equal quality, performance, and features can be submitted as approved equal for acceptance:

1. A/V Matrix Switches: Extron Electronics XTP II Crosspoint 1600 Series, or approved equal.

2. 4K A/V Twisted Pair Transmitters\Receivers and Wall Plates: Extron Electronics XTP

3. HDTV Tuner: Contemporary Research 232-ATSC 4, or approved equal

4. DVD\Blu-ray\CD player: Tascam BD-01U, or approved equal

5. A/V Scalers: Extron Electronics, or approved equal.

6. A/V Control Processor: Extron Electronics IPCP Pro Series, or approved equal

7. Wall and Desk Mounted Touch Panel Controllers: Extron Electronics TLP Pro 1025, or approved equal.

8. Digital Signal Processor (DSP): Extron DMP 128 Plus, or approved equal.

9. Audio Amplifiers: Extron Electronics XPA 1002, or approved equal.

10. Mic Mixers: Extron Electronics MVC 121 Plus, or approved equal.

11. Wireless Microphone System: (2) Shure GLXD14R/85, or approved equal.

12. 18” Lectern Gooseneck Microphone: Shure MX418S/C, or approved equal

13. Loudspeakers: Extron Electronics FF 220T, or approved equal.

14. ALS System: Listen Technologies (1) LT-84-01 Transmitters/Radiator Combo;(1) LA-141 Expansion Radiator, (1) Advanced Intelligent DSP IR Receiver 6-Pack,, or approved equal.

15. Equipment Rack: Middle Atlantic Products, Inc. Heavy duty 19” rack, or approved equal.

16. Fixed Projector Mounts: Chief Manufacturing RPA Series, or approved equal. Confirm projector model with the State.

17. Fixed Wall TV Mount: Chief Manufacturing LSM Fusion Series, or approved equal. Confirm TV models and sizes with the State.

18. Articulating Wall TV Mount: Chief Manufacturing TS525TU, or approved equal. Confirm TV models and sizes with the State.

19. Ceiling Mounted Projector: Sony Model VPL-FHZ131L, or approved equal. Confirm projector model with the State.

2.03 MISCELLANEOUS EQUIPMENT

A. General: The contractor shall provide all miscellaneous ancillary audiovisual equipment to ensure a fully operational and functioning system. This includes but not limited to the following.

1. Cabling

2. Converters

3. Patch cables and patch bays

4. Line drivers

5. Video, audio and control interfaces

6. DVI, RGB, Coax, HDMI, BNC, audio and RS-232 interfaces and extenders

7. Filters and line conditioners

8. Distribution Amplifiers

9. Notch filters

10. Power Supplies

11. IR and RF Extenders

12. Signal Processors

13. Scalers

14. Transceivers and media converters

15. Splitters and combiners

B. The Contractor shall coordinate with the State and provide extension and patch cabling, converters and or gender changers for each PC or laptop multimedia interface signal type shown on the drawings to allow State furnished computer equipment to be interfaced with the A/V Systems.

2.04 CABLES

A. General

1. Wire and cable shall be provided and meet the following minimum specifications:

   a. All wire and cable shall be UL listed.

   b. All wire and cable shall meet individual subsystem manufacturer specifications.

   c. All wire and cable shall conform to the minimum requirements of ICEA standards; and shall comply with applicable requirements of the National Electrical Code (NEC).

   d. All wire and cable shall be plenum rated where required.

2. Cabling shall be provided as shown on drawings and as described herein.

3. Provide male/female connectors/cabling as required to connect device to device through wallplates and cable with State's inputs/outputs. Coordinate with Government for requirements.

4. All cabling and connectors shall be UL listed.

5. Provide cabling that is rated for use at the installed distance (plus assuming 10' equipment cords at any location terminated at a connection plate).

6. Provide all A/V cabling by one manufacturer unless noted otherwise:

   a. Approved Manufacturers: Audioquest, Belden, Comprehensive, Crestron, Extron, Gefen, Tripp Lite, West Penn Wire or Approved Equal.

B. Twisted Pair Horizontal Cabling:

1. Reference to Section 27 10 15.

2. Microphone and Line Level Cables: Provide #22 AWG Shielded Twisted Pair Cable.

3. High-Impedance Loudspeaker Cables: Provide #16 AWG Unshielded Twisted Pair Cable.

4. DC Power Cables: Provide #16 AWG Unshielded Twisted Pair Cable.

5. Low-Impedance Loudspeaker Cables: Provide #12 AWG Unshielded Twisted Pair Cable.

6. RS-232/RS-422/RS-485 Control Cables: Provide Shielded Data Cable.

C. Data/Power Cables: Provide Data/Power Cable.

1. STP Cable: Provide CAT6A Shielded Twisted Pair (STP) Cable.

D. Coaxial Horizontal Cabling:

1. Comply with Section 27 10 15.

2. The following distance guidelines shall be used for baseband video cable selection:

a. Series 11/U where lengths between active devices are between 45.72 m (150 feet) and 91.5 m (300 feet).

b. Series 11/U or Series 6/U where lengths between active devices are between 15.24 m (50 feet) and 45.72 m (150 feet).

c. Series 11/U, Series 6/U, or Series 59/U where lengths between active devices are 15.25 m [(50 feet)] or less.

3. Video Cables (Series 59/U): Provide Series 59/U – Coaxial Video Cable.

4. Video Cables (Series 6/U): Provide Series 6/U – Coaxial Video Cable.

5. Video Cables (Series 11/U): Provide Series 11/U – Coaxial Video Cable.

E. VGA cables (HD-15):

1. Provide pre-manufactured shielded cable with ferrite core on each end for noise suppression.

F. Audio cables (3.5mm mini stereo):

1. Provide pre-manufactured shielded cable.

2. Provide cabling with a minimum of 95% shield.

G. Digital Visual Interface (DVI-D) cables:

1. Provide high performance pre-manufactured cabling.

2. Cables shall be HDCP and EDID compliant.

3. Provide cable that is rated for use at the installed distance for resolutions up to 1920 x 1200 @ 60Hz and 1080p/60 verified minimum. Data rates to 4.95 Gbps. Provide equalizers or DVI over IP or twisted pair connections to extend distance is required.

H. High Definition Multimedia Interface (HDMI) cables:

1. Provide high performance pre-manufactured cabling.

2. Cables shall be HDCP and EDID compliant.

3. HDMI version 2.0 minimum compliant

4. Provide cable that is rated for use at the installed distance for resolutions up to 4096 x 2160 @ 60Hz and 3840 x 2160 @ 60Hz verified minimum. Data rates to 18.0 Gbps. Provide equalizers over IP or twisted pair connections to extend distance if required.

I. Display Port (DP) cables:

1. Provide high performance pre-manufactured cabling.

2. Cables shall be HDCP and EDID compliant.

3. Display Port version 1.2 minimum compliant

4. Provide cable that is rated for use at the installed distance for resolutions up to 4096 x 2160 @ 60Hz and 3840 x 2160 @ 60Hz verified minimum. Data rates to 21.6 Gbps. Provide equalizers over IP or twisted pair connections to extend distance if required.

J. Universal Serial Bus (USB 3.0) cables:

1. Provide pre-manufactured active extension cables in quantities as required to achieve distance from monitor to computer. Coordinate with Government for requirements.

2. Active extension shall require no additional power source.

3. Cable system shall be capable of USB 3.0 data transmission with type A connectors.

K. Antennae cabling:

1. Provide pre-manufactured cabling.

2. Provide antennae cabling rated for frequencies used.

3. Describe losses in submittals for lengths proposed.

L. Miscellaneous cabling:

1. Provide pre-manufactured cabling as described on drawings.

2. Provide all cabling required for interconnections as required for a complete system.

M. Provide and install all patch panels as required to support A/V cabling infrastructure.

PART 3 - EXECUTION

3.01 INSTALLATION

A. General:

1. The following Installation requirements shall govern the design, fabrication and installation of the system(s) specified herein. In case of a discrepancy between these overall system standards and the individual equipment item specifications, the latter shall govern:

   a. The equipment specified shall be installed according to standards of good human engineering practice and the conditions specified herein.

   b. Workmanship on the installed systems shall be of professionally quality, best commercial practice and accomplished by persons experienced in the techniques and standards of the particular industries involved.

   c. The specifications describe required performance. The specifications describe a general design; it is the intention of the specification that the Contractor will supply from his background of experience and knowledge the necessary supporting details; for example, the implementation of specific components into functioning sub-systems.

   d. In general, the specifications describe materials, qualities and methods.

   e. Any work not mentioned in the specifications, shall be performed as though fully set forth in the specifications. Work not particularly detailed, marked or specified, shall be construed to be the same as similar parts or areas that are detailed, marked, or specified.

2. Equipment markings shall present only needed information and be readable from the operator's normal work position. These markings shall be designed to minimize ambiguous interpretation.

3. Control panels shall be designed to reduce chances of human error and controls shall be natural and consonant with normal operator expectations.

4. All control consoles and their panel mountings shall be provided with the necessary controls, clocks and switches, etc., as outlined in the pertinent sections of the specification. The grouping of these facilities shall, in all cases, be arranged to present a neat, functional appearance. The layout of controls shall be such that priority of

accessibility shall be given to those facilities which frequently require attention. The total design of the system shall simplify the operator's task and insure maximum performance and reliability while minimizing possibilities for human error and providing a comfortable environment for the operator during operation.

B. The Conduit System:

1. The Contractor shall inspect and verify that the conduit system shall support the installation of the audio-visual systems, and shall report any discrepancies in writing and provide written notification that the conduit system is ready for the Architect's approval. The Contractor shall also verify that conduits are adequate for the wiring and functions specified.

2. Each conduit shall contain wires or cable of the same signal level or the same type of circuitry only. Level lines and control circuits shall be run in their respective, separate conduits.

3. The conduit diagram indicates schematically the functions served by the conduit system. Also, the conduit diagram may indicate the locations at which functions are served at several locations in the facility.

4. Low level lines, medium level lines, video level lines, high Wiring and Cabling:

   a. During installation both ends of all single wires or cables shall be marked with consecutive approved number markers, and a careful running log kept of route and terminations. After attachment at terminations these markers shall be accessible and readable for identification. A detailed wiring diagram shall be furnished with these numbers shown. At the operational level (i.e., patch panels, Audio-Visual equipment, receptacle boxes, etc.) all receptacles shall be clearly marked by function and number (when there are many of the same function). For example, where a given microphone line may appear at several locations, the same label shall show. Extreme care and rigid observation shall be exercised when making patch bay, receptacle, patch cord and extension cable soldered connections.

   b. Extreme care must be taken to physically segregate and separate all high level lines from lower level lines.

   c. Control cables and power distribution wiring shall not be installed adjacent to signal cables. Power distribution cabling shall be on the opposite side from signal wiring in equipment enclosures and shall be uniformly located throughout an installation.

5. It is intended that, within the Audio-Visual Equipment Rooms and cabinets, all cables and wires that are semi-permanent (i.e., those leading from rack to rack; rack to conduit terminus or rack to equipment locations) shall be carried not within conduit, but rather within ducts, troughs or cable trays mounted along walls or below the ceiling. This provides flexibility, ease or access, ease of modification and promotes order and neatness.

6. Likewise, appropriate hooks along the wall or on the ceiling will aid in running occasional or frequently changed extension cables to use position.

7. A wall location near the racks shall be chosen and suitable suspension “fingers” provided so that all patch cords of a given type can be grouped and suspended.

8. Cables shall be grouped and bundled by type and routed from source to termination in a uniform manner throughout all equipment housing. Care shall be taken not to break the insulation or deform the cable by harness supports.

9. Cables shall not change relative position in a cable group throughout a cable route.

10. Cable support bars shall be installed to support cables in areas of dense harness breakouts such as behind patch panels, distribution amplifiers and other multiple input/output devices.

11. Edge protection material (“cat rack”) shall be installed on the edges of holes, lips of ducts or any other point where cables or harnesses cross metallic edges.

12. The Contractor shall employ the latest installation practices and materials. Coaxial connectors shall be crimp-on and then soldered. Audio and control wires shall be crimp-on and then soldered. Audio and control wires shall be terminated in crimp-on lugs, and then soldered, at terminal strips or installed with other approved devices.

13. Audio and control cable ends shall be neatly formed and shrinkable tubing applied where necessary to secure the insulation against fraying or raveling.

14. All wire and cable utilized in systems interconnection shall be of the flame retardant type (FR-1 flame test).

15. All cabling or system interconnection which passes through or into acoustically isolated areas, such as sound locks and studios, shall be suitable sealed after cable has been installed.

16. The Contractor shall be responsible for supplying any additional conduit which may be required to complete the system installation in accordance with the specifications.

C. Audio-Visual Cabinet Arrangements: The Contractor shall prepare and submit detailed layouts for approval.

D. Rack Layouts and Assembly:

1. Perform rack fabrication before delivering the racks to the job site. Only wiring and terminations dependent on external devices shall be done at the job site.

2. Test equipment power and functionality to the fullest extent possible prior to delivering the racks to the job site.

3. Equip the rack with sufficient AC power distribution to support equipment as well as two spare, non-switched, convenience outlets. One convenience outlet is to be readily accessible from the front and one readily accessible from the rear of the rack.

4. Provide service loops within the equipment rack for cables connected to external devices.

5. Locate equipment in racks to comply with ADA guidelines.

6. Install equipment racks level and plumb with the room and with adjacent racks.

7. Organize inner-rack cables in an orthogonal manner and organized into neat harnesses by cable type. The rear of equipment shall be fully visible without an array of cables in the way.

8. Horizontal cable management in rack shall be neatly tied in manageable bundles with cable lengths cut to minimize excessive cable slack, but allowing for service and testing.

9. Provide horizontal support bars if cable bundles sag.

10. Adhesive backed cable tie anchors shall not be used.

11. Velcro style cable wraps shall be used in vertical wire management. Plastic cable ties shall not be acceptable.

12. Arrange unlike signal types in separate harnesses maintaining adequate separation distances to avoid interference.

13. Package spare parts for each device in a clear plastic pouch and attach it to the rear of that device.

14. Provide all required seismic bracing and supports per local code.

E. System Grounding:

1. The “spider” concept, is designed to avoid ground loops and inductive coupling.

2. The systems shall be free of ‘hums’, stable and free of oscillation with the earth ground temporarily disconnected.

3. The earth ground shall be made at only one point in the system as indicated and shall be in accordance with National Fire Protection Association 70-1990, paragraphs 250-74 Exception No. 4, 250-75 Exception and 384-2 Exception or the equivalent from the latest NEC.

4. The grounding method shall insure that the system is free of the following problems under any mode of operation:

   a. RF oscillation, pickup and interference.

   b. Distortion.

   c. Crosstalk.

   d. Signal Leakage.

   e. Audio Hum.

5. Major wiring ducts or trays shall be grounded to the conduit system.

6. The equipment racks shall be isolated from, and not electrically connected to, the building grounding system. This means that the conduit system shall not be electrically connected to the equipment racks and that the equipment racks shall be installed so that they are electrically isolated from the building structural steel. The racks shall be electrically connected at only one point to the isolated grounding system.

3.02 OVERALL SYSTEM PERFORMANCE REQUIREMENTS AND QUALIFICATIONS

A. High quality laboratory instruments shall be employed to verify, calibrate and adjust the systems.

B. Specific Tests:

1. General:

   a. Tests shall include but not be limited to those listed below in order to verify that the system meets all design requirements.

   b. All tests shall be fully recorded and a neat copy presented for review and inclusion in the system manual.

   c. The Contractor shall pre-assemble and test as much of the system as possible in his own facility before delivery to the project.

2. Performance Tests on Individual Components:

   a. Perform in Contractor's facility.

   b. Verify that the manufacturer's specifications are met.

   c. Measure the impedance and verify the acoustical output and freedom from rattles and distortion of all loudspeakers.

3. Performance Tests on Completed Component Sub-assemblies:

   a. Perform in Contractors facility.

   b. Verify the achievement of the specifications for each electronic component in situ, i.e., as assembled in its console, rack or other enclosure, powered by the system power supply and with all other components also activated, i.e., powered and interconnected. The magnitude and character of the threshold noise shall be observed for appearance of hum in excess of that pre- sent with individual activation, or the appearance of high frequency oscillation.

   c. Projection equipment shall be tested to verify that the manufacturer's specifications are met after it has been incorporated into a complete subassembly.

4. Performance Tests on the Complete System:

    a. Verify that all wiring is correctly and completely installed. Verify that there are no short circuits between conductors within any cable, or from cable to cable. Verify the integrity of each conductor, i.e., that the conductor is not open circuited. In addition, the correct polarity of each connector, including those in patch panels, shall be verified and the color coding scheme shall be recorded and included in the documentation provided to the State.

C. Verify that the entire system performance is in accordance with the design requirements.

D. All optical projection system performance shall be in accordance with the following:

1. Projected images shall properly fill their respective screens to full size without "cropping." This may not be the case for the secondary screens in some of the classrooms.

2. Projection lenses shall provide distortion free images without color fringing or aberration.

3. Screen brightness and screen brightness ratio shall reasonably approach the theoretical value based on the projector's specified light output value with the necessary light loss corrections.

E. Test procedures for the optical projection systems shall conform to the following basic guidelines.

1. All equipment items shall be 100% tested for correct functional operation.

2. Image brightness and side-to-center/corner-to-corner brightness distribution ratio shall be determined with a commercial grade light meter (Tektronix, J-16 or approved equal) using the SMPTE standard light measurement technique and form (SMPTE Motion Picture Projection and Theatre Presentation Manual, 1969, page 60).

3. Image brightness and brightness ratios shall be determined as before with the SMPTE method and light meter. Sound track measurement shall be principally by observation but unsatisfactory performance may require further electrical tests.

F. All these tests, and any others that the Contractor may wish for their own satisfaction, shall have been performed and successfully achieved before observation is requested. If specifications are not met, further observations will be at the Contractor's expense.

3.03 PROGRAMMING

A. General:

1. Perform the Work of this Section in accordance with acknowledged industry and professional standards and practices, and the procedures specified herein.

2. Furnish all programming labor required for complete and operational systems.

3. User Group Interview: Conduct interview with end users to acquire programming requirements. Submit in writing results of interview and the requirements set forth by the user group. Associate user group requirements into the programming of each system.

B. Matrix Switcher/Digital Signal Processor: Programming shall include, but not limited to, the following:

1. A user-friendly graphical interface shall be programmed by the Contractor to allow for easy operation of the system. This interface shall allow novice users the control of main system components without having to access the digital schematic diagram. These main system control functions shall include as a minimum:

   a. Master volume control.

   b. Zone volume control.

   c. Room combining.

   d. Routing.

   e. Switching.

   f. Source equipment level control.

2. Signal present indicators shall be placed on the graphical user interface to al- low monitoring of all inputs and outputs to the audio system.

3. Meters will be placed along strategic points in the signal chain to allow for monitoring signal level.

4. Schematic diagram will be arranged so wire paths are easily traced. All in- puts and output will be clearly labeled.

5. Basic signal processing functions available for programming shall include but not be limited to the following:

   a. Equalization

   b. Automatic microphone mixing.

   c. Standard (manual) mixing.

   d. Compression and limiting.

   e. Signal delay.

   f. Metering.

   g. Room Combining.

   h. Signal routing.

i. Speaker control.

j. Automatic gain control.

k. Gating.

6. Room combining of audio control to be accomplished through presets that control the various room arrangements. These presets will include routing, level change, delay, etc.

7. Contractor to allow programming time for at least (20) twenty different presets as directed by owner and his representative.

8. A floor plan of the facility will be imported into the graphic user interface of the digital signal processor. Each speaker zone will be identified and labeled. Each zone will have a child window associated to it. When a zone is selected, its child window will appear. This window will house the control functions associated with that zone. The control function will include but not be limited to muting, level control, source select, signal present LED of all incoming and out-going signals. The owner might have other functions that they require in this child window. The Contractor is to assess these requirements during the user group interview and incorporate them into the programming.

C. Control System: Programming of the Control system shall include, but not be limited to, the following:

1. Control of Matrix Switcher/Digital Signal Processor for user defined presets. Contractor to allow time in bid for on-site programming with States Representative and owner. The time allotted for on-site programming will be at least 4 hours.

2. Utilize Avixa International's "Dashboard for Controls" as a guideline for touch panel layouts.

3. Control of all A/V equipment and devices including A/V Matrix Switch, LCD displays, DVD players, projectors, projector screens, DSP's, amplifiers, etc. and any other equipment necessary for the system to function remotely.

4. Contractors must allow sufficient time for the programming of the system, and then allow time in bid accordingly. Any question as to the systems functional requirements must be sent in RFI form to the States Representative. All programming schemes must be submitted to States Representative for approval before programming starts. This includes the appearance of user interfaces and touch panel pages. Contractor will also submit a narrative for the control system concept to States Representative for approval.

5. Contractor is to interview the State Representative to acquire the necessary information needed to allow the proper programming of this system as he is directed. The Contractor, after interviewing the State, will then submit a written report stating his interpretation of the State Representative requirements for approval by States Representative. Only after the State and States Representative has approved the programming report may the Contractor proceed with the programming of this system.

D. Contractors must allow sufficient time for the programming of systems. Contractors must evaluate the system functional requirements and user interface, then allow time in the bid accordingly. Any question as to the systems functional requirements must be sent in RFI for to the States Representative. All programming schemes must be submitted to States Representative for approval before programming starts. This includes appearance and function of the user interface, preset and sub-preset information (acquired through State interviews), speaker control schemes, Contractor will also submit a narrative for the audio and control system concept to States Representative for approval.

E. All approved programming schemes shall be forwarded to the Commissioning Agent and the Commissioning Agent will include the information as a Sequence of Operation in the Functional Performance Test documents.

3.04 ACCEPTANCE OF THE WORK, OBSERVATIONS AND ACCEPTANCE

A. Acceptance of the Work Observation: Prior to the Acceptance of the Work Observation, the Contractor shall file a written notice with the General Contractor when all of the aids to use described and all tests are complete and the systems are ready for the Acceptance of the Work Observation.

   1. In the event that the systems are found not to be Acceptance of the Work, all of the observation costs including consulting fees, travel and living expenses in connection with subsequent observations or corrective work may be borne solely by the Contractor. This includes now problems that arise during the course of the subsequent observations.

B. Acceptance Observation:

   1. After Acceptance of the Work of the systems has been documented, and the Contractor has filed written notice with the General Contractor that the corrections ordered, have been completed, as Acceptance Observation shall be scheduled.

   2. In the event that the corrections have not been completed, or if new problems arise at the time of the Acceptance Observation, all of the observations costs including consulting fees, travel and living expenses in connection with subsequent observations or corrective work may be borne solely by the Contractor.

C. Acceptance:

   1. After observations and tests indicate that the entire Audio/Visual system and auxiliary systems as specified herein are in total compliance.

   2. Acceptance of the system shall be accomplished as described in the Contract.

3.05 GO-LIVE SUPPORT

A. Provide one person for 8 hours with the first scheduled go-live date. For a period of one week after this day, provide necessary support to ensure 4-hour response time to issues that arise.

END OF SECTION

F. Submit documents including the following:

1. All information submitted under submittals, with submittal comments incorporated.
2. Final copies of all shop drawings, incorporating manufacturing and field changes. Where drawings are larger than 11 by 17 inches, provide the full-size drawings neatly folded and installed in 8-1/2 by 11-inch top loading clear plastic sheet protectors. In addition, provide copies of these drawings reduced to 11 by 17-inch sheet size.
3. Electronic copies in PDF and AutoCAD formats on CD-ROM or DVD media or "thumb drive".
4. All final inspection reports, DSA verified reports and DSA certification.

1.04 APPLICABLE DOCUMENTS

A. The following documents form a part of the operational requirements to the extent specified. In the event of conflict between the documents referenced below and the contents of this Section, the contents of this Section shall be considered a superseding requirement.

1. American Institute of Steel Construction Design Manual, AISC 360-10, Fifteenth Edition.
2. American National Standards Institute, ANSI A14.3, Safety Code for Fixed Ladders.
3. American Society of Civil Engineers, Minimum Design Loads for Buildings and Other Structures (ASCE/SEI 7-16).
4. American Society of Testing Materials, ASTM (applicable sections as listed in this specification).
5. American Welding Society (AWS) Structural Welding Code D1.1 and AWS D1.8 – Seismic Welding.
6. California Building Standards Code (CBSC) 2019 edition with supplements.
7. Federal Aviation Administration, FAA Advisory Circular AC 70/7476, Obstruction Marking and Lighting, including all Changes.
8. Federal Aviation Administration, FAA Advisory Circular AC 150-5345-43, FAA/DOT Specification L-856: High Intensity Obstruction Lighting Systems. Federal Communications Commission, FCC Rules and Regulations, Part 17, Subpart C. Specifications for Obstruction Marking and Lighting of Antenna Structures, Sections 17.21 through 17.58, and FCC Form 715, Obstruction Marking and Lighting Specifications for Antenna Structures.
9. National Fire Protection Association (NFPA):
   a. Publication No.70 - National Electric Code
   b. Publication No.780 - Lightning Protection Code
      1) All Local Building Codes, Rulings and Zoning.
10. Telecommunication Industry Association, ANSI/TIA 222-H, "Structural Standards for Antenna Supporting Structures and Antennas", August 2005 and all addendums.

1.05 QUALITY CONTROL

A. Tower Manufacturer Technician: The Contractor shall have the Tower Manufacturer provide a qualified field technician representing the Tower Manufacturer to monitor, observe, inspect, to submit Tower Manufacturer's Reports, and ensure that the entire Tower system is installed in accordance with the Tower Manufacturer.

B. Tower Manufacturer Reports: The reports shall include, but not be limited to, date, time, weather conditions, attendees, conditions observed, solutions to problems, and the like.

C. Regulations and Standards: The communications tower; antenna mounts; ladders; foundations; and the like; and its appurtenant design and construction, shall be in compliance with Codes, Regulations, Standards, and the like, as may be required by the design, and as specified herein.

D. Document Certification: Contractor shall cause design, drawings, specifications, and calculations, and other pertinent documents, to be prepared by currently California-licensed Engineers as specified herein.

1.06 QUALITY ASSURANCE

A. The self-supporting steel communication Tower Fabricator shall have successfully fabricated self-supporting steel radio communication towers of 60 feet in height or greater within the past three years. This shall include the furnishing of design calculations of the tower, actual fabrication and supervision of field erection of the tower. Submit documentation of this with submittals provided under Article 1.02.

1.07 TOWAIR QUERY

A. Contractor shall submit the tower data to TOWAIR to determine whether FAA notification and FCC registration is required for this tower.

B. The Wireless Telecommunications Bureau provides public access to its TOWAIR Query through the Internet. TOWAIR Query is a landing facility slope calculation program used to determine whether a structure with an overall height of 200 feet or less, that does not meet the 20-foot rule criteria, requires FAA notification and FCC registration.

C. A structure meets the 20-foot (6 meter) rule criteria when the top-mounted antenna, tower, pole, etc. does not exceed 20 feet (6 meters) above the top of the support structure. Only support structures that were not built for the express purpose of mounting an antenna can be considered eligible to be exempt from FAA notification and FCC registration based on meeting the 20-foot (6 meter) rule criteria. Any antenna structure (i.e., tower) greater than 200 feet (61 meters) requires FAA notification and FCC registration. The program calculates the location of the structure in relation to nearby airports and runways and will determine if the structure data will penetrate the glide slope. A "Fail Slope" result requires FAA notification and FCC registration. To run the TOWAIR Query, entry of site latitude, longitude, overall (highest) height above ground (AGL) of antenna structure INCLUDING all appurtenances (antennas, dishes, lightning rods, obstruction lighting, etc.) and elevation of site above mean sea level is required.

D. TOWAIR query can be submitted at this website (http://wireless2.fcc.gov/UlsApp/AsrSearch/towairSearch.jsp). Additional information regarding the FAA and FCC Tower Registration process can be found at this web site https://www.fcc.gov/help/antenna-structure-registration-asr-help

E. This tower is 120 feet from base to the pinnacle platform. Designed with a 20-foot mast atop the pinnacle platform, and an 8-foot lightning rod atop the mast for a total height of 148 feet.

PART 2 - PRODUCTS

2.01 OPERATIONAL AND PERFORMANCE REQUIREMENTS

A. Provide a free-standing lattice tower with four legs. Refer to Part 4 Reference Drawings T Drawings for requirements. The tower with the Base Antenna Loads (as defined in Paragraph 1.05.A.3) shall meet or exceed the operational and design requirements of the standards listed in this article and the following:

B. Face Width: The communications tower shall be as follows:

1. Ground Level: The communications tower face width at ground level shall be 22 feet, center line to center line of each leg.

C. Loading: Design the tower to support all appurtenances, antennas and feedlines indicated on the generic tower elevation construction documents and Schedules A (Generic Tower VHF/UHF Antenna Loading) and Schedule B (Generic Tower Microwave Antenna Loading) of Section 13 50 00. The schedules indicate maximum number of antennas at each platform and specifies the heaviest antenna that shall be used for tower and platform design. When a tower is specified as being less than 120 feet tall, use only the antennas corresponding to tower height. Example: If a tower is specified as 80 feet, then use all antennas shown on the table starting at 80 feet and below. These antenna and waveguide loads are and will be referred to as "Base Antenna Loads". In addition, the communications tower and all its appurtenances, including, but not limited to, the communications tower, tower footing, Base Antenna Loads, mounts, and ladder shall meet or exceed the following listed standards:

1. ANSI/TIA: The communications tower and all its appurtenances shall be classified Structural Class III as an Essential Facilities and shall meet or exceed the requirements of the Telecommunication Industry Association, ANSI/TIA 222-H, “Structural Standards for Antenna Supporting Structures and Antennas”, August 2005 and related addendums for the design parameters listed in Appendix A.

2. California Building Standards Code (CBSC): The communications tower and all its appurtenances shall be classified as an Essential Facilities per CBSC and shall meet the requirements except where it references the ANSI/TIA 222-H Standard for towers.

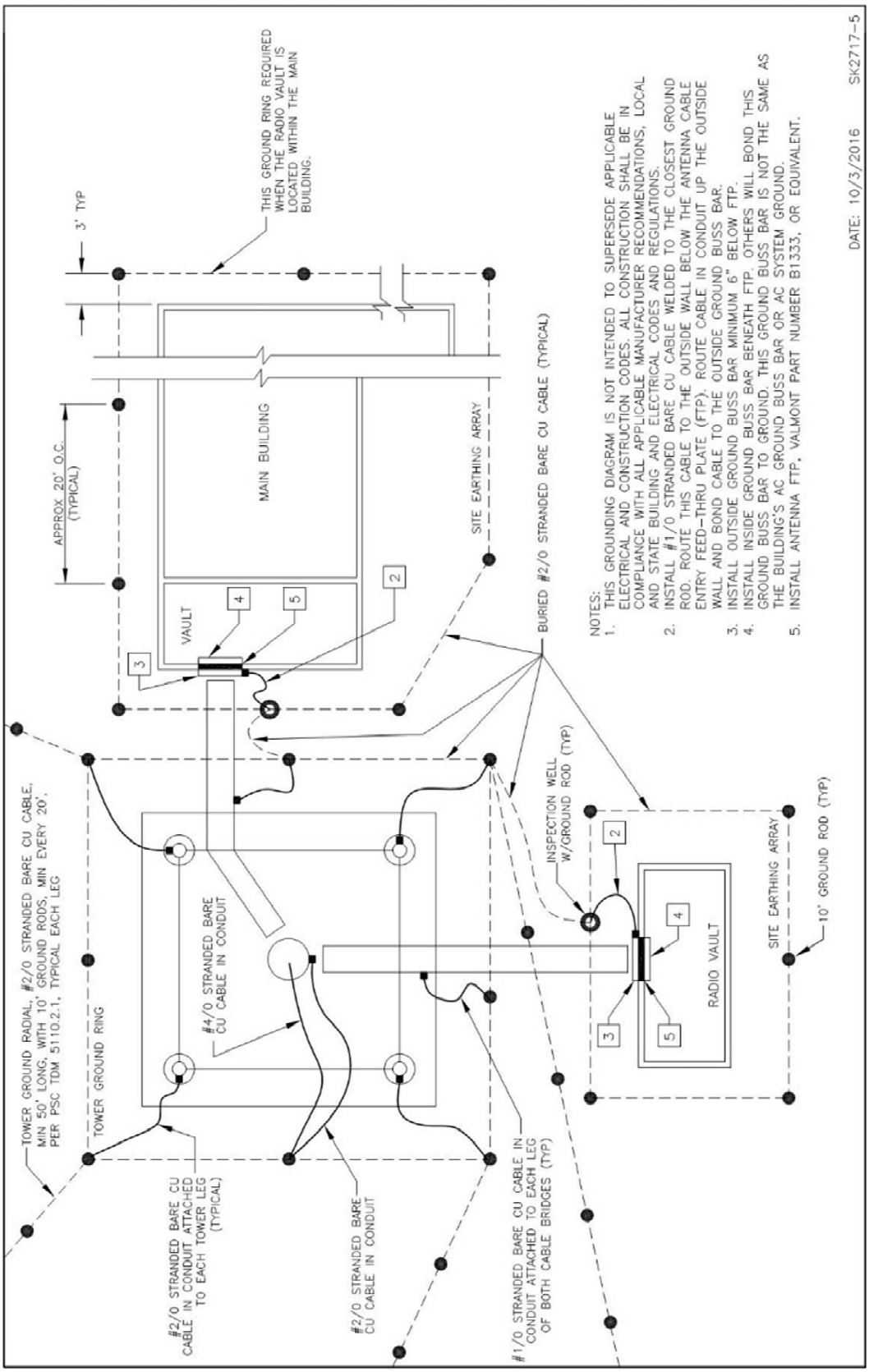
3. American Institute of Steel Construction, Steel Construction Manual, AISC 360.

4. All individual tower components, including lattice, bracing railings, antenna mounts, etc., shall be designed to support safety lanyard and temporary rigging per OSHA requirements. All horizontal members shall be capable of supporting a 250 lb. vertical load in any direction at mid-span, in addition to all other design loads. Provide and mark anchorage attachment points meeting TIA-222-H requirements at each platform level and corners.

D. Lightning Protection & Grounding: The communications tower ground shall conform

to the requirements of TIA-222-H Standard, Section 10, inclusive.

1. Provide pre-drilled grounding landing pads at the base of each tower leg and center waveguide cage mast for grounding to the earth grounding system. Weld grounding landing points to the tower legs at 18 inches above the bottom of each tower leg in line with the center of the tower. Grounding landing points shall face outward. Provide pads with 9/16-inch diameter holes spaced 1.75 inches apart (NEMA 2-hole configuration). Holes shall line up in a vertical configuration.
2. Feedline Ladder: For grounding of feedline shields, provide feedline ladder with 42 inches long grounding bus bars in accordance with the drawings. Provide three grounding bus bars facing in, one for each ladder face. Mount on ladder 12 inches above elevation of feedline bridge. Ground each bus bar using #1/O AWG bare copper conductor to one #4/O AWG bare copper conductor.
3. Lightning Protection: Supplier shall provide lightning protection by including one (1) solid 1-inch (nominal) x 8 feet long copper clad lightning rod with all related hardware required for its installation. Mount rod at the top of the tower mast.
4. Site Grounding: Earthing Array Diagram (for reference only). This is diagrammatic and will need to be adapted for each site. Final configuration must meet the performance requirements of a maximum of 10 ohms to ground.


3' TYP
THIS GROUND RING REQUIRED WHEN THE RADIO VAULT IS LOCATED WITHIN THE MAIN BUILDING.
APPROX 20' O.C. (TYPICAL)
MAIN BUILDING
SITE EARTHING ARRAY
VAULT
BURIED #2/0 STRANDED BARE CU CABLE (TYPICAL)
NOTES:
1. THIS GROUNDING DIAGRAM IS NOT INTENDED TO SUPERSEDE APPLICABLE ELECTRICAL AND CONSTRUCTION CODES. ALL CONSTRUCTION SHALL BE IN COMPLIANCE WITH ALL APPLICABLE MANUFACTURER RECOMMENDATIONS, LOCAL AND STATE BUILDING AND ELECTRICAL CODES AND REGULATIONS.
2. INSTALL #1/0 STRANDED BARE CU CABLE WELDED TO THE CLOSEST GROUND ROD. ROUTE THIS CABLE TO THE OUTSIDE WALL BELOW THE ANTENNA CABLE ENTRY FEED-THRU PLATE (FTP). ROUTE CABLE IN CONDUIT UP THE OUTSIDE WALL AND BOND CABLE TO THE OUTSIDE GROUND BUSS BAR.
3. INSTALL OUTSIDE GROUND BUSS BAR MINIMUM 6" BELOW FTP.
4. INSTALL INSIDE GROUND BUSS BAR BENEATH FTP. OTHERS WILL BOND THIS GROUND BUSS BAR TO GROUND. THIS GROUND BUSS BAR IS NOT THE SAME AS THE BUILDING'S AC GROUND BUSS BAR OR AC SYSTEM GROUND.
5. INSTALL ANTENNA FTP, VALMONT PART NUMBER B1333, OR EQUIVALENT.
DATE: 10/3/2016
SK2717-5
TOWER GROUND RADIAL, #2/0 STRANDED BARE CU CABLE, MIN 50' LONG, WITH 10' GROUND RODS, MIN EVERY 20', PER PSC TDM 5110.2.1, TYPICAL EACH LEG
TOWER GROUND RING
#4/0 STRANDED BARE CU CABLE IN CONDUIT
INSPECTION WELL W/GROUND ROD (TYP)
RADIO VAULT
SITE EARTHING ARRAY
10' GROUND ROD (TYP)
#2/0 STRANDED BARE CU CABLE IN CONDUIT ATTACHED TO EACH TOWER LEG (TYPICAL)
#2/0 STRANDED BARE CU CABLE IN CONDUIT
#1/0 STRANDED BARE CU CABLE IN CONDUIT ATTACHED TO EACH LEG OF BOTH CABLE BRIDGES (TYP)
2
3
4
5

E. Ice Loading: The design ice thickness shall be as noted in Table 1 and of solid radial ice per TIA-222-H minimum default, with a density of 56 lbs/ft, applied to all parts of the tower, platforms, antennas and accessories.

F. Basic Design Wind Speed: The communications tower specified basic wind speed (v) for the structure shall be as noted in Table 1.

G. Under operational wind pressures (70 miles per hour), all horizontal members shall be capable of supporting a 250-pound vertical load at mid-span in addition to all other design loads.

H. Exposure Coefficient: The communications tower exposure coefficient (Kz) shall be rated for Exposure C or as noted in Table 1.

I. Gust Response: The communications tower gust response (Gh) shall be in conformance with the TIA-222-H Standard.

J. Topographic Category: The communications tower topographical category shall be in conformance with the TIA-222-H Standard and as noted in Table 1.

K. Twist and Sway: The maximum limit of communications tower twist and sway shall not exceed 0.7 degrees at the uppermost antenna attachment point of the tower per TIA-222-H.

   The twist and sway requirement shall be maintained through operational wind speeds to seventy (70) miles per hour.

   The communications tower twist and sway at all antenna mounting elevations shall be determined by analytical methods and shall be noted on the formal stress analysis.

L. Tower Deflection: The communications tower deflection limits shall be held both vertically and horizontally. Deflection must be determined at each specific point on the tower where an antenna is attached.

M. Flange/Pipe Connections (typical for between tower leg sections and pole sections): Provide stiffened flanged type connections between pipes and flanges. The inside flange opening shall not be less the inside diameter of the pipe.

N. Snow Loading: The tower shall be designed with the ground snow loads as noted in Table 1.

O. Kzt Factors: The Kzt Factor shall be determined using the criteria as noted in Table 1.

P. Seismic Criteria: The tower shall be designed with the seismic loads as noted in Table 1.

Q. Table 1: Tower Design Criteria (criteria per TIA-222-H definitions), see Note 1 at bottom of table.

Table 1

PARAMETER	STANDARD TOWER
Basic Design Wind Speed (V) (mph)	90
Wind Speed with ice (mph)	40
Ice Thickness (inches)	1.0
Exposure Category	C
Topographic Category	4
Ground Snow Load (psf)	60
Structure Classification	III
Seismic Criteria: Ss S_{DS} Site Class Design Category	 2.48 1.65 D D
Crest Height (feet)	1,500

Note 1: Values shown are *not site specific.* Actual values shall be determined *by contractor* based on the location of the tower, *local standards as applicable*, surrounding topography, conditions determined by Authorities Having Jurisdiction and the CBC 2019, suing the most stringent requirements.

R. Fixed Climbing Ladder:

The fixed climbing ladder shall conform to CCR Title 8, Industrial Relations, Subchapter 7, General Industry Safety Orders, Group, Article 4, Section 3277.

1. Provide a continuous fixed ladder in accordance to the following paragraphs.
2. Ladder shall meet the requirements of TIA-222-H, strength requirements per Section 12.4 and dimensional requirements as per Section 12.5 unless otherwise noted. Ladder shall extend continuously from the tower base to the top lattice platform. The top mast shall be equipped with step bolts to the top of the mast.
3. The maximum allowable spacing of the horizontal step rungs will be 12 inches. The minimum diameter of the step rungs will be 3/4 inch and will support a concentrated load of 300 pounds. The minimum allowable spacing of the side rails shall be 16 inches.

4. Equip ladder and top mast step bolts with a DBI-SALA LAD-SAF vertical fall arrest system consisting of a 3/8-inch diameter galvanized steel safety cable, top brackets consisting of elastomeric attenuators (shock absorbers), intermediate cable guides and bottom brackets. Equip with top, bottom and intermediate brackets in accordance with the manufacturer's recommendations.

5. The ladder shall be centrally co-located with the waveguide and coaxial support system.

6. Provide anchoring bolts, nuts, and washers.

7. The design and construction of fixed ladders, safety devices, climber attachment anchorages, platforms and cages used for climbing or working on communications structures shall be in conformance with TIA-222-H Section 12.0. A load factor, $\alpha L = 1.5$ shall be applied to the nominal loads specified in Section 12.0. Revise all loads to conform to this Section.

8. Equip the bottom 10 feet of the ladder with an anti-climb steel cover that prevents climbing the ladder from both sides. Equip the cover with provisions to be able to padlock the cover closed.

S. Work Platforms:

1. Provide work platforms as shown on the construction documents. The work platforms shall consist of a level platform of steel grating, complete with handrails and access hatches and shall be in conformance with the TIA-222-H standard, Section 12.0.

2. The platforms shall provide reasonable access to appropriate work areas.

3. Provide safety handrails around the perimeter of each platform, with the upper railing at 42 inches above the deck, and the intermediate railing at an 18-inch height. Equip handrails with face mounted pipe mounts. Handrails shall be sized to handle the loads imposed by the handrails fully loaded with three Andrew DB674G65A-C antennas while under full wind conditions with one antenna mounted at each pipe mount.

4. Communications tower diagonals may be used to support platform handrails. If diagonals are used, they shall be sized to handle the loads imposed by the handrails fully loaded with antennas while under full wind conditions.

5. Equip platforms with access hatch to eliminate the hazard of an access opening in the work area. Equip the access hatch on the lowest platform with a hardened steel hasp set for future padlocking. Equip access hatches with two heavy duty, gas-strut assisted opening mechanisms. Equip hatches with a hand operated lever that can be operated from above and below the hatch. The lever shall be used to keep the hatch in a closed position.

6. Work platforms shall be designed in conformance with the TIA-222-H Standard, Section 12.0 and shall at minimum be able to support two 350 pound concentrated loads applied at any location, and a uniform vertical pressure of 25 psf. In addition, platforms shall be designed to accommodate snow loading. Snow loading shall be in accordance with the ground snow load values given in Table 1.

7. Feedline Support and Grounding Capabilities: Around the exterior base of the platforms, provide a 2 inch minimum angle iron to attach feedline support clamps.

Pre-drill holes on 6 inch centers on both faces of the angle iron. Holes will be used to ground the feedline cable shield.

8. VHF Feedline Supports: Underneath each platform, provide 4 inch schedule 80 electrical conduits with PVC end bells on both ends for cable support between the feedline ladders and the antennas. Securely clamp each conduit to the tower at a minimum of four locations. Refer to drawings for locations and lengths.

9. Feedline Pass-Through Areas: For feedlines routed through platforms, provide an opening in the platform. Provide 9 inch distance between feedline support structure and edge of opening. Provide 4 inch high safety toe guards (1/8 inch thick minimum) around the openings.

T. Feedline Cable Supports:

1. Feedline Cable Support: The feedline support system shall include, but not be limited to, a 36 inch square feedline ladder, vertical running, centrally located support system which shall be co-located with the tower ladder. Orient the feedline ladder in the same orientation as the tower. The vertical, centrally located feedline support system shall have the capacity to support all of the specified antennas feedlines noted as Base Antenna Loads. Equip the base of the feedline support structure with a NEMA two-hole grounding tab located 18” above the base plate.

2. Locate the feedline support system in the center of the tower. The feedline support structure shall be fabricated from and supported by rigid members. Cable supports/tiebacks are not acceptable.

3. The feedline support system shall be able to support feedline cushions and feedlines support brackets on 40 inch centers. For the feedline ladder structural members, install horizontally, 40 inches on center, with 7/16 inch diameter holes drilled 2.25 inches on center. Holes will be used for mounting feedline cushion assemblies. Horizontal structural members shall be capable of supporting a 250 pound man. In addition, the members shall be capable of restraining (without damage) a 250 pound man who has attached a safety line to a structural member and who has fallen a distance of six feet.

4. Feedline support structure shall be grounded.

U. Antenna Supports:

1. VHF Antenna Supports: Equip towers with 2-3/8 inch outside diameter vertical pipe mounts to support antennas in accordance to the following paragraphs.

   a. Provide 6 foot long pipe mounts mounted on the end of V formation (V-Mount) standoffs. Except at the top platform provide V-Mounts for each tower leg at all platform levels regardless of initial antenna loading. V-Mounts shall be level and plum. Pipe mounts shall be plum. V-Mounts shall be designed to support two Andrew DB674G65A-C antennas (one antenna attached to each pipe mount) with the more stringent icing and wind conditions specified. In addition, at any point, V-Mounts shall be capable of supporting and restraining (without damage) a 250 pound person who has attached a safety line (at any point) to the V-Mount and has fallen a distance of six feet. Equip V-Mounts with azimuth stabilizer struts. Fabricate the top of the V-Mount with steel angle such that top surface is flat. The bottom of the V-Mounts shall be near the same elevation as the platform.

b. For all platforms excluding the top platform, provide three (3) antenna pipe mounts (face mounts) for each platform face. For the top platform, provide (4) antenna pipe mounts (face mounts) per face.

1) Face mounts shall be equally spaced apart. Install 16 face mounts at the top 120' platform level regardless of initial antenna loading. Install 12 face mounts per lower platform regardless of initial antenna loading. Face mounts shall be plum. Each face mount shall be designed to support one Andrew DB674G65A-C antenna with the more stringent icing and wind conditions specified.

2) For all platforms except the top platform, the middle face mount shall be mounted on an outrigger arm. Provide an outrigger arm for the center face mount that extends 6 feet from the tower face. Provide a total of four outriggers for each lower platform, one on each side of the tower. Outriggers shall be level and plum. Pipe mounts shall be plum. Each outrigger arm shall be designed to support one Andrew DB674G65A-C antenna and shall also be capable of supporting and restraining without damage a 250 pound person who has attached a safety line (at any point) to the outrigger and has fallen a distance of six feet.

c. Provide a pipe mount at each corner of the top platform regardless of initial antenna loading. Pipe mounts shall be as long as and installed outboard of the corner post. Pipe mounts shall be plum.

d. Provide three six foot long vertical pipe mounts on the upper mast. Equally spaced 120 degrees apart. Installed approximately 48" above the top platform deck. Pipe mounts shall be plum.

2. Microwave Antenna Supports: Equip towers with both face and leg mounted microwave dish pipe mounts consisting of a minimum 6 foot length (or longer if ice shield mounting is included) of 4-1/2 inch outside diameter pipe. Provide pipe mounts for all microwave dishes regardless of initial antenna loading. Position pipe mounts to prevent the antenna feed horn assembly from being directly opposite a tower member. Pipe mount shall not prevent proper feedline and connection installation. Leg mounted microwave dish pipe mounts shall not interfere with the installation of V-Mounts above or below the pipe mount.

a. Microwave Antenna Waveguide Support: Between the feedline ladder and microwave antennas, provide a section of grating-type waveguide channel to support the microwave waveguide. Point the channel opening downward. Channel shall be approximately 6 inches wide by 4 inches deep and designed to accommodate snow loading as specified for the tower. Channels shall not extend beyond the tower face or legs. Where mounted over work platforms, install approximately 7 feet above the work platform. Provide waveguide support for both leg and face mounted microwave antennas. Feedline bridge shall not extend beyond tower legs.

b. Equip tower with support members, brackets and adjustable methods to support the ends of the microwave antenna adjustable azimuth strut and two fixed horizontal side struts based on an Andrews UHX10-65 10 foot diameter antenna. The method shall have the capability to move the brackets (for attaching the struts) horizontally and vertically to accommodate the maximum allowable adjustment angles specified by Andrews based on various heights

and orientations of the antenna. Brackets and tower members shall be designed to accommodate the forces imposed by the struts at all locations.

V. Anchor Rods (Bolts):

1. Provide tower with anchor rods as required to properly anchor the tower members and to resist the calculated maximum loads.
2. Provide three nuts for each rod, one below the base plate and two above.
3. Provide steel templates to secure the anchor rods during concrete placement. Provide top and bottom templates for each tower leg and provide all securing hardware.
4. Provide ties for anchor bolts as required by ACI 318.

W. Miscellaneous – Anti-Perching Requirements:

X. Equip tower with anti-perching hardware if required by any or all authorities having jurisdiction.

Y. Masts:

1. Minimum size and wall thickness shall be as follows:
   a. Top Mast: 10.75 inch outside diameter, 0.5 inch wall thickness.

2.02 CALCULATIONS

A. Provide complete tower design. Submit drawings, Bill of Materials, specifications, and structural calculations prepared and stamped by a California licensed structural engineer. Include calculations for all components and welds as required to meet DSA review and approval requirements. Provide additional calculations and backup data as requested by DSA's review. Provide the following as a minimum:

1. Specifications: Specifications shall indicate the various types of materials that will be used and shall describe the methods not covered in the technical regulations which are to be used to obtain the required quality of the work shown on the plans and as described in the specifications. The grades and materials shall be shown on the drawings for each item.

2. Computations, stress diagrams and other pertinent data so that calculations for individual structural members can be readily interpreted. The computations shall be prefaced by a statement clearly and concisely outlining the basis for the structural design and indicating the manner in which the structure will resist vertical loads and horizontal forces.
   a. The computations shall establish that the structure will resist the loads and forces prescribed in the ANSI/TIA 222-H Standard and the California Building Standards Code and Title 24, CCR. Bearing pressures on soils and specified

strengths of concrete shall be given in computations and noted on plans. Where unusual conditions occur, such additional data as are pertinent to the work shall be submitted.

3. Calculations: Calculations to determine member stresses shall include the effects of both horizontal and vertical eccentricities at the connection joints.

   a. The design strength and the actual member stresses resulting from the specified design loads shall not exceed those given in the AISC Specifications nor the ANSI/TIA-222 Standard including Kzs to compensate for the greater gust factor response for pole structures mounted on latticed structures.

   b. All members shall be considered primary members for the purpose of establishing allowable compressive stresses per AISC, except those members whose sole function is to reduce the effective slenderness ratio (kl/r) of primary members.

   c. Combined telecommunications tower wind loads and antenna loads shall be applied in combination such that the maximum forces are produced in girders, diagonals, and legs. Multiple analyses for different wind directions and load combinations will be necessary to ensure that worst case design conditions have been investigated.

4. Calculations shall clearly show how all loads are transferred from the steel tower to the concrete foundation. Include calculations for anchor rod design.

5. Calculations supporting the design that ladder members and V formation standoffs meet the strength requirements of Section 12.4 of the TIA-222-H Standard.

6. Design drawings indicating all antenna types, manufacturer, model number, sizes, weights with and without ice, and effective projected areas with and without ice, and ice loads, used in the design. Provide manufacturer's cut sheets to support the above information.

7. Design and Calculations shall comply with the following:

   a. Design: A finite element analysis computer program using a 3-dimensional (space) model in conformance with Section 3.4 of the TIA-222-H Standard shall be used to structurally analyze the tower. The tower design shall consider at minimum twelve (12) wind directions: four (4) face winds, four (4) apex winds and six (6) parallel winds. When excessive shear forces and moments occur on tower locations other than joints, an additional second order analysis may be required. (Excessive forces and moments would be caused by conditions such as all microwave antennas loaded on one face of the tower, or several microwave antennas concentrated in one compact location of the tower mounted at non-joint locations.)

   b. Structural Calculations: The software computer analysis program name and a brief description of the theoretical theory used shall be included. The analysis calculations output will include but not limit to the following items clearly labeled and identified:

      i. Tower profile representing the graphical analytical model.

ii. Load Forces, uniform and concentrated.

iii. Member sizes and their material.

iv. Effective Projected Areas and Weights of appurtenances.

v. Deflection Twist and Sway at design and operational loads.

vi. Maximum Forces & Design Strength of all members.

vii. Kzt Factors for all tower heights.

viii. Foundation reaction loads.

c. Calculations: Computations, stress diagrams and other pertinent data shall be included in the submittal drawings and specifications. This data shall be complete and shall include, but not be limited to, the design of the tower, foundation, and the like. Calculations for individual structural members shall be organized, tabulated, and properly represented so as to effect individual member design to be clearly, readily, and properly deducible. Calculations shall be provided for all components of the tower including, but not limited to, bolts, welds, members, etc.

d. Calculation Criteria: Computations shall include a statement of Calculation Criteria, clearly and concisely outlining the basis for the structural design; computations shall clearly and properly indicate the way by which the structure will resist vertical loads, horizontal forces, and the like.

e. Loads and Forces: The computations shall clearly and properly establish that the structure will resist the loads and forces in accordance with, and cross-referenced with, TIA-222 and CBSC. Bearing pressures on soils and specified strengths of concrete shall be included in the computations and noted on plans and drawings; where unusual conditions occur, such additional data as are pertinent to the work, shall be submitted.

f. Eccentricities: Calculations used to determine member stresses shall include the effects of horizontal and vertical eccentricities at the connection joints.

g. Transfer Loads: Calculations shall clearly show how all vertical and horizontal loads are transferred from the steel tower to the concrete foundation.

h. Provide finite element analysis for all flange to pipe welds, flange plate connections and the tower legs to tower base connection. Submit analysis calculations for review and approval by DSA and the State. Include computer model electronic files in the submittals.

i. Provide calculations for the microwave ice shields. Include calculations for snow load, ice fall and wind uplift loading calculations.

j. For the calculation submittal, provide a cover sheet and index. Calculations shall be organized in a logical manner.

k. Provide vortex shedding/fatigue calculations for the top mast in accordance with Section 13 38 00, EVALUATION OF SELF-SUPPORTING STEEL COMMUNICATIONS TOWER FOR THE EFFECTS OF VORTEX SHEDDING. Design top mast such that vortex shedding will not occur.

l. Provide seismic analysis and design calculations per 2019 CBC Section 1613A, ASCE 7-16 Chapters 12 and 15, and TIA 222-H-05.

m. Provide design calculations of the feedline support system.

n. Provide design calculations of support framing details between antenna and tower.

o. Provide design calculations of support framing details between ice shield and tower.

p. Provide design calculations of support framing details between apparatus and tower.

q. Provide design calculations of support framing details between ladders and tower.

r. Provide design calculations and drawings of handrails and their support framing details.

s. Provide design calculations of waveguide channels and support framing details.

t. Provide design calculations for snow loads in accordance with ASCE 7-16.

u. For microwave antennas, for both wind-no ice and wind-ice loading conditions, calculate the forces imposed onto the tower by the antenna, bracket, adjustable azimuth strut and two fixed struts, one on each side of the antenna. For the fixed strut's provide three sets of calculations, one set with both sets of struts installed, one with only the left strut installed, and the other with only the right strut installed.

2.03 DRAWINGS - DESIGN

Provide drawings in accordance with the following:

A. Plans, details and elevations shall clearly and completely show all tower components, dimensions, weldments, weld sizes, coping sizes, connection details, material types, bolt grades, bolt sizes, member sizes, antenna types, material thicknesses, sizes, weights, and projected areas for wind design; and shall properly be cross-referenced with other drawings. All lettering shall be 1/8 inch minimum height. Submit drawings in PDF and AutoCAD format.

B. Cross-Reference: Use commonly-used, logical, and consistent cross-referencing symbols, conventions, and the like.

C. Titles: Identify each and every sheet and drawing.

D. Identification: Shall include the signatory engineering name, title, firm name, address, telephone number, facsimile number, and email address, on each sheet.

E. Drawings shall show all the design loading parameters.

F. Provide 3D drawings of the tower complete with three dimensional views of all components, including antennas, mounts, platforms, ladders, etc. Provide in AutoCAD (.dwg) format. All items shall be drawn to scale.

G. Provide required bolt torqueing requirements for all U-bolts.

H. Drawing sizes shall match those used for the construction documents.

I. Provide a title sheet that shows the project title. Include a drawing index listing all drawings in the package including sheet numbers and sheet titles.

J. After the title sheet provide a DSA Code sheet which lists all applicable DSA notes

and applicable codes. Also include a completed DSA-103 form, Statement of Structural Tests and Special Inspections showing all DSA and code required structural tests and special inspections. The structural engineer performing the tower design shall determine inspections and special tests required and shall sign the form at the appropriate location. Size the form such that font size is 12 point on the drawing.

K. Provide a Project Notes sheet. Include the following on this sheet:

1. General Notes
2. Structure Design Notes per next paragraph.

L. On the Project Notes sheet, list the following design criteria for the tower. (XXX indicates project specific information that needs to be updated by the Tower Manufacturer.)

1. Standards & Design Codes:

   Industry Standard: ANSI/TIA 222 Rev. H, & 2019 CBC
   Steel Manual: AISC 15th Edition
   Welding Code: AWS D1.1

2. Design:

   Wind: XXX mph (3-Second Gust) per ANSI/TIA 222-H-2 2009
   Structure Classification: XXX
   Exposure Category: XXX
   Topographic Category: XXX
   Ice: XXX mph (3-Second Gust) with XXX Escalated Radial Ice
   Wind Direction Probability Factor: Kd = XXX
   Wind Importance Factors: Kd = XXX [w/o Ice]
   Kd = XXX [with Ice]
   Ground Snow Load: XXX psf [Roof Snow Load = XXX psf]
   Soil: XXX

3. Seismic Parameters:

   Per 2019 CBC Section 1613A and ASCE 7-16, SECT's 15.1.3 & 12.8
   Importance Factor = XXX
   Site Classification = XXX
   Spectral Acceleration X Fv = XXX
   Occupancy Category = XXX
   Design Category = XXX
   Response Mod. Coef = XXX

4. Loading:

   See structural calculations for loading information.

5. Factored Reactions (TIA-222-H – indicate applicable controlling load combinations):

   Overturning Moment = XXX -KIPS
   Base Shear = XXX -KIPS
   Base Axial = XXX -KIPS (No Snow/No Ice)
   Torque = XXX FT -KIPS

Per Leg Max. Reactions:
Shear = XXX -KIPS
Uplift = XXX -KIPS
Down = XXX -KIPS

6. Factored Reactions (ASCE 7-16):

   Per Load Comb. 3 [1.20 + 1.65 + 0.8W]
   Overturning Moment XXX FT -KIPS
   Base Shear = XXX -KIPS
   Base Axial = XXX -KIPS (No Snow/No Ice)
   Torque = ·XXX FT -KIPS
   Per Leg Max. Reactions:
   Shear = XXX -KIPS
   Uplift = XXX -KIPS
   Down = XXX -KIPS

7. Allowable stress design controlling load combination and reactions for foundation size design.

M. Steel, Welding & Hardware Specifications:

1. All materials shall conform to the following standards:

Angle:	ASTM A36
Flat Plate:	ASTM A572 GR.50/ASTM A36
Base Plate:	ASTM A572 GR.50
Handhole Rim:	ASTM A572 GR.50
Pipe Diagonals:	ASTM A500 GR.B/API5L (Fy=42 KSI Min.)
Pipe Legs:	ASTM A500 GR.C/API5L (Fy=46 KSI Min.)
Channel:	ASTM A36
Wide-Flange:	ASTM A992 (Fy=50 KSI Min.)
Anchor Bolts:	ASTM F1554 GR.55 KSI
Structural Bolts:	ASTM A325X SC
Non-Struct. Bolts:	SAE J429 GR.5
U-Bolts:	ASTM A36
Non-Struct.Thd-Rod:	ASTM A307
Welding Electrode:	E70xx

2. All welding to be performed by welders certified in accordance with AWS D1.1. Field welding is prohibited.

3. All structural steel shall be galvanized in accordance with ASTM A123.

N. Antenna Weight & Area:

1. Complete table with information for all antennas being mounted on the tower:

			Front CaAa [Ft^2]			Side CaAa [Ft^2]		
Antenna Manufacturer/Model	Weight	Weight w/ice	w/o ice	–	w/ ice	w/o ice	–	w/ ice

	_	_
	_	_
	_	_
	_	_
	_	_

O. Provide as a minimum the following scaled and dimensioned drawings and details complete with parts and hardware lists:

1. Tower elevations indicating legs, cross members, platforms, guardrails, antenna mounts, ice shields, showing all items being installed in that section.
2. Tower anchoring details, sections and plan views. Include anchor bolts, nuts, washers, grout thickness, drainage requirements, etc.
3. Platform framing plans, grating plans, elevations and details for each platform level. Elevations shall include handrails, V-Mounts, grounding plates, etc.
4. Antenna pipe mount details.
5. Climbing ladder details and elevations. Include anchoring details.
6. Grounding details.
7. Feedline ladder and feedline support details.
   a. Include an isometric view detail of the feedline ladder.
8. Erection details.
9. Feedline cage erection details.
10. Antenna layout elevations and plan views. Show the tower elevation with all antennas clearly shown and identified. Provide plan views for each antenna level and clearly show and identify each antenna. Provide tower elevations for all sides of the tower.
    a. For microwave antennas, provide plan view and elevation view details for both leg and face mounted antennas. The plan view shall show an Andrews UHX10-65 antenna, its mounting bracket, tower pipe mount, tower leg, tower, ice shield, adjustable ten foot azimuth strut, and two ten foot long fixed struts, one on both sides of the antenna. Indicate the 25 degree limits for the struts. Indicate on the details the full horizontal azimuth range that the antenna could swing before touching the tower and the strut anchoring points over this range. On the detail, for each strut and bracket, show the forces that are imposed onto the tower during the worst possible case wind loading condition.
11. Pipe mount details.
12. V-Mount standoff and azimuth stabilizer strut details. In addition, provide an isometric view of the V-Mounts.

13. Microwave antenna waveguide support details including plan and elevated views. Provide for both face and leg mounted antennas. Show the microwave antenna (Andrew UHX10-65) and associated support bracket.
14. Identifier plate mounting details.
15. Ice shields including support framing and guying details.
16. 3D model of tower, showing structural components including antenna mounts.
17. DSA-103 Form, Special Inspection and Tests.
18. Handrails including support framing details, anchorage, and elevations.
19. Conduit anchoring methods.
20. Microwave antennas and feedline support systems for both leg and face mounted antennas.
21. Safety cable anchorage and installation details.
22. Provide tower leg and ladder base plate plans and elevation details. Elevations shall show the recommended dimensional projection of the anchor bolts, base plate flanges, nuts, washers, recommended grout height between the base plate and foundation, water weeping holes, and grounding tab.
23. Top mast elevation views showing lightning rod, step bolts, and safety cable assembly.
24. Grating anchoring details and sections.
25. Access hatch plan views, elevation details, hinged details, lever details, and air strut details.
26. Kick plate details, sections, and elevations.
27. Conduit layout plans for each platform showing the location of conduits, conduit lengths, and dimensions from the conduit ends to the outer platform edge and feedline ladder.
28. Provide any additional details requested by DSA.

2.04 DRAWINGS - INSTALLATION

A. Installation/Erection Drawings: Provide detailed installation drawings showing how the tower is to be erected. Drawings shall show all component part numbers, Mark #s, component descriptions, and quantities, and shall show where these items go on the tower in detailed views. Views shall include tower faces, platform plans (separate plans for each platform), platform elevations, hand rail elevations, center feedline ladder isometrics and elevations, hatch plans, hatch elevations, grating plans, anti-climb device details, microwave antenna mounts, V-Mounts, V-Mount isometrics, waveguide bridges, struts, pipe mounts, safety cable system, etc.

2.05 DIMENSIONS

A. Dimensions shown on drawings are minimum expected. If tower furnished is different from the minimum dimensions indicated, make necessary adjustments to foundations, grading and feedline bridges at no additional cost to the Owner.

Submit revised drawings and supporting calculations showing the revised adjustments and obtain DSA approval.

2.06 COMPONENTS

A. Components shall meet structural design and performance requirements per Part 1 of this Section and as approved by the State. Manufacturer's standard components parts may be used, providing components, accessories, and complete structure conformance to requirements as specified herein.

B. Components shall be factory drilled for field assembly, easily erected, capable of being dismantled and re-erected without damage to components.

2.07 ZINC COATINGS

A. ASTM A525, G90 coating class.

B. All steel items inside and out shall be hot-dip galvanized after fabrication per ASTM A123. "Fabrication" includes shearing, punching, bending, forming, or welding. Fabricate units completely or in largest practical sections before galvanizing.

C. Clean welded and damaged galvanized surfaces. Remove weld spatter, burns, char, smoke, flux, oil, grease, and other deleterious matter.

D. Repair air exposed galvanized finish work (not to be painted) with hot process field galvanizing (Re-galv, Galvalloy, Galvweldalloy, or equal) per manufacturer's published directions.

2.08 SHAPES, PLATES, AND BARS

A. All structural steel used for the tower structure shall conform to Section 5.0 of the TIA-222-H Standard and to one of the pre-qualified steel material standards listed in TIA-222-H Table 5.1.

B. The use of A36 modified material to obtain the 50 ksi minimum yield strength is prohibited. Utilizing mill certifications to obtain minimum yield strengths is prohibited. Yield strengths shall be based upon ASTM designated minimums. Proper drainage of all moisture and condensation shall be provided for all members. Minimum thickness of any structural steel member shall be 1/8 inch.

2.09 ANCHOR BOLTS AND OTHER STRUCTURAL BOLTS

A. All structural bolts and anchor rods used for the tower structure shall conform to Section 5.0 of the TIA-222-H Standard and to one of the pre-qualified steel material standards listed in TIA-222-H Table 5.1. Provide galvanized bolts throughout except unpainted anchor bolts and high-strength bolts.

B. All bolts shall be A-325 Type X high strength bolts or equal. A449 bolts or A325 type N bolts are acceptable if the designer discounts the capacity of the bolts in accordance with AISC specifications. All bolts shall be constructed utilizing a Heavy Hex Structural

head. The use of A-325M bolts is prohibited unless the designer utilizes an A449 capacity. All bolts shall be hot dipped in accordance with ASTM A153 or mechanically galvanized in accordance with B695 class 50. All fasteners shall project a minimum of two threads beyond the nut and nut locking devices when the nut is properly tensioned. Pre-tensioning shall be defined as a snug tight condition unless modified by the engineer of record.

2.10 FABRICATION AND ASSEMBLY

A. Fabrication & Workmanship: All fabrication shall be in accordance with AISC requirements for fabrication of structural steel and Section 5.0 of the TIA-222-H Standard.

Under no circumstances shall “dissimilar metals” be used in contact with one another.

All welding processes and welding operators shall be qualified in accordance with AWS “Standard Qualification Procedure.”

All materials shall be properly marked and match-marked for field assembly.

All furnished materials shall be new and of the best quality as measured by the highest standards of the trade. Any defect shall be cause for rejection. Mill certificates shall be available for all materials furnished and shall be submitted upon request.

Fabricate items of structural steel in accordance with AISC specifications and as indicated on the final approved shop drawings.

The structure and its individual members shall be constructed so that there are no pockets, wells or traps in which moisture can condense or water collect. Tubular legs shall be sealed at the top of the structure and weep holes shall be provided where necessary.

Unless specified otherwise by the designer, straightness and shape of tower members shall meet the tolerances specified in ASTM A-6 after galvanizing.

B. Connections: Shop connections shall welded. Field connections shall be bolted. Drawings shall indicate where high tensile bolts are used. Such bolts shall bear the identifying head mark. Tighten nuts for high strength bolts to specifications therefor. Use beveled washers under bolt heads and nuts on beveled surfaces.

No field welding shall be permitted unless specifically approved in writing.

All members shall be connected with galvanized structural bolts unless otherwise approved.

The vendor shall provide bolts, nuts and lock-washers in a quantity in excess of the actual bolt count and per the table below, for each size required for each tower site.

BOLT COUNT	EXCESS	MINIMUM EXCESS
0-200	5%	1
200-500	4%	10
500-1000	3%	20

1000 and over	2%	30

All threaded fasteners shall extend not less than 2 threads beyond nuts and locking devices.

2.11 IDENTIFIER PLATES

A. For each platform level provide four (one for each leg) leg identifier plates and one elevation identifier plate. For the tower legs at the base of the tower provide eight leg identifier plates, two for each leg.

B. Leg Identifier Plates: Provide four insert, vertical extrusion formed aluminum plate holders (Almetek Industries #PHE3V4 or equal) complete with 2-1/2 inches wide by 3-3/4 inches high reflective black on yellow aluminum insert plates (Almetek Industries TR-3 series or equal).

C. Elevation Identifier Plates: Provide three insert, vertical extrusion formed aluminum plate holders (Almetek Industries #PHE3V3 or equal) complete with 2-1/2 inches wide by 3-3/4 inches high reflective black on yellow aluminum insert plates (Almetek Industries TR-3 series or equal).

D. Mounting Bands: Provide .015 inch thick by .75 inch wide stainless steel bands secured with crimp lock buckles. Provide Almetek Industries #B4 stainless steel bands and #BB-4 stainless steel crimp lock buckles or equal.

2.12 TOWER AND FEEDLINE BRIDGE FOUNDATION DESIGNS

A. Provide tower foundation and feedline bridge design and provide and install these foundations. Tower foundation shall be designed to resist the tower reactions as determined in accordance with Part 1 and shall meet the requirements of the ANSI/TIA 222-H Standard Section 9 and the California Building Code applicable sections and shall be in accordance with the geotechnical report for the tower site and the construction documents. This effort shall include, but not be limited to, the following:

1. Design tower foundation as required by the soil properties of the site and for the tower design reactions.

2. Prepare foundation drawings and calculations stamped and sealed by a professional structural engineer registered to practice in the state of California.

B. Drawings Submittal

The Contractor shall submit to the Owner and California Division of State Architect for approval copies of the detailed drawings showing the foundations with all dimensions and any other specification notes and information necessary to convey the details of the foundation designs and installation.

C. Tower and Feedline Bridge Foundation Drawings

The foundation plan shall be accurately drawn to scale, dimensioned and detailed. The drawings shall include, but not be limited to, the following details:

1. Foundation Plan.

2. Typical Sections.

3. Details showing anchor placement and reinforcing requirements.

D. Tower and Feedline Bridge Foundation Calculations

The design of the foundation shall be complete and in accordance with accepted engineering practice and the provisions of these specifications. Submit calculations to DSA and the State.

PART 3 - EXECUTION

3.01 FACTORY FABRICATION

A. 60 days prior to factory fabrication, provide a proposed factory fabrication schedule. Notify the State Inspector and lead the coordination effort required for material testing and inspection requirements.

B. 60 days prior to start of factory fabrication meet at DSA's offices at the location of the DSA office responsible for construction administration with DSA's supervising structural engineer to discuss factory testing, inspection, mill certification, material handling and tagging, and chain of custody documentation requirements and all other requirements of DSA. Prior to the meeting, provide a proposed agenda.

C. Submit a detailed procedure for material control that demonstrates the fabricator's ability to maintain suitable records and procedures such that, at any time during the fabrication process, the material specification, grade and mill test reports for the main stress-carrying elements are capable of being determined.

D. Provide sufficient data and documentation providing evidence of conformance to quality standards for materials in Chapter 3 of ACI 318.

E. Provide identification markings to conform to ASTM standards.

F. Ensure that all special inspections are being performed by the State Inspection and Testing Firm and provide documentation to comply with the California Building Code and DSA requirements.

G. During hot dip galvanizing, provide and pay for a DSA-certified inspector at the galvanizing facility to inspect and verify that galvanizing of all components complies with the specifications. Inspector shall verify coating thickness using a magnetic thickness gauge. Measurements of coating thickness shall be in accordance with ASTM E376. Inspection shall be in accordance with "The Inspection of Hot-Dip Galvanized Steel Products" as published by the American Galvanizers Association. A minimum of 60 days prior to the inspection the inspector shall complete and pass successfully a

"Inspection of Hot-Dip Galvanized Steel" online course and score at least 80% on the test.

H. Provide certificate of compliance forms and verified reports as required per DSA.

I. Prior to shipping, obtain DSA certification and approval.

3.03 TOWER PACKAGING, STORAGE

A. Package tower in accordance with Section 13 36 00, COMMUNICATIONS TOWER PACKING, MARKING, AND SHIPPING.

3.04 TOWER RECEIVING

A. Un-packaging meeting: Thirty (30) days prior to receiving tower, installing Contractor shall meet with DGS, DSA and States Representative to discuss delivery, chain of custody and un-packaging requirements. Installing Contractor shall provide meeting minutes and distribute to all parties.

B. Open, unbundle and uncrate items in the presence of the State and tower fabricator. Verify and document that the contents are correct.

3.05 TOWER ORIENTATION

A. Tower orientation shall be as indicated on the plans, within plus or minus one degree. Orientation on plans shall be referenced to true north.

B. Prior to excavations for tower foundation, mark and outline proposed foundation and anchor bolt locations as referenced to true north. Complete the foundation forms, rebar and tower leg bolt installation, center mast forming, tower grounding conduits. Contact State inspector twenty-one days in advance to review locations and orientations prior to concrete pour.

3.06 TOWER FOUNDATION

A. Tower foundations shall be in accordance with the geotechnical report and the construction documents.

B. Anchor Rods: Furnish in advance for installation under "Concrete Work", complete with correctly-dimensioned setting drawings and spacing templates.

C. Provide method of allowing water in tower legs to drain.

3.07 ERECTION

A. Erect tower according to manufacturer's published directions and CCR, Title 24, Part 2. Install tower in accordance with OSHA and CAL-OSHA requirements.

B. Coordinate with the State Inspector for required erection tests and inspection requirements.

C. Furnish all necessary personnel, supervision, tools, equipment, and transportation required to complete the installation and erection of all items specified herein.

D. Any members which are damaged shall be replaced.

E. Field modifications including welding or burning of holes in members is not acceptable. Except minor modifications to existing components per section 3.10.

F. Sheet structural members accurately to lines and elevations indicated on the erection drawings. Align and adjust the various members forming each tower bay before permanently fastening.

G. Tower Manufacturer Technician: The Contractor shall have the Tower Manufacturer provide a qualified field technician representing the Tower Manufacturer to monitor, observe, inspect, to submit Tower Manufacturer's Reports, and ensure that the entire Tower system is installed in accordance to the Tower Manufacturer requirements. Responsibilities will include, but not be limited to:

1. Verification of tower and anchor locations.

2. Joint inspection of construction with the installing Contractor.

H. Tower Antenna Mount Plumbness:

1. Install tower and antenna mounts plumb such that the horizontal distance between the center lines at any two elevations shall not exceed 0.25 percent of the vertical distance between the two elevations.

2. Maintain tower plumbness during all phases of the erection work. Measure plumbness by means of a transit placed so that sight elevation angles are less than 45 degrees. Make at least two sights for each check, oriented at right angles to each other and taken within the tolerance specified in drawings. After completion of tower construction, with all joints tight, and all appurtenances installed, a final check of tower plumbness in the manner prescribed above shall be done and documentation submitted to the State.

3.08 FIELD FINISH TOUCH-UP

A. Touch-up galvanized finish that has been damaged with ZRC Worldwide ZRC Cold Galvanizing Compound or equal. Repairs shall be made in accordance with ASTM A780/A780, Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings except that sprays are not acceptable.

B. Application Equipment: Apply coating with brush.

C. Application: Apply coating of sufficient wet film thickness to achieve a minimum dry film build of 2.5 to 3.5 mills. Apply 2 coats. The 2nd coat shall be applied no earlier than 24 hours after application of the 1st coat.

3.09 TOWER LEGS, PLATFORM CORNER, AND ELEVATION IDENTIFIERS

A. Tower Legs: At two locations, identify each tower leg with identifier plates indicating its correct leg designation (LEG 1, LEG 2, LEG 3 or LEG 4). For each leg, one identifier plate shall face towards the center of the tower and the other shall face outward. Mount top of identifier plates at 4 feet above base of tower.

B. Platforms: At each corner of the platforms, mount an identifier plate facing towards the center of the tower. The identifier plate shall indicate the leg position of that corner of the platform (LEG 1, LEG 2, LEG 3 or LEG 4). Mount top of identifier plate 6 inches below top handrail.

C. Tower Elevations: At 20-foot intervals and at each platform, mount an identifier plate indicating the height at that point. Mount identifier plates on the feedline ladder facing the access ladder.

D. Secure identifier plates with two mounting bands, one at the top and the other at the bottom. Wrap bands completely around posts or structural members.

3.10 NON-FITTING PARTS

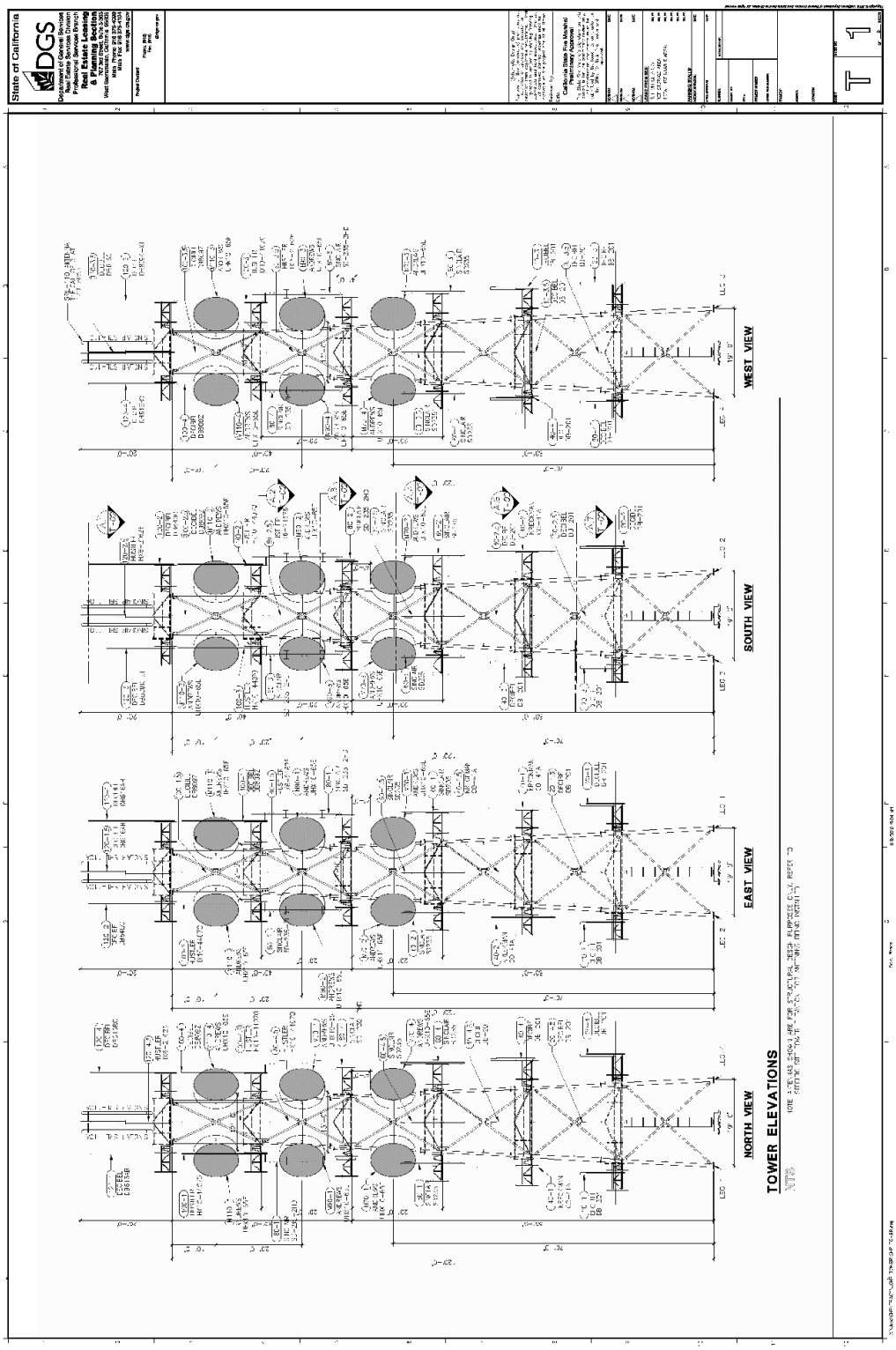
A. During erection, if components do not fit or work, both installing Contractor and tower vendor shall diligently work together to resolve the issue. If the issue requires fabrication of new parts, tower vendor shall immediately fabricate and ship the items to the site. If the issue requires minor modifications to existing components, the installing Contractor may perform these modifications.

3.11 VERIFIED REPORTS

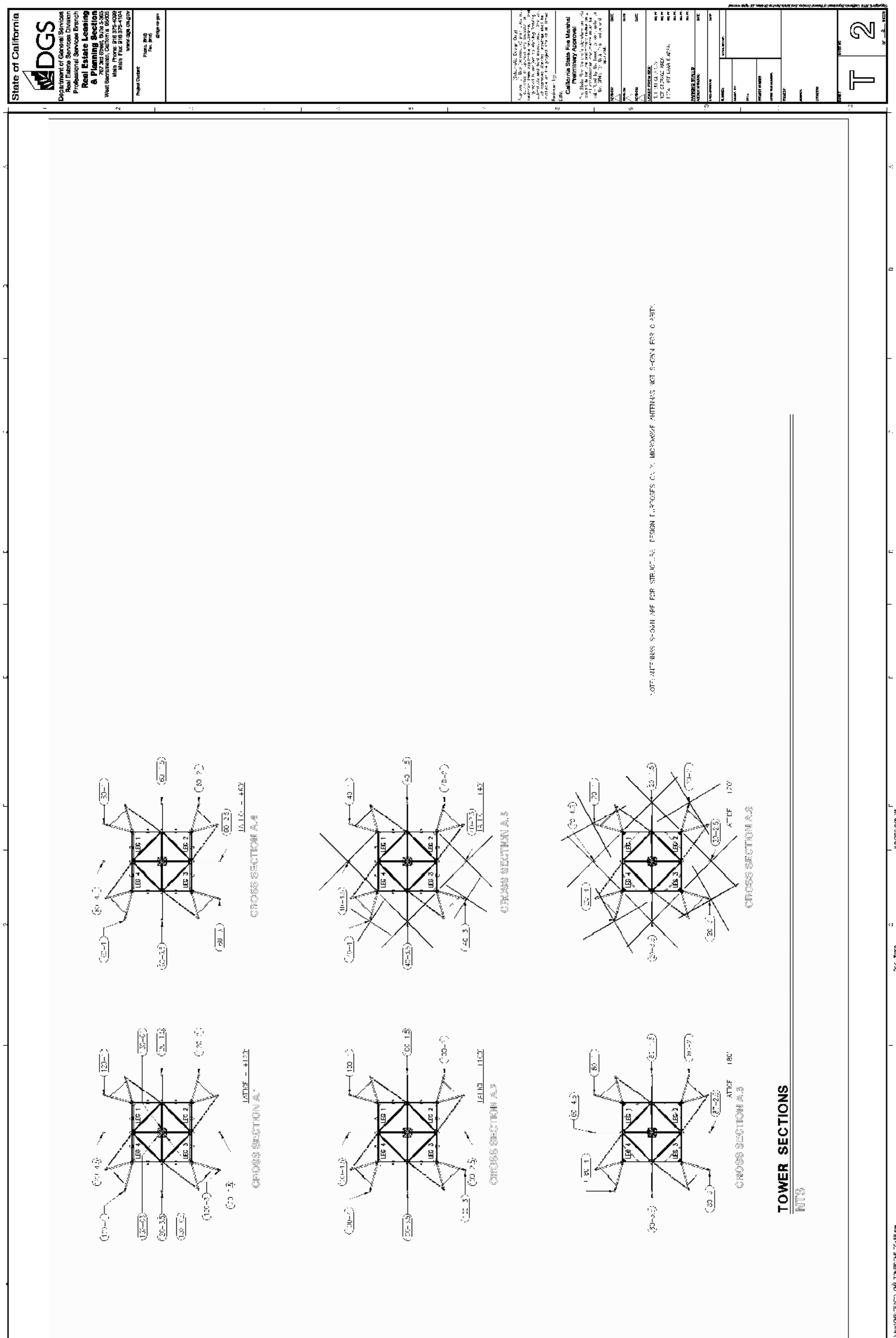
At the completion of the tower installation, Contractor's structural Engineer who stamped and signed the drawings and calculations shall review all inspector's reports pertaining to the tower. If erected properly, structural engineer shall sign and date DSA Form DSA 6AE and any other forms required by DSA.

SEE FOLLOWING PAGES FOR PART 4 - REFERENCE DRAWINGS

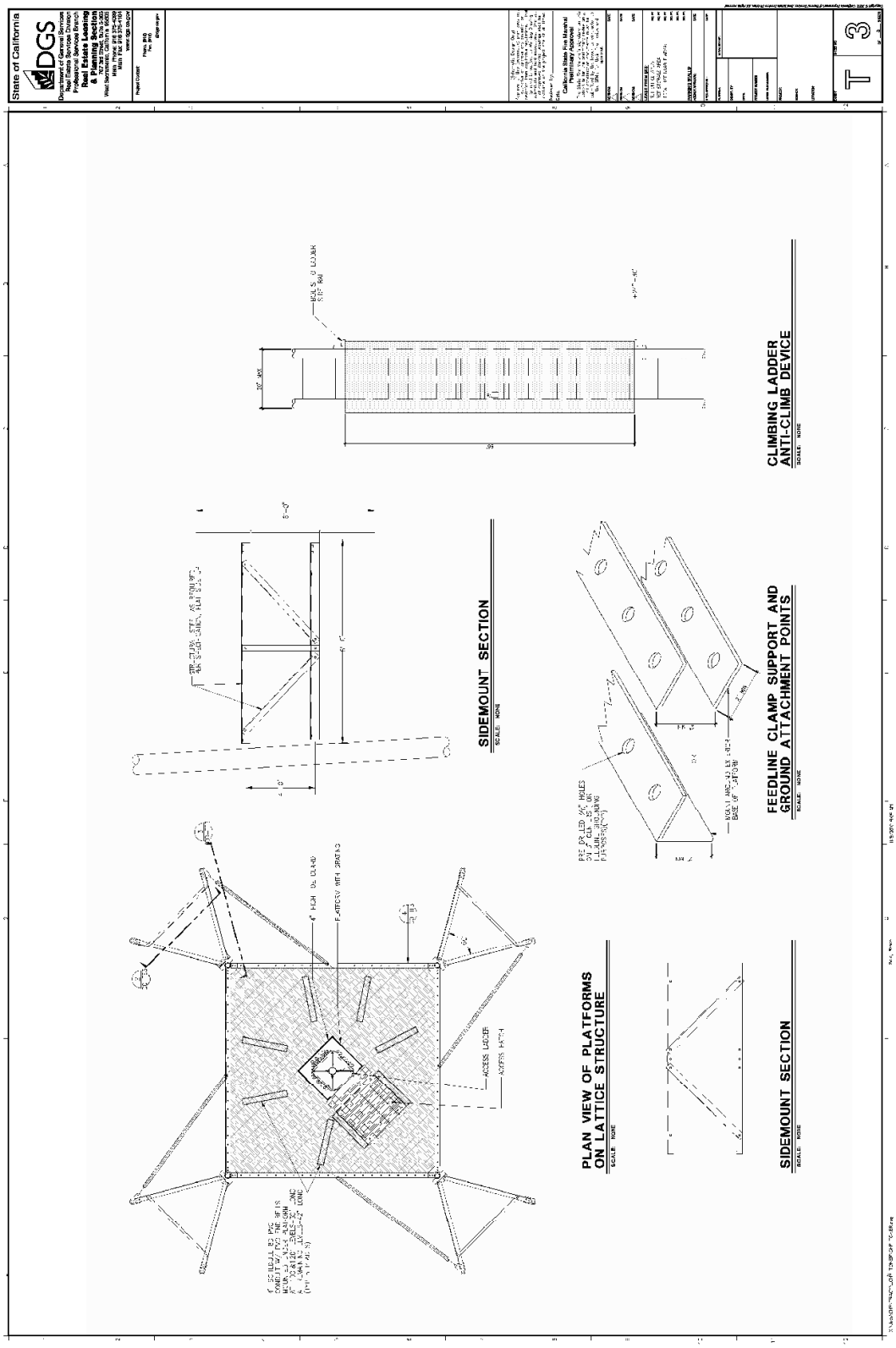
PART 4 - TOWER REFERENCE DRAWINGS



Tower Drawing 1 of 3

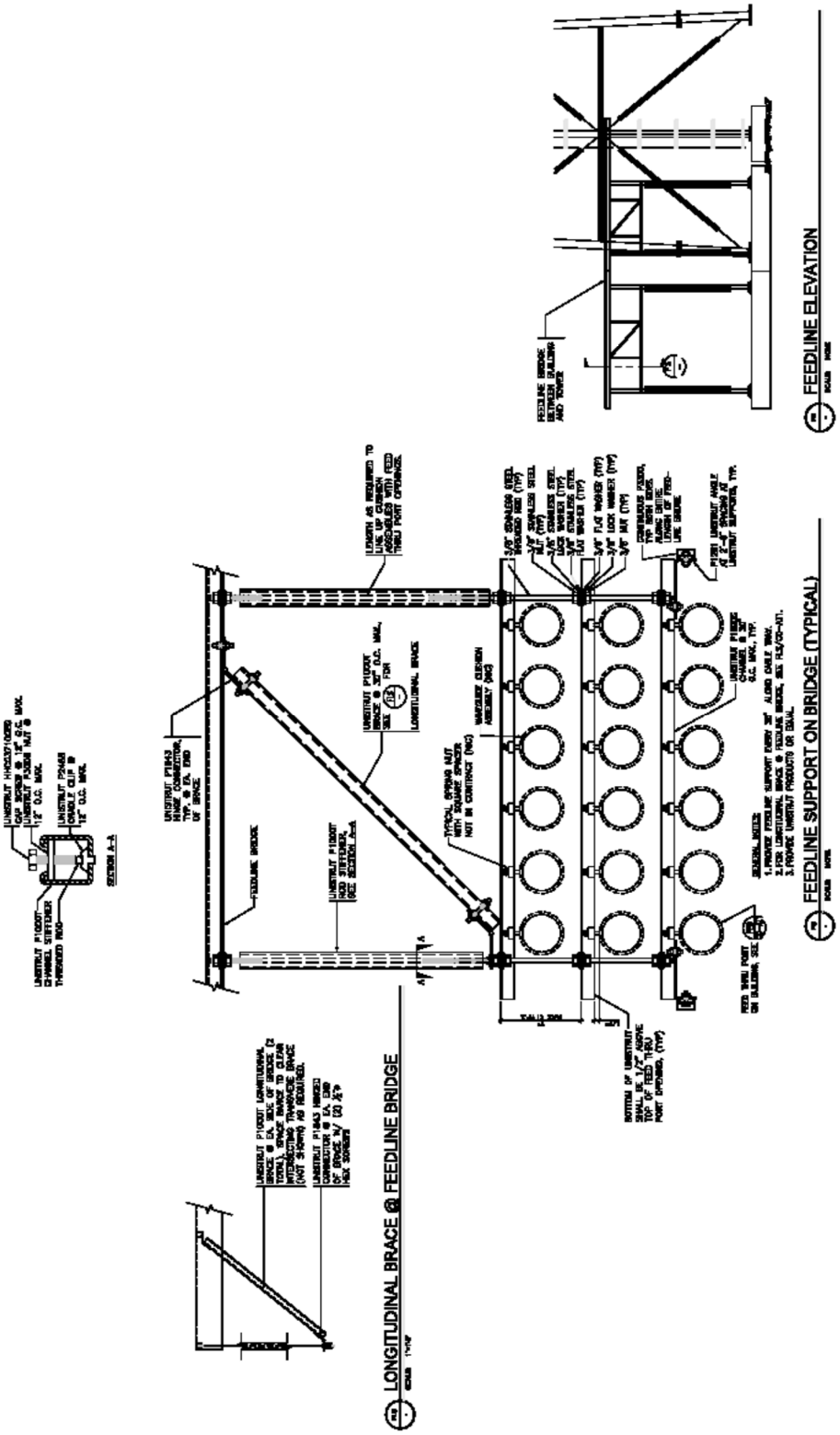


Tower Drawing 2 of 3



Tower Drawing 3 of 3

4.01 FEEDLINE BRIDGE REFERENCE DRAWINGS



END OF SECTION

SECTION 13 36 00

COMMUNICATIONS TOWER PACKING, MARKING & SHIPPING

PART 1 - GENERAL

1.01 DESCRIPTION

A. This specification (the "Specification") details the minimum requirements for the packing, marking and documentation of the communications tower and are designed to protect such Products against the hazards associated with the handling, transportation and climate conditions encountered whilst the Products are being handled, in transit or in storage.

B. Related Work

1. Section 01 33 00 Submittal Procedures

2. Section 13 34 00 Communications Tower

1.02 STANDARDS AND CODES

A. The packaging of Products shall be carried out in accordance with, but not limited to, the latest revision of the following standards and codes. Should requirements of this Specification in any way differ from the following standards and codes then the more stringent requirement shall apply.

1. ASTM Standards:

a.	D6179	Standard Test Methods for Rough Handling of Unitized Loads and Large Shipping Cases and Crates
b.	D6199	Standard Practice for Quality of Wood Members of Containers and Pallets
c.	D6251	Standard Specification for Wood-Cleated Panelboard Shipping Boxes
d.	D6253	Practice for Treatment and/or Marking of Wood Packaging Materials
e.	D6254	Standard Specification for Wirebound Pallet-Type Wood Boxes
f.	D6256	Standard Specification for Wood-Cleated Shipping Boxes and Skidded, Load-Bearing Bases
g.	D6573	Standard Specification for General Purpose Wirebound Shipping Boxes
h.	D6880-05	Standard Specification for wooden boxes

2. National Wooden Pallet and Container Association, UNIFORM STANDARD FOR WOOD CONTAINERS.

1.03 CORROSION PROTECTION

A. The Supplier shall ensure the Products are suitably protected and packaged to prevent corrosion during handling, transport and storage. Items such as bolts, nuts, etc. shall be protected against the possibility of coming in contact with corrosive or harmful substances.

1.04 SAFETY

A. The Supplier shall ensure all Products are packed to avoid personal injury and damage to equipment and property.

1.05 SHIPMENT NOTIFICATION

A. The Supplier shall ensure all shipping information sheets, together with any special handling requirements for the Products to be supplied are completed and dispatched to the Contractor within 4 weeks after Division of the State Architect approval is obtained.

1. This requirement for forward notification does not alleviate the Supplier of its obligation to provide documentation as required by law, or government regulation.

1.06 DOCUMENTATION AND PACKING LISTS

A. The Supplier shall ensure documents, special handling requirements, and packing lists are completed and dispatched with consigned Products.

B. Packing list distribution:

1. 1 copy in an envelope enclosed within the case or package.
2. 1 copy together with any special handling instructions and preservation requirements in a waterproof envelope securely fastened to the outside of each case or package.
3. 1 copy to accompany the consignment upon collection.
4. Packaging lists shall contain no less than the following information for each bundle, box, etc.:
   a. Standard Purchase Order Number OR Blanket Release Number.
   b. Tag/Equipment number.
   c. Supplier's name.
   d. Item number.
   e. Detailed list of all contents, including quantities, part numbers and how packaged.
   f. Total packages and package numbers.
   g. Supplier reference number.
   h. Package dimensions and gross weights.
   i. Assembly shall match marking identification - where applicable.
5. One electronic copy, Adobe Acrobat PDF, summarizing the packaging lists per above for all bundles, boxes, etc.

C. Provide a photograph of each side of each completed shipping box, container, bundle, etc. The photo's file names shall correspond to the package number.

PART 2 - PRODUCTS

2.01 PACKAGING MATERIALS

A. All packaging materials and procedures being utilized or to be utilized by the Supplier shall be subject to inspection by the State.

B. All packaging together with packaging and protective materials shall be new, maintain its integrity and perform its intended function while being transported, handled and stored.

C. Packaged Products showing any damage, defect or shortage resulting from improper packaging, packaging materials or packing procedure or having concealed damage or being short at the time of unpacking shall be subject to rejection and be replaced at the Supplier's cost.

2.02 OPTIMIZATION

A. The Supplier shall optimize the size, weight and complexity of the packaging and packaging materials to minimize the cost of transport, handling, storage and site removal and disposal of packaging materials.

1. The design of packages shall take into consideration the method of lifting and where slings are to be utilized, particularly those weighing in excess of 300 kg, the top edge shall be sufficiently reinforced to withstand the loads that will be applied during lifting.

2. For the purpose of lifting by forklift truck, packages, where applicable, shall be fitted with skids having a skid height of no less than 4" high and 6" wide.

2.03 SUPPORT SADDLES

A. Where support saddles are required for the transportation of products such as tower legs, they shall be designed and provided by the supplier incorporating the following:

1. Saddles shall be designed for the purpose of transporting the Products and transport drawings shall be submitted for review.

2. Where appropriate steel wrapper plates shall be supplied to distribute the load and protect the Products.

3. Saddles shall be fitted with lifting lugs and supplied with a steel rope or flat metal strapping to secure the saddle to the Products during lifting or transport.

4. A packing medium that has no detrimental effect to the Products treatment shall be provided for placement between Products and saddle, securing ropes and/or straps.

5. Subject to the transport configuration and design requirements, saddles may be either of timber or steel construction.

6. Where bolsters and chock blocks are required, they shall be contoured to suit the outside curvature of the Products to ensure adequate and uniform distribution of loadings over the surface of the Products to be supported.

2.04 STRUCTURAL BOLTING

A. Structural bolting, nuts and fasteners shall be packed in a drum or boxes.

2.05 STRUCTURAL STEEL

A. Structural steel items such as handrail, stanchions and grating etc. shall be, where practical, bundled together for shipment.

2.06 TOWER LEGS AND STRUCTURAL STEEL

A. Pipe lengths shall be bundled by strapped timber cleats of suitable dimensions above and below the bundle.

1. Tower legs and structural steel shall be provided with maximum protection to prevent damage by abrasion or impact.

2.07 MISCELLANEOUS ITEMS

A. Miscellaneous items shall be sorted according to type and shall be packaged in timber boxes or crates.

2.08 BUNDLES

A. Bundles shall be treated as individual packages and marked accordingly.

1. Strapping of bundled materials shall be in accordance with the referenced standards.

2. Timber boxes and crates shall be steel strapped and secured with crimped steel clips.

2.09 HANDLING

A. Containerized Products shall be blocked, braced and/or bolted to prevent movement within the container. Products which cannot be anchored or blocked shall be removed and packed separately.

2.10 PAINTED SURFACES

A. Painted surfaces shall be suitably protected to prevent rubbing or scuffing during transport.

2.11 TIMBER BOXES, CRATES AND SKIDS

A. The Supplier shall ensure the construction of timber boxes and crates etc. complies with the referenced standards.

1. All timber used in the construction of packaging boxes, crates and skids etc. shall be sound and well-seasoned without evidence of rot, bark, grazes or splits. Knots shall be sound and not in excess of one quarter the width of the board or timber section to be utilized.

2. Timber boxes, crates and skids shall be steel strapped and straps shall be secured with crimped steel seals.

3. Non-metallic strapping shall only be used on cartons or packages packed within the boxes or crates.

4. For purpose of lifting by forklift truck boxes, crates and skids shall be fitted with bearers having a height of no less than 3.5 inches high and 1.5 inches wide. Bearers are to permit forklift tine access from two opposite sides.

5. The design of timber boxes and crates shall take into consideration the method of lifting and where slings or chains are to be utilized, particularly those weighing in excess of 200 lbs., the top edge shall be sufficiently reinforced to withstand the loads that will be applied during lifting.

2.12 PALLETS

A. Pallets shall be non-returnable and pallet construction shall conform to ASTM Standard D6199.

1. Pallets for the most part shall be constructed so as the width dimensions facilitate the placing of two pallets within the internal width of an ISO freight container.

2. Material items when packed onto pallets shall be secured to the pallet and in all instances protected from damage and the ingress of moisture, dust and other contaminants.

3. Material items when packed onto pallets shall at no time protrude beyond the extremities of the pallet.

4. Soft wood pallets shall not be used.

PART 3 - EXECUTION

3.01 GENERAL TRANSPORT

A. Reference shall be made to all Statutory Regulations, as appropriate, relating to oversize transport with respect to allowable transport dimensions, weight and other details.

1. Transportation of Pipe: Damaged pipe shall not be loaded on board. If damaged pipe is detected on board, it should be noted and the pipe marked by the carrier to indicate pre-transit damage. This should then be reported to a supervisor.

a. Where wire rope or chains are used, adequate padding shall be used at points of contact with pipe.

b. Care must be taken to prevent any chafing of pipes against each other or against the metal structures of the vehicle during transportation.

c. Where necessary, such metal structures must be padded with planks or plastic tubes.

d. Skids and dunnage must be used between the bundles in transit as well as in the storage of coated pipes.

e. Pipes are to be secured in the cargo with no less than four lashing belts each. Use lashing belts of minimum 50mm width.

f. Care must be taken not to damage materials in transit.

g. Should damage occur, it must be reported immediately.

h. Products must not be loaded on top of each other unless this can be done without damaging the pipes.

i. Pipes must be positioned in the transport vehicle in such a manner that unloading will not damage the pipes.

2. Loading/Unloading Pipe

a. Always lift the pipe in a horizontal position. Pipe must not be lifted with chains or cables, as these could damage the pipe work. The proper suspension points for lifting are 1/4 of the pipe length measured from the pipe ends. Bundles must not be knocked or chafed against anything during transfers and lifts. Be careful not to damage the coating, pipe ends, the bevels thereon or any protection for these.

3. Lifts with Hooks

a. Pipes shall not be hoisted with unpadded hooks, as these might damage the lining and edges and even ovalize the pipe ends. Note: the use of hooks of any type for the lifting of pipe with lining is forbidden.

b. For lifts with hooks, the following should be noted:

(1) The counter-face of the hooks should be of Teflon, rubber or other non-marking material.

(2) The chain angle must not exceed 30 degrees.

4. Lifts with Forklift

a. Ensure the elimination of and risk of rolling when shifting unbundled pipes by forklift, if necessary, the lift must lashed.

b. Forklift operations in brief:

(1) The surfaces of forklift arms must be smooth, clean and sufficiently wide.

(2) Tubular products must not be pushed with the fork or the points of forklift arms.

(3) Forklifts used for transfers of coated products should rather be furnished with rubber-padded arms.

(4) The fork must not slide against the surface of pipe.

(5) Position the forklift arms under the pipe or bundle so that the load remains in balance.

3.02 SHIPPING MARKS

A. Each shipping unit (package) shall be marked as shown below using letters of at least ½ inch in height. Markings shall be shown on the top and two (2) adjacent sides of each shipping unit/package and shall be of waterproof ink or exterior grade, waterproof paint in a color which produces high contrast with the background. Packages in any one consignment shall be numbered consecutively and in sequence commencing with the number one (1).

1. Marks

Supplier Name:_____

Standard Purchase/Blanket Release No.:_____ Rev. No:_____

Tag/Equipment No.:_____

Package No.:_____ of _____

Dimension: L_____ W_____ H_____ inches

Net weight: _____pounds

Gross weight: _____pounds

Mark: Name
Address
Address
Address

B. Fractional numbering shall be used indicating the total number of packages in each consignment and the initial number of packages, i.e. for three (3) packages in one consignment 1/3, 2/3 and 3/3 shall be used.

3.03 GENERAL MARKINGS

A. Markings or individual piece marks for sections of fabricated steel, equipment or other structure shall be permanently stamped with alpha/numeric lettering of not less than 10mm.

B. Marking tags where required to be utilized on bundled structural steel etc. shall be made of metal or durable weather resistant material, display all the relevant information and be clamped flat to each bundle utilizing the bundle end strapping. The markings on metal tags shall either be stamped or stenciled utilizing indelible ink, waterproof or exterior grade paint covered with clear shellac.

C. Paper, cloth and aluminum tags or tags with markings etched into the surface of the tag are unacceptable and shall never be used.

D. Placards, where required to be utilized, shall be constructed of exterior grade timber, galvanized sheet steel or durable weather resistant material. Placards shall be securely attached with stainless steel, non-corrosive fasteners or wire.

E. Labels shall be printed on durable, weather resistant material with surface marks being stenciled or printed in waterproof ink or paint. Labels shall be affixed to packages using only waterproof and non-corrosive glues.

F. To prevent metal contamination the Supplier shall ensure marker inks and paints when used for placing marks on stainless steel or similar metal are chlorine free.

3.04 SPECIAL MARKINGS

A. Structural Steel

1. Fabricated structural steel shall in all cases be marked to facilitate assembly on site. Each section of steel shall have the section piece mark.

B. Installation Spares

1. Installation and operational spare parts supplied by the Supplier shall be packaged separately with packages clearly identified with the words "INSTALLATION SPARES". Packing lists in all instances shall clearly identify by quantity and description all Installation Spare parts supplied.

3.05 SHIPPING

A. Ship tower to the location as directed by the Contractor.

B. Coordinate off-loading with the Contractor.

3.06 PACKAGING

A. Prior to packing, provide packing lists. Package all components into the shipping unit in the presence of the Contractor’s representative and State Inspector. Notify Contractor and State Inspector a minimum of 7 calendar days in advance of the packaging date.

END OF SECTION

a. Provide Adobe Acrobat Pro PDF drawings in full size format. Provide a separate PDF file of each sheet. File names shall consist of the sheet drawing number. In addition, provide a single PDF file that contains all drawings. All PDF files shall be generated directly from the software application and shall not be generated by scanning hard copies.

b. Provide AutoCAD files for all drawings.

3. Catalog cut sheets of all pre-manufacture items such as the DBI-SALA safety cable system, identifier plates, air struts, and lightning rods.

4. DSA has RISA-3D, SAP 2000 and ETABS. Submit calculation files. The following items shall be submitted for a computer program used which DSA does not have a copy:

a. Program Description. A program description (User's Guide) shall be made available to DSA including information necessary to determine the nature and extent of the analysis, verify the input data, interpret the results and allow a determination of code and regulations compliance. Theoretical basis for member/element modeling for such non-frame member/elements as membranes, plates or thick shells should be provided.

b. Software Verification. Provide examples to demonstrate the analytical capabilities of the computer software system. For purposes of verification, key results produced by the computer program shall be compared to independent sources, such as hand calculated results, theoretical or published results, or results obtained from other structural/finite element programs (such as SAP, RISA, STAAD.) The examples cover each type of element, static and dynamic analysis and linear and nonlinear options that is used in this project.

1.03 SUBMITTALS – INSPECTION, FABRICATION AND SHIPPING

A. Inspection. Shop verification and inspection is required for steel construction per CBC 2019 Table 1705.A.2.1. The State will perform inspection and provide a special inspector. Attend pre-fabrication meeting or conference call with, at minimum, State's Special Inspection agency, Design Entity, Fabrication Entity and Owner to review inspection requirements. Coordinate inspections with the State's Special Inspection agency and designated Special Inspector prior to fabrication.

B. Provide verification and documentation for all materials and welders in accordance with CBC 2019, Chapter 17A and ANSI/TIA-222-H, Section 13.

C. Shipping. Provide a detailed Microsoft Excel spreadsheet table showing how the tower has been packaged, boxed and bundled. Provide a row for each package, box, and bundle. Spreadsheet shall define for each package what items were packaged in the box or bundle and dimensions and weight of each box and bundle. Provide a total shipping weight of all items. Provide additional documentation in accordance with Section 13 36 00, Tower Packing, Marking, and Shipping.

D. During fabrication, obtain inspection reports from the Special Inspector for all inspections.

E. After fabrication, provide documentation for mill certs, shipping, packaging, and inspector reports in a pdf file.

SECTION 13 38 00

EVALUATION OF SELF-SUPPORTING STEEL COMMUNICATIONS TOWER FOR THE EFFECTS OF VORTEX SHEDDING

PART 1 – GENERAL

1.01 DESCRIPTION

A. Work Included:

1. Evaluation of Self-Supporting Steel Communications Tower Top mast for the Effects of Vortex Shedding.

B. Related Work:

1. Section 13 34 00: Steel Communications Tower

C. Applicability:

1. Self-supported steel communications towers with top masts of total height less than 200 feet.
2. Top mast structures with fundamental modes of vibration between 1 Hz and 10 Hz.
3. Prismatic top mast sections less than 60 inches in diameter.

1.02 SUBMITTALS - DESIGN

A. Provide submittals.

1. All submittals shall be submitted for review and approval to the California Division of the State Architect (DSA). DSA approval shall be obtained prior to the start of any factory tower fabrication. Provide complete submittals within 60 days after State's Notice to Proceed to Contractor.

B. Provide a separate submittal for each tower design.

C. Each tower design submittal shall include the following:

1. Qualification Information. Submit documentation verifying the engineer performing the vortex shedding evaluation meets the qualifications specified in Section 1.04.
2. Calculations. Provide calculations illustrating that the effects of vortex shedding have been considered in the design of the tower in accordance with Part 2 of this specification.
3. Report. Submit a written report in accordance with Part 2 of this specification. The report shall include descriptions of any design changes needed to satisfy Section G in Part 3.
4. Other information as may be deemed necessary by the State.

1.03 APPLICABLE DOCUMENTS

A. The following documents form a part of the operational requirements to the extent specified. In the event of conflict between the documents referenced below and the contents of this Section, the contents of this Section shall be considered a superseding requirement.

1. California Building Code (CBC) – latest edition.
2. American Institute of Steel Construction Load Resistance Factor Design Manual, 1999, AISC – 3rd Edition.
3. American Association of State Highway and Transportation Officials (AASHTO), Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals, Sixth Edition, 2013.
4. American Welding Society (AWS) Structural Welding Code D1.1 – latest revision.
5. American Society of Civil Engineers (ASCE)/SEI Standard 7, Minimum Design Loads for Buildings and Other Structures, 2010.

1.04 QUALIFICATIONS

A. The evaluation shall be performed by a California-licensed Structural Engineer.

B. The engineer performing the vortex shedding evaluation shall have performed a vortex shedding evaluation (generally consistent with the requirements of this specification) of a minimum of five self-supporting steel radio communication towers of 100 feet in height or greater within the past three years, or otherwise must demonstrate comparable experience in dynamic analysis of similar structures. This shall include the furnishing of evaluation calculations. Submit documentation of experience for approval prior to starting the work.

PART 2 – MATERIALS AND FABRICATION

2.01 PERFORMANCE REQUIREMENTS

A. Provide calculations that illustrate the ability of the tower top mast to resist the effects of vortex shedding for a design life of 50 years. The evaluation shall include the top mast pipe sections themselves, connections between the individual sections, connection of the top mast to the supporting tower, and connections of appurtenances to the top mast sections.

B. A vortex shedding evaluation performed in accordance with methodology outlined in Part 3 of this specification meets Requirement A above.

2.02 CALCULATIONS

A. Finite element model:

1. Name and version of software used.
2. Tower profile representing the graphical analytical model.

3. Member sizes and materials.
4. Magnitude and location of discrete masses.
5. Magnitude, direction, and location of loads.

B. Modal analysis results:
1. Natural frequencies.
2. Mode shapes (including orientation of motion).
3. Modal mass participating in each direction of motion.

C. Vortex shedding analysis results:
1. Magnitude, direction, and frequency of forces considered in each analysis case.

D. Dynamic analysis results:
1. Analysis method, loads, time step, analysis duration, and damping.
2. Representative plots of top mast structure deflection and stresses versus time.
3. Tabular summary of maximum stress ranges in each top mast section for each analysis case.

E. Connection details to be used if stress ranges are above minimum limits.

PART 3 – EXECUTION

3.01 VORTEX SHEDDING EVALUATION METHODOLOGY

A. Definitions.

Top mast Structure	pole structure comprised of individual top mast sections
Top mast Section	length of top mast comprised of same steel pipe section (same diameter and thickness)
C_L	pressure coefficient for circular pole sections (to be taken as 0.50)
D	diameter of top mast section
f	frequency (cycles/second)
F	force applied to top mast section due to vortex shedding, uniform load per unit length
L	length of top mast section
S	Strouhal number (to be taken as 0.18)
V	wind speed
Re	Reynold's number
v	kinematic viscosity of air (to be taken as $1.61 * 10^{-4} \frac{ft^2}{s}$)
ρ	air density (obtain from Table C27.3-2 in ASCE 7-16)

B. Methodology Sequence.

1. Develop a finite element model of the tower top mast structure and supporting steel lattice structure in accordance with Section C below.
2. Conduct a modal response analysis of the structure to identify the primary modes of vibration of the top mast structure in accordance with Section D below.
3. Develop the time-varying force effects from vortex shedding that must be considered in accordance with Section E.
4. Perform a dynamic analysis to predict the internal forces and stresses that result from application of the vortex shedding forces in accordance with Section F.
5. Compare the calculated stress ranges to the applicable fatigue limits in accordance with Section G.

C. Finite Element Model.

1. The model shall consider all significant structural elements (those with mass and/or stiffness) of the tower top mast structure and supporting steel lattice structure.
    a. One dimensional frame elements are sufficient for this purpose.
    b. The stiffness of the connection of the top mast structure base to the supporting steel lattice structure must be taken into account (cannot assumed to be fixed).
    c. Top mast sections shall be subdivided into individual finite elements such that the length of each element is less than the lesser of L/20 and D.
    d. All connections between top mast sections and between frame members of the tower lattice structure shall assumed to be fixed (allowing no relative rotation), unless they are constructed as true pins (one-bolt connections, for example).
    e. The model of the steel lattice tower structure can be terminated at the top of the tower foundations. These connections shall assumed to be fixed.
2. The model shall consider the mass of all significant elements attached to the top mast structure, include tower platforms, antennae, lighting rods, etc.
    a. Discrete masses shall be assigned to the top mast sections such to represent the correct spatial distribution of the attachments.
    b. All attached elements that weigh more than 5 percent of the total weight of the *top mast section to which they are attached* must be considered.
3. The supporting steel lattice structure can be omitted from the model if the effects of the finite stiffness of the lattice structure and its connection to the top mast structure are taken into account when evaluating the tower dynamic response in Section D, E, and F below.

D. Tower Modal Analysis

1. Perform a modal analysis of the top mast structure. The modal analysis shall achieve at least 95 percent mass participation in the lateral vibration directions with respect to the mass of the top mast structure and its attachments (sum of all modes identified shall be greater than 95 percent of the mass of the top mast structure and its attachments). Identify the modes of lateral vibration of the top mast structure where the participating mass is greater than 5 percent of the mass of the top mast structure and its attachments.

2. Determine the natural frequency, mode shape, and direction of vibration each mode identified.

E. Vortex Shedding Forces.

1. Calculate the following parameters for each mode of vibration (with natural frequency ***f***) identified in Section D above and for each top mast section (with diameter ***D***) comprising the top mast structure:

Wind velocity that causes vortex shedding	$\boldsymbol{V = \frac{fD}{S}}$
Reynold's number of flow at vortex shedding velocity	$\boldsymbol{Re = \frac{VD}{\nu}}$
Force from vortex shedding	$\boldsymbol{F = \frac{1}{2}\rho V^2 C_L D \sin(2\pi f t)}$

2. Apply sinusoidal-varying loads ***F*** along the full length of each top mast section where $\boldsymbol{Re}$ for the section and mode considered is less than 300,000. Vortex shedding forces shall be applied simultaneously to all contiguous top mast sections that have a diameter within 10 percent of each other (measured relative to the larger diameter section). The direction of ***F*** shall be the same as the direction of the mode under consideration. The frequency of the applied load shall match precisely the calculated natural frequency of the top mast structure.

F. Dynamic Analysis.

1. A dynamic analysis shall be performed for each of the analysis cases developed in Section E2.

2. Linear modal analysis or direct integration shall be used to calculate the dynamic response of the top mast structure. If using modal analysis, enough modes must be used to account for at least 95 percent of the lateral-vibrating mass of the top mast structure. A frequency domain approach is also acceptable.

3. Unless a larger value is obtained from field-testing, the dynamic analysis shall be performed using 0.2 percent of critical damping in all modes.

4. The analysis time step shall be no larger than one-tenth of the period of the highest applicable mode of vibration for which vortex shedding forces must be considered as calculated in Section E2.

5. The analysis duration shall be such to calculate the steady-state response of the structure (long-term resonant response). This shall be satisfied by ensuring that the change in response amplitude is less than 1 percent over 50 consecutive cycles of motion.
6. The applied moments and extreme fiber stresses shall be calculated along the full length of each top mast section for each analysis case.
7. The stress range shall be calculated as two times the maximum steady-state stress at each point (which is the same as the maximum stress minus the minimum stress in each cycle).

G. Fatigue Limits.

1. For top mast sections with wall thickness less than 0.8 inches, the stress ranges calculated in Section F7 must be less than 4,500 pounds per square inch (psi) along the full length of each top mast section for each analysis case defined in Section E2 to be judged acceptable. For top mast sections greater than 0.8 inches in thickness, the stress ranges must be less than 2,600 psi.
2. As an alternative to G1, the design details of the connections between top mast sections and of all connections of appurtenances to the top mast structure must be such that the allowable stress range limits provided in AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals (2013) for the specified connection details are larger than the calculated stress ranges.
3. If the calculated stress ranges are above the allowable limits set forth in Section G1 or G2, the top mast sections must be increased in size or otherwise redesigned such that the stress ranges determined in accordance with Section D through F are below the allowable limits.

END OF SECTION

SECTION 13 50 00

ANTENNAS

PART 1 - GENERAL

1.01 DESCRIPTION

A. Work Included:

1. Tower design loading information for antennas.

B. Related Work:

1. Section 13 34 00: Communications Tower

PART 2 - MATERIALS

2.01 NOT USED

PART 3 - EXECUTION

3.01 GENERAL

A. The tower “Base Antenna Loads” to be utilized for tower design purposes are per:

1. “Schedule A: Generic Tower VHF/UHF Antenna Loading” in Part 4 below.
2. “Schedule B: Generic Tower Microwave Antenna Loading” in Part 4 below.
3. VHF and microwave antennas shown on the tower reference drawings in 13 34 00.

B. Site specific antennas and feedlines will be installed by the owner.

1. Owner to provide 1 elliptical cable, EW63, for each installed microwave dish and 1 heliax cable, LDF5-50A, for each installed VHF antenna.

SEE FOLLOWING PAGES FOR PART 4 - REFERENCE INFORMATION

PART 4 - REFERENCE INFORMATION

4.01 SCHEDULE A: GENERIC TOWER VHF/UHF ANTENNA LOADING

Item #	Antenna Height (Mounting Location)	Tower Leg Position*	Antenna Mfr.	Antenna Model Number	Antenna Length/ Diameter
1	120	1.20	Andrews	DB674G65A-C	78"/19"
2	120	1.40	Andrews	DB674G65A-C	78"/19"
3	120	2.60	Andrews	DB674G65A-C	78"/19"
4	120	2.80	Andrews	DB674G65A-C	78"/19"
5	120	3.20	Andrews	DB674G65A-C	78"/19"
6	120	3.40	Andrews	DB674G65A-C	78"/19"
7	120	4.60	Andrews	DB674G65A-C	78"/19"
8	120	4.80	Andrews	DB674G65A-C	78"/19"
9	130	C1	Andrews	DB674G65A-C	78"/19"
10	130	C2	Andrews	DB674G65A-C	78"/19"
11	130	C3	Andrews	DB674G65A-C	78"/19"
12	100	1A	Andrews	DB674G65A-C	78"/19"
13	100	1B	Andrews	DB674G65A-C	78"/19"
	100	1.50	Andrews	DB674G65A-C	78"/19"
14	100	2A	Andrews	DB674G65A-C	78"/19"
15	100	2B	Andrews	DB674G65A-C	78"/19"
	100	2.50	Andrews	DB674G65A-C	78"/19"
16	100	3A	Andrews	DB674G65A-C	78"/19"
17	100	3B	Andrews	DB674G65A-C	78"/19"
	100	3.50	Andrews	DB674G65A-C	78"/19"
18	100	4A	Andrews	DB674G65A-C	78"/19"
19	100	4B	Andrews	DB674G65A-C	78"/19"
	100	4.50	Andrews	DB674G65A-C	78"/19"
20	80	1A	Andrews	DB674G65A-C	78"/19"
21	80	1B	Andrews	DB674G65A-C	78"/19"
	80	1.50	Andrews	DB674G65A-C	78"/19"
22	80	2A	Andrews	DB674G65A-C	78"/19"
23	80	2B	Andrews	DB674G65A-C	78"/19"
	80	2.50	Andrews	DB674G65A-C	78"/19"
24	80	3A	Andrews	DB674G65A-C	78"/19"
25	80	3B	Andrews	DB674G65A-C	78"/19"
	80	3.50	Andrews	DB674G65A-C	78"/19"
26	80	4A	Andrews	DB674G65A-C	78"/19"
27	80	4B	Andrews	DB674G65A-C	78"/19"
	80	4.50	Andrews	DB674G65A-C	78"/19"
28	60	1A	Andrews	DB674G65A-C	78"/19"

29	60	1B	Andrews	DB674G65A-C	78"/19"
	60	1.50	Andrews	DB674G65A-C	78"/19"
30	60	2A	Andrews	DB674G65A-C	78"/19"
31	60	2B	Andrews	DB674G65A-C	78"/19"
	60	2.50	Andrews	DB674G65A-C	78"/19"
32	60	3A	Andrews	DB674G65A-C	78"/19"
33	60	3B	Andrews	DB674G65A-C	78"/19"
	60	3.50	Andrews	DB674G65A-C	78"/19"
34	60	4A	Andrews	DB674G65A-C	78"/19"
35	60	4B	Andrews	DB674G65A-C	78"/19"
	60	4.50	Andrews	DB674G65A-C	78"/19"

4.01 SCHEDULE A: GENERIC TOWER VHF/UHF ANTENNA LOADING (CONT'D).

Item #	Antenna Height (Mounting Location)	Tower Leg Position*	Antenna Mfr.	Antenna Model Number	Antenna Length/ Diameter
36	40	1A	Andrews	DB674G65A-C	78"/19"
37	40	1B	Andrews	DB674G65A-C	78"/19"
	40	1.50	Andrews	DB674G65A-C	78"/19"
38	40	2A	Andrews	DB674G65A-C	78"/19"
39	40	2B	Andrews	DB674G65A-C	78"/19"
	40	2.50	Andrews	DB674G65A-C	78"/19"
40	40	3A	Andrews	DB674G65A-C	78"/19"
41	40	3B	Andrews	DB674G65A-C	78"/19"
	40	3.50	Andrews	DB674G65A-C	78"/19"
42	40	4A	Andrews	DB674G65A-C	78"/19"
43	40	4B	Andrews	DB674G65A-C	78"/19"
	40	4.50	Andrews	DB674G65A-C	78"/19"
44	20	1A	Andrews	DB674G65A-C	78"/19"
45	20	1B	Andrews	DB674G65A-C	78"/19"
	20	1.50	Andrews	DB674G65A-C	78"/19"
46	20	2A	Andrews	DB674G65A-C	78"/19"
47	20	2B	Andrews	DB674G65A-C	78"/19"
	20	2.50	Andrews	DB674G65A-C	78"/19"
48	20	3A	Andrews	DB674G65A-C	78"/19"
49	20	3B	Andrews	DB674G65A-C	78"/19"
	20	3.50	Andrews	DB674G65A-C	78"/19"
50	20	4A	Andrews	DB674G65A-C	78"/19"
51	20	4B	Andrews	DB674G65A-C	78"/19"
	20	4.50	Andrews	DB674G65A-C	78"/19"

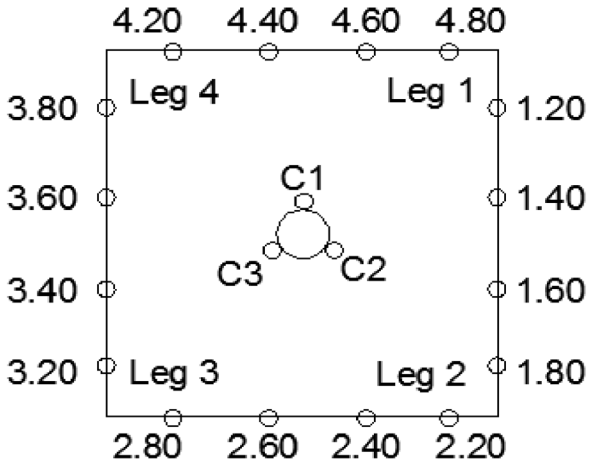
* See 4.03 for "Antenna Leg Position Layout" diagram.

4.02 SCHEDULE B: GENERIC TOWER MICROWAVE ANTENNA LOADING

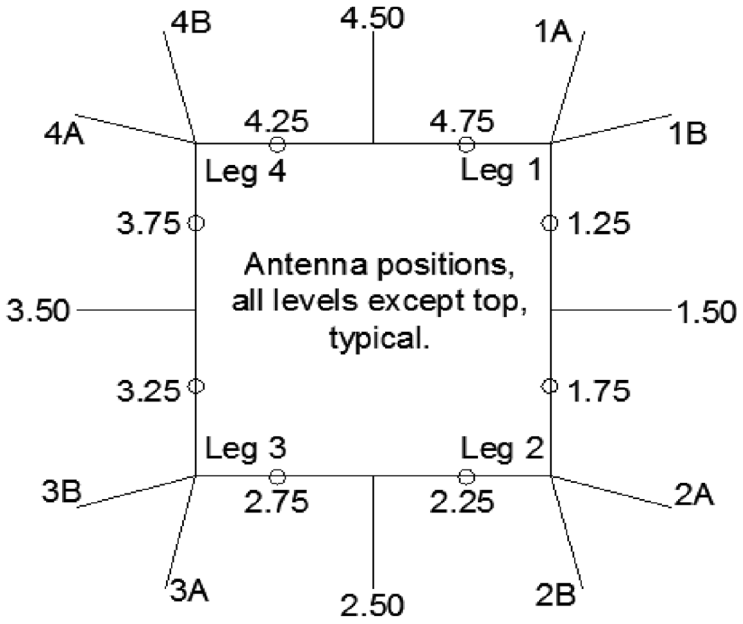
Item #	Antenna Height (Mounting Location)	Tower Leg Position*	Antenna Mfr.	Antenna Model Number	Antenna Diameter
1	110	1	Andrews	UHX10-65	10' Diameter
2	110	2	Andrews	UHX10-65	10' Diameter
3	110	3	Andrews	UHX10-65	10' Diameter
4	110	4	Andrews	UHX10-65	10' Diameter
5	90	1	Andrews	UHX10-65	10' Diameter
6	90	2	Andrews	UHX10-65	10' Diameter
7	90	3	Andrews	UHX10-65	10' Diameter
8	90	4	Andrews	UHX10-65	10' Diameter
9	70	1.5	Andrews	UHX10-65	10' Diameter
10	70	2.5	Andrews	UHX10-65	10' Diameter
11	70	3.5	Andrews	UHX10-65	10' Diameter
12	70	4.5	Andrews	UHX10-65	10' Diameter

* See 4.03 for “Antenna Leg Position Layout” diagram.

4.03 ANTENNA LEG POSITION LAYOUT DIAGRAM



Antenna positions,
top level, typical.



END OF SECTION

1. Confirmation that the Project has met requirements for the appropriate Project category: Non-Smoking Building;

2. An optional narrative may be provided to further describe the testing protocols/results and compliance methods implemented by the Project.

GG. EQc1 Enhanced Indoor Air Quality Strategies

1. Option 1 Enhanced IAQ Strategies

   a. Entryway Systems

      1) Provide confirmation that the required entryway systems have been provided

      2) Provide a listing of each entryway product installed in the building. For roll-up or carpet systems, confirm that the required contracted maintenance will take place.

      3) Provide copies of the Project's construction drawings to highlight the location of the installed entryway systems.

   b. Interior Cross-Contamination Prevention

      1) Confirm that chemical use areas have been designed as separate rooms with dedicated exhaust systems and appropriate negative pressurization.

      2) Provide copies of the Project's mechanical drawings to highlight the location of chemical usage areas, room separations, and the associated exhaust systems.

   c. Filtration

      1) If mechanically ventilated, confirm that the installed filters and their associates MERV rating of 13 or better.

      2) Provide listing of the installed filters and their associated MERV ratings.

   d. Natural Ventilation Design Calculations

      1) Provide calculations based on the appropriate strategies in Chartered Institution of Building Services Engineers (CIBSE) Applications Manual AM10, March 2005, Natural Ventilation in Non-Domestic Buildings, Section 2.4

   e. Mixed-Mode Design Calculations

      1) Provide calculations that comply with the Chartered Institution of Building Services Engineers (CIBSE) Applications Manual 13-2000, Mixed Mode Ventilation.

2. Option 2 Additional Enhanced IAQ Strategies

   a. Exterior Contamination Prevention

1) Perform computational fluid dynamics modeling, Gaussian dispersion analyses, wind tunnel modeling, or tracer gas modeling to provide a report that will indicate outdoor air contaminant concentrations at outdoor air intakes are below the thresholds listed.

b. Increased Ventilation

1) Confirm that the breathing zone ventilation rates in all occupied spaces have been designed to exceed the minimum rates required by ASHRAE Standard 62.1-2010 or the applicable code, whichever is more stringent, by a minimum of 30%.

2) Provide a design narrative describing the Project's ventilation system design. Include specific information regarding the fresh air intake volume for each specific occupied zone to demonstrate that the design exceeds the referenced standard or the applicable local code; whichever is more stringent, by at least 30%.

c. Carbon Dioxide Monitoring

1) Confirmation of the type of ventilation system and installed controls.

2) Design narrative describing the Project's ventilation design and CO2 monitoring system. Include specific information regarding the location and quantity of installed monitors, operational parameters and set points.

3) Provide copies of applicable Project drawings to document the location and type of installed sensors. Drawings should also show natural ventilation components (operable windows, air intakes, etc.) as applicable.

d. Additional Source Control Monitoring

1) Provide a materials handling plan.

2) Provide copies of applicable Project drawings to document the location and type of installed sensors and alarms.

e. Natural Ventilation Room-by-Room Calculations

1) Provide design calculations based on CIBSE AM10, Section 4.

3. Provide a narrative to describe any special circumstances or non-standard compliance paths taken by the Project.

HH. EQc5 Thermal Comfort

1. Provide data regarding the seasonal temperature and humidity design requirement.

2. Provide a narrative describing the method used to establish the thermal comfort conditions for the Project and how the systems design addresses the design requirement. Include specific information regarding compliance with the referenced standard.

3. For individual workstation controls, provide a listing of the total number of individual workstations and thermal controls.

4. For shared multi-occupant space control, provide a listing of the Project's group multi-occupant spaces and a description of the installed thermal controls.

5. Provide a narrative describing the Project's comfort control strategy. Include data regarding the type and location of individual and shared group occupancy controls.

6. Provide a narrative describing the survey planned for the validation of the thermal comfort conditions for the Project. Include specific description of the provisions for creating a plan for corrective action.

II. EQc6 Interior Lighting

1. Option 1 Lighting Control

   a. For individual workstation controls, provide a listing of the total number of individual workstations and lighting controls.

   b. For shared multi-occupant space control, provide a listing of the Project's group multi-occupant spaces and a description of the installed lighting controls.

   c. Provide a narrative describing the Project's lighting control strategy. Include data regarding the type and location of individual controls (general area illumination controls for multi-workstation spaces may not be counted towards this credit) and also the type and location of controls provided for shared multi-occupant spaces.

2. Option 2 Lighting Quality

   a. Provide a narrative describing the Project's four lighting quality strategies. Include data (as applicable) regarding light fixture luminance, CRI values, rated life, surface reflectance, and surface illuminance.

JJ. EQc7 Daylight

1. Option 1 Simulation: Spatial Daylight Autonomy (55% / 75%) and Annual Sunlight Exposure

   a. Complete the template calculation spreadsheet to demonstrate that the Project complies with the minimum spatial daylight autonomy and maximum annual sunlight exposure. The following data is required for input in the template:

      1) Total regularly occupied space (sq.ft.)

      2) Total regularly occupied space area that achieves a simulated minimum of 25 foot-candles.

   b. Provide an output summary from the daylight computer simulations.

   c. Provide copies of the applicable Project drawings showing the illumination simulation results.

OR

2. Option 2 Illuminance Calculations (75% / 90%)

    a. Complete the template calculation spreadsheet to demonstrate that the Project complies with the minimum illumination levels. The following data is required for input in the template:

        1) Total regularly occupied space (sq. ft.)

        2) Total regularly occupied space area that achieves simulated illuminance levels between 300 lux and 3,000 lux.

    b. Provide an output summary from the daylight computer simulations.

    c. Provide copies of the applicable Project drawings showing the illumination simulation results.

3. Option 3 Measurement:

    a. Complete the template calculation spreadsheet to demonstrate that the Project complies with the minimum illumination levels. The following data is required for input in the template:

    b. Total regularly occupied space area (sq. ft.).

    c. Total regularly occupied space area that achieves simulated illuminance levels between 300 lux and 3,000 lux.

    d. Provide copies of the applicable Project drawings showing the recorded daylight measurements. Comply with the timing requirements by providing second measurements in the indicated months.

    AND

4. Provide a narrative describing any special occupancy areas that have been excluded from compliance. The narrative should include detailed description of the space function and explanation as to why the inclusion of daylight would hinder the normal tasks/function of each excluded area.

5. For projects that have used computer simulation or physical measurements, please include detailed information describing the method used to determine the daylighting contributions in the building. Include specific information regarding the actual or simulated time of day and weather conditions, measurement equipment or software used, and the calculation method for determining the final daylighting area.

KK.EQc8 Quality Views

1. Provide copies of the applicable Project drawings showing the location of regularly occupied spaces with views.

2. Provide a narrative describing the types of views that have been used. The narrative should include detailed description of lines of sight, obstructions to views, unobstructed views, and view factors.

LL. EQc9 Acoustic Performance

1. HVAC Background Noise

    a. Provide calculations or measurements for background sound levels from HVAC systems.

    b. Provide a narrative describing the types of views that have been used. The narrative should include detailed description of lines of sight, obstructions to views, unobstructed views, and view factors.

2. Sound Transmission

    a. Provide copies of the applicable Project drawings showing STC values for wall, ceiling and floor assemblies; indicate on plans the treatments used for sound control where ductwork or other passages connect spaces.

3. Reverberation Time

    a. Provide document showing reverberation time.

4. Sound Reinforcement and Masking Systems

    a. Provide copies of the applicable Project drawings showing STC values for wall, ceiling and floor assemblies; indicate on plans the treatments used for sound control where ductwork or other passages connect spaces.

    b. Confirm the criteria for reinforcement systems are being met.

MM. IDc1.1-1.5 Innovation and Design Credits

1. Up to five independent sustainability measures may be applied to ID credits

    a. Provide the specific title for the ID credit being pursued.

    b. Provide a narrative describing the Credit Intent.

    c. Provide a narrative statement describing the Credit Requirements.

    d. Provide a detailed narrative describing the Project's approach to achievement of the credit. This narrative should include a description of the quantifiable environmental benefits of the credit proposal.

    e. Provide copies of any specific construction drawings or exhibits that serve to illustrate the Project's approach to the credit. (Note: this may not be applicable to all ID credit proposals.)

1.11 LEED® CONSTRUCTION SUBMITTAL REQUIREMENTS

Project Data Sheet. The minimum LEED® Construction Submittal requirements are listed below for prerequisites and credits the Contractor intends to pursue. In this document, LEED v4 prerequisites and credits are named alphanumerically in the order of their appearance in the LEED v4 BD&C reference guide table of contents for ease of reference. The Contractor is responsible for submission of all LEED® credit requirements, using the online v4 submittal template to achieve LEED® Silver Certification. Copies of all submittals made to the USGBC shall be forwarded to the State:

A. SSp1 Construction Activity Pollution Prevention

1. Provide copies of the Project drawings documenting erosion and sedimentation control measures implemented on the site.

2. Provide confirmation of the compliance path taken by the Project National Pollutant Discharge Elimination System (NPDES) Compliance or Local Erosion Control Standards).

3. Provide narrative to describe the Erosion and Sedimentation control measures implemented on the Project. If local standard has been followed, provide specific information to demonstrate that the local standard is equal to or more stringent than the referenced NPDES program.

B. SSc2 Site Development – Protect or Restore Habitat

1. Provide Project Site Area.

2. Provide Project Building Footprint Area.

3. Provide narrative describing the Project's approach to this credit. Include information regarding any special circumstances or considerations of the Project.

AND for:

4. Greenfield sites: Provide a copy of the Project's grading drawings highlighting the designated site disturbance boundaries. (Upload to LEED®-Online website in acceptable format).

5. Option 1 On-Site Restoration

   a. Previously Developed/Graded Sites: Provide area (sq. ft.) of site that has been restored using native/adaptive planting.

OR

6. Option 2 Financial Support

   a. Provide documentation of the financial support, and the $/sq. ft. value for the total site area (including building footprint).

C. SSc5 Heat Island Reduction

1. Provide the measured reflectance and emittance of each paving material provide Project's site drawings highlighting the location of specific paving materials, landscape shading, and/or underground or covered parking (upload to LEED®-Online website in acceptable format).

AND

2. Option 1:

    a. Provide the measured reflectance and emittance of each paving material installed on-site (to calculate the SRI OR the actual SRI for each paving material installed on site OR the default SRI value for typical materials from Table 1 on page 112 of the v4 Ref Guide.

    b. Total Area of site hardscape.

    c. Total Area of hardscape to be shaded within 5 years.

    d. Total Area of installed SRI complaint hardscape materials.

    e. Total Area of open grid pavement.

OR

3. Option 2:

    a. Total number if parking spaces provided on-site.

    b. Total number of covered parking spaces on-site.

AND (For Either Compliance Option)

4. Provide an optional narrative to describe any special circumstances or non-standard compliance paths taken by the Project.

D. EAp1 Fundamental Commissioning and Verification

1. Provide the name and company information of the CxA.

2. Confirm the nine required tasks have been completed.

3. Provide a narrative description of the systems that were commissioned and the results of the commissioning process.

E. EAc1 Enhanced Commissioning

1. Provide the name and company information of the CxA.

2. Confirm the nine required tasks have been completed.

3. Provide a narrative description of the results of the commissioning design review, implementation of the systems manual and training, and the plan for the review of building operation at 8 to 10 months.

F. MRc1 Building Life-Cycle Impact Reduction

1. Option 3 Building and Material Reuse – Reuse 25% / 50% / 75% surface area

   a. Confirm whether the Project is strictly a renovation of an existing building or a renovation with an addition. For projects with additions, confirm the square footage of the new addition(s).

   b. Provide tabulation of the total and reused areas (sq.ft.) of each structural/envelope element.

   c. Provide tabulation of the total and reused areas (sq. ft.) of each non-structural interior element.

   d. Provide an optional narrative describing any special circumstances or considerations regarding the Projects credit approach.

2. Option 4 Whole-Building Life-Cycle Assessment

   a. Provide a life-cycle assessment of the project's structure and enclosure that demonstrates a minimum of 10% reduction, compared with a baseline building, in at least three of the six impact categories listed in the LEED v4 Reference Guide, one of which is the global warming potential.

G. MRc5 Construction Waste Management

1. Option 1 Diversion (Divert 50% and Three Material Streams/75% and Four Material Streams from Disposal)

   a. Complete the construction waste calculation tables including: General description of each type/category of waste generated; location of receiving agent (recycler/landfill) for waste; quantity of waste diverted (by category) in tons or cubic yards.

   b. Provide a narrative describing the Project's construction waste management approach including a copy of the Project's construction waste management plan. Please provide any additional comments or notes to describe special circumstances or considerations regarding the Project's credit approach.

2. Option 2 Reduction of Total Waste Material

   a. Provide Building Floor Area

   b. Calculate total construction waste

   c. Calculate total construction waste per foot of building floor area.

H. EQc2 Low-Emitting Materials

1. Option 1 Product Category Calculations

    a. Provide a listing of each indoor paint and coatings used on the Project. Include the manufacture's name, product name, specific VOC data (in g/L less water and emissions) for each product, and the corresponding allowable VOC from the referenced standard (listed on page 483 of the LEED-NC v4 reference guide)

    b. Provide a listing of each indoor adhesive, sealant and sealant primer product used on the Project. Include the manufacture's name, product name, specific VOC data (in g/L less water and emissions) for each product, and the corresponding allowable VOC from the referenced standard (listed on page 474 of the LEED-NC v4 reference guide)

    c. Provide a listing of each indoor aerosol adhesive product used on the Project. Include the manufacture's name, product name, specific VOC data (in g/L less water and emissions) for each product, and the corresponding allowable VOC from the referenced standard (listed on page 474 of the LEED-NC v4 reference guide)

    d. Provide a listing of carpet product installed in the building interior. Confirm that the product complies with CRI Green Label Plus testing program. For more information visit: www.carpet-rug.org

    e. Provide a listing of carpet cushion product installed in the building interior. Confirm that the product complies with CRI Green Label testing program. For more information visit: www.carpet-rug.org

    f. Provide a listing of hardwood surface flooring installed in the building interior. Confirm that the product complies with FloorScore.

    g. Provide a listing of each composite wood and Agrifiber product installed in the building interior. Confirm that the product does not contain any added urea-formaldehyde.

2. Option 2 Budget Calculation Method

    a. Provide a budget calculation indicating percentage compliance.

3. Confirm that emissions and content requirements are met.

4. Provide a narrative to describe any special circumstances or non-standard compliance path taken by the Project.

I. EQc3 Construction Indoor Air Quality Management Plan

1. Provide a copy of the Project's Indoor Air Quality (IAQ) Management Plan.

2. Confirm if the permanently installed air handling equipment was used during construction.

3. Provide photos to highlight the implemented construction IAQ practices.

4. List all filtration media (manufacturer, model #, MERV rating, location of installed filter) installed during construction and confirm that each unit replaced prior to occupancy.

5. Provide an optional narrative describing any special circumstance or non-standard approached taken by the Project.

J. EQc4 Indoor Air Quality Assessment

1. Confirm approach taken by Project (pre-occupancy flush-out; flush-out with early occupancy; IAQ testing).

2. Provide a copy of the Project's Indoor Air Quality Testing Report (if applicable).

3. Provide a narrative describing the Project's specific flush-out procedures and/or IAQ testing process and results.

K. IDc1.1-1.5 Innovation and Design Credits

1. Up to five independent sustainability measures may be applied to ID credits using the online v4 submittal template:

a. Provide the specific title for the ID credit being pursued.

b. Provide a narrative describing the Credit Intent

c. Provide a narrative statement describing the Credit Requirements

d. Provide a detailed narrative describing the Project's approach to achievement of the credit. This narrative should include a description of the quantifiable environmental benefits of the credit proposal.

e. Provide copies of any specific construction drawings or exhibits that serve to illustrate the Project's approach to the credit. (Note: this may not be applicable to all ID credit proposals.)

1.12 SPECIAL PRODUCTS AND SUBSITUTIONS

A. In addition to the requirements of Section 01 60 00, Products Requirements, the special substitution requirements described here apply only to the LEED® certification related materials and requirements, and environmental products and procedures identified in this Section.

B. Notify the State when Contractor wishes to substitute materials, equipment, or products that meet the aesthetic and programmatic intent of the Construction Documents and offer equivalent or increased environmental sensitivity to materials, equipment, or products specified to meet LEED® requirements as indicated in the Construction Documents.

C. Substitutions that may affect LEED® certification must be clearly stated as such.

D. Comply with the requirements of Division 1 with the following in addition to Section 01 60 00, Product Requirements as follows:

1. Prior to submitting detailed information required under Section 01 60 00, Product Requirements, submit the following for initial review by the State.

    a. Product data including manufactures names, address, and phone number.

    b. Include copy of Material Safety Data Sheet (MSDS) if applicable.

    c. Description of the differences of the proposed substitution from specified product related to LEED® requirements. Include description of environmental advantages of proposed substitution over specified product.

    d. The Contractor is responsible for re-submittal of all calculations, and documentation of products or material substitutions that affect LEED® prerequisites and credits referenced in 1.10 and 1.11 of this Section and applies to any credits previously submitted as part of the LEED® Design Application Submittal and all credits included in the LEED® Construction Submittal. Products that do not meet these requirements should not be submitted for substitution.

    e. Substitutions of materials and products specified as part of the Contract Documents in the following areas (but not necessarily limited to these items) will require review and potential re-submittal of LEED® Design Application Pre-requisites and Credits:

        1) Irrigation System

        2) Storm water System

        3) Roofing products and materials

        4) Plumbing fixtures and controls

        5) Interior and Exterior Lighting systems and controls

        6) HVAC equipment, systems and controls

        7) CO2 monitoring system

    f. Substituted products shall not be ordered or installed without written acceptance by the State.

2. Requests for Substitutions

    a. Submit a separate request for each LEED® related product substitution.

    b. Identify product Specification Section and LEED® credit or credits, if applicable.

    c. List similar Projects using product, dates of installation, and names of Contractor and Owner.

    d. Give itemized comparison of proposed substitution with specified product, listing variations, and reference Specification Section and Article number.

e. Include copy of Material Safety Data Sheet (MSDS) if applicable.

f. Give cost data comparing proposed substitution with specified product and amount of net change to Contract Sum. The cost data should be based on life cycle analysis for each affected product including annual energy consumption and maintenance costs.

g. State effect of substitution on construction schedule and changes required in other work of products.

Part 2 PRODUCTS

2.01 MATERIALS, GENERAL

A. Provide products and procedures necessary to obtain LEED credits required in this Section. Although other Sections may specify some requirements that contribute to LEED credits, the Contractor shall determine additional materials and procedures necessary to obtain LEED credits indicated. Contractor to determine a combination of credit options best suited for achieving credits required.

1. Exclusions: Special equipment, such as elevators, escalators, process equipment, and fire suppression systems, is excluded from the credit calculations. Also excluded are products purchased for temporary use on the project, like formwork for concrete.

2.02 BUILDING PRODUCT DISCLOSURE AND OPTIMIZATION

A. MRc2, Building Product Disclosure and Optimization, Environmental Product Declarations (EPD) (v4.1 credit substitution): Option 1. Provide at least 20 permanently installed products (sourced from at least 5 different manufacturers) which meet one of the disclosure criteria:

1. Product-Specific Declaration, self-declared: Valued as one (1) product.
2. Industry-Wide (Generic) EPD: Valued as one (1) product.
3. Product-Specific Type III EPD: Valued as one and a half (1.5) products.

B. MRc2, Building Product Disclosure and Optimization, Environmental Product Declarations (EPD) (v4.1 credit substitution): Option 2: Multi-Attribute Optimization.

1. Use products that comply with one of the criteria below for at least 10%, by cost, of the total value of permanently installed products in the project or use at least 10 permanently installed products sourced from at least three different manufacturers. Products will be valued as below:

a. Life Cycle Impact Reduction Action Plan: Valued as 50% cost or one half (0.5) product.
b. Life Cycle Impact Reductions in Embodied Carbon
1) Third party EPD or verified LCA that demonstrates reduction in global warming potential (GWP) impact category and has narrative describing how reductions were achieved: Valued as 100% cost or one (1) product.
2) Third party EPD or verified LCA that demonstrates 10% minimum reduction in global warming potential (GWP) impact category and has narrative

describing how reductions were achieved: Valued as 150% cost or one and a half (1.5) products.

3) Third party EPD or verified LCA that demonstrates 20% minimum reduction in global warming potential (GWP) impact category and at least 5% reductions in two additional categories and has narrative describing how reductions were achieved: Valued as 200% cost or two (2) products.

Impact Categories:

a) global warming potential (greenhouse gases), in CO2e;
b) depletion of the stratospheric ozone layer, in kg CFC-11e;
c) acidification of land and water sources, in moles H+ or kg SO2e;
d) eutrophication, in kg nitrogen equivalent or kg phosphate equivalent;
e) formation of tropospheric ozone, in kg NOx, kg O3 eq, or kg ethene; and
f) depletion of nonrenewable energy resources, in MJ using CML / depletion of fossil fuels in TRACI

C. MRc3, Building Product Disclosure and Optimization, Sourcing of Raw Materials (v4.1 credit substitution): Leadership Extraction Practices: Provide products that meet at least one of the responsible extraction criteria below for at least 20%, by cost, of the total value of permanently installed building products in the project:

1. Extended producer responsibility program.
2. Bio-based materials.
3. Certified Wood: Wood-based materials include, but are not limited to, the following materials when made from wood, engineered wood products, or wood-based panel products:

   a. Rough carpentry.
   b. Miscellaneous carpentry.
   c. Heavy timber construction.
   d. Wood decking.
   e. Metal-plate-connected wood trusses.
   f. Structural glued-laminated timber.
   g. Finish carpentry.
   h. Architectural woodwork.
   i. Wood paneling.
   j. Wood veneer wall covering.
   k. Wood flooring.
   l. Wood lockers.
   m. Wood cabinets.
   n. Furniture.
4. Materials Reuse
5. Recycled content.
   a. Exceptions: Do not include fire protection, operational plumbing, operational mechanical, and operational electrical components, and specialty items, such as elevators and equipment, in the calculation.

D. MRc4, Building Product Disclosure and Optimization, Material Ingredients (v4.1 credit substitution): Option 1, Material Ingredient Reporting.

1. Use at least 20 different permanently installed products from at least five different manufacturers that use any of the following programs to demonstrate the chemical inventory of the product to at least 0.1% (1000 ppm), which meet one of the following disclosure criteria:

    a. Manufacturer Inventory.
    b. Health Product Declarations (HPDs).
    c. Cradle to Cradle (C2C) certifications.
    d. Declare product labels.
    e. ANSI/BIFMA e3 Furniture Sustainability Standard.

E. MRc4, Building Product Disclosure and Optimization, Material Ingredients (v4.1 credit substitution): Option 2, Material Ingredient Optimization.

1. Use products that document their material ingredient optimization using the paths below for at least 10 products, or 10%, by cost, of the total value of permanently installed products in the project, sourced from at least three different manufacturers, which meet one of the following disclosure criteria:
    a. Material Ingredient Screening and Optimization Action Plan (value at 50% by cost or ½ product)
    b. Advanced Inventory & Assessment (value at 100% by cost or 1 product)
    c. Material Ingredient Optimization (value at 150% by cost or 1.5 products).
    d. REACH Optimization (value at 100% by cost or 1 product)

2.03 LOW-EMITTING MATERIALS

A. EQc2, Low-Emitting Materials (v4.1 credit substitution), General Emissions Requirements: Products must demonstrate they have been tested and determined compliant in accordance with California Department of Public Health, (CDPH), Standard Method v1.2-2017, using the applicable exposure scenario. Manufacturer's documentation demonstrating compliance must state the range of total VOCs (tVOC) after 14 days measured as specified in the CDPH Standard Method v1.2 as follows:

    1. 0.5mg/m3 or less,
    2. between 0.5 and 5.0 mg/m3 or,
    3. 0.50 mg/m3 or more.

B. EQc2, Low-Emitting Materials (v4.1 credit substitution), Paints and Coatings: For field applications that are inside the weatherproofing system, use ONLY paints and coatings that comply with the limits for VOC content when calculated according to the California Air Resources Board (CARB) 2007, Suggested Control Measure (SCM) for Architectural Coatings, or the South Coast Air Quality Management District (SCAQMD) Rule 1113, effective February 5, 2016.

Product Type:	Allowable VOC Content (g/L):
Bond Breaker	350
Clear wood finishes - Varnish	275
Clear wood finishes – Sanding Sealer	275
Clear wood finishes - Lacquer	275
Colorant – Architectural Coatings, excluding IM	50

coatings	
Colorant – Solvent Based IM	600
Colorant - Waterborne IM	50
Concrete – Curing compounds	100
Concrete – Curing compounds for roadways & bridges	350
Concrete surface retarder	50
Driveway Sealer	50
Dry-fog coatings	50
Faux finishing coatings - Clear topcoat	100
Faux finishing coatings – Decorative Coatings	350
Faux finishing coatings - Glazes	350
Faux finishing coatings - Japan	350
Faux finishing coatings – Trowel applied coatings	50
Fire-proof coatings	150
Flats	50
Floor coatings	50
Form release compounds	100
Graphic arts (sign) coatings	200
Industrial maintenance coatings	100
Industrial maintenance coatings – High temperature IM coatings	420
Industrial maintenance coatings – Non-sacrificial anti-graffiti coatings	100
Industrial maintenance coatings – Zinc rich IM primers	100
Magnesite cement coatings	450
Mastic coatings	100
Metallic pigmented coatings	150
Multi-color coatings	250
Non-flat coatings	50
Pre-treatment wash primers	420
Primers, sealers and undercoaters	100
Reactive penetrating sealers	350
Recycled coatings	250
Roof coatings	50
Roof coatings, aluminum	100
Roof primers, bituminous	350
Rust preventative coatings	100
Stone consolidant	450
Sacrificial anti-graffiti coatings	50
Shellac- Clear	730
Shellac – Pigmented	550
Specialty primers	100
Stains	100
Stains, interior	250
Swimming pool coatings – repair	340
Swimming pool coatings – other	340
Traffic Coatings	100
Waterproofing sealers	100
Waterproofing concrete/masonry sealers	100
Wood preservatives	350
Low solids coatings	120

C. EQc2, Low-Emitting Materials (v4.1 credit substitution), Paints and Coatings: For field applications that are inside the weatherproofing system, 75 percent by volume or surface area of

paints and coatings shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

D. EQc2, Low-Emitting Materials (v4.1 credit substitution), Adhesives and Sealants: For field applications that are inside the weatherproofing system, use adhesives and sealants that comply with the limits for VOC content when calculated according to South Coast Air Quality Management District (SCAQMD) Rule #1168, requirements in effect on October 6, 2017:

Architectural Applications:	Allowable VOC Content (g/L):
Indoor carpet adhesives	50
Carpet pad adhesives	50
Wood flooring adhesives	100
Rubber floor adhesives	60
Subfloor adhesives	50
Ceramic tile adhesives	65
VCT and asphalt tile adhesives	50
Dry wall and panel adhesives	50
Cove base adhesives	50
Multipurpose construction adhesives	70
Structural glazing adhesives	100
Single ply roof membrane adhesives	250
Specialty Applications:	
PVC welding	510
CPVC welding	490
ABS welding	325
Plastic cement welding	250
Adhesive primer for plastic	550
Computer diskette manufacturing adhesive	350
Contact adhesive	80
Special purpose contact adhesive	250
Tire retread	100
Structural wood member adhesive	140
Top and Trim adhesive	250
Substrate Specific Applications:	
Metal to metal substrate specific adhesives	30
Plastic foam substrate specific adhesives	50
Porous material (except wood) substrate specific adhesives	50
Wood substrate specific adhesives	30
Fiberglass substrate specific adhesives	80
Sealants:	
Architectural sealant	250
Other sealant	420
Sealant Primers:	
Architectural non-porous sealant primer	250
Architectural porous sealant primer	775
Modified bituminous sealant primer	500
Marine deck sealant primer	760
Other sealant primer	750
Other	
Other adhesives, adhesive bonding primers, adhesive primers or any other primers	250

1. Exception: The provisions of SCAQMD Rule 1168 do not apply to adhesives and sealants subject to state or federal consumer product VOC regulations.

E. EQc2, Low-Emitting Materials (v4.1 credit substitution), Adhesives and Sealants: For field applications that are inside the weatherproofing system, 75 percent by volume or surface area of adhesives and sealants shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

F. EQc2, Low-Emitting Materials (v4.1 credit substitution), Flooring: 90 percent by cost or surface area of flooring shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers," or are inherently non-emitting or are salvaged / reused.

G. EQc2, Low-Emitting Materials (v4.1 credit substitution), Composite Wood: 75 percent by cost or surface area of composite wood, agrifiber products, and adhesives shall be made using ultra-low-emitting formaldehyde (ULEF) resins as defined in the California Air Resources Board's "Airborne Toxic Control Measure to Reduce Formaldehyde Emissions from Composite Wood Products" or shall be made with no added formaldehyde or are salvaged / reused.

H. EQc2, Low-Emitting Materials (v4.1 credit substitution), Ceilings: 90 percent by cost or surface area, of ceilings shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers" or are inherently non-emitting or are salvaged / reused.

I. EQc2, Low-Emitting Materials (v4.1 credit substitution), Walls Panels: 75 percent by cost or surface area of wall panels shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers" or are inherently non-emitting or are salvaged / reused.

J. EQc2, Low-Emitting Materials (v4.1 credit substitution), Insulation: 75 percent by cost of all insulation shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

K. EQc2, Low-Emitting Materials (v4.1 credit substitution), Furniture: At least 75 percent of furniture, measured by cost, shall be tested in accordance with ANSI/BIFMA Standard Method M7.1-2011; comply with ANSI/BIFMA e3-2011 Furniture Sustainability Standard, Sections 7.6.1 and 7.6.2, using either the concentration modeling approach or the emissions factor approach; and model the test results using the open plan, private office, or seating scenario in ANSI/BIFMA M7.1, as appropriate or are inherently non-emitting or are salvaged / reused.

L. Additional Low-Emitting Requirements:

1. If the applicable regulation requires subtraction of exempt compounds, any content of intentionally added exempt compounds larger than 1% weight by mass (total exempt compounds) must be disclosed.
2. If a product cannot reasonably be tested as specified above, testing of VOC content must comply with ASTM D2369-10; ISO 11890, part 1; ASTM D6886-03; or ISO 11890-2.
3. Methylene chloride and perchloroethylene may not be intentionally added in paints, coatings, adhesives, or sealants.

2.04 INDOOR WATER USE REDUCTION

A. WEp2, Indoor Water Use Reduction, Appliances: Provide ENERGY STAR or performance equivalent appliances.

B. WEp2/WEc2, Indoor Water Use Reduction, Plumbing Fixtures: Do not exceed water flow requirements indicated in Division 22 - PLUMBING.

Part 3 EXECUTION

3.01 FIELD EXECUTION OF LEED® REQUIREMENTS

A. The Contractor is responsible for ensuring proper field execution of all LEED® prerequisites and submittal requirements, communication with sub-contractors of all requirements and submission of all documentation in a timely manner.

B. Contractor shall notify the State immediately of any potential failure to meet any stated LEED® pre-requisite or planned credit requirement.

3.02 PROTECTION

A. Protect stored on-site and installed absorptive materials from moisture damage. Where absorptive materials not intended for wet applications are exposed to moisture, immediately remove from site and dispose of properly.

B. Protect installed materials using methods that do not support growth of molds and mildews

1. Immediately remove from site and properly dispose of materials showing signs of mold and signs of mildew, including materials with moisture stains.

3.03 CONSTRUCTION MATERIALS REPORTING: RESOURCE EFFICIENT MATERIALS

A. LEED® Materials and Resources Credits 2 through 4 (when selected by the Contractor in the LEED® Silver Compliance Plan), Article 1.09, Paragraph E of this section, and Section 00 87 00, Management Plan Information and Requirements, all contain requirements for Construction Materials Reporting.

B. Contractor shall develop a Construction Materials Report to have the following components:

a. Recycled Content Materials Cost Data

b. Local/Regional Materials Cost Data

c. Construction Materials Cost Data

C. The Contractor shall tabulate totals for the above Cost Data components.

D. Construction Materials Reporting

1. Construction Materials Cost Data will summarize the total cost of all construction materials used. This will include:

    a. A list of materials used, organized by Specification Division and Section.

    b. The cost of each material used.

    c. Exclude all labor costs, mechanical and electrical material costs, equipment costs and projected overhead and fees.

2. The Contractor shall provide the following Submittals on the Submittal Dates identified:

    a. An electronic version, including all Construction Materials Cost Data, at the end of construction.

E. Recycled Content Materials Reporting

1. LEED® Materials and Resources Credit 3 (MRc3) (when selected by the Contractor in the LEED® Silver Compliance Plan), Section 1.09 of this section, and Division 0, Section 00 87 00 all contain requirements for Construction Materials Reporting.

2. Product Information

    a. For Purposes of LEED® Certification, Recycled Content refers to those materials and products that contain a verifiable percentage of one or both of the following:

        1) Post-Consumer Recycled Content: This is the percentage of waste material available from consumer use incorporated into a building material.

        2) Post Industrial Recycled Content: This is the percentage of waste material available from industrial use incorporated into a building material.

    b. Contractor shall provide information on Recycled Content for the following materials and products:

3. Recycled Content Materials Cost Data will include:

    a. A description of each material

    b. The cost of each recycled content material used.

    c. The recycled content of each material broken down by:

        1) Percentage of Post-Consumer Recycled Content

        2) Percentage of Post-Industrial / Pre-Consumer Recycled Content

4. The Contractor shall provide product specifications or cut sheets indicating the recycled content percentage and type for all recycled content materials.

5. Provide a Recycled Content Certification Form for each Recycled Content material used on the project. This shall indicate the percentage of post-consumer and post-industrial recycled content and shall be signed by a Corporate Officer of the Product Manufacturer.

6. The Contractor shall provide the following Submittals at the end of construction:

    a. An electronic version including all Recycled Content Material Cost Data.

    b. All product specifications and cut sheets highlighting the recycled content amount and type.

    c. All Recycled Content Certification Forms, with original signatures.

F. Local/Regional Materials Reporting

1. LEED® Materials and Resources Credits 2 through 4 (MRc2 through MRc4) (when selected by the Contractor in the LEED® Silver Compliance Plan), Section 1.09 of this section, and Section 00 87 00, Management Plan Information and Requirements, all contain requirements for Construction Materials Reporting.

2. Product Information

    a. For Purposes of LEED® Certification, Local/Regional refers to those materials and products that are manufactured within a 500-mile radius of the project site.

    b. Manufacturing refers to the final assembly of the components into the building product that is furnished and installed by the tradesman. An accounting of manufacturer locations for components used in a final assembly is not required.

3. Local/Regional Materials Cost Data will include:

    a. A description of each material

    b. The cost of each Local/Regional material used.

4. The Contractor shall provide a list of Local/Regional manufacturers that includes:

    a. The manufacturer and product name of each product used on the project that is manufactured within a 100-mile radius of the project site.

    b. The address and contact information of the product manufacturer.

    c. The distance, measured in miles, of the product manufacturer from the project site.

    d. The distance, measured in miles, of the location of extraction, harvest or recovery of the raw material used to make the product from the project site.

5. The Contractor shall provide the following Submittals at the end of construction:

    a. An electronic version including all Local/Regional Material Cost Data

b. All specifications and submittals highlighting Local/Regional materials used on the project.

6. A list of Local/Regional Material Manufacturers that identifies their distance from the jobsite.

3.04 OPERATIONS PLANS

A. Contractor shall develop a Jobsite Operations Plan that shall have the following components:

1. Construction Erosion and Sedimentation Control Plan (not optional see also Section 00 87 00, Management Plan Information and Requirements)

2. Construction Waste Management Plan (not optional, see also requirements of Section 00 87 00, Management Plan Information and Requirements)

3. Construction Indoor Air Quality (IAQ) Management Plan (optional depending whether the Contractor selects this credit in the LEED® Silver Compliance Plan)

B. Each component of the plan shall include the following information:

1. Goals

2. Construction practices to be used to achieve those goals

3. Methods to train or otherwise communicate these goals to field personnel

4. Methods to track and assess progress towards those goals

5. Method of documenting compliance with these goals

C. Construction Erosion and Sedimentation Control Plan. This section supplements but does not supersede requirements for a Storm Water Pollution Prevention Plan (SWPPP). Refer also to Division 2 of the Performance Criteria.

1. LEED® Sustainable Sites Prerequisite 1 (SSp1).

2. The Contractor shall comply with all local and state requirements and the EPA's Storm water Management for Construction Activities

3. The Contractor shall use the more stringent requirements of the above in developing and implementing a plan.

4. The Contractor shall comply with the requirements of Erosion and Sediment Control of this section.

5. Contractor shall submit the Plan to the State for review and shall include a narrative of the approach and measures taken and drawings with the erosion and sedimentation measures highlighted.

6. Plan measures shall remain in place at the site for the duration of construction.

7. Changes to the Plan shall be reviewed by the State for conformance to the intent of LEED® requirements for Construction Erosion and Sedimentation Control.

8. The Contractor shall provide the following Submittals on the following Submittal Dates:

    a. An Erosion and Sedimentation Control Plan that includes a listing of measures that will be implemented, prior to any construction site activity.

9. Final Erosion and Sedimentation Control Plan clearly identifying all control measures, including changes from the original Plan with approval signatures, at the end of construction.

D. Construction Waste Management Plan. This section supplements but does not supersede requirements of Section 01 74 19. See also Section 00 87 00, Management Plan Information and Requirements.

1. LEED® Materials and Resources Credit 5 (MRc5) (See also Section 00 87 00.)

2. The Contractor shall recycle, salvage, reuse, and/or donate a minimum of seventy-five percent (75%), by weight not volume, of the total construction and demolition waste (less excavation soil, hazardous and chemical waste materials) generated during construction of the project.

3. The Contractor shall comply with the requirements Construction Waste Management of this Section.

4. The Contractor shall provide the following Submittals on the Submittal Dates identified:

    a. Construction Waste Management Plan before any construction site activity begins.

    b. Construction Waste Monthly Reports

    c. Construction Waste Final Report at the end of construction

    d. Construction Waste Final Cost Report at the end of construction shall per Section 01 74 19, Construction Waste Management.

5. Contractor will assign (and identify in the Waste Management Plan) the person who will be responsible for implementing and monitoring the plan.

E. Construction IAQ Management Plan (Optional if selected by the Contractor in the LEED® Silver Compliance Plan)

1. LEED® Indoor Environmental Quality Credit 3 and 4 (EQc3 and EQc4).

2. The Contractor shall comply with the requirements of Article 3.07, Construction Indoor Air Quality Management, of this Section.

3. The Contractor shall provide the following Submittals on the Submittal Dates identified:

a. Construction Indoor Air Quality Management Plan before beginning building construction activity.

b. Construction Indoor Air Quality Management Plan after construction ends and prior to occupancy.

4. Contractor will assign (and identify in the IAQ Management Plan) the person who will be responsible for implementing and monitoring the plan.

F. HVAC&R CFC Refrigerant Waste Disposal Plan HVAC&R: Heating, Ventilation, Air Conditioning and Refrigeration CFC: Chlorofluorocarbon

1. LEED® Energy and Atmosphere Prerequisite 4 (EAp4).

2. The Contractor shall prepare a HVAC&R CFC Refrigerant Waste Disposal Plan for all refrigeration equipment used in any existing buildings. If there is no existing equipment, this requirement will not apply.

3. The Contractor shall provide the following Submittals on the Submittal Dates identified:

a. HVAC&R CFC Refrigerant Waste Disposal Plan prior to any HVAC&R equipment removal. The Contractor shall receive Plan approval from the Construction Manager and Mechanical Design Engineer.

b. Certification Letter, signed by the Contractor, indicating compliance with the HVAC&R CFC Refrigerant Waste Disposal Plan.

c. HVAC&R CFC Refrigerant Waste Disposal Cost Report identifying the Contactor's cost associated with complying with the HVAC&R CFC Refrigerant Waste Disposal Plan.

4. Contractor will assign (and identify in the HVAC&R CFC Refrigerant Waste Disposal Plan) the person who will be responsible for implementing and monitoring the plan

3.05 EROSION AND SEDIMENT CONTROL

A. LEED Sustainable Sites Prerequisite 1 (SSp1), (see also Section 00 87 00, Management Plan Information and Requirements, for additional requirements).

B. The Contractor shall develop and implement Erosion and Sediment Control Plan to reduce negative impacts on water and air quality that includes:

1. Procedures for preventing loss of soil during construction by storm water runoff and/or wind erosion and for protecting topsoil for reuse onsite.

2. Procedures for preventing sedimentation of storm sewer or receiving streams and for preventing pollution of air with dust and particulate matter.

3. Procedures for preventing chemicals or waste debris from polluting soil, water and air.

4. Procedures for training all contractors and subcontractors so that they understand and agree to comply with the Erosion and Sediment Control Plan requirements.

C. Prevent loss of soil during construction.

1. Plan and execute construction by methods to control surface drainage from cuts and fills, from borrow and waste disposal areas.

2. Minimize surface area of bare soil exposed at one time.

3. Provide temporary measures including berms, dikes, and drains, and other devices to prevent water flow.

4. Construct fill and waste areas by selective placement to avoid erosive surface silts or clays.

5. Periodically inspect earthwork to detect evidence of erosion and sedimentation; promptly apply corrective measures.

6. Any slopes with disturbed soils or denuded of vegetation must be stabilized so as to inhibit erosion by wind or water.

7. Sediments and other materials may not be tracked from the site by vehicle traffic. The construction entrance roadways must be stabilized so as to inhibit sediments from being deposited into the public way. Accidental depositions must be swept up immediately and may not be washed down by rain or by other means.

D. Prevent sedimentation in storm sewers or receiving streams and pollution of air with dust and particulate matter.

1. Eroded sediments and other pollutants must be retained on site and may not be transported from the site via sheet flow, swales, area drains, natural drainage courses, or wind.

2. Stockpiles of earth and other construction-related materials must be protected from being transported from the site by the forces of wind or water.

E. Prevent chemicals or waste debris from polluting soil, water and air.

1. Fuels, oils, solvents, and other toxic materials must be stored in accordance with their listing and are not to contaminate the soil nor surface waters. All approved storage containers are to be protected from the weather.

2. Spills must be cleaned up immediately and disposed of in a proper manner. Spills may not be washed into the drainage system.

3. Excess or waste concrete may not be washed into the public way or any other drainage system. Provisions shall be made to retain concrete wastes on site until they can be disposed of as solid waste.

4. Trash and construction-related solid wastes must be deposited into a covered receptacle to prevent contamination of rainwater and dispersal by wind.

3.06 CONSTRUCTION WASTE MANAGEMENT

A. LEED® Materials and Resources Credit 5 (MRc5), (see also Section 00 87 00, Management Plan Information and Requirements, for additional requirements).

B. The Contractor shall develop and implement a Construction Waste Management (WM) Plan for the land clearing, demolition, and construction phases of the project that includes:

1. Procedures for the collection, handling and storage of solid waste materials on-site.

2. Procedures for coordinating the pick-up, transportation and disposition of solid waste materials.

3. Procedures for training all contractors and subcontractors so that they understand and agree to comply with the Construction Waste Management Plan requirements.

C. Collection and handling of solid waste materials on-site.

1. Plans for deconstruction, salvage and reuse of on-site materials.

2. Recyclable materials will be separated from waste or non-recyclable materials.

3. Recyclable materials can be co-mingled or separated at the construction site.

4. Two solid waste bins should be available at all times - at least one for recyclables and one for waste materials.

5. Collection bins will be located at designated construction locations. A centralized staging area for recycling operations will be created.

6. Store all recyclable materials in a secure area prior to market transportation.

7. The contract waste hauler will be employed to rotate bins as needed. An on-site coordinator will insure efficient bin replacement and quality control. To avoid bin overflows, extra bins (or more frequent pick-up) will, be provided during waste surge periods.

8. Construction schedules will be analyzed to identify the timing of specific phases of work and the associated generation of materials such as drywall, insulation, etc. thereby allowing for the provision of an appropriate number of collection bins.

9. Clean contaminated materials prior to placing in collection containers. Deliver materials free of dim adhesives, solvents, petroleum contamination, and other substances deleterious to recycling process.

D. Pick-up, transportation and disposition of solid waste materials.

1. Arrange for collection by or delivery to the appropriate recycling or reuse facility.

2. Identify licensed haulers and processors of recyclables and hazardous waste.

3. Identify markets for salvaged materials.

4. Provide lists of the recycling facilities, reuse facilities, municipal solid waste landfills, and other disposal area(s) to be used. (Haulers and processors of recyclables that are used must be approved by the architect.) Include:

    a. Name, location, and phone number.

    b. Copy of permit or license for each facility.

5. Provide an accounting by weight and final disposition of all construction waste materials generated.

6. Document the cost of recycling, salvaging and reusing materials.

7. Provide an accounting of the disposition of construction waste materials. Dispositions include:

    a. Recycling

    b. Salvage

    c. Reuse on site

    d. Donations to charitable and/or non-profit organizations

    e. Hazardous waste disposal

    f. Landfill

8. Provide calculations on end-of-project recycling rates, salvage rates, and landfill rates demonstrating the wastes that were recycled, salvaged, etc. Calculate each material separately based on whether the final disposition was recycle, savage, reuse and/or donation, hazardous waste disposal or landfill.

E. Hazardous and Chemical Wastes

1. Chemical waste includes, but is not limited to, paints, adhesives, sealants, coatings, glues, petroleum products, bituminous materials, salts, acids, alkalis, herbicides, and pesticides, and cleaning agents or solutions. Some chemical waste may be classified as hazardous and must be disposed of per local regulations.

2. Hazardous materials and wastes generated or encountered as part of the construction process will be processed separately from solid wastes in compliance with state hazardous waste disposal statutes. A firm specializing in hazardous waste disposal shall be contracted to handle these materials.

    a. These materials include, but are not limited to:

        1) Lead

        2) Asbestos

        3) Solvents

4) Adhesives and Sealants

5) Fluorescent Light Tubes and Ballasts

b. Regulatory agencies controlling these materials include, but are not limited to:

1) U.S. Environmental Protection Agency (EPA)

2) State of California

3) County of Imperial

4) City of El Centro

F. The Contractor shall provide the following Submittals on the Submittal Dates identified:

1. Provide monthly reports to the State's designated representative indicating the current recycling/salvage rate, broken down by each recycled, salvaged or reused material, and that the expected future rate is sufficient to ensure that the requirements of this credit are met.

2. Provide a final report at the end of construction to the State's designated representative indicating the final recycling/salvage rates and costs, broken down by each recycled, salvaged or reused material. Include electronic summary forms based on the sample form included in Appendix C - Construction Waste Disposal and Diversion Summary.

3.07 CONSTRUCTION INDOOR AIR QUALITY MANAGEMENT (Optional if selected by the Contractor as part of the LEED® Silver Compliance Plan)

A. LEED® Indoor Environmental Quality Credit 3 and 4 (EQc3 and EQc4).

B. The Contractor shall develop and implement an Indoor Air Quality Management (IAQ) Plan for the construction and preoccupancy phases of the building that includes:

1. Procedures for meeting the Sheet Metal and Air Conditioning National Design/Builders Association (SMACNA) IAQ Guidelines for Occupied Buildings Under Construction (1995, Chapter 3).

2. Procedures for required end of construction flush-out or IAQ testing.

3. Procedures for training all contractors and subcontractors so that they understand and agree to comply with the Construction IAQ Management Plan requirements.

C. The IAQ Plan shall meet or exceed the 5 SMACNA Requirements and shall include the following control measures:

1. HVAC Protection

a. Protect all air handling and distribution equipment, and air supply and return ducting during construction.

b. Adequately cover and protect all exposed air inlets and outlets openings grilles, ducts, plenums, etc. to prevent water, moisture, dust, and other contaminate intrusion.

c. Apply protection immediately after installation of equipment and ducting.

d. Ducting runs that require more than a single day to install shall be protected at the end of each day's Work.

e. During dust producing activities (e.g. drywall installation and finishing), turn the ventilation system off, and protect HVAC supply and return openings from dust infiltration Provide temporary ventilation as required.

2. Source Control

a. Protect stored on-site or installed absorptive or porous materials such as batt insulation and drywall from exposure to moisture.

b. Do not use wet, damaged porous materials in the building. Materials with evidence of moisture damage, including stains, are not acceptable, including both stored and installed materials. Immediately remove them from the site and properly dispose.

c. Preconditioning:

1) Prior to delivery to the construction site allow products that have odors and significant VOC emissions to off-gas in dry, well-ventilated space for 14 calendar days to allow for reasonable dissipation of odors and emissions.

2) Condition products, without containers and packaging, to maximize off-gassing of VOCs.

3) Condition products in a ventilated warehouse or other building. Provide a temperature range of 60 degrees F minimum to 90 degree F maximum continuously during the ventilation period.

4) Do not ventilate within limits of Work unless otherwise approved by Architect.

5) Comply with substitution requirements for consideration of other locations.

d. Take special care to prevent accumulation of moisture on installed materials and within packaging during delivery, storage, and handling to prevent development of molds and mildew on packaging and on products.

e. Immediately remove from site and properly dispose of materials showing signs of mold and signs of mildew, including materials with moisture stains.

f. Replace moldy materials with new, undamaged materials.

g. Provide sufficient ventilation, air circulation and air changes to dissipate excess humidity when present.

3. Pathway Interruption.

    a. All openings within the designated work area should be sealed.

    b. Adequate exhaust ventilation equipment should be installed to maintain a negative pressure differential between the work area and adjacent areas of the building.

    c. Ventilation units should be exhausted to the outside of the building.

4. Housekeeping:

    a. Provide temporary ventilation during construction to minimize accumulation of dust fumes, vapors, or gases in the building.

        1) Continuously ventilate during and after installation of materials that emit Volatile Organic Compounds (VOCs) until emissions dissipate:

            a. Period after installation shall be sufficient to dissipate odors and elevated levels of VOCs. Where no specific period is stated in these Specifications, a period of 72 hours shall be used.

            b) Ventilate areas directly to outside areas, do not ventilate to other enclosed spaces.

            c) If continuous ventilation is not possible via the building's HVAC system(s), then ventilate via open windows and temporary fans that sufficiently provide no less than three air changes per hour.

    b. Suppress dust with wetting agents or sweeping compounds.

    c. Clean-up dust using a wet rag or damp mop.

    d. Increase the cleaning frequency when dust build-up is noted.

    e. Remove spills or excess applications of solvent-containing products as soon as possible.

    f. Remove accumulated water and keep work areas as dry as possible.

    g. Store volatile liquids, including fuels and solvents, in closed containers and outside of the building when not in use.

    h. Keep volatile liquid containers closed when the container is inside of the building and not in use.

    i. HEPA vacuuming and duct cleaning:

        1) Vacuum carpeted and soft surfaces with a high-efficiency particulate arrestor (HEPA) vacuum.

        2) If ducts contain dust and dirt, clean them using a HEPA vacuum immediately before Completion and prior to using the ducts to circulate air.

3) Oil film on sheet metal should be removed before shipment to site. However, ducts will be inspected to confirm that no oil film is present. Remove any oil.

j. Use nontoxic cleaning materials and procedures.

1) Alternatives to toxic cleaning agents include:

a) Vinegar

b) Citrus

c) Borax

d) Cornstarch

e) Baking Soda

2) Examples of nontoxic alternatives for several cleaning methods are listed below:

a) Abrasive Cleaners: Substitute half lemon dipped in borax.

b) Ammonia: Substitute vinegar, salt, and water mixture: or baking soda and water.

c) Disinfectants: Substitute half-cup borax in a gallon of water.

d) Drain Cleaners: Substitute one-fourth cup baking soda and one-fourth cup vinegar in boiling water.

e) Upholstery Cleaners: Substitute dry cornstarch.

5. Scheduling:

a. Where odorous and/or high VOC-emitting products are applied on-site, apply them before installation of porous and fibrous materials. Where this is not possible, protect porous materials with polyethylene vapor retarders.

b. Insure that all wet applied interior finish materials, such as paints, adhesives, sealants, coatings, finishes and spray-applied materials, such as structural fireproofing, are properly and fully cured before installing other finish materials over them.

c. Install carpets and furnishings after all other interior finish materials have been applied and fully cured.

d. Provide adequate ventilation of packaged dry products prior to installation. Remove from packaging and ventilate in a secure, dry, well-ventilated space free from strong contaminant sources and residues.

e. Complete interior finish material installation no less than 14 days prior to Completion to allow for building flush-out.

D. Indoor Air Quality Assessment (v4.1 credit substitution) Option 1, Flush Out (if pursuing)

1) Conduct a minimum two-week building flush-out with new MERV 13 filtration media after construction ends and prior to occupancy.

a. Flush-out will use 100% tempered outside air for 24 hours each day.

b. When the Contractor is required to perform touch-up work, provide temporary construction ventilation during installation and extend the building flush-out by a minimum of four days after touch-up installation.

c. Do not "bake out" the building by increasing the temperature of the space. Maintain an internal temperature of at least 60°F and no higher than 80°F.

d. After building flush-out, replace all filtration media before building occupancy.

e. Replaced filtration media shall have a Minimum Efficiency Reporting Value (MERV) of 13 as determined by ASHRAE Standard 52.2-2007. Efficiency rating shall be maintained throughout the life of the filter.

E. Indoor Air Quality Assessment (v4.1 credit substitution) Option 2, IAQ Testing (if pursuing)

1. IAQ Testing: The contractor should implement the Building IAQ Test Procedure. After construction and before occupancy the Contractor shall conduct an IAQ testing as described in Path 1 and/or Path 2 below.

2. Finish Materials Fully Installed: All finishes must be installed.

3. Testing Subcontractor: Using a qualified Testing Subcontractor, such as an Industrial Hygienist, as approved by the Owner.

4. Completion of TAB: Prior to testing, the Testing and Balancing agency shall verify the performance of the HVAC air distribution system.

5. Path 1. Particulate Matter and Inorganic Gases

a. Test for the particulate matter (PM) and inorganic gases listed in Table 1, using an allowed test method, and demonstrate the contaminants do not exceed the concentration limits listed in the table.

Table 1. Particulate Matter and inorganic gases

Contaminant (CAS#)	Concentration Limit ($\mu g/m^3$)	Allowed Test Methods
Carbon monoxide (CO)	9 ppm; no more than 2 ppm above outdoor levels	ISO 4224 EPA Compendium Method IP-3 GB/T 18883-2002 for projects in China Direct calibrated electrochemical instrument with accuracy of (+/- 2% ppm <50 ppm minimum accuracy).
PM 10	ISO 14644-1:2015, cleanroom class of 8 or lower 50 $\mu g/m^3$ Healthcare only: 20 $\mu g/m^3$	Particulate monitoring device with accuracy greater of 5 micrograms/m3 or 20% of reading and resolution (5 min average data) +/- 5 $\mu g/m^3$
PM 2.5	12 $\mu g/m^3$ or 35 $\mu g/m^3$**	
Ozone	0.07 ppm	Monitoring device with accuracy greater of 5 ppb or 20% of reading and resolution (5 min average data) +/- 5 ppb ISO 13964 ASTM D5149 -- 02 EPA designated methods for Ozone

**Projects in areas with high ambient levels of PM2.5 (known EPA nonattainment areas for PM2.5, or local equivalent) must meet the 35 ug/m^3 limit, all other projects should meet the 12 ug/m^3 limit.

AND/OR

6. Path 2. Volatile Organic Compounds

a. The contractor shall perform a screening test for Total Volatile Organic Compounds (TVOC). Use ISO 16000-6, EPA TO-17, or EPA TO-15 to collect and analyze the air sample. Calculate the TVOC value per EN 16516:2017, CDPH Standard Method v1.2 2017 section 3.9.4, or alternative calculation method as long as full method description is included in test report. If the TVOC levels exceed 500 µg/m3, investigate for potential issues by comparing the individual VOC levels from the GC/MS results to associated cognizant authority health-based limits. Correct any identified issues and re-test if necessary.

b. Additionally, test for the individual volatile organic compounds listed in Table 2 using an allowed test method and demonstrate the contaminants do not exceed the concentration limits listed in the table. Laboratories that conduct the tests must be accredited under ISO/IEC 17025 for the test methods they use.

c. Exemplary performance is available for projects that test for the additional target volatile organic compounds specified in CDPH Standard Method v1.2-2017, Table 4-1 and do not exceed the full CREL levels for these compounds adopted by Cal/EPA OEHHA in effect on June 2016.

Table 2. Volatile organic compounds

Contaminant (CAS#)	Concentration Limit ($\mu g/m^3$)	Allowed Test Methods
Formaldehyde 50-00-0	20 $\mu g/m^3$ (16 ppb)	ISO 16000-3, 4; EPA TO-11a, EPA comp. IP-6A ASTM D5197-16
Acetaldehyde 75-07-0	140 $\mu g/m^3$	
Benzene 71-43-2	3 $\mu g/m^3$	ISO 16000-6 EPA IP-1, EPA TO-17, EPA TO-15 ISO 16017-1, 2; ASTM D6196-15
Hexane (n-) 110-54-3	7000 $\mu g/m^3$	
Naphthalene 91-20-3	9 $\mu g/m^3$	
Phenol 108-95-2	200 $\mu g/m^3$	
Styrene 100-42-5	900 $\mu g/m^3$	
Tetrachloroethylene 127-18-4	35 $\mu g/m^3$	
Toluene 108-88-3	300 $\mu g/m^3$	
Vinyl acetate 108-05-4	200 $\mu g/m^3$	
Dichlorobenzene (1,4-) 106-46-7	800 $\mu g/m^3$	
Xylenes-total 108-38-3, 95-47-6, and 106-42-3	700 $\mu g/m^3$	

7. Air Sampling:

   a. The air sample testing shall be conducted as follows:

   b. All measurements must be conducted prior to occupancy, but during normal occupied hours and with the building ventilation system starting at the normal daily start time and operated at the minimum outside air flow rate for the occupied mode throughout the duration of the air testing.

   c. The building must have all interior finishes installed, including but not limited to millwork, doors, paint, carpet and acoustic tiles. Non-fixed furnishings such as workstations and partitions are encouraged, but not required, to be in place for the testing.

   d. The number of sampling locations will vary depending upon the size of the building and number of ventilation systems. For each portion of the building served by a separate ventilation system, the number of sampling points shall not be less than one per 25,000 square feet, or for each contiguous floor area, whichever is larger, and include areas with the least ventilation and greatest presumed source strength.

   e. Air samples shall be collected between 3 feet and 6 feet from the floor to represent the breathing zone of occupants, and over a minimum 4-hour period.

8. Temporary (Remediation) Flushout:

a. For each sampling point where the maximum concentration limits are exceeded conduct additional flush-out with outside air and retest the specific parameter(s) exceeded to indicate the requirements are achieved.

b. Repeat procedure until all requirements have been met.

c. Documentation and Flushout Requirements: For areas where test results exceed the maximum limits conduct a building temporary flushout of those areas as recommended by the Testing Subcontractor. The building flushout procedure should include:

1) Number of days of operation.

2) Number of hour and time of day of flushout.

3) Flushout Air Temperature: Data logging, recorded at least every 15 minutes. The flushout shall not be conducted when flushout air is at a temperature below 60 degree Fahrenheit.

4) Flushout Air Relative Humidity: Data logging, recorded at least every 15 minutes. The flushout shall not be conducted when flushout air is at a relative humidity below 60 percent.

5) Percent outside air mixture required.

6) When retesting non-complying building areas, take samples from the same locations as in the first test.

d. Use of temporary flexible ductwork and temporary exhaust fans is recommended for conducting the temporary flushout. All temporary air must be filtered using a MERV rated air filter as required in the section.

e. If the building ventilation systems are used to conduct a temporary flush out use new filtration media over each return air grille. Filtration Media shall have a Minimum Efficiency Reporting Value (MERV) of 8 or better as determined by ASHRAE Standard 52.2.

F. No smoking is permitted in Indoor Project site locations, per California Labor Code (Section 400-6413.5). No smoking is permitted within 25 feet (8 m) of entrances, operable windows, or outdoor-air intakes

G. The Contractor shall provide the following Submittals on the Submittal Dates identified:

1. Provide cut sheets of filtration media used during construction and installed prior to occupancy with MERV values highlighted at the end of construction.

2. Provide a letter declaring that all filtration media was replaced prior to occupancy at the end of construction.

3. Provide photographs of construction IAQ management measures such as protection of ducts and on-site stored or installed absorptive materials during construction.

3.08 BUILDING COMMISSIONING

A. LEED® Energy and Atmosphere Prerequisite I (EAp1).

1. The Contractor shall provide support to the State's Commissioning Authority during all phases of the commissioning process from pre-design through to and including post-occupancy evaluation.

2. The Contractor shall coordinate activities between the Contractor, subcontractors, and the Commissioning Authority as described in Section 01 91 13, General Commissioning Requirements.

3. The Contractor shall provide access to the construction site to the Commissioning Authority.

4. The Contractor shall coordinate construction and testing activities with the Commissioning Authority to ensure that the Commissioning activities are completed during the construction process.

5. The Contractor shall provide the following Submittals on the Submittal Dates identified:

   a. All submittals as described in Sections 01 33 00, Submittal Procedures, and 01 91 13, General Commissioning Requirements, and as defined in the Performance Specifications.

3.09 Completion of LEED Online Form and Uploads

A. Complete and conclude assigned credits on Project LEED website.

1. When LEED requirements associated with the Contractor's assigned credits have been met, Contractor representative shall be responsible for, but not limited to, completing and uploading required information to project LEED website.

   a. Complete forms and provide required documentation on LEED Online within 30 days of Substantial Completion of project.

2. Apprise Project Team LEED Administrator of progress during completion of documentation process.

3. Respond to clarification comments received from GBCI for assigned credits within required timeframe.

3.09 Certification Plaque Display

A. Mount the LEED Silver Certification plaque on the wall in the Reception Area.

END OF SECTION

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SECTION 13 40 00

HOT-DIP GALVANIZING FOR STEEL COMMUNICATIONS TOWER

PART 1- GENERAL

1.01 WORK INCLUDED

A. Hot-dip galvanizing of communication towers and respective hardware and accessories.

1.02 RELATED WORK

A. Section 13 34 00: Communications Tower

1.03 REFERENCE STANDARDS

A. ASTM:

1. *A*123/ *A123M Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products*

2. *A*143 *Practice for Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedure for Detecting Embrittlement*

3. *A*153/ *A153M Zinc Coating (Hot-Dip) on Iron and Steel Hardware*

4. *A*384 *Practice for Safeguarding Against Warpage and Distortion During Hot-Dip Galvanizing of Steel Assemblies*

5. *A*385 *Practice for Providing High-Quality Zinc Coatings (Hot-Dip)*

6. *A780 Repair of Damaged Hot-Dip Galvanized Coatings*

7. *B*6 *Specification for Zinc*

8. *E*376 *Practice for Measuring Coating Thickness by Magnetic-Field or Eddy-Current (Electromagnetic) Test Methods*

1.04 QUALITY ASSURANCE

A. Coating Applicator: Company specializing in hot-dip galvanizing after fabrication and following the procedures set forth in the applicable ASTM Standard(s).

B. Pre-construction Conference Call for Metal Fabrications: Contractor shall schedule a call to be attended by contractor, State, fabricator and galvanizer. Topics to be addressed include project schedule, scope of metal fabrications, coordination between fabricator and galvanizer, finish of surfaces, application of coatings, inspection, testing, submittals and approvals.

C. Materials: For steel to be hot-dip galvanized, provide steel chemically suitable for metal coatings complying with the following requirements: carbon below 0.25, phosphorous below 0.04, manganese below 1.3, and silicon below 0.04. Notify the galvanizer if steel does not meet these requirements so that suitability for galvanizing may be determined and whether special processing techniques are required.

1.05 SUBMITTALS

The Galvanizer shall submit an original and two copies of the duly notarized Certificate of Compliance indicating that the hot-dip galvanized coating meets or exceeds the specified requirements of ASTM A123 / A123M or A153 / A153M, as applicable.

1.06 DELIVERY, STORAGE & HANDLING

A. Store and protect products in accordance with generally accepted industry practices.

B. Load and store galvanized articles in accordance with generally accepted industry practices.

PART 2 - PRODUCTS

2.01 ACCEPTABLE COATING APPLICATORS

Acceptable coating applicators shall be approved by the State.

2.02 STEEL MATERIALS

A. Material for galvanizing to be geometrically suitable for galvanizing as described in ASTM A384 and A385. Steel materials suitable for galvanizing include structural shapes, pipe, fabrications and assemblies.

B. Material to be chemically suitable for galvanizing.

Steel containing carbon below 0.25, phosphorus below 0.04 and manganese below 1.3, either individually or in combination, and providing the silicon content is 0.04 or less, will normally develop a typical coating when conventional galvanizing techniques are applied.

Recommended steel materials for hot-dip galvanizing include but are not limited to:

1. Structural shapes and plates: ASTM A36, A242 type 2, A283, A441, A500, A501, A529, A572, A588 and A992.

2. Steel for fasteners:

General Category	Bolt Material	Nut Material
Carbon Steel	A307 GrA or B	A563 GrA
High-strength	A325 Type I	A563 GrDH
Tower Bolts	A394	A563 GrA
Quenched & Tempered *(Carbon Steel Bolts)*	A499	A563 GrC
Quenched & Tempered *(Alloy Steel Bolts)*	A354 GrBC	A563 GrDH

NOTE: Avoid use of steel with an ultimate tensile strength greater than 150 ksi. These steels have been shown to have a potential for hydrogen embrittlement resulting from the pickling process prior to galvanizing.

2.03 FABRICATION REQUIREMENTS

A. Fabrication practices for products to be in accordance with the applicable portions of ASTM A143, A384, and A385, except as specified herein. Avoid fabrication techniques that could cause steel distortion or embrittlement.

B. The fabricator shall consult with the State and galvanizer regarding potential concerns, including handling issues, during the galvanizing process that may require design modification before fabrication proceeds.

C. Remove all welding slag, spatter, anti-splatter compounds and burrs prior to delivery for galvanizing.

D. Provide holes and/or lifting lugs to allow for handling and zinc drainage during galvanizing.

E. Avoid unsuitable marking paints. Consult with the galvanizer about removal of grease, oil, paint and other deleterious material prior to fabrication.

F. Remove by blast-cleaning or other methods, surface contaminants and coatings that are not removable by the normal chemical cleaning process in the galvanizing operation.

PART 3 - EXECUTION

3.01 SURFACE PREPARATION

Pre-clean steel work in accordance with accepted methods to produce an acceptable surface for quality hot-dip galvanizing.

3.02 COATING APPLICATION

A. Galvanize steel members, fabrications and assemblies after fabrication by the hot-dip process in accordance with ASTM A123 / 123M.

B. Galvanize bolts, nuts, washers and iron and steel hardware components in accordance with ASTM A153 / 153M.

C. Safeguard products against steel embrittlement in conformance with ASTM A143.

D. Handle all articles to be galvanized in such a manner as to avoid any mechanical damage and to minimize distortion.

3.03 COATING REQUIREMENTS

A. Conform to paragraph 6.1 of ASTM A123 / 123M or Table 1 of ASTM A153 / 153M.

B. Surface Finish: Continuous, adherent, as smooth and evenly distributed as possible and free from any defect detrimental to the stated end use of the coated article.

C. Adhesion: Withstand normal handling consistent with the nature and thickness of the coating and normal use of the article.

3.04 INSPECTION AND TESTING

A. Inspection and testing for adherence, zinc coating thickness and roughness detrimental to the end user of hot-dip galvanized coatings shall be done at the galvanizer's plant prior to shipping.

B. Include visual examination and tests in accordance with ASTM A123 / 123M or A153 / 153M, as applicable, to determine the thickness of the zinc coating on the metal surface.

C. Furnish notarized Certificate of Compliance with ASTM standards and specifications herein listed. The Certificate must be signed by the galvanizer, notarized and contain a detailed description of the material processed. The Certificate shall include information as to the ASTM standard used for the coating.

3.05 REPAIR OF DAMAGED COATING

A. The maximum area to be repaired is defined in accordance with ASTM A123 / 123M, Section 6.2.

   1. The maximum area to be repaired in the field shall be determined in advance by mutual agreement between parties.

B. Repair areas damaged by shop welding, flame cutting or during handling, transport or erection by one of the approved methods in accordance with ASTM A780 whenever damage exceeds 3/16" in width. Minimum thickness requirements for the repair are those described in ASTM A123 / 123M, Section 6.2. Aerosol cans shall not be permitted.

END OF SECTION

SECTION 22 05 23

GENERAL-DUTY VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.01 SUMMARY

A. Types of valves specified in this Section include but are not limited to the following and apply to all Division 22 work:

1. Ball valves.
2. Seismic shutoff valves.
3. Calibrated balance valves.
4. Cocks.
5. Drain valves.
6. Gate valves.
7. Globe valves.
8. Plug valves.
9. Underground valves.

B. Volume 1 - Contracting Requirements, and Division - 01 General Requirements apply to the Work of this Section.

1.02 SYSTEM DESCRIPTION

A. Design and performance requirements:

1. Provide valves necessary to segregate branches or units.
2. Place unions adjacent to each threaded valve and at three-way control valves.
3. Provide valves recommended by manufacturer for use in service indicated. Provide sizes and connections which properly mate with pipe, tube, and equipment connections.
4. Provide valves of same size as upstream pipe size.
5. Discs shall be suitable for service intended.

6. Install valves with bodies of metal other than cast iron where thermal or mechanical shock can be expected to occur.

7. Install extended-stem valves arranged in proper manner to receive insulation.

8. Select and install valves with the following ends or types of pipe/tube connections:

    a. Pipe size 2 inches and smaller: One of the following:

        1) Threaded valves.

        2) Soldered Valves.

        3) Flanged valves.

    b. Pipe size 2-1/2 inches and larger: One of the following:

        1) Grooved-end valves.

        2) Flanged valves.

        3) Wafer valves.

        4) Single flanged valves.

        5) Mechanical joint end valves.

9. Valve stem: Provide valves with outside screw and yoke stems, except provide inside screw non-rising stem valves where headroom prevent full opening of OS&Y valves.

10. Non-metallic disc: Limit selection and installation of valves with non-metallic discs where foreign material in piping system can be expected to prevent tight shutoff of metal seated valves.

11. Renewable seats: Provide valves with removable seats.

B. Fluid control: Install gate, ball, globe, and butterfly valves to comply with ANSI B31.1. Where throttling is recognized as principal reason for valve, install globe, flow control or butterfly valves.

1.03 ACTION SUBMITTALS

A. No action submittals are necessary.

1.04 INFORMATIONAL SUBMITTALS

A. Submit under provisions of Section 01 33 00.

1. Schedule of valves and their application.

2. Product data for specified products.

3. Submit all warranties signed by the manufacturer.

B. Provide all special tools, loose gauges and test kits and maintenance and calibration instructions.

1.05 QUALITY ASSURANCE

A. Manufacturer's qualifications: Firms regularly engaged in manufacture of valves, of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Valve types: Provide valves of same type by same manufacturer.

C. Identification: Provide valves with manufacturer's name (or trademark) and pressure rating clearly marked on valve body.

D. Valves in boiler rooms: Comply with ASME Boiler and Pressure Vessel Code.

E. Requirements of regulatory agencies: UL and FM Compliance: Provide valves used in fire protection piping which are UL listed and FM approved.

F. Provide one wrench of each size required for operating underground valves.

PART 2 - PRODUCTS

2.01 GATE VALVES

A. Comply with the following standards:

1. Cast-iron valves: MSS SP-70.

2. Bronze valves: MSS SP-80.

3. Steel valves: ANSI 816.34.

2.02 FOR DOMESTIC WATER SERVICE:

A. Threaded ends 2 inches and smaller: Class 150, bronze body, union bonnet, rising stem, solid wedge.

1. Flanged ends 2-1/2 inches and larger: Class 125, iron body, bronze mounted, bolted bonnet, rising stem, OS&Y, solid wedge.

2. Soldered ends 2 inches and smaller: Class 150, bronze body, union bonnet, non-rising stem, solid wedge.

3. AWWA double disc valves, hub end or rubber ring type, equipped with operating nuts, may be used in underground water lines 3 inches and larger.

B. Underground valves 3 inches and smaller may be furnished with operating nuts or hand wheels, and with Ring-Tite joint ends.

2.03 BALL VALVES:

A. General: Select with port area equal to or greater than connecting pipe area, include seat ring designed to hold sealing material.

B. Comply with the following standards:

1. Cast-iron valves: MSS SP-72.

2. Steel valves: ANSI B16.34.

3. Bronze valves: WW-V-35.

C. Domestic water service:

1. Threaded ends 2 inches and smaller: Class 125, bronze two-piece body, bronze ball, bronze stem.

2. Soldered ends 2 inches and smaller: Class 125, bronze two-piece body, bronze ball, bronze stem.

D. At each valve installed below grade provide transition fittings from polyethylene pipe to steel pipe. Anchor each transition fitting for valve to valve box with welded angle iron, or provide vertical stiff leg minimum 18 inches into earth.

1. Provide 3 piece bronze, threaded ball valve for compressed air services.

2. Install valves at meter location and downstream of pressure regulating devices.

E. Solenoid valves; UL listed, manual override. Provide motor voltage to suit application.

2.04 CALIBRATED BALANCE VALVES:

A. Circuit setter (balance valve), calibrated type of bronze/cast-iron construction with bronze disc, with provision for connection of a portable differential meter and following features:

1. Built-in check valve.

2. Integral pointer to register degree of valve opening.

3. Internal seals.

B. Each balancing valve shall be constructed for 125 psig working pressure at a maximum temperature of 250 degrees F and supplied with preformed polyurethane insulation shall be of the following construction:

1. For chilled, condenser, and heating water service:

   a. Threaded ends: 2 inches and smaller.

   b. Flanged ends: 2-1/2 inches and larger.

2. For domestic water service:

   a. Soldered ends: 2 inches and smaller.

   b. Flanged ends: 2-1/2 inches and larger.

C. Provide one differential pressure meter, suitable for all flow rates anticipated for this Project. Turn meter over to the State at Beneficial Occupancy.

2.05 SEISMIC SHUT-OFF VALVES:

A. Provide seismic shut-off valves all gas meters. Valves shall automatically stop gas flow when actuated by earth tremor. Valve shall automatically shut bubble tight within five seconds when subjected to a horizontal sinusoidal oscillation having a peak acceleration of 0.3G and a period of 0.4 seconds.

B. The valve shall not shut-off when subjected for five seconds to horizontal, sinusoidal oscillations having a peak acceleration of 0.4G with a period of 0.1 second; or a peak acceleration of 0.08G with a period of 0.4 second or 1.0 second.

1. Type: Single seated, manual reset. Do not provide manual shut-off attachments.

2. Construction: Cast iron or aluminum body, rated for 125 psi ANSI flanged ends for pipe sizes above two inches. Threaded ends for pipe sizes two inches and under.

C. Approvals: UL listed, DSA approved.

2.06 VALVE FEATURES:

A. Provide valves with features specified, and provide proper valve features as determined by Contractor for installation requirements. Comply with ANSI B31.1.

1. Bypass: Comply with MSS SP-45 and provide manufacturer's standard bypass piping and valving.

2. Drain: Comply with MSS SP-45, and provide threaded pipe plugs.

B. Connections:

1. Flanges: Valve flanges complying with ANSI B16.1 (cast iron), ANSI B16.5 (steel), or ANSI B16.24 (bronze).

2. Threaded: Valve ends complying with ANSI B2.1

3. Solder Joint: Valve ends complying with ANSI B16.18

4. Flangeless: Valve bodies manufactured to fit between flanges complying with ANSI B16,1 (cast iron), ANSI B16.5 (steel), or ANSI B16.24 (bronze).

C. Valve terminology:

1. Wafer: Flangeless valves.

2. Single flange: Flangeless valves including bolt holes dimensioned for mating flanges.

3. Trim: Fabricate pressure-containing components of valve, including stems (shafts) and seats from brass or bronze materials, of standard alloy recognized in valve manufacturing industry.

4. Non-metallic disc: Non-metallic material selected for service indicated in accordance with manufacturer's published literature.

5. Renewable seat: Design seat of valve with removable disc and assemble valve so disc can be replaced when worn.

6. Extended stem: Increase stem length by 2 inch minimum to accommodate insulation applied over valve.

7. Mechanical actuator: Factory-fabricated gears, gear enclosure, external chain attachment and chain designed to provide mechanical advantage in operating valve.

8. Bonnet: Part of gate or globe valve through which stem passes to valve body and attached to valve body by screws, bolts, union, or welding.

9. Solid wedge: One-piece tapered disc in gate valve, designed for contact on both sides.

10. Double disc: Two-piece tapered disc in gate valve designed for contact on one side of each disc.

11. Parallel double disc: Two parallel discs in gate valve designed for contact by action of separate wedging block.

12. Inside screw, non-rising stem: Stem and hand wheel designed to rotate without rising when valve is operated from closed to open position.

13. Tight shutoff: Butterfly valve designed for flow regulation, and manufactured to be tight in closed position.

14. Low leakage: Butterfly valve designed for flow regulation and manufactured with minimum leakage tolerance in closed position.

D. Nominal leakage: Butterfly valve designed for flow regulation.

PART 3 - EXECUTION

3.01 GENERAL

A. Install valves where required for proper operation of piping and equipment, including valves in branch lines where necessary to isolate sections of piping. Locate valves so as to be accessible and so that separate support can be provided when necessary.

B. Install valves with stems pointed up, in vertical position where possible, but in no case with stems pointed downward from horizontal plane.

C. Provide union at each connection to equipment and downstream of each valve. Provide unions at both ends of valves when valves cannot be turned due to an obstruction.

   1. Provide unions at all three connections to 3 way control valves.

D. Insulation: Where insulation is incorporated, install extended-stem valves. Arranged in proper manner to receive insulation.

E. Install valves with bodies of metal other than cast iron where thermal or mechanical shock is indicated or can be expected to occur.

F. Do not install bronze valves and valve components in direct contact with steel unless bronze and steel are separated by dielectric insulator. Install bronze valves in steam and condensate service and in other services where corrosion can be expected to occur.

G. Install mechanical actuators with chain operators as required, and where valves 4 inches and larger are mounted more than 7 foot-0 inch above floor in Mechanical Rooms; and where recommended by valve manufacturer because of valve size, pressure differential or other operating condition making manual operation difficult.

3.02 INSTALLATION OF CHECK VALVES:

A. Swing check valves: Install in horizontal position with hinge pin horizontally perpendicular to centerline of pipe. Install for proper direction of flow.

B. Wafer check valves: Install between two flanges in horizontal or vertical position; position for proper direction of flow.

C. Horizontal lift check valve: Install in horizontal piping line with stem vertically upward; position for proper direction of flow.

D. Vertical lift check valve: Install in vertical piping line with upward flow with stem vertically upward.

E. Air compressor lift check valve: Install in air compressor discharge line.

F. Spring loaded horizontal lift check valve: Install in horizontal piping line with stem vertically upward, position for proper direction of flow.

G. After piping systems have been tested and put into service, but before final testing, adjusting, and balancing, inspect each valve for possible leaks.

H. Tag each valve and provide a complete listing of valve locations and functions.

END OF SECTION

SECTION 22 05 53

IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Equipment labels.

2. Pipe labels.

B. Volume 1 - Contracting Requirements, and Division - 01 General Requirements apply to the Work of this Section.

1.02 ACTION SUBMITTALS

A. No action submittals are necessary.

1.03 INFORMATIONAL SUBMITTALS

A. Submit under provisions of Section 01 33 00.

B. Product Data: For each type of product indicated.

C. Samples: For color, letter style, and graphic representation required for each identification material and device.

D. Valve numbering scheme.

E. Valve Schedules: For each piping system to include in maintenance manuals.

1.04 COORDINATION

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate installation of identifying devices with locations of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.01 EQUIPMENT LABELS

A. Plastic Labels for Equipment:

1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.

2. Letter Color: White.

3. Background Color: Black.

4. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

7. Fasteners: Stainless-steel rivets or self-tapping screws.

8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Label Content: Include equipment's Drawing designation or unique equipment number. Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified.

C. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.02 PIPE LABELS

A. Do not use pipe labels or plastic tapes for bare pipes conveying fluids at temperatures of 125 deg F (52 deg C) or higher.

B. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.

C. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to partially cover circumference of pipe and to attach to pipe without fasteners or adhesive.

D. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

E. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.

2. Lettering Size: At least 1-1/2 inches high.

PART 3 - EXECUTION

3.01 PREPARATION

A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.02 EQUIPMENT LABEL INSTALLATION

A. Install or permanently fasten labels on each major item of mechanical equipment.

B. Locate equipment labels where accessible and visible.

3.03 PIPE LABEL INSTALLATION

A. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:

1. Near each valve and control device.

2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.

3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.

4. At access doors, manholes, and similar access points that permit view of concealed piping.

5. Near major equipment items and other points of origination and termination.

6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.

7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

B. Pipe Label Color Schedule:

1. Domestic Water Piping:

    a. Background Color: White.

    b. Letter Color: Green.

END OF SECTION

SECTION 22 07 00

PLUMBING INSULATION

PART 1 - GENERAL

1.01 SUMMARY

A. Types of mechanical insulation products specified in this Section include the following:

1. Pipe insulation.

2. Equipment insulation.

3. Facings, sealants and adhesives for above.

B. Volume 1 - Contracting Requirements, and Division - 01 General Requirements apply to the Work of this Section.

1.02 ACTION SUBMITTALS

A. No action submittals are necessary

1.03 INFORMATIONAL SUBMITTALS

A. Submit under provisions of Section 01 33 00.

B. Submittals for review during construction document phase:

1. Product data: Submit manufacturer's technical product data and installation instructions for each type of mechanical insulation. Submit schedule showing manufacturer's product number, K-value, thickness, density, and furnished accessories for each mechanical system requiring insulation. Include complete description of installation methods with this submittal.

C. Submittals for review during construction phase:

1. Submit qualifications of manufacturer and installer, demonstrating compliance with paragraph "Quality Assurance".

D. Submittals for closeout:

1. Maintenance data: Submit maintenance data and replacement material lists for each type of mechanical insulation. Include this data and product data in maintenance manual.

2. Submit all warranties signed by the manufacturer.

3. Provide all special tools, loose gauges and test kits and maintenance and calibration instructions.

1.04 QUALITY ASSURANCE

A. Manufacturer's qualifications: Firms regularly engaged in manufacture of mechanical insulation products, of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Installer's qualifications: Firm with at least 5 years successful installation experience on projects with mechanical insulation similar to that required for this project.

C. Install thermal insulation products on equipment in accordance with manufacturer's written instructions to ensure that insulation serves its intended purpose.

D. Flame/smoke ratings: Provide composite mechanical insulation (insulation, jackets, coverings, sealers, mastic, and adhesives) with flame-spread rating of 25 or less and smoke-developed index of 50 or less.

E. Building insulation shall comply with California Quality Standards for insulating material.

F. Insulation material shall be certified by the California Energy Commission.

G. Installation shall comply with the National Commercial & Industrial Insulation Standards published by Midwest Insulation Contractors Association (MICA) and endorsed by National Insulation Contractors Association (NICA) regional associations.

PART 2 - PRODUCTS

2.01 INSULATION MATERIALS:

A. Insulation jackets:

1. Cover insulation exposed in conditioned areas and mechanical/electrical rooms with 30 mil thick fire-retardant PVC jacket. Provide pre-molded insulation covering on fittings. Seal cold piping, including domestic cold water, and condensate drain piping vapor tight to provide a continuous moisture resistant seal.

2. Cover insulation exposed to weather with a heavy duty, 0.016 inch thick, aluminum jacket, sealed weathertight. Secure jacket with 1/2 inch aluminum bands on 12 inch centers.

3. Cold piping (below 60 degrees F): Cover with heavy density glass fiber insulation, having factory-applied, self-sealing vapor barrier all-service jacket, molded to conform to piping, K-value at 75 degrees F, maximum 0.23 Btu-in/hr-sq ft degrees F.

B. Hot piping: Cover with heavy density glass fiber insulation, having factory-applied, self-sealing all-service jacket, molded to conform to piping, K-value at 75 degrees F, maximum 0.23 Btu-in/hr-sq ft degrees F.

C. Refrigerant piping and condensate drain pans: Cover with foamed plastic of closed cell structure, K-value at 75 degrees F, maximum 0.28 Btu-in/hr-sq ft degrees F and a maximum water vapor transmission rating of 0.1 perms. Armstrong Armaflex or Imcolock.

D. Roof drains and overflow drains: Cover with flexible glass fiber insulation, K-value at 75 degrees F, maximum 0.26 Btu-in/hr-sq ft degrees F, having factory-applied all-service jacket. Insulation shall be applied to the first horizontal section 15 ft from drain.

E. Hot equipment: Cover with rigid glass fiber insulation board, having a factory-applied all-service jacket, K-value at 75 degrees F, maximum 0.23 Btu-in/hr-sq ft degrees F, 6 pcf density.

F. Fittings and valves: Pre-molded PVC covers installed over pre-formed insulation having same K-value as adjacent material.

G. Minimum piping thickness shall be per latest California Energy Efficiency Standards, T-24.

PART 3 - EXECUTION

3.01 INSTALLATION OF PIPING AND EQUIPMENT INSULATION PRODUCTS.

A. Installation of piping insulation:

1. Install insulation products in accordance with manufacturer's written instructions and in accordance with recognized industry practices to ensure that insulation serves its intended purpose.

B. Provide equivalent thickness insulation on all fittings, expansion loops, flanges, strainers, and valves and finish with pre-molded PVC fitting covers. Maintain vapor barrier integrity and install in accordance with manufacturer's instructions.

C. Finish insulation neatly at hangers, supports and other protrusions. Refer to Section 22 05 29 – Hangers and Supports for Plumbing Piping and Equipment.

D. Locate cover seams on insulation in least visible locations.

E. Do not insulate flexible connections, expansion joints, and seismic joints except on chilled water systems and condensate drain systems.

F. Terminate insulation neatly with mastic troweled on bevel.

G. Cover cold piping fittings and valves with equivalent thickness of insulation material.

1. Seal lap joints with 100 percent coverage vapor barrier and adhesive.

2. Seal butt joints with 4 inch wide strips of vapor barrier sealed with vapor barrier adhesive.

3. Cover unions, flanges, couplings, valves, etc., with pre-molded insulated PVC fitting covers.

H. Cover hot piping fittings and valves up to bonnets with equivalent thickness of insulation material.

1. Cover unions, flanges, couplings, valves, etc., with pre-molded insulted PVC fitting covers.

I. Cover refrigerant piping, fittings, and valves up to bonnets with equivalent thickness of insulation material.

1. Apply with edges tightly butted.

2. Seal joints with vapor barrier sealer.

J. Roof drains and overflow drains shall have flexible insulation with adhesive applied in 6 inch wide strips on 16 inch centers.

1. Provide 16 gauge annealed tie wire, tied spiral wound or half hitched at 16 inch centers for securing insulation until adhesive sets.

2. Butt insulation and seal joints and breaks with 2 inches of foil adhered over joint.

3. Apply insulation to the sump of roof drains and overflow drains, including the vertical drop to the related horizontal line.

4. For roof drains, insulate all horizontal and vertical lines.

5. For overflow drains, insulate all interior lines to a minimum length of 20’-0” from the sump vertical drop.

K. Equipment shall have insulation applied with edges tightly butted, joints staggered and secured in place by steel bands.

1. Where necessary, provide suitable pin anchors welded in place.

2. Provide sufficient clearance around openings for normal operation of equipment.

3. Finish hot surface insulation with 1 inch galvanized hexagonal mesh and coat with hydraulic setting insulation cement.

4. Finish cold surface insulation joints with 4 inch wide strips of vapor barrier tape sealed with vapor barrier adhesive.

5. Finish insulation with heavy coat of vapor barrier mastic applied over entire outer surface.

L. Repair separation of joints and cracking of insulation caused by thermal movement, poor workmanship, or damage.

M. Insulate pump bodies with material compatible with respective systems for which insulation is specified.

N. Construct hinged, removable pump insulation boxes in accordance with standards outlined under Quality Assurance.

O. Where insulation requires sealing and taping, complete required procedures at the same time insulating material is applied to assure clean surfaces exist for proper adhesion.

P. Cinch staples shall be permitted only in accordance with insulation installation instructions. Cover all staples with vapor barrier mastic.

Q. Insulate all chilled water system appurtenances so that no condensation forms, i.e., drain lines, sensing lines, thermometer stems, etc.

R. Cover insulated outdoor piping systems with aluminum lagging.

S. Cover generator exhaust piping and muffler with aluminum lagging.

T. Install insulation on pipe systems subsequent to installation of heat tracing, testing, and acceptance of tests.

U. Insulate flanges, unions and traps with removable sections of insulation.

V. The term "piping" used herein shall include pipe, valves, strainers, and fittings. Apply insulating cements to fittings, valves, and strainers, and trowel smooth to the thickness of adjacent covering. Covering on valves shall extend up to the bonnet. The covering cement shall be of the types herein specified.

END OF SECTION

SECTION 22 11 16

DOMESTIC WATER PIPING

PART 1 - GENERAL

1.01 SUMMARY

A. Type of plumbing systems specified in this section include the following:

1. Domestic hot and cold water piping.

B. Volume 1 - Contracting Requirements, and Division - 01 General Requirements apply to the Work of this Section.

1.02 ACTION SUBMITTALS

A. Submit under provisions of Section 01 33 00.

1.03 INFORMATIONAL SUBMITTALS

A. Product data for specified products.

B. Maintenance data: Submit maintenance data and parts lists for plumbing piping systems materials and products. Include this data, product data, shop drawings, and record drawings in maintenance manual.

C. Submit all warranties signed by the manufacturer.

D. Provide all special tools, loose gauges and test kits and maintenance and calibration instructions.

1.04 QUALITY ASSURANCE

A. Manufacturer's qualifications: Firms regularly engaged in manufacture of plumbing piping 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. Requirements of regulatory agencies: The publications listed below are a part of this Specification; comply with provisions of these publications except as otherwise specified.

1. Plumbing code compliance: Comply with applicable portions of latest California Plumbing Code pertaining to selection and installation of plumbing materials and products.

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 required.

2.02 BASIC PIPES AND PIPE FITTINGS:

A. Provide pipes and pipe fittings in accordance with the following listing:

1. Interior water piping:

a. Tube size 1-1/2 inches and smaller: Copper tube; Type L, hard-drawn temper; wrought-copper fittings with full solder cups, solder joints.

b. Tube size 2 inches and larger: Copper tube; Type L, hard-drawn temper; wrought-copper fittings, brazed joints.

c. Capped or plugged outlets shall be Schedule 40 screwed brass.

2. Exterior water piping:

a. Sizes 2 1/2 inches and larger ductile iron pipe with cement mortar lining; Schedule 150; ductile iron cement mortar lined fittings with rubber gasket joints.

b. Sizes 2 inches and less: Type L copper tubing, hard temper, with wrought copper fittings.

2.03 PIPING SPECIALTIES:

A. Water hammer arresters: Provide properly sized water hammer arrestors with nesting type bellows contained within a casing having sufficient displacement volume to dissipate the calculated kinetic energy generated in the piping system. Provide all stainless shell construction with stainless steel bellows and threaded connection to water system.

B. Water hammer arrestors shall be approved by P.D.I. (Standard WH201) and by A.S.S.E. (Standard 1010).

C. Select units in accordance with the requirements of Plumbing and Drainage Institute Standard P.D.I. WH201.

2.04 BASIC VALVES:

A. Provide valves complying with Section 22 05 23, in accordance with the following listing:

1. Sectional valves:

a. 2 inches and smaller: Gate valves or ball valves.

b. 2-1/2 inches and larger: Gate valves or butterfly valves.

2. Shutoff valves:

a. 2 inches and smaller: Gate valves or ball valves.

b. 2-1/2 inches and larger: Gate valves.

3. Check valves: Swing check valves.

PART 3 - EXECUTION

3.01 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 clearances. 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, located and installed in accordance with Plumbing and Drainage Institute Standard PDI WH201.

C. For all faucets, hose bibbs, or other water outlets delivering industrial hot and/or cold water, provide a sign, permanently mounted, indicating "DANGER-UNSAFE WATER".

3.02 INSTALL VALVES IN THE FOLLOWING LOCATIONS:

A. Shutoff valves: Install on inlet of each plumbing equipment item, and on inlet of each plumbing fixture.

B. 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 as required to completely drain potable water system.

3.03 DOMESTIC WATER SYSTEM STERILIZATION:

A. Clean and disinfect all hot and cold water systems connected to domestic water systems in accordance with AWWA Standard C601 and as required by the local Building and Health Department Codes, and EPA. The procedure shall be performed by a water treatment company that has a current Cal-EPA license to apply disinfectant chlorine in potable water.

1. Disinfect existing piping systems as required to provide continuous disinfection upstream to existing valves.

B. Chemical and bacteriological tests shall be conducted by a certified laboratory and approved by the local authorities having jurisdiction. Copies of the test results shall be submitted to the State.

3.04 QUALITY CONTROL

A. Test each piece of equipment to show that it will operate in accordance with indicated requirements.

B. Repair or replace broken, damaged, or otherwise defective parts, materials, and work. Leave entire work in condition satisfactory to State.

C. 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.

END OF SECTION

SECTION 22 11 19

DOMESTIC WATER PIPING SPECIALTIES

PART 1 - GENERAL

1.01 SUMMARY

A. Type of plumbing systems specified in this section include the following:

1. Reduced-pressure-principal backflow prevention devices
2. Balancing Valves.
3. Temperature-actuated water mixing valve.
4. Pipeline strainers.
5. Hose bibs.
6. Water hammer arrestors.
7. Trap-seal primer valves.
8. Gauges.
9. Unions and flanges.

B. Volume 1 - Contracting Requirements, and Division - 01 General Requirements apply to the Work of this Section.

1.02 ACTION SUBMITTALS

A. No action submittals are necessary.

1.03 INFORMATIONAL SUBMITTALS

A. Submit under provisions of Section 01 33 00.

B. Submittals for review during construction document phase:

1. Product data for specified products.

C. Submittals for closeout:

1. Record drawings: At project closeout, submit record drawings of installed piping systems.

2. Maintenance data: Submit maintenance data and parts lists for plumbing piping systems materials and products. Include this data, product data, shop drawings, and record drawings in maintenance manual.

3. Submit all warranties signed by the manufacturer.

4. Provide all special tools, loose gauges and test kits and maintenance and calibration instructions.

1.04 QUALITY ASSURANCE

A. Manufacturer's qualifications: Firms regularly engaged in manufacture of plumbing piping 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. Requirements of regulatory agencies: The publications listed below are a part of this Specification; comply with provisions of these publications except as otherwise specified.

1. Plumbing code compliance: Comply with applicable portions of California Plumbing Code pertaining to selection and installation of plumbing materials and products.

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 required.

2.02 SPECIAL PIPING SPECIALTIES:

A. Water hammer arresters: Provide properly sized water hammer arrestors with nesting type bellows contained within a casing having sufficient displacement volume to dissipate the calculated kinetic energy generated in the piping system. Provide all stainless shell construction with stainless steel bellows and threaded connection to water system.

B. Water hammer arrestors shall be approved by P.D.I. (Standard WH201) and by A.S.S.E. (Standard 1010).

C. Select units in accordance with the requirements of Plumbing and Drainage Institute Standard P.D.I. WH201.

2.03 BASIC VALVES:

A. Provide valves complying with 22 05 23, in accordance with the following listing:

1. Sectional valves:

a. 2 inches and smaller: Gate valves or ball valves.

b. 2-1/2 inches and larger: Gate valves or butterfly valves.

2. Shutoff valves:

a. 2 inches and smaller: Gate valves or ball valves.

b. 2-1/2 inches and larger: Gate valves.

3. Drain valves:

a. 2 inches and smaller: Gate valves or ball valves.

b. 2-1/2 inches and larger: Gate valves.

4. Check valves: Swing check valves.

5. Gas Cocks: Lubricated plug valves, and lever handle gas cocks.

6. Balance valves: Calibrated balance valves.

2.04 HOSE BIBBS:

A. Wall hydrant: Recessed wall hose box with door and vacuum breaker and access door. Box and flange shall be stainless steel. Flange shall be 16 gauge stainless steel. Valve shall be cartridge type with vandal resistant lockshield loose key handle and screwdriver stop. Door shall have removable hinge and cylinder lock.

B. Exterior wall mounted: Integral vacuum breaker protected, nickel bronze finish, and "T" handle key.

C. Roof mounted: Integral vacuum breaker protected cartridge operated hose valve with lock-shield bonnet and removable key handle.

D. Interior wall mounted: Integral vacuum breaker protected cartridge operated hose valve with lock-shield bonnet and removable key handle.

E. Exterior wall mount non-freeze: Non-freeze wall box type with integral vacuum breaker.

F. All hose bibbs shall be backflow prevention equipped.

2.05 REDUCED PRESSURE BACKFLOW PREVENTERS:

A. Provide reduced-pressure principle backflow preventers consisting of assembly, including shutoff valves on inlet and outlet, and strainer on inlet. Construct in accordance with ASSE Standard 1013.

2.06 RELIEF VALVES:

A. Provide relief valves as selected by Contractor for proper relieving capacity, in accordance with ASME Boiler and Pressure Vessel Code.

B. Combined pressure-temperature relief valves of bronze body, test lever, thermostat, complying with ANSI A21.22 listing requirements for temperature discharge capacity.

2.07 TRAP PRIMER:

A. Provide trap primers.

B. 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.

C. Provide trap primer wall box with access door.

2.08 TEMPERED WATER CONTROL VALVE:

A. Provide tempered water control valves complete with angle strainer checkstops. Valves shall be thermostatic type.

PART 3 - EXECUTION

3.01 GENERAL

A. Installation of backflow device:

1. Install backflow device per local City or County requirements. Provide drain connection available from the manufacturer at drain connection, pipe drain outlet to the nearest floor drain.

B. Installation of trap primers:

1. Install as stipulated in manufacturer's printed literature, with 1/2-inch, type-L, hard copper piping to trap primer connection on floor drains and floor sinks. Provide valve and union ahead of each trap primer.

3.02 QUALITY CONTROL

A. Test each piece of equipment to show that it will operate in accordance with indicated requirements.

B. Repair or replace broken, damaged, or otherwise defective parts, materials, and work. Leave entire work in condition satisfactory to State.

C. 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.

END OF SECTION

SECTION 22 11 23

DOMESTIC WATER PUMPS

PART 1 - GENERAL

1.01 GENERAL

A. Volume 1 - Contracting Requirements, and Division - 01 General Requirements apply to the Work of this Section.

B. Section includes: Types of pumps specified in this Section include the following:

1. In-line recirculation pumps.

1.02 ACTION SUBMITTALS

A. No action submittals are necessary.

1.03 INFORMATIONAL SUBMITTALS

A. Submit under provisions of Section 01 33 00.

B. Submittals for review during construction document phase:

1. Product data for specified products.

C. Submittals for closeout:

1. Maintenance data: Submit maintenance data and parts lists for each type of pump, control, and accessory, including "trouble-shooting" maintenance guide. Include this data, product data and shop drawings in maintenance manual.

2. Submit all warranties signed by the manufacturer.

3. Provide all special tools, loose gauges and test kits and maintenance and calibration instructions.

1.04 QUALITY ASSURANCE

A. UL compliance: Provide electric components for pumps which have been listed by Underwriters Laboratories.

B. Ratio of impeller diameter to cut water volute diameter shall be limited to 85% or less for noise and vibration control.

PART 2 - PRODUCTS

2.01 IN-LINE DOMESTIC WATER CIRCULATION PUMPS:

A. Pumps shall be of the centrifugal type with non-overloading characteristics and shall not overload the motor above its nameplate horsepower rating (no use of service factor will be allowed) under any operating condition.

B. Type: Horizontal, oil-lubricated, designed for 125 psi working pressure, 225 degrees F continuous water temperature, bronze construction, stainless steel shaft with integral thrust collar, mechanical seal and self-aligning, flexible coupling.

C. Pumping assemblies and pressure regulating valves shall be guaranteed for five years from date of shipment.

PART 3 - EXECUTION

3.01 GENERAL

A. Installation of pumps:

1. Install pumps in accordance with manufacturer's published instructions, complying with recognized industry practices to ensure that pumps comply with requirements and serve intended purposes.

2. Provide access space around pumps for service as indicated, but in no case less than that recommended by manufacturer.

3. Install in-line pumps with support from overhead structure on each side of pump.

4. Piping shall be supported from the building structure so as to prevent any strain on the pump casings. A final check for perfect alignment of the piping connections shall be made after pump has been secured to its base. Provide valves, accessories, gauges, flexible connections, and supports as required.

5. Check alignment, and where necessary, realign shafts of motors and pumps within recommended tolerances by manufacturer.

6. Lubricate pumps before start-up. Start-up in accordance with manufacturer's instructions.

7. 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.

3.02 QUALITY CONTROL

A. Training: Provide training and orientation to the State's operating staff in proper care and operation of equipment, systems, and controls for plumbing pumps.

B. Operation test: Test each piece of equipment to show that it will operate in accordance with indicated requirements.

C. Cleaning up: Upon completion of Work, remove materials, equipment, apparatus, tools, and the like, and leave premises clean, neat, and orderly.

END OF SECTION

SECTION 22 14 23

STORM DRAINAGE PIPING SPECIALTIES

PART 1 - GENERAL

1.01 SUMMARY

A. Type of plumbing systems specified in this section include the following:

1. Cleanouts.

2. Roof drains.

B. Volume 1 - Contracting Requirements, and Division - 01 General Requirements apply to the Work of this Section.

1.02 ACTION SUBMITTALS

A. No action submittals are necessary.

1.03 INFORMATIONAL SUBMITTALS

A. Submit under provisions of Section 01 33 00.

B. Submittals for review during construction document phase:

1. Product data for specified products.

C. Submittals for closeout:

1. Record drawings: At project closeout, submit record drawings of installed piping systems.

2. Maintenance data: Submit maintenance data and parts lists for plumbing piping system materials and products. Include this data, product data, shop drawings, and record drawings in maintenance manual.

3. Submit all warranties signed by the manufacturer.

4. Provide all special tools, loose gauges and test kits and maintenance and calibration instructions.

1.04 QUALITY ASSURANCE

A. Manufacturer's qualifications: Firms regularly engaged in manufacture of plumbing piping 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. Requirements of regulatory agencies: The publications listed below are a part of this Specification; comply with provisions of these publications except as otherwise specified.

   1. Plumbing code compliance: Comply with applicable portions of latest California Plumbing Code pertaining to selection and installation of plumbing materials and products.

PART 2 - PRODUCTS

2.01 GENERAL

A. Materials and products: Provide piping materials and factory-fabricated piping products of sizes, types, pressure ratings, temperature ratings, and capacities as required.

B. Cleanouts:

   1. Cleanouts in floor and in concrete sidewalks: Ducco cast iron with brushed chrome or stainless steel top, clamping collar and ABS plastic plug with square or round top to suit floor construction.

   2. Cleanouts in concealed locations shall be furnished above ground cast-iron soil or waste lines with raised head ABS Plastic plug.

   3. Cleanouts in walls shall be furnished with stainless steel cover. Provide long sweep elbow or combination wye at connection to riser.

   4. Cleanouts exterior to building in landscaped areas shall be furnished with 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.

   5. Cleanouts in drive areas: Furnish with heavy duty traffic rated top stainless steel or brushed chrome top.

C. Roof drains:

   1. Provide adapter fittings as necessary to connect to roof and overflow drains.

   2. Provide roof drains, overflow roof drains, parapet drains, balcony drains, deck drains, terrace drains, and trench drains as required including features as specified herein.

      a. All drains shall have coated cast iron body. Provide all flashing clamps, gravel guards, frames, adapters, deck clamps, expansion joints, strainers, and grates to suit application. Grates in finished areas shall be brushed chrome or stainless

steel and all roof drain domes shall be cast iron. Provide lambs tongues at overflow roof drain.

b. Insulate where condensation may occur.

PART 3 - EXECUTION

3.01 GENERAL

A. Installation of roof drains:

1. Install roof drains and overflow roof drains in accordance with manufacturer's written instructions.

3.02 QUALITY CONTROL

A. Repair or replace broken, damaged, or otherwise defective parts, materials, and work. Leave entire work in condition satisfactory to State.

B. 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.

END OF SECTION

SECTION 22 15 13

GENERAL SERVICE COMPRESSED-AIR PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Volume 1 - Contracting Requirements, and Division - 01 General Requirements apply to the Work of this Section.

1.02 SUMMARY

A. This Section includes piping and related specialties for general-service compressed-air systems operating at 200 psig or less.

B. Related Sections include the following:

1. Division 22 Section 22 15 19 "Air Compressor Unit" for general-service air compressors and accessories.

1.03 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Compressed-air piping and support and installation shall withstand effects of seismic events determined according to latest CBC requirement.

1.04 ACTION SUBMITTALS

A. No action submittals are necessary.

1.05 INFORMATIONAL SUBMITTALS

A. General:

1. Comply with Division 01 Section 01 33 00 “Submittals Procedures”.

2. Submit items as applicable to the Project from submittals specified in this Article.

B. Construction Phase Submittals, Prior to Fabrication and Installation:

1. Product Data: For the following:

a. Copper and/or Schedule 40 Steel pipe.

b. Dielectric fittings.

c. Flexible pipe connectors.

d. Safety valves.

e. Pressure regulators. Include rated capacities and operating characteristics.

f. Automatic drain valves.

g. Filters. Include rated capacities and operating characteristics.

h. Lubricators. Include rated capacities and operating characteristics.

i. Quick couplings.

j. Hose assemblies.

C. Closeout Phase:

1. Field quality-control test reports.

2. Operation and Maintenance Data: For general-service compressed-air piping specialties to include in emergency, operation, and maintenance manuals.

1.06 QUALITY ASSURANCE

A. Brazing: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications," or to AWS B2.2, "Standard for Brazing Procedure and Performance Qualification."

B. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX.

C. ASME Compliance:

1. Comply with ASME B31.1, "Power Piping," for high-pressure compressed-air piping.

2. Comply with ASME B31.9, "Building Services Piping," for low-pressure compressed-air piping.

PART 2 - PRODUCTS

2.01 PIPES, TUBES, AND FITTINGS

A. Schedule 40, Steel Pipe: ASTM A 53/A 53M, Type E or S, Grade B, black or hot-dip zinc coated with ends threaded according to ASME B1.20.1.

1. Steel Nipples: ASTM A 733, made of ASTM A 53/A 53M or ASTM A 106, Schedule 40, galvanized seamless steel pipe. Include ends matching joining method.

2. Malleable-Iron Fittings: ASME B16.3, Class 150 or 300, threaded.

3. Malleable-Iron Unions: ASME B16.39, Class 150 or 300, threaded.

4. Steel Flanges: ASME B16.5, Class 150 or 300, carbon steel, threaded.

5. Wrought-Steel Butt-Welding Fittings: ASME B16.9, Schedule 40.

6. Steel Flanges: ASME B16.5, Class 150 or 300, carbon steel.

B. Copper Tube: ASTM B 88, Type K or L seamless, drawn-temper, water tube.

1. Wrought-Copper Fittings: ASME B16.22, solder-joint pressure type or MSS SP-73, wrought copper with dimensions for brazed joints.

2. Cast-Copper-Alloy Flanges: ASME B16.24, Class 150 or 300.

3. Copper Unions: ASME B16.22 or MSS SP-123.

2.02 JOINING MATERIALS

A. Pipe-Flange Gasket Materials: Suitable for compressed-air piping system contents.

1. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch maximum thickness unless thickness or specific material is indicated.

a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.

b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

C. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

D. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated.

2.03 VALVES

A. Metal Ball, Butterfly, Check, Gate, and Globe Valves: Comply with requirements in Division 22 Section 22 05 23 "General-Duty Valves for Plumbing Piping"

2.04 DIELECTRIC FITTINGS

A. General Requirements for Dielectric Fittings: Combination fitting of copper alloy and ferrous materials with insulating material; suitable for system fluid, pressure, and temperature. Include threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.

B. Dielectric Unions: Factory-fabricated union assembly, for 250 psig minimum working pressure at 180 deg F.

C. Dielectric Flanges: Factory-fabricated companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.

D. Dielectric-Flange Kits: Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.

1. Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig minimum working pressure where required to suit system pressures.

2.05 FLEXIBLE PIPE CONNECTORS

A. Bronze-Hose Flexible Pipe Connectors: Corrugated-bronze tubing with bronze wire-braid covering and ends brazed to inner tubing.

1. End Connections, NPS 2 and Smaller: Threaded copper pipe or plain-end copper tube.

2. End Connections, NPS 2-1/2 and Larger: Flanged copper alloy.

B. Stainless-Steel-Hose Flexible Pipe Connectors: Corrugated-stainless-steel tubing with stainless-steel wire-braid covering and ends welded to inner tubing.

1. End Connections, NPS 2 and Smaller: Threaded steel pipe nipple.

2. End Connections, NPS 2-1/2 and Larger: Flanged steel nipple.

2.06 SLEEVES

A. Galvanized-Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

B. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.

1. Underdeck Clamp: Clamping ring with set screws.

2.07 ESCUTCHEONS

A. General Requirements: Manufactured wall and ceiling escutcheons and floor plates, with ID to closely fit around pipe and tube and OD that completely covers opening.

B. One-Piece, Deep-Pattern Escutcheons: Deep-drawn, box-shaped brass with polished chrome-plated finish.

C. One-Piece, Cast-Brass Escutcheons: With set screw.

1. Finish: Polished chrome-plated.

D. Split-Casting, Cast-Brass Escutcheons: With concealed hinge and set screw.

1. Finish: Polished chrome-plated.

E. One-Piece, Stamped-Steel Escutcheons: With set screw or spring clips and chrome-plated finish.

F. Split-Plate, Stamped-Steel Escutcheons: With concealed hinge, set screw or spring clips and chrome-plated finish.

G. One-Piece, Floor-Plate Escutcheons: Cast iron.

H. Split-Casting, Floor-Plate Escutcheons: Cast brass with concealed hinge and set screw.

2.08 SPECIALTIES

A. Safety Valves: ASME Boiler and Pressure Vessel Code: Section VIII, "Pressure Vessels," construction; National Board certified, labeled, and factory sealed; constructed of bronze body with poppet-type safety valve for compressed-air service.

1. Pressure Settings: Higher than discharge pressure and same or lower than receiver pressure rating.

B. Air-Main Pressure Regulators: Bronze body, direct acting, spring-loaded manual pressure-setting adjustment, and rated for 250 psig inlet pressure, unless otherwise indicated.

1. Type: Pilot operated.

C. Air-Line Pressure Regulators: Diaphragm or pilot operated, bronze body, direct acting, spring-loaded manual pressure-setting adjustment, and rated for 200 psig minimum inlet pressure, unless otherwise indicated.

D. Air-Line Pressure Regulators: Diaphragm operated, aluminum alloy or plastic body, direct acting, spring-loaded manual pressure-setting adjustment, and rated for 200 psig minimum inlet pressure, unless otherwise indicated.

E. Automatic Drain Valves: Stainless-steel body and internal parts, rated for 200 psig minimum working pressure, capable of automatic discharge of collected condensate. Include mounting bracket if wall mounting is required.

F. Coalescing Filters: Coalescing type with activated carbon capable of removing water and oil aerosols; with color-change dye to indicate when carbon is saturated and warning light to indicate when selected maximum pressure drop has been exceeded. Include mounting bracket if wall mounting is required.

G. Mechanical Filters: Two-stage, mechanical-separation-type, air-line filters. Equip with deflector plates, resin-impregnated-ribbon-type filters with edge filtration, and drain cock. Include mounting bracket if wall mounting is required.

H. Air-Line Lubricators: With drip chamber and sight dome for observing oil drop entering air stream; with oil-feed adjustment screw and quick-release collar for easy bowl removal. Include mounting bracket if wall mounting is required.

1. Provide with automatic feed device for supplying oil to lubricator.

2.09 QUICK COUPLINGS

A. General Requirements for Quick Couplings: Assembly with locking-mechanism feature for quick connection and disconnection of compressed-air hose.

B. Automatic-Shutoff Quick Couplings: Straight-through brass body with O-ring or gasket seal and stainless-steel or nickel-plated-steel operating parts.

1. Socket End: With one-way valve and threaded inlet for connection to piping or threaded hose fitting.

2. Plug End: With barbed outlet for attaching hose.

C. Valve-less Quick Couplings: Straight-through brass body with stainless-steel or nickel-plated-steel operating parts.

1. Socket End: With O-ring or gasket seal, without valve, and with barbed inlet for attaching hose.

2. Plug End: With barbed outlet for attaching hose.

PART 3 - EXECUTION

3.01 PIPING APPLICATIONS

A. Low-Pressure Compressed-Air Distribution Piping: Use one of the following piping materials for each size range:

1. NPS 2 and Smaller: Schedule 40, black or galvanized-steel pipe; threaded, malleable-iron fittings; and threaded joints.

2. NPS 2 and Smaller: Type K or L, copper tube; wrought-copper fittings; and brazed joints.

B. Drain Piping: Use one of the following piping materials:

1. NPS 2 and Smaller: Type M copper tube; wrought-copper fittings; and brazed or soldered joints.

3.02 VALVE APPLICATIONS

A. General-Duty Valves: Comply with requirements in Division 22 Section 22 05 23 "General-Duty Valves for Plumbing Piping" for metal general-duty valves. Use metal valves, unless otherwise indicated.

   1. Metal General-Duty Valves: Use valve types specified in "Valve Applications" Article in Division 22 Section 22 05 23 "General-Duty Valves for Plumbing Piping" according to the following:

      a. Low-Pressure Compressed Air: Valve types specified for low-pressure compressed air.

      b. Equipment Isolation NPS 2 and Smaller: Safety-exhaust, copper-alloy ball valve with exhaust vent and pressure rating at least as great as piping system operating pressure.

3.03 PIPING INSTALLATION

A. Install piping concealed from view and protected from physical contact by building occupants, unless otherwise indicated and except in equipment rooms and service areas.

B. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited, unless otherwise indicated.

C. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal and to coordinate with other services occupying that space.

D. Install piping adjacent to equipment and machines to allow service and maintenance.

E. Install air and drain piping with 1 percent slope downward in direction of flow.

F. Install nipples, flanges, unions, transition and special fittings, and valves with pressure ratings same as or higher than system pressure rating, unless otherwise indicated.

G. Equipment and Specialty Flanged Connections:

   1. Use steel companion flange with gasket for connection to steel pipe.

   2. Use cast-copper-alloy companion flange with gasket and brazed or soldered joint for connection to copper tube. Do not use soldered joints for connection to air compressors or to equipment or machines producing shock or vibration.

H. Flanged joints may be used instead of specified joint for any piping or tubing system.

I. Extended-tee outlets with brazed branch connection may be used for copper tubing, within extruded-tee connection diameter to run tube diameter ratio for tube type, according to Extruded Tee Connections Sizes and Wall Thickness for Copper Tube (Inches) Table in ASTM F 2014.

J. Install eccentric reducers where compressed-air piping is reduced in direction of flow, with bottoms of both pipes and reducer fitting flush.

K. Install branch connections to compressed-air mains from top of main. Provide drain leg and drain trap at end of each main and branch and at low points.

L. Install thermometer and pressure gage on discharge piping from each air compressor and on each receiver. Comply with requirements in Division 22.

M. Install piping to permit valve servicing.

N. Install piping free of sags and bends.

O. Install fittings for changes in direction and branch connections.

P. Install seismic restraints on piping. Seismic-restraint devices are specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."

3.04 JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

   1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.

   2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

D. Brazed Joints for Copper Tubing: Join according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter.

E. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Join according to ASTM B 828 or CDA's "Copper Tube Handbook."

F. Flanged Joints: Use asbestos-free, nonmetallic gasket suitable for compressed air. Join flanges with gasket and bolts according to ASME B31.9 for bolting procedure.

3.05 VALVE INSTALLATION

A. General-Duty Valves: Comply with requirements in Division 22 Section 22 05 23 "General-Duty Valves for Plumbing Piping."

B. Install shutoff valves and unions or flanged joints at compressed-air piping to air compressors.

C. Install shutoff valve at inlet to each automatic drain valve, filter, lubricator, and pressure regulator.

D. Install check valves to maintain correct direction of compressed-air flow to and from compressed-air piping specialties and equipment.

3.06 DIELECTRIC FITTING INSTALLATION

A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.

B. NPS 2 and Smaller: Use dielectric unions.

3.07 FLEXIBLE PIPE CONNECTOR INSTALLATION

A. Install flexible pipe connectors in discharge piping and in inlet air piping from remote air-inlet filter of each air compressor.

B. Install bronze-hose flexible pipe connectors in copper compressed-air tubing.

C. Install stainless-steel-hose flexible pipe connectors in steel compressed-air piping.

3.08 SPECIALTY INSTALLATION

A. Install safety valves on receivers in quantity and size to relieve at least the capacity of connected air compressors.

B. Install air-main pressure regulators in compressed-air piping at or near air compressors.

C. Install air-line pressure regulators in branch piping to equipment and tools.

D. Install automatic drain valves on aftercoolers, receivers, and dryers. Discharge condensate onto nearest floor drain.

E. Install coalescing filters in compressed-air piping at or near air compressors and upstream from mechanical filters.

F. Install mechanical filters in compressed-air piping at or near air compressors and downstream from coalescing filters.

G. Install contaminate filters near each air outlet fitting, at equipment connected to compressed air piping or other similar point-of-use location throughout facility. The filters shall remove water, liquids and solid particles from compressed air servicing point-of-use locations. Provide Class 2 filters for solids and Class 4 for Oil contaminates in accordance with ISO 8573.1.

H. Install air-line lubricators in branch piping to machine tools.

I. Install quick couplings at piping terminals for hose connections.

J. Install hose assemblies at hose connections.

3.09 CONNECTIONS

A. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment and machine.

B. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment and machine.

3.10 SLEEVE INSTALLATION

A. Sleeves are not required for core-drilled holes.

B. Permanent sleeves are not required for holes formed by removable PE sleeves.

C. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs using galvanized-steel pipe or galvanized-steel sheet.

D. Install sleeves for pipes passing through concrete and masonry walls, gypsum board partitions, and concrete floor and roof slabs.

1. Wall Penetrations: Cut sleeves to length for mounting flush with both surfaces.

2. Floor Penetrations: Extend sleeves installed in floors of mechanical equipment areas or other wet areas above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.

E. Install sleeves in new walls and slabs as new walls and slabs are constructed.

F. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:

1. Steel Pipe Sleeves: For pipes smaller than NPS 6.

2. Steel Sheet Sleeves: For pipes NPS 6 and larger, penetrating gypsum board partitions.

3. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level. Comply with requirements in Division 07 Section 07 62 00 "Sheet Metal Flashing and Trim" for flashing.

a. Seal space outside of sleeve fittings with grout.

G. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements in Division 07 Section 07 84 13 "Penetration Firestopping."

3.11 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment" for seismic-restraint devices.

B. Comply with requirements in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment" for pipe hanger and support devices.

C. Vertical Piping: MSS Type 8 or 42, clamps.

D. Individual, Straight, Horizontal Piping Runs:

   1. 100 Feet or Less: MSS Type 1, adjustable, steel clevis hangers.

   2. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.

E. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.

F. Base of Vertical Piping: MSS Type 52, spring hangers.

G. Support horizontal piping within 12 inches of each fitting and coupling.

H. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch minimum rods.

I. Install hangers for Schedule 40, steel piping with the following maximum horizontal spacing and minimum rod diameters:

   1. NPS 1/4 to NPS 1/2: 96 inches with 3/8-inch rod.

   2. NPS 3/4 to NPS 1-1/4: 84 inches with 3/8-inch rod.

   3. NPS 1-1/2: 12 feet with 3/8-inch rod.

   4. NPS 2: 13 feet with 3/8-inch rod.

J. Install supports for vertical, Schedule 40, steel piping every 15 feet.

K. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:

   1. NPS 1/4: 60 inches with 3/8-inch rod.

   2. NPS 3/8 and NPS 1/2: 72 inches with 3/8-inch rod.

   3. NPS 3/4: 84 inches with 3/8-inch rod.

   4. NPS 1: 96 inches with 3/8-inch rod.

   5. NPS 1-1/4: 108 inches with 3/8-inch rod.

6. NPS 1-1/2: 10 feet with 3/8-inch rod.

7. NPS 2: 11 feet with 3/8-inch rod.

L. Install supports for vertical copper tubing every 10 feet.

3.12 LABELING AND IDENTIFICATION

A. Install identifying labels and devices for general-service compressed-air piping, valves, and specialties. Comply with requirements in Division 22 Section "Identification for Plumbing and Equipment."

3.13 FIELD QUALITY CONTROL

A. Perform field tests and inspections.

B. Tests and Inspections:

1. Piping Leak Tests for Metal Compressed-Air Piping: Test new and modified parts of existing piping. Cap and fill general-service compressed-air piping with oil-free dry air or gaseous nitrogen to pressure of 50 psig above system operating pressure, but not less than 150 psig. Isolate test source and let stand for four hours to equalize temperature. Refill system, if required, to test pressure; hold for two hours with no drop in pressure.

2. Repair leaks and retest until no leaks exist.

3. Inspect filters, lubricators and pressure regulators for proper operation.

C. Prepare test reports.

END OF SECTION

SECTION 22 15 19

AIR COMPRESSOR UNIT

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes:

1. Packaged, reciprocating air compressor.
2. Refrigerated compressed air dryer.
3. Compressed air filter assemblies.
4. Condensate drain.
5. Oil/water separator.

B. The fully packaged two stage electrical industrial Type 30 air compressor with a 7.5 horse power motor, 80 gallon vertical tank, with a max pressure of 175 psig.

C. Volume 1 - Contracting Requirements, and Division - 01 General Requirements apply to the Work of this Section.

1.02 ACTION SUBMITTALS

A. No action submittals are necessary.

1.03 INFORMATIONAL SUBMITTALS

A. Submit under provisions of Section 01 33 00.

B. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

1. Wiring Diagrams: For power, signal, and control wiring.

C. Field quality-control reports.

D. Operation and Maintenance Data: For compressed-air equipment to include in operation and maintenance manuals.

1.04 QUALITY ASSURANCE

A. Source Limitations: The compressed air system shall be from a single source and single manufacturer.

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

C. ASME Compliance: Fabricate and label receivers to comply with latest ASME Boiler and Pressure Vessel Code.

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS FOR PACKAGED AIR COMPRESSORS

A. Description: Factory-assembled, -wired, -piped, and -tested; electric-motor-driven; air-cooled; continuous-duty air compressors and receivers that deliver air of quality equal to intake air.

B. Control Panels: Automatic control station with load control and protection functions. Comply with NEMA ICS 2 and UL 508.

C. Receivers: Steel tank constructed according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

1. Pressure Rating: At least as high as highest discharge pressure of connected air compressors and bearing appropriate code symbols.

2. Interior Finish: Corrosion-resistant coating.

3. Accessories: Include safety valve, pressure gage, automatic drain, and pressure regulator.

2.02 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. BelAire.

2. EMAX.

3. Ingersoll Rand

4. Or equal.

B. Description: Packaged unit.

C. Air Compressor(s): Two-stage, tank-mounted reciprocating-piston type, that will deliver air of quality equal to intake air.

1. High discharge-air temperature switch.

2. OSHA-style belt guard totally enclosing pulleys and belts.

3. Intercooler between stages of two-stage units.

D. Basis of Design: Ingersoll Rand 2475.

2.03 REFRIGERANT COMPRESSED-AIR DRYERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Ingersoll-Rand; Air Solutions Group.

2. Hankison International.

3. Or approved equal.

B. Description: Non-cycling, air-cooled, electric-motor-driven unit with steel enclosure and capability to deliver 35 deg F, 1174-psig, air at dew point. Include automatic ejection of condensate from airstream, step-down transformers, disconnect switches, inlet and outlet pressure gages, thermometers, automatic controls, and filters.

C. Refrigeration System: Direct expansion, fully hermetic reciprocating compressor using R-134A refrigerant.

D. Control System: Full feature electronic control system, alarms for high and low dew point and probe failure. Shall include energy saving mode to shut down dryer during periods of low demand.

E. Heat Exchanger: Stainless steel plates, precooler/reheater, evaporator section and integral moisture separator.

F. Condenser: Air-cooled refrigerant condenser.

G. Electrical: 115/1/60 or 230/1/60 incoming power. NEMA 12 electrical rating.

H. Housing: Baked on powder paint coating. Shall be easily removed for access to internal components.

I. Drain: Electronic solenoid drain valve with adjustable frequency and duration operating parameters. Provide strainer.

2.04 COMPRESSED-AIR FILTER ASSEMBLIES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Ingersoll-Rand; Air Solutions Group.

2. Hankison International.

3. Or approved equal.

B. Description: Filter assemblies suitable for compressed air, in parallel duplex arrangement. Size each assembly for maximum capacity of connected equipment and operating pressure of compressed-air system. Include automatic ejection of condensate from airstream, inlet and outlet pressure gages, and shutoff valves.

1. Size filter assemblies for 5-psig maximum air-pressure drop when filters are new and clean, at system rated capacity, and at 100-psig pressure.

2. Differential Pressure Switch: Adjustable, diaphragm type, with electrical connections for alarm system, to indicate when air-pressure drop through filters rises to more than 2 psig greater than when new and clean.

3. Particulate Filters: Collection efficiency of 98 percent retention of particles 1 micrometer and larger.

4. Odor and Taste Filters: Vapor-absorbing, activated charcoal.

5. Coalescing Filters: Collection efficiency of 99.9 percent retention of particles 0.3 micrometer and smaller.

6. Include automatic drain trap for each filter.

2.05 OIL WATER SEPARATOR

A. Provide non-electrical Oil Water separator to part and adsorb virtually all lubricants produced by the compressor systems.

2.06 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements.

1. Motor Sizes: Minimum size as indicated.

2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 26 Sections.

2.07 POINT OF USE

A. Air Filtration/Regulation Systems shall be provided at point of use in addition to the filter and air dryer system defined above.

   1. Install a two-stage filter system with gauge at each air outlet valve.

PART 3 - EXECUTION

3.01 COMPRESSED-AIR EQUIPMENT INSTALLATION

A. General Requirements for Compressed-Air Equipment Installation:

   1. Install compressed-air equipment to allow maximum headroom unless specific mounting heights are indicated.

   2. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces unless otherwise indicated.

   3. Install mechanical equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings (if applicable) to accessible locations.

   4. Install equipment to allow right of way for piping installed at required slope.

   5. Install the following devices on compressed-air equipment:

      a. Thermometer, Pressure Gage, and Safety Valve: Install on each compressed-air receiver.

      b. Pressure Regulators: Install downstream from air compressors, dryers, purification units, and filter assemblies.

      c. Drain Valves: Install on aftercoolers, receivers, and dryers.

      d. Discharge condensate over nearest floor drain.

      e. Vibration Isolation: Mount equipment on a vibration isolation equipment base.

3.02 CONNECTIONS

A. Comply with requirements for compressed-air piping specified by code.

B. Install piping adjacent to equipment to allow service and maintenance.

C. Connect compressed-air piping to compressed-air equipment, accessories, and specialties with shutoff valve and union or flanged connection.

D. Install piping from automatic water drain valves on compressed air storage tanks and air dryers to nearest floor drain.

3.03 STARTUP SERVICE

A. Perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.

2. Check for lubricating oil in lubricated-type equipment.

3. Check belt drives for proper tension.

4. Verify that air-compressor inlet filters and piping are clear.

5. Check for equipment vibration-control supports and flexible pipe connectors and verify that equipment is properly attached to substrate.

6. Check safety valves for correct settings. Ensure that settings are higher than air-compressor discharge pressure but not higher than rating of system components.

7. Drain receiver tanks.

8. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

9. Test and adjust controls and safeties.

3.04 DEMONSTRATION

A. Engage a factory-authorized service representative to train The State's maintenance personnel to adjust, operate, and maintain air compressors, compressed air dryers and compressed air filter assemblies. Refer to Division 01 Section 01 70 00 "Demonstration and Training."

B. Training shall be scheduled with at least 5 working day notice and shall occur during the workweek, Tuesday through Thursday, between the hours of 9:00 am and 2:00 pm. All training shall be coordinated with facility staff. The system shall be fully installed with all parts and components confirmed prior to training request being submitted.

END OF SECTION

SECTION 22 05 00

COMMON WORK RESULTS FOR PLUMBING

PART 1 - GENERAL

1.01 SUMMARY

A. Types of piping specialties specified in this section include the following:

1. Pipe escutcheons.
2. Sleeves.
3. Sleeve seals.
4. Drip pans.
5. Unions and flanges.
6. Cathodic protection.
7. Pipe identification.
8. Gauges.
9. Strainers.

B. Volume 1 - Contracting Requirements, and Division - 01 General Requirements apply to the Work of this Section.

1.02 ACTION SUBMITTALS

A. No action submittals are necessary.

1.03 INFORMATIONAL SUBMITTALS

A. Submit under provisions of Section 01 33 00.

1. Shop drawings indicating locations of heat traced piping systems.
2. Submit all warranties signed by the manufacturer.
3. Provide all special tools, loose gauges and test kits and maintenance and calibration instructions.

1.04 QUALITY ASSURANCE

A. All fire stopping materials shall be U.L. listed.

B. Manufacturer's qualifications: Firms regularly engaged in manufacture of piping specialties, of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

C. Identification: Provide piping specialties with manufacturer's name (or trademark) and pressure rating clearly marked on valve body.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Pipe escutcheons for moist areas: For water resistant floors, and areas where water and condensation can be expected to accumulate, provide cast brass or sheet brass escutcheons, solid or split hinged. Split hinged type shall not be used in areas with security requirements.

B. Provide pipe escutcheons for exposed finish surfaces: Provide chrome plated escutcheons, solid or split hinged. Split hinged type shall not be used in areas with security requirements.

C. Where pipes pass through concrete floors or walls, install galvanized metal or plastic sleeves having not less than 1/2-inch or more than 1-inch clearance around sides of the pipe or pipe covering for the full thickness of the concrete. Extend sleeves through floors one inch above floor and seal watertight.

D. After piping has been installed, fill annular space with UL listed fire stopping system, HILTI One-Max, 3M, Fire Barrier, Dow Firestop or Nelson Firestop. All through-wall firestop penetrations shall comply with the requirements of Section 07 84 13.

E. The annular space between the pipe sleeves and the pipe and between duct openings and ducts through all floors, hard ceilings, and walls shall be fire resistant. Seal duct penetrations with an incombustible material.

F. Provide sleeve seals for sleeves located in foundation walls below grade or in exterior walls.

G. Provide unions at each threaded or soldered connection to all equipment, tanks and valves.

H. Provide insulating couplings or flanges at connections of piping with dissimilar materials. Construct couplings so that the two pipes being connected are completely insulated from each other with no metal to metal contact. Heavily line the couplings with a hard, insulating, phenolic threaded coupling in standard pipe sizes.

I. Flanges:

Type of Pipe	Flanges
Screwed black or galvanized steel pipeline, 2-1/2 inches and larger.	125 lb. cast iron screwed steel flange flat faced, black or galvanized.
Welded steel pipe, 2-1/2 inches and larger for all services	150 lb. forged steel welding flanges, 1/16 inch raised faced.

J. Provide full faced or ring type gasket material to suit facing on flanges and material carried in pipe.

K. Gauges shall be in compliance with Marsh Quality, with an accuracy to be within 1 percent in the middle third of the dial range and equipped with front calibration. Gauge movements shall be phosphor bronze, bushed, rotary type. Gauges mounted on panel boards shall be the flush mounting type in cast iron or aluminum cases. Stem or pipe mounted gauges shall have non flanged cases of drawn or stamped steel, phenolic, or aluminum. Gauges shall have a minimum dial size of 3-1/2 inches.

L. Insulate any/all plumbing where condensation may form on the plumbing exterior to prevent such condensation.

2.02 PIPELINE STRAINERS:

A. Provide Y type strainers, full line size of connecting piping, with ends matching piping system materials and cast iron body. Select strainers for 125 psi working pressure, with type 304 stainless steel screens and gasket seal on plug. Provide 3/64 inch perforations at 233 per square inch.

B. Strainer screens shall have an open area equal to at least twice the cross sectional area of the pipe in which they are installed.

C. End styles:

1. Threaded ends, 2 inches and smaller: Cast iron body, screwed screen retainer with centered blowdown fitted with pipe plug.

2. Threaded ends, 2-1/2 inches and larger: Cast iron body, bolted screen retainer with off center blowdown fitted with pipe plug.

3. Flanged ends, 2-1/2 inches and larger: Cast iron body, bolted screen retainer with off center blowdown fitted with pipe plug.

4. Buttwelded ends, 2-1/2 inches and larger: Schedule 40 cast carbon steel body, bolted screen retainer with off center blowdown fitted with pipe plug.

2.03 FABRICATION

A. Drip pans: Provide drip pans fabricated from corrosion resistant sheet metal with watertight joints and with edges turned up 2-1/2 inches. Extend drain pans 4 inches beyond pipes or equipment on all sides. Reinforce top, either by structural angles or by

rolling top over 1/4 inch steel rod. Provide hole, gasket, and flange at low point for watertight joint and 1 inch drain line connection.

PART 3 - EXECUTION

3.01 GENERAL

A. Provide unions at each threaded or soldered connection to all equipment, tanks and valves.

B. Provide flanges at each flanged connection to equipment, tanks, and valves.

C. Provide dielectric unions at all locations described herein.

D. Installation of piping specialties:

1. Pipe escutcheons: Install pipe escutcheons on each pipe penetration through finish floors, walls, partitions, and ceilings where penetration is exposed to view and on exterior of building. Secure escutcheon to pipe or insulation so escutcheon covers penetration hole and is flush with adjoining surface.

2. Sleeves: Secure sleeves to metal or wood forms in such a manner that they will not become displaced during pouring of concrete. Fill sleeves on deck with sand. After forms have been removed from concrete, the sleeves shall be removed from the openings.

3. Core drill properly sized holes in the concrete to replace metal sleeves that are crushed or knocked out of position during pouring of concrete. Coordinate core drilling with structural engineer.

4. Sleeve seals: Install in accordance with the following:

   a. Mastic and oakum: Fill and pack annular space between sleeve opening and pipe with oakum; caulk with mastic on both sides.

   b. Mechanical sleeve seals: Loosely assemble rubber links around pipe with bolts and pressure plates located under each bolt head and nut. Push into sleeve opening and center. Tighten bolts until links have expanded to form watertight seal.

E. Installation of Y-type strainers:

1. Install Y-type strainers full size of pipeline in accordance with manufacturer's installation instructions. Install pipe nipple and shutoff valve in strainer blow down connection, full size of connection, except for strainers 2 inches and smaller installed ahead of control valves feeding individual terminals. Provide drain line from shutoff valve to plumbing drain, full size of blowdown connection.

2. Locate Y-type strainers in supply line ahead of the following equipment, if integral strainer is not included in equipment:

a. Pumps.

b. Temperature control valves.

c. Pressure reducing valves.

d. Temperature or pressure regulating valves.

F. Installation of unions and flanges: Install unions and flanges so that piping can be easily disconnected for removal of tanks, equipment, and valves. Provide three unions at each three way valve.

G. Installation of electric heat tape: Installation shall conform to manufacturers printed instructions.

H. Installation of fabricated piping specialties:

1. Drip pans: Hang from structure with rods and building attachments, weld rods to sides of drip pan. Brace to prevent sagging or swaying. Connect 1 inch drain line to drain connection, and run to nearest plumbing drain. Provide drain if none nearby or are not safely accessible.

   a. Locate drip pans under piping passing over or within 3 feet horizontally of electrical equipment.

   b. Provide drip pans under storm, waste and vent piping in space above food preparation areas.

END OF SECTION

SECTION 22 05 29

HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.01 SUMMARY

A. Types of supports and anchors specified in this section include the following:

1. Horizontal-piping hangers and supports.
2. Vertical-piping clamps.
3. Hanger-rod attachments.
4. Building attachments.
5. Saddles and shields.
6. Spring hangers and supports.
7. Miscellaneous materials.
8. Anchors.
9. Equipment bases.
10. Seismic Restraint of piping, and equipment.

B. Volume 1 - Contracting Requirements, and Division - 01 General Requirements apply to the Work of this Section.

1.02 SYSTEM DESCRIPTION

A. Supports, anchorage and restraints for all piping shall be in accordance with a State pre-approved system such as SMACNA "Seismic Restraint Manual - Guidelines for Seismic Restraints of Mechanical Systems", Mason, or equal. System shall have a current ‘OPA’ number and shall meet the requirements of the authority having jurisdiction. Contractor shall provide all supporting documentation required by the reviewing authority. For SMACNA, use seismic hazard level "A".

B. In lieu of the above or for non-standard installations not covered in the above pre-approved systems, Contractor shall provide detail supports, attachments and restraints, and furnish supporting calculations and legible details with a stamp by a California registered structural engineer, in accordance with California Building Code Volume 2, Chapter 16. Use Seismic Zone 4 unless noted or approved otherwise.

C. Support all piping so that it is firmly held in place by approved hangers and supports and special hangers as required. All components shall support the 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. Do not support piping or ductwork with plumbers tape, wire, rope, wood, or other makeshift devices.

D. Structural considerations:

1. Steel or concrete roof/floor system including slabs or roof deck shall be in place and complete before installation of any mechanical piping system.

2. Space hangers so maximum individual hanger load will not exceed values listed in paragraph "pipe hanger loading".

3. Do not attach hangers to steel roof deck.

4. Attach hangers to beams whenever possible.

E. Provide epoxy plate, electroplate or galvanized finish for all material used for support of piping.

F. Provide a bracing system analysis which has been designed and signed by a California registered structural engineer and approved by DSA, if required.

1.03 ACTION SUBMITTALS

A. No action submittals are necessary.

1.04 INFORMATIONAL SUBMITTALS

A. Submit under provisions of Section 01 33 00.

B. Submittals for review during construction document phase:

1. Catalog cuts, specifications, installation instructions, and dimensioned drawings for each type of support, anchor, and seal.

2. Submit pipe hanger and support schedule showing manufacturer's figure number, size, location, and features for each required pipe hanger and support.

3. Details and calculations for all non-preapproved seismic restraints and anchoring.

C. Submittals for review during construction phase:

1. Field modifications to any support or anchorage details approved during working drawing phase.

D. Submittals for closeout:

1. Submit all warranties signed by the manufacturer.

2. Provide all special tools, loose gauges and test kits and maintenance and calibration instructions.

1.05 QUALITY ASSURANCE

A. Manufacturers: Firms regularly engaged in manufacture of supports, anchors, and seals of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. UL and FM compliance: Provide products which are Underwriters' laboratories listed and Factory Mutual approved.

C. Design and performance requirements:

1. Provide pipe hangers and supports of which materials, design, and manufacture comply with ANSI/MSS SP-58.

2. Provide pipe hangers and supports, complying with MSS SP-69.

3. Provide pipe hangers and supports, complying with MSS SP-89.

4. Terminology used in this Section is defined in MSS SP-90.

5. Provide hangers and supports in conformance with SMACNA Standards, latest edition.

PART 2 - PRODUCTS

2.01 HORIZONTAL PIPING HANGERS AND SUPPORTS

A. General: Provide factory-fabricated horizontal-piping hangers and supports complying with ANSI/MSS SP-58, of one of the following MSS types listed, selected by Contractor to suit horizontal-piping systems, in accordance with MSS-SP-69 and manufacturer's published product information.

B. Use only one type by one manufacturer for each piping service.

C. Select size of hangers and supports to exactly fit pipe size for bare piping, and to exactly fit around piping insulation with saddle or shield for insulated piping.

D. Use felt-lined J hangers for installation at copper piping as follows.

1. Adjustable steel clevises: MSS Type 1.

2. Adjustable J hanger: MSS Type 5.

3. Split pipe rings: MSS Type 11.

4. Clips: MSS Type 26.

5. Single pipe rolls: MSS Type 41.

6. Adjustable roller hangers: MSS Type 43.

E. Isolate copper tubing from ferrous materials and hangers with two thicknesses of 1 inch wide 10 mil polyvinyl tape, spiral-wrapped around pipe. Total width shall be minimum of 3 inches.

2.02 HANGER RODS AND ATTACHMENTS

A. General: Provide factory-fabricated hanger-rods and attachments complying with ANSI/MSS SP-58, of one of the following MSS types listed, selected by Contractor to suit horizontal- piping hangers and building attachments, in accordance with MSS SP-69 and manufacturer's published product information. Use only one type by one manufacturer for each piping service. Select size of hanger-rod attachments to suit hanger rods. Provide lock nuts at all threaded connections.

1. Steel turnbuckles: MSS Type 13.

2. Swivel turnbuckles: MSS Type 15.

3. Steel weldless Eye Nuts: MSS Type 7.

B. Pipe hanger rod size:

Pipe Size	Rod Size
2 inches and smaller	3/8 inches.
2-1/2 inches to 3-1/2 inches	1/2 inches.
4 inches to 5 inches	5/8 inches.
6 inches	3/4 inches.
8 inches to 12 inches	7/8 inches.

C. Trapeze suspension: 1-5/8 inches width channel in accordance with manufacturer's published load ratings.

1. Trapeze supporting rods shall have a safety factory of five; securely anchor to building structure.

2. Isolate copper pipe with two thicknesses of 2 Inches wide 10 mil polyvinyl tape, 3 inches wide.

2.03 BUILDING ATTACHMENTS

1. Steel structure:

a. Top beam C-clamps: MSS Type 19.

b. Center beam clamps: MSS Type 21.

c. Welded attachments: MSS Type 22.

d. Malleable C-clamps: MSS Type 23.

e. Malleable beam clamps: MSS Type 30.

2. Provide retaining straps for all single sided beam clamps and C-clamps.

3. Concrete structure: Do not use powder actuated fasteners for support of overhead piping unless approved by Structural Engineer of Record.

a. Concrete insert: B-Line B3014

b. Spot inserts: B-Line B2505

c. Equipment anchor bolt: B-Line B3022

d. Metal deck ceiling bolt: B-Line B3019

e. Light duty spot inserts: B-Line B2500

2.04 SADDLES AND SHIELDS

A. General: Provide saddles or shields under piping hangers and supports, factory-fabricated, for all insulated piping. Size saddles and shields for exact fit to mate with pipe insulation.

1. Protection saddles: Fill interior voids with segments of insulation matching adjoining insulation.

2. Thermal hanger shields: Constructed of 360-degree insert of high density, 100 psi, water resistant calcium silicate, encased in 360-degree sheet metal shield. Provide assembly of same thickness as adjoining insulation.

2.05 SPRING HANGERS AND SUPPORTS

A. General: Provide factory-fabricated spring hangers and supports complying with Part 3 - Chapter G, Design Requirements Mechanical Noise and Vibration Control.

2.06 VERTICAL PIPING CLAMPS

A. General: Provide factory-fabricated vertical- piping clamps complying with ANSI/MSS SP-58 selected by Contractor to suit vertical piping systems, in accordance with MSS SP-69 and manufacturer's published product information. Select size of vertical piping clamps to exactly fit pipe size of bare pipe. Provide copper-plated clamps for copper-piping systems.

B. Two-bolt riser clamps: PHD, B-Line B3373 - MSS Type 8. Support vertical piping risers securely to the pipe above each floor slab, with the arms of the clamp resting on the slab or the structural supports.

C. Support pipe lines passing up through the building at each floor of the building. Bolt riser clamps securely to the floor slab.

2.07 MISCELLANEOUS MATERIALS

A. Metal framing: Provide products complying with NEMA Standard ML1.

B. Steel plates, shapes and bars: Provide products complying with ANSI/ASTM A36.

C. Cement grout: Portland cement (ANSI/ASTM C150, Type I or Type III) and clean, uniformly graded, natural sand (ANSI/ASTM C404, Size No. 2). Mix at a ratio of 1.0 part cement to 3.0 parts sand, by volume, with minimum amount of water required for placement and hydration.

D. Heavy duty steel trapezes: Fabricate from steel shapes selected for loads required; weld steel in accordance with AWS standards.

E. Pipe guides: Provide factory-fabricated guides, of cast semi-steel or heavy fabricated steel, consisting of a bolted two-section outer cylinder and base with a two-section guiding spider bolted tight to pipe. Size guide and spiders to clear pipe and insulation, (if any), and cylinder. Provide guides of length recommended by manufacturer to allow required travel.

2.08 SEISMIC RESTRAINT

A. Typical exclusions for Compliance with this requirement are:

1. Gas piping less than 1 inch inside diameter.

2. Piping in mechanical rooms less than 1.25 inches inside diameter.

3. All other piping less than 2 ½ inches inside diameter (does not apply to fire sprinkler piping).

4. All piping suspended by individual hangers 12 inches or less in length from the top of the pipe to the bottom of the support of the hanger.

5. All electrical conduit (included in Division 26) less than 2½ inches diameter.

6. All rectangular air-handling ducts less than six square feet in cross sectional area.

7. All round air handling ducts less than 28 inches in diameter.

8. All ducts suspended by individual hangers 12 inches or less in length from the top of the pipe to the bottom of the support of the hanger.

B. Seismic restraint: Brace all piping of the following systems and sizes laterally every 40 feet and simultaneously laterally and longitudinally every 80 feet except as noted otherwise within this Specification and California Building Code (CBC), within 5 feet of any change of direction.

PART 3 - EXECUTION

3.01 GENERAL

A. Install building attachments at required locations within concrete or on structural steel for proper piping support. Install additional building attachments where support is required for additional concentrated loads, including valves, flanges, guides, strainers, expansion joints, and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten insert securely to forms. Where concrete with compressive strength less than 2500 psi is utilized, install reinforcing bars through openings at top of inserts.

B. Install hangers, supports, clamps and attachments to support piping properly from building structure; comply with MSS SP-69. Arrange for grouping of parallel runs of horizontal piping to be supported together on trapeze-type hangers where possible. Where piping of various sizes is to be supported together by trapeze hangers, space hangers for smallest pipe size or install intermediate supports for smaller diameter pipe. Do not support piping from other piping. Install seismic restraints in accordance with SMACNA.

C. Locate hangers at each change of direction, within one foot of elbow, and space it according to California Building Code (CBC) requirements.

D. Support fire protection system piping independently of other piping.

E. Prevent electrolysis in support of copper tubing by use of hanger, and supports which are copper plated, or by other recognized industry methods.

F. Install hangers and supports to allow controlled movement of piping systems and to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends and similar units.

G. Install hangers and supports so that piping live and dead loading and stresses from movement will not be transmitted to connected equipment.

H. Install hangers and supports to provide indicated pipe slopes, and so that maximum pipe deflections allowed by ANSI B31 are not exceeded.

I. Insulate piping to comply with the following installation requirements.

   1. Clamps: Attach clamps, including spacers (if any), to piping with clamps projecting through insulation; do not exceed pipe stresses allowed by ANSI B31.

2. Shields: Where low-compressive-strength insulation or vapor barriers are utilized on cold and chilled water piping, install thermal hanger shields. For pipe 8 inches and over, install metal insulation saddles.

J. Saddles: Where insulation without vapor barrier is utilized, install protection saddles.

K. Install anchors at proper locations to prevent stresses from exceeding those permitted by ANSI B31, and to prevent transfer of loading and stresses to connected equipment.

L. Fabricate and install anchor by welding steel shapes, plates, and bars to piping and to structure. Comply with ANSI B31 and with AWS standards.

M. Where expansion compensators are utilized, install anchors in accordance with expansion unit manufacturer's written instructions, to limit movement of piping and forces to maximums recommended by manufacturer for each unit.

END OF SECTION

SECTION 22 13 16

SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

1.01 SUMMARY

A. Type of plumbing systems specified in this section include the following:

1. Sanitary waste and vent piping.

2. Condensate drain piping.

B. Volume 1 - Contracting Requirements, and Division - 01 General Requirements apply to the Work of this Section.

1.02 ACTION SUBMITTALS

A. No action submittals necessary.

1.03 INFORMATIONAL SUBMITTALS

A. Submit under provisions of Section 01 33 00.

B. Submittals for review during construction document phase:

1. Product data for specified products.

C. Submittals for closeout:

1. Record drawings: At project closeout, submit record drawings of installed piping systems.

2. Submit all warranties signed by the manufacturer.

3. Provide all special tools, loose gauges and test kits and maintenance and calibration instructions.

1.04 QUALITY ASSURANCE

A. Manufacturer's qualifications: Firms regularly engaged in manufacture of plumbing piping 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. Requirements of regulatory agencies: The publications listed below are a part of this Specification; comply with provisions of these publications except as otherwise specified.

1. Plumbing code compliance: Comply with applicable portions of latest California Plumbing Code pertaining to selection and installation of plumbing materials and products.

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 required.

B. Below ground sanitary waste and vent piping:

1. Schedule 40 PVC pipe and DWV solvent cement fittings.

C. Above ground sanitary waste and vent piping: Hubless cast iron soil pipe and fittings. Joints shall be made with FM No. 1680 approved, Class 1 rated couplings as manufactured by Anaco Husky, Clamp All, Mission Heavyweight, or equal.

1. Pumped discharge pipe and vent piping above the floor: Type L copper tube and pressure rated fittings.

D. Perforated underdrain pipe: "J M" PVC perforated underdrain pipe, swedge and solvent weld joints with matching fittings. Provide transition fittings for connection to non-perforated subsurface drainage piping.

E. Condensate drain: Provide Type L hard drawn copper tubing with wrought copper solder joint fittings.

PART 3 - EXECUTION

3.01 GENERAL

A. Installation of sanitary systems:

1. Make joints in PVC sewer pipe with PVC-type couplings and rubber rings.

2. Check final location of rubber rings within the couplings with gauge or as recommended by the manufacturer. Make joints between PVC pipe and cast iron pipe or fittings using cast iron adapter fittings, installed as recommended by the manufacturer. Provide thrust blocks or anchors as needed.

3. Ring-Tite cast iron pipe fittings may be used in lieu of standard fittings.

4. Sewer piping: Install horizontal sanitary drainage piping above and below grade with 2% slope. Sizes 4” and larger may be installed at 1% where approved.

5. Hubless cast iron joints: Comply with coupling manufacturer's installation instructions.

6. Insulate all sanitary waste and vent piping where condensation may occur.

3.02 QUALITY CONTROL

A. Test each piece of equipment to show that it will operate in accordance with indicated requirements.

B. Repair or replace broken, damaged, or otherwise defective parts, materials, and work. Leave entire work in condition satisfactory to State.

C. 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.

END OF SECTION

SECTION 22 13 19

SANITARY WASTE PIPING SPECIALTIES

PART 1 - GENERAL

1.01 SUMMARY

A. Type of plumbing systems specified in this section include the following:

1. Cleanouts.
2. Floor drains.
3. Indirect waste drains.

B. Volume 1 - Contracting Requirements, and Division - 01 General Requirements apply to the Work of this Section.

1.02 ACTION SUBMITTALS

A. No action submittals necessary.

1.03 INFORMATIONAL SUBMITTALS

A. Submit under provisions of Section 01 33 00.

B. Submittals for review during construction document phase:

1. Product data for specified products.

C. Submittals for closeout:

1. Record drawings: At project closeout, submit record drawings of installed piping systems.
2. Maintenance data: Submit maintenance data and parts lists for plumbing piping systems materials and products. Include this data, product data, shop drawings, and record drawings in maintenance manual.
3. Submit all warranties signed by the manufacturer.
4. Provide all special tools, loose gauges and test kits and maintenance and calibration instructions.

1.04 QUALITY ASSURANCE

A. Manufacturer's qualifications: Firms regularly engaged in manufacture of plumbing piping 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. Requirements of regulatory agencies: The publications listed below for a part of this Specification; comply with provisions of these publications except as otherwise specified.

   1. Plumbing code compliance: Comply with applicable portions of latest California Plumbing Code pertaining to selection and installation of plumbing materials and products.

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 required.

2.02 CLEANOUTS:

A. Cleanouts in floor and in concrete sidewalks: Ducco cast iron with brushed chrome or stainless steel top, clamping collar and ABS plastic plug with square or round top to suit floor construction.

B. Cleanouts in concealed locations shall be furnished with above ground cast-iron soil or waste lines with raised head ABS Plastic plug.

C. Cleanouts in walls shall be furnished with stainless steel cover. Provide long sweep elbow or combination wye at connection to riser.

D. Cleanouts exterior to building in landscaped areas 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.

E. Cleanouts in drive areas: Furnish with heavy duty top stainless steel or brushed chrome traffic-rated cover.

2.03 FLOOR DRAINS:

A. Provide floor drains of size and type as required, including features as specified herein. Provide flashing ring and clamp at floors with water resistant membrane. Set top of drain slightly below floor to insure drainage. Install vented P-trap below each drain. Where drain does not receive a continuous waste stream, install trap primer connection in the P-trap.

2.04 INDIRECT WASTE DRAINS:

A. Hopper drains: Cast iron body and funnel with strainer. Install behind access panel.

B. Fixed air gap: Coated cast iron with slip joint inlet and No-Hub outlet.

C. 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. Install floor sinks flush with finished floor, unless required otherwise by local code. Insulate underside of floor sinks where surface condensation may occur.

PART 3 - EXECUTION

3.01 GENERAL

A. Installation of sanitary drainage systems:

1. Make joints in PVC sewer pipe with PVC-type couplings and rubber rings.

2. Check final location of rubber rings within the couplings with gauge or as recommended by the manufacturer. Make joints between PVC pipe and cast iron pipe or fittings using cast iron adapter fittings, installed as recommended by the manufacturer. Provide thrust blocks or anchors as needed.

3. Ring-Tite cast iron pipe fittings may be used in lieu of standard fittings.

4. Install horizontal drainage piping above and below grade with 2% slope. Sizes 4” and larger may be installed at 1% where approved.Hubless cast iron joints: Comply with coupling manufacturer's installation instructions.

3.02 QUALITY CONTROL

A. Repair or replace broken, damaged, or otherwise defective parts, materials, and work. Leave entire work in condition satisfactory to State.

B. 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.

C. Tests and Inspections:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.

2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.03 PROTECTION

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

B. Place plugs in ends of uncompleted piping at end of each day or when work stops

END OF SECTION

SECTION 22 14 13

STORM DRAINAGE PIPING

PART 1 - GENERAL

1.01 SUMMARY

A. Type of plumbing systems specified in this section include the following:

1. Pipe, tube and fittings.

2. Specialty pipe fittings.

3. Encasement for underground metal piping.

B. Volume 1 - Contracting Requirements, and Division - 01 General Requirements apply to the Work of this Section.

1.02 ACTION SUBMITTALS

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

1.03 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Certificates: For storm drainage piping, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

2. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

B. Submittals for review with system confirmation:

1. Product data for specified products.

C. Submittals for closeout:

1. Record drawings: At project closeout, submit record drawings of installed piping systems.

1.04 QUALITY ASSURANCE

A. Manufacturer's qualifications: Firms regularly engaged in manufacture of plumbing piping system products, of types, materials, and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Requirements of regulatory agencies: The publications listed below are a part of this Specification; comply with provisions of these publications except as otherwise specified.

   1. Plumbing code compliance: Comply with applicable portions of latest California Plumbing Code pertaining to selection and installation of plumbing materials and products.

C. Comply with NSF/ANSI 14, "Plastics Piping System Components and Related Materials," for plastic piping components. Include marking with "NSF-drain" for plastic drain piping and "NSF-sewer" for plastic sewer piping.

D. Piping materials shall bear label, stamp, or other markings of specified testing agency.

PART 2 - PRODUCTS

2.01 PRODUCTS

A. MATERIALS AND PRODUCTS: Provide piping materials and factory-fabricated piping products of sizes, types, pressure ratings, temperature ratings, and capacities as required.

   1. Below ground rainwater systems piping:

      a. Schedule 40 PVC pipe and DWV solvent cement fittings

   2. Above ground rainwater systems piping: Hubless cast iron soil pipe and fittings. Joints shall be made with FM No. 1680 approved, Class 1 rated couplings as manufactured by Anaco Husky, Clamp All, Mission Heavyweight, or equal.

      a. In coastal environment storm drain pipe extending above grade to intercept exposed roof downspout shall be Schedule 80 DMV solid core pipe with painted finish.

   3. Pumped discharge pipe and vent piping above the floor: Type L copper tube and pressure rated fittings.

   4.

   5. Steel-Pipe Pressure Fittings:

      a. Galvanized-Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M or ASTM A 106/A 106M, Schedule 40, seamless steel pipe. Include ends matching joining method.

b. Fittings in first subparagraph below are available in NPS 1/8 to NPS 4 (DN 6 to DN 100).

c. Malleable-Iron Unions: ASME B16.39; Class 150; hexagonal-stock body with ball-and-socket, metal-to-metal, bronze seating surface; and female threaded ends.

6. Cast-Iron, Hubless-Piping Couplings:

7. Husky 2000.Cast-Iron Flanges: ASME B16.1, Class 125.

a. Flange Gasket Materials: ASME B16.21, full-face, flat, nonmetallic, asbestos-free, 1/8-inch (3.2-mm) maximum thickness unless thickness or specific material is indicated.

b. Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

PART 3 - EXECUTION

3.01 GENERAL

A. Installation of storm drainage systems:

1. Check final location of rubber rings within the couplings with gauge or as recommended by the manufacturer. Make joints between PVC pipe and cast iron pipe or fittings using cast iron adapter fittings, installed as recommended by the manufacturer. Provide thrust blocks or anchors as needed.

2. Ring-Tite cast iron pipe fittings may be used in lieu of standard fittings.

3. Install horizontal storm drainage piping above and below grade with 2% slope. Sizes 4” and larger may be installed at 1% where approved.Hubless cast iron joints: Comply with coupling manufacturer's installation instructions.

3.02 QUALITY CONTROL

A. During installation, notify inspector or authorities having jurisdiction if necessary at least 24 hours before inspection must be made. Perform tests specified below in presence of Engineer or authorities having jurisdiction if necessary.

1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in.

2. Final Inspection: Arrange for final inspection by Inspector or authorities having jurisdiction if necessary to observe tests specified below and to ensure compliance with requirements.

B. Re-inspection: If inspector or authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for re-inspection.

C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

D. Test storm drainage piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.

2. Leave uncovered and unconcealed new, altered, extended, or replaced storm drainage piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.

3. Test Procedure: Test storm drainage piping on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water (30 kPa). From 15 minutes before inspection starts until completion of inspection, water level must not drop. Inspect joints for leaks.

4. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.

5. Prepare reports for tests and required corrective action.

E. Test force-main piping according to procedures of related standard or, in absence of published procedures, as follows:

1. Leave uncovered and unconcealed new, altered, extended, or replaced force-main piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.

2. Cap and subject piping to static-water pressure of 50 psig (345 kPa) above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for 15mins. Leaks and loss in test pressure constitute defects that must be repaired.

3. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.

4. Prepare reports for tests and required corrective action.

3.03 CLEANING

A. Clean interior of piping. Remove dirt and debris as work progresses.

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

C. Place plugs in ends of uncompleted piping at end of day and when work stops.

END OF SECTION

SECTION 22 34 00

DOMESTIC WATER HEATERS

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes: Types of plumbing equipment include the following:

1. Gas/Electric water heaters.

2. Tankless water heater.

B. Coordination with other Divisions:

1. Division 01 – General Requirements, for commissioning

2. Division 26 - Electrical, for power wiring.

C. Volume 1 - Contracting Requirements, and Division - 01 General Requirements apply to the Work of this Section.

1.02 ACTION SUBMITTALS

A. No action submittals are necessary.

1.03 INFORMATIONAL SUBMITTALS

A. Submit under provisions of Section 01 33 00.

B. Submittals for review during construction document phase:

1. Product data for specified products.

C. Submittals for closeout: Submit maintenance data and parts list for each item of plumbing equipment. Include troubleshooting maintenance guides.

1. Submit all warranties signed by the manufacturer.

2. Provide all special tools, loose gauges and test kits and maintenance and calibration instructions.

1.04 QUALITY ASSURANCE

A. Regulatory requirements:

1. California Energy Commission compliance: Provide written confirmation of listing of all water heaters in the directory of certified water heaters, latest edition.

2. ASME code symbol stamps indicating compliance with ASME boiler and pressure vessel code for construction.

1.05 WARRANTY

A. Special warranty: All storage type water heaters shall be warranted for a period of not less than five years. Water to water exchanger and storage tank shall be furnished with a minimum 10-year warranty.

PART 2 - PRODUCTS

2.01 GENERAL

A. Commercial, High-Efficiency, Gas Water Heaters:

1. Comply with ANSI Z21.10.3/CSA 4.3.

2. Storage-Tank Construction: ASME-code steel.

3. Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.

4. Lining: Cement, Glass, Nickel plate, Phenolic coating or Sheet copper complying with NSF 61 barrier materials for potable-water tank linings, including extending lining into and through tank fittings and outlets.

5. Factory-Installed, Storage-Tank Appurtenances:

a. Anode Rod: Replaceable magnesium.

1) Locate water heater so that nothing blocks the anode in case of replacement. Provide 12 inches or more of space between water heater (Anode side) and other obstruction such like walls, pipes, ducts and etc.

b. Dip Tube: Provide unless cold-water inlet is near bottom of tank.

c. Drain Valve: Corrosion-resistant metal complying with ASSE 1005.

d. Insulation: Comply with ASHRAE/IESNA 90.1. Surround entire storage tank except connections and controls.

e. Jacket: Steel with enameled finish.

f. Combination Temperature and Pressure Relief Valves: ANSI Z21.22/CSA 4.4. Include one or more relief valves with total relieving capacity at least as great as

heat input, and include pressure setting less than water heater working-pressure rating. Select one relief valve with sensing element that extends into storage tank.

6. Burner or Heat Exchanger: Comply with UL 795 or approved testing agency requirements for high-efficiency water heaters and for natural-gas fuel.

7. Temperature Control: Adjustable thermostat.

8. Safety Controls: Automatic, high-temperature-limit and low-water cutoff devices or systems.

B. Commercial electric water heaters:

1. General: Comply with current California Energy Commission, Appliance Efficiency Regulations. Provide UL listing, and NSF approval.

2. Heater: Working pressure of 150 psi, magnesium anode rod; glass lining on internal surfaces exposed to water.

3. Heating elements: Heavy-duty, medium watt density, with incoloy sheath, thermostat stepped through magnetic contactors.

4. Safety controls: Double-pole, manual-reset, high-limit, probe type electric water flow cutoff; both factory wired.

C. Instantaneous water heaters: Cabinet mounted stainless steel electric heating style, flow switch activated, UL listed, 150 psi rated.

D. Tankless Water Heater

a. Manufacturers: Subject to compliance with requirements,

b. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings.

c. Standard: ANSI Z21.10.3/CSA 4.3 for gas-fired, instantaneous, domestic-water heaters for indoor application.

d. Construction: Copper piping or tubing complying with NSF 61 barrier materials for potable water, without storage capacity.

1) Tappings: ASME B1.20.1 pipe thread.

2) Pressure Rating: 150 psig (1035 kPa).

3) Heat Exchanger: Copper tubing.

4) Insulation: Comply with ASHRAE/IESNA 90.1.

5) Jacket: Metal, with enameled finish, or plastic.

e. Support: Bracket for wall mounting.

E. Storage tank and heat exchanger packaged water heater:

1. Construction: Self-contained, packaged, factory assembled, factory pre-insulated, storage type packaged water heater. Construct storage section with carbon steel plate, stamped in accordance with ASME Code for working pressure of 150 psig. Unit shall be factory mounted on steel skids, and shall be registered by National Board Registration.

2. Lining: Protect interior of tanks, including manhole cover with factory lining approved by independent laboratory to be suitable for both acidic and alkaline conditions to impart no taste or discoloration to the water and to be entirely non-toxic.

3. Heat exchanger: Provide water-to-water heat exchanger as part of the water heater.

4. Internal circulation: Provide in-line, all bronze circulator arranged to pump stored water continuously through the heating and storage section at the rate established by the water heater manufacturer for the service specified.

5. Temperature control:

   a. Provide diverting valve at heat exchanger heating section to regulate outlet water temperature on the domestic side.

F. Diaphragm-type expansion tanks:

1. Construct tank of welded steel, constructed, tested, and stamped in accordance with Section VIII of ASME Boiler and Pressure Vessel Code.

   a. Tanks shall be IAPMO approved and listed for use with domestic water systems.

PART 3 - EXECUTION

3.01 GENERAL

A. Installation of hot water heaters:

1. Install water heaters in accordance with manufacturer's installation instructions and in compliance with applicable codes.

2. Furnish wiring diagrams (for electric water heaters).

3. Connect hot and cold water piping to units with shutoff valves and dielectric unions. Connect drain and relief piping.

4. Start-up, test, and adjust water heaters in accordance with manufacturer's start-up instructions. Check and calibrate controls.

5. Domestic hot water supply temperature shall be generated at 140˚F, and shall be capable of tempered water to at least 121˚F using a three-way mixing valve, before supplying to all plumbing fixtures. Circulation systems shall be included. Recirculation pipe with pumps shall be employed to keep hot water in branches from cooling down when system is on low use and to eliminate water waste. Hot water shall be available at the furthest fixture from the heating source within 15 seconds of the time of operation. Hot water return piping shall be sized for a maximum velocity of 3 feet per second.

3.02 QUALITY CONTROL

A. Training:

1. Provide sufficient training and orientation to State's maintenance staff in proper care and operation of all plumbing equipment.

2. Training shall conform to the requirements of section 01 79 00 Demonstration and Training. Training shall be scheduled with at least 5 working day notice and shall occur during the workweek, Tuesday through Thursday, between the hours of 9:00 am and 2:00 pm. All training shall be coordinated with facility staff. The system shall be fully installed with all parts and components confirmed prior to training request being submitted.

B. Care and cleaning: Repair or replace broken, damaged, or otherwise defective parts, materials, and work. Leave entire work in condition satisfactory to State. 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.

C. Operation test: Test each piece of equipment to show that it will operate in accordance with indicated requirements.

END OF SECTION

SECTION 22 40 00

PLUMBING FIXTURES

PART 1 - GENERAL

1.01 SUMMARY

A. This Section includes the following conventional plumbing fixtures and related components:

1. Faucets for lavatories showers and sinks.
2. Laminar-flow faucet-spout outlets.
3. Flushometers.
4. Toilet seats.
5. Protective shielding guards.
6. Fixture supports.
7. Disposers.
8. Water closets.
9. Urinals.
10. Lavatories.
11. Kitchen sinks.
12. Service sinks.

B. Volume 1 - Contracting Requirements, and Division - 01 General Requirements apply to the Work of this Section.

1.02 DEFINITIONS

A. Accessible Fixture: Plumbing fixture that can be approached, entered, and used by people with disabilities.

B. Fitting: Device that controls the flow of water into or out of the plumbing fixture. Fittings specified in this Section include supplies and stops, faucets and spouts, shower heads and tub spouts, drains and tailpieces, and traps and waste pipes. Piping and general-duty valves are included where indicated.

1.03 ACTION SUBMITTALS

A. Submit under provisions of Section 01 33 00.

B. Product Data: For each type of plumbing fixture indicated. Include selected fixture and trim, fittings, accessories, appliances, appurtenances, equipment, and supports. Indicate materials and finishes, dimensions, construction details, and flow-control rates.

1.04 INFORMATIONAL SUBMITTALS

A. Submit under provisions of Section 01 33 00.

B. LEED Submittal:

1. Product Data for Credit WE 2, 3.1, and 3.2: Documentation indicating flow and water consumption requirements.

C. Shop Drawings: Floor plans, schematic drawings, legends and standard details.

D. Operation and Maintenance Data: For plumbing fixtures to include in emergency, operation, and maintenance manuals.

E. Warranty: Special warranty specified in this Section.

1.05 QUALITY ASSURANCE

A. Source Limitations: Obtain plumbing fixtures, faucets, and other components of each category through one source from a single manufacturer.

1. Exception: If fixtures, faucets, or other components are not available from a single manufacturer, obtain similar products from other manufacturers specified for that category.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in California Electrical Code, Article 100, by a testing agency acceptable to the State, and marked for intended use.

C. Regulatory Requirements: Comply with requirements in latest California Building Code for plumbing fixtures for people with disabilities.

D. Regulatory Requirements: Comply with requirements in Public Law 102-486, "Energy Policy Act," about water flow and consumption rates for plumbing fixtures.

E. Regulatory Requirements: Comply with requirements in latest CalGreen for plumbing fixtures.

F. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.

G. Select combinations of fixtures and trim, faucets, fittings, and other components that are compatible.

H. Comply with the following applicable standards and other requirements specified for plumbing fixtures:

1. Enameled, Cast-Iron Fixtures: ASME A112.19.1M.

2. Stainless-Steel Commercial, Handwash Sinks: NSF 2 construction.

3. Stainless-Steel Sinks: ASME A112.19.3.

4. Vitreous-China Fixtures: ASME A112.19.2M.

5. Water-Closet, Flush Valve, Tank Trim: ASME A112.19.5.

6. Water-Closet, Flushometer Tank Trim: ASSE 1037.

I. Comply with the following applicable standards and other requirements specified for lavatory and sink faucets:

1. Backflow Protection Devices for Faucets with Hose-Thread Outlet: ASME A112.18.3M.

2. Faucets: ASME A112.18.1.

3. Hose-Connection Vacuum Breakers: ASSE 1011.

4. Hose-Coupling Threads: ASME B1.20.7.

5. Integral, Atmospheric Vacuum Breakers: ASSE 1001.

6. NSF Potable-Water Materials: NSF 61.

7. Pipe Threads: ASME B1.20.1.

8. Sensor-Actuated Faucets and Electrical Devices: UL 1951.

9. Supply Fittings: ASME A112.18.1.

10. Brass Waste Fittings: ASME A112.18.2.

J. Comply with the following applicable standards and other requirements specified for shower faucets:

1. Backflow Protection Devices for Hand-Held Showers: ASME A112.18.3M.

2. Combination, Pressure-Equalizing and Thermostatic-Control Antiscald Faucets: ASSE 1016.

3. Faucets: ASME A112.18.1.

4. Hand-Held Showers: ASSE 1014.

5. High-Temperature-Limit Controls for Thermal-Shock-Preventing Devices: ASTM F 445.

6. Hose-Coupling Threads: ASME B1.20.7.

7. Manual-Control Antiscald Faucets: ASTM F 444.

8. Pipe Threads: ASME B1.20.1.

9. Pressure-Equalizing-Control Antiscald Faucets: ASTM F 444 and ASSE 1016.

10. Sensor-Actuated Faucets and hard-wired electrical devices: UL 1951.

11. Thermostatic-Control Antiscald Faucets: ASTM F 444 and ASSE 1016.

K. Comply with the following applicable standards and other requirements specified for miscellaneous fittings:

1. Atmospheric Vacuum Breakers: ASSE 1001.

2. Brass and Copper Supplies: ASME A112.18.1.

3. Manual-Operation Flushometers: ASSE 1037.

4. Brass Waste Fittings: ASME A112.18.2.

5. Sensor-Operation Flushometers: ASSE 1037 and hard wired electrical devices UL 1951.

L. Comply with the following applicable standards and other requirements specified for miscellaneous components:

1. Disposers: ASSE 1008 and UL 430.

2. Flexible Water Connectors: ASME A112.18.6.

3. Hose-Coupling Threads: ASME B1.20.7.

4. Off-Floor Fixture Supports: ASME A112.6.1M.

5. Pipe Threads: ASME B1.20.1.

6. Plastic Toilet Seats: ANSI Z124.5.

7. Supply and Drain Protective Shielding Guards: California Building Code.

1.06 WARRANTY

A. Special Warranties: Provide 1-Year manufacturer's warranty in which manufacturer agrees to repair or replace components of whirlpools that fail in materials or workmanship.

1. Failures include, but are not limited to, the following:

a. Structural failures of unit shell.

b. Faulty operation of controls, blowers, pumps, heaters, and timers.

c. Deterioration of metals, metal finishes, and other materials beyond normal use.

PART 2 - PRODUCTS

2.01 LAVATORY FAUCETS

A. Lavatory Faucets, LF-1:

1. Products: Subject to compliance with requirements, provide one of the following:

a. Sloan Valve Company; ETF-610.

b. Zurn Plumbing Products Group; Commercial Brass Operation.

c. Or equal.

2. Description: Single-control valve. Coordinate faucet inlets with supplies and fixture holes; coordinate outlet with spout and fixture receptor.

a. Body Material: Commercial, solid brass.

b. Finish: Polished chrome plate.

c. Maximum Flow Rate: 0.5 gpm.

d. Centers: 4 inches.

e. Mounting: Deck, exposed.

f. Valve Handle(s): Not applicable.

g. Inlet(s): NPS 3/8 tubing, plain end.

h. Spout: Rigid type.

i. Spout Outlet: Aerator.

j. Operation: Hard wired, electric sensor actuator.

k. Drain: Grid.

l. Tempering Device: Below Deck Thermostatic

B. Lavatory Faucets, LF-2:

1. Products: Subject to compliance with requirements, provide one of the following:

a. Chicago Faucets; 50-317CP.

b. Moen, Inc.

c. Or equal.

2. Description: Combination faucet without spray. Include hot and cold water indicators; coordinate faucet inlets with supplies and fixture holes; coordinate outlet with spout and fixture receptor.

a. Body Material: Commercial, solid brass.

b. Finish: Polished chrome plate.

c. Maximum Flow Rate: 2.2 gpm, unless otherwise indicated.

d. Mixing Valve: Two Lever handles.

e. Centers: Single Hole.

f. Mounting: Deck.

g. Handle(s): 4” Wristblade, accessible.

h. Inlet(s): NPS 3/8 plain-end tubing.

i. Spout Type: Gooseneck Swing/Rigid, solid brass.

j. Spout Outlet: Aerator.

k. Operation: Noncompression, manual.

l. Drain: Not required.

2.02 SHOWER FAUCETS

A. Shower Faucets, SH-1:

1. Products: Subject to compliance with requirements, provide one of the following:

a. Symmons Industries, Inc.; 25-500-B30-V

b. Chicago Faucets.

c. Or equal.

2. Description: Single-handle accessible, pressure-balance valve. Include hot- and cold-water indicators; check stops; and shower head, arm, and flange. Coordinate faucet inlets with supplies and outlet with diverter valve.

   a. Body Material: Solid brass with nonmetallic trim.

   b. Finish: Polished chrome plate.

   c. Maximum Flow Rate: 1.5 gpm, unless otherwise indicated.

   d. Diverter Valve: Not integral with mixing valve.

   e. Mounting: Concealed.

   f. Backflow Protection Device for Hand-Held Shower: Required.

   g. Operation: Noncompression, manual.

   h. Antiscald Device: Integral with mixing valve.

   i. Check Stops: Check-valve type, integral with or attached to body; on hot- and cold-water supply connections.

   j. Supply Connections: NPS 1/2.

   k. Shower Head Type: Ball joint and head integral with mounting flange and hand held, slide-bar mounted.

   l. Shower Head Material: Combined, metallic and nonmetallic with chrome-plated finish.

   m. Spray Pattern: Adjustable.

   n. Integral Volume Control: Required.

   o. Shower-Arm Flow-Control Fitting: Not required.

   p. Temperature Indicator: Not required.

2.03 SINK FAUCETS

A. Sink Faucets, SF-1:

1. Products: Subject to compliance with requirements, provide one of the following:

   a. Chicago Faucets; 1100-GN8AE3-317CP.

   b. Moen, Inc.

c. Or equal.

2. Description: 8-1/2” gooseneck Kitchen faucet without spray. Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture holes; coordinate outlet with spout and fixture receptor.

   a. Body Material: Commercial, solid brass.

   b. Finish: Polished chrome plate.

   c. Maximum Flow Rate: 2.2 gpm, unless otherwise indicated.

   d. Mixing Valve: Two Lever handles.

   e. Centers: 8 inches.

   f. Mounting: Deck, exposed.

   g. Handle(s): 4” Wristblade, accessible.

   h. Inlet(s): NPS 3/8 plain-end tubing.

   i. Spout Type: 8-1/2” Gooseneck Swinging, solid brass.

   j. Spout Outlet: Aerator.

   k. Operation: Noncompression, manual.

   l. Drain: Not required.

B. Sink Faucets, SF-2:

1. Products: Subject to compliance with requirements, provide one of the following:

   a. Chicago Faucets; 895-317GN2ACP.

   b. Moen, Inc.

   c. Or equal.

2. Description: Kitchen faucet without spray. Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture holes; coordinate outlet with spout and fixture receptor.

   a. Body Material: Commercial, solid brass.

   b. Finish: Polished chrome plate.

   c. Maximum Flow Rate: 2.2 gpm, unless otherwise indicated.

   d. Mixing Valve: Two Lever handles.

e. Centers: 4 inches.

f. Mounting: Deck, exposed.

g. Handle(s): 4” Wristblade, accessible.

h. Inlet(s): NPS 3/8 plain-end tubing.

i. Spout Type: Gooseneck Swinging, solid brass.

j. Spout Outlet: Aerator.

k. Operation: Noncompression, manual.

l. Drain: Not required.

C. Sink Faucets, SF-3:

1. Products: Subject to compliance with requirements, provide one of the following:

a. Chicago Faucets; 897-RCF.

b. Moen, Inc.

c. Or equal.

2. Description: Service sink faucet with stops in shanks, vacuum breaker, hose-thread outlet, and pail hook. Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture holes; coordinate outlet with spout and fixture receptor.

a. Body Material: Commercial, solid brass.

b. Finish: Rough Chrome Plated.

c. Maximum Flow Rate: 2.2 gpm, unless otherwise indicated.

d. Mixing Valve: Two-lever handle.

e. Centers: Adjustable.

f. Mounting: Back/wall, exposed.

g. Handle(s): Lever, accessible.

h. Inlet(s): NPS 1/2 female shank.

i. Spout Type: Rigid, solid brass, wall brace, pail hook.

j. Spout Outlet: Hose thread.

k. Vacuum Breaker: Required.

l. Operation: Non-compression, manual.

m. Drain: Not required.

D. Sink Faucets, SF-4:

1. Products: Subject to compliance with requirements, provide one of the following:

a. American Standard; 8340-234

b. Chicago Faucets.

c. Kohler.

d. Or equal.

2. Description: Service sink faucet with stops in shanks, vacuum breaker, hose-thread outlet, and pail hook. Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture holes; coordinate outlet with spout and fixture receptor.

a. Body Material: Commercial, solid brass.

b. Finish: Rough Chrome Plated.

c. Maximum Flow Rate: 2.2 gpm, unless otherwise indicated.

d. Mixing Valve: Two-lever handle.

e. Centers: 8 inches.

f. Mounting: Back/wall, exposed.

g. Handle(s): Lever.

h. Inlet(s): NPS 1/2 female shank.

i. Spout Type: Rigid, solid brass, pail hook.

j. Spout Outlet: Hose thread.

k. Vacuum Breaker: Required.

l. Operation: Noncompression, manual.

m. Drain: Not required.

2.04 FLUSHOMETERS

A. Flushometers, FV-1:

1. Products: Subject to compliance with requirements, provide one of the following:

a. Sloan Valve Company; Wes-113.

b. Zurn Plumbing Products Group; Commercial Brass Operation.

c. Or equal.

2. Description: Flushometer for water-closet-type fixture. Include brass body with corrosion-resistant internal components, non-hold-open feature, control stop with check valve, vacuum breaker, copper or brass tubing, and polished chrome-plated finish on exposed parts.

a. Internal Design: Diaphragm operation.

b. Style: Exposed.

c. Inlet Size: NPS 1.

d. Trip Mechanism: Dual-flush, oscillating, lever-handle actuator, accessible.

e. Consumption: 1.1 gal/flush and 1.28 gal./flush.

f. Tailpiece Size: NPS 1-1/2 and standard length to top of bowl.

B. Flushometers, FV-2:

1. Products: Subject to compliance with requirements, provide one of the following:

a. Sloan Valve Company; ECOS-111.

b. Zurn Plumbing Products Group; Commercial Brass Operation.

c. Or equal.

2. Description: Flushometer for water-closet-type fixture. Include brass body with corrosion-resistant internal components, sensor operated, control stop with check valve, vacuum breaker, copper or brass tubing, and polished chrome-plated finish on exposed parts.

a. Internal Design: Diaphragm operation.

b. Style: Exposed.

c. Inlet Size: NPS 1.

d. Trip Mechanism: Hard wired, electric sensor actuator.

e. Consumption: 1.28 gal./flush.

f. Tailpiece Size: NPS 1-1/2 and standard length to top of bowl.

C. Flushometers, FV-3 (Urinals):

1. Products: Subject to compliance with requirements, provide one of the following:

    a. Sloan Valve Company; ECOS 186. .

    b. Zurn Plumbing Products Group; Commercial Brass Operation.

    c. Or equal.

2. Description: Flushometer for urinal-type fixture. Include brass body with corrosion-resistant internal components, non-hold-open feature, control stop with check valve, vacuum breaker, copper or brass tubing, and polished chrome-plated finish on exposed parts.

    a. Internal Design: Diaphragm operation.

    b. Style: Exposed.

    c. Inlet Size: NPS 3/4.

    d. Trip Mechanism: Hard wired, electric sensor actuator.

    e. Consumption: 0.125 gal./flush.

    f. Tailpiece Size: NPS 3/4 and standard length to top of bowl.

D. Flushometers, FV-4:

1. Products: Subject to compliance with requirements, provide one of the following:

    a. Bradley Corporation; 7905 or current similar product.

    b. Acorn Engineering;

    c. Or equal.

2. Description: Flushometer for detention-type fixture. Include cast bronze body with corrosion-resistant internal components, non-hold-open feature, control stop with check valve, vacuum breaker, copper or brass tubing, and polished chrome-plated finish on exposed parts.

    a. Style: Exposed with Stainless Steel Box cover.

    b. Trip Mechanism: Push button.

2.05 TOILET SEATS

A. Toilet Seats, TS-1:

1. Products: Subject to compliance with requirements, provide one of the following:

    a. American Standard; 5910 110.

b. Bemis Manufacturing Company; 1955 SSC.

c. Church Seats; 9500 SSC.

d. Or equal.

2. Description: Toilet seat for water-closet-type fixture.

a. Material: Molded, solid plastic.

b. Configuration: Open front without cover.

c. Size: Elongated.

d. Hinge Type: SC, self-sustaining, check.

e. Class: Heavy-duty commercial.

f. Color: White.

2.06 PROTECTIVE SHIELDING GUARDS

A. Protective Shielding Pipe Covers, PSG-1:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Plumberex Specialty Products Inc.

b. TRUEBRO, Inc.

c. Or equal.

2. Description: Manufactured plastic wraps for covering plumbing fixture hot-water supply and trap and drain piping. Comply with Americans with Disabilities Act (ADA) requirements.

2.07 FIXTURE SUPPORTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. MIFAB Manufacturing Inc.

2. Smith, Jay R. Mfg. Co.

3. Or equal.

B. Water-Closet Supports, WCS-1:

1. Description: Combination carrier designed for accessible and standard mounting height of wall-mounting, water-closet-type fixture. Include single or double, vertical or horizontal, hub-and-spigot or hubless waste fitting as required for piping arrangement; faceplates; couplings with gaskets; feet; and fixture bolts and hardware matching fixture. Include additional extension coupling, faceplate, and feet for installation in wide pipe space.

2. MIFAB Manufacturing MC-13.

C. Urinal Supports, URS-1 (Where Required):

1. Description: Type I, urinal carrier with fixture support plates and coupling with seal and fixture bolts and hardware matching fixture for wall-mounting, urinal-type fixture. Include steel uprights with feet.

2. Accessible-Fixture Support: Include rectangular steel uprights.

3. MIFAB Manufacturing MC-30 Series.

D. Lavatory Supports, LS-1 (Where Required):

1. Description: Type II, lavatory carrier with concealed arms and tie rod for wall-mounting, lavatory-type fixture. Include steel uprights with feet.

E. Accessible-Fixture Support: Include rectangular steel uprights.

1. Description: Floor mounted concealed arm lavatory carrier with lacquered, adjustable, ductile iron concealed support arms, Complete with lacquered cast iron invertible and adjustable arm supporting brackets, adjustable steel nipples with locknut and set screws, Used to support off-the-floor fixtures so that the vertical load bearing components are concealed within the wall the fixture carrier has no contact with finished floor inside the room.

2. MIFAB Manufacturing MC- 41 series.

2.08 DISPOSERS

A. Disposers, GD-1:

1. Product: Subject to compliance with requirements, provide one of the following:

a. In-Sink-Erator Evolution Series –Evolution Compact Co.

2. Description: ACCESSIBLE (ADA) COMPLIANT. Continuous Feed, food-waste disposer. Include manual reset button; wall switch; stainless steel chamber with stainless-steel grinder or shredder; Drain Connection NPS 1-1/2 outlet; quick-mounting, stainless-steel sink flange; and combination cover/stopper.

a. Type: Continuous Feed.

b. Model: Evolution Series.

c. Capacity: 35 oz.

d. Motor: 120-V ac, 1725 rpm, 3/4 hp with overload protection.

2.09 WATER CLOSETS

A. Water Closets, WC-1:

1. Products: Subject to compliance with requirements, provide the following:

   a. American Standard Companies, Inc.; AFWALL 3351.160. or current similar product

   b. Kohler Co.

   c. Or equal.

2. All products to be provided by a single manufacturer.

3. Description: Standard height, wall-mounting, back-outlet, vitreous-china fixture designed for flushometer valve operation.

   a. Style: Flushometer valve.

      1) Bowl Type: Elongated with siphon-jet design.

      2) Design Consumption: per latest edition of California Green Building Standards Code (CalGreen).

      3) Color: White.

   b. Flushometer: FV-1 or FV-2.

   c. Toilet Seat: TS-1.

   d. Fixture Support: Water-closet support WCS-1 combination carrier.

B. Water Closets, WC-2:

1. Products: Subject to compliance with requirements, provide one of the following:

   a. Bradley Co; WC7249FM or current similar product.

   b. Acorn Engineering.

   c. Or equal.

2. Description: Accessible (ADA Compliant), wall-mounted, back-outlet, Stainless Steel Type 304 welded construction (Detention Quality).

   a. Style: Flushometer valve.

1) Bowl Type: Elongated with siphon-jet design.

2) Design Consumption: per latest edition of CalGreen

3) Standard: ASSE 1037

4) Minimum Pressure Rating: 125 psig

5) Actuator: Solenoid complying with UL 1951, and listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

6) Trip Mechanism: Hard-wired electronic sensor complying with UL 1951, and listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

7) Color: Bead Blasted.

8) Remote flush control required.

b. Flushometer: FV-4.

c. Toilet Seat: Integral.

2.10 URINALS

A. Urinals, UR-1:

1. Products: Subject to compliance with requirements, one of the following:

   a. American Standard Companies, Inc.

   b. Kohler Co.

   c. Or equal.

2. Description: Accessible, wall-mounting, back-outlet, vitreous-china fixture designed for flushometer valve operation.

   a. Type: Washout with extended shields.

   b. Strainer or Trapway: Open trapway with integral trap.

   c. Design Consumption: per latest edition of CalGreen.

   d. Color: White.

   e. Supply Spud Size: NPS 3/4.

   f. Outlet Size: NPTF 2.

g. Flushometer: FV-3.

h. Fixture Support: Urinal URS-1 chair carrier.

2.11 LAVATORIES

A. Lavatories: L-1:

1. Products: Subject to compliance with requirements, provide one of the following:

a. American Standard Companies, Inc.; Ovalyn Universal 9482-000.

b. Kohler Co.

c. Or equal.

2. Description: Under-counter-mounting, vitreous-china fixture.

a. Type: Under counter.

b. Size: 19 by 16 inches.

c. Color: White.

d. Faucet: Lavatory LF-1.

e. Supplies: NPS 3/8 chrome-plated copper with stops.

f. Drain: Grid.

1) Location: Near back of bowl.

g. Drain Piping: NPS 1-1/4 by NPS 1-1/2 chrome-plated, cast-brass P-trap; NPS 1-1/2, 0.032-inch- thick tubular brass waste to wall; and wall escutcheon.

h. Protective Shielding Guard(s): PSC-1.

B. Lavatories, L-2:

1. Products: Subject to compliance with requirements, provide one of the following:

a. American Standard Companies, Inc.; Wheelchair Users 9140047.

b. Kohler Co.

c. Or equal.

2. Description: Accessible, wall-mounting, vitreous-china fixture.

a. Type: Shelf back.

b. Size: 27 by 20 inches rectangular.

c. Faucet Hole Punching: Center Hole Single.

d. Faucet Hole Location: Top.

e. Color: White.

f. Faucet: Lavatory LF-2.

g. Supplies: NPS 3/8 chrome-plated copper with stops.

h. Drain: Grid.

1) Location: Near back of bowl.

i. Drain Piping: NPS 1-1/4 by NPS 1-1/2 chrome-plated, cast-brass P-trap; NPS 1-1/2, 0.032-inch- thick tubular brass waste to wall; and wall escutcheon.

j. Protective Shielding Guard(s): PSG-1.

k. Fixture Support: Lavatory LS-1.

C. Lavatory, L-3:

1. Products: Subject to compliance with requirements, provide the following:

a. Acorn Engineering; Penal-Ware 1652-FALRB-ADA-1-DMS.

b. Sloan Valve Company; EHS-1000.

c. Or equal.

2. Description: Rectangular bowl, detention quality, accessible, wall-mounted, stainless-steel Type 304 lavatory. Removable access panel.

a. Overall Dimensions: 18 inches wide by 20 inches deep.

b. Metal Thickness: 14 gauge.

c. Bowl:

1) Dimensions: 14 inches long by 12 inches wide by 4-1/2 inches deep.

2) Deck mounted spout.

d. Finish: Satin.

e. Sink Faucet: Time-trol Single Temp.

f. Supplies: NPS 1/2.

g. Drain Piping: NPS 1-1/2.

2.12 SINKS

A. Sink, S-1:

1. Products: Subject to compliance with requirements, provide the following:

   a. Elkay Manufacturing Co.; LRAD250.

   b. Just Manufacturing Company.

   c. Or equal.

2. Description: ACCESSIBLE (ADA) COMPLIANT. Two-bowl, residential, accessible, stainless-steel kitchen sink.

   a. Metal Thickness: 0.050 inch.

   b. Left Bowl:

      1) Drain: 3-1/2-inch outlet for disposer.

         a) Location: Near back of bowl.

   c. Right Bowl:

      1) Drain: 3-1/2-inch crumb cup.

         a) Location: Near back of bowl.

   d. Sink Faucet: SF-1.

   e. Supplies: NPS 1/2 chrome-plated copper with stops.

   f. Drain Piping: NPS 1-1/2 chrome-plated, cast-brass P-trap; 0.045-inch- thick tubular brass waste to wall; and wall escutcheon(s).

   g. Disposer: GD-1.

   h. Hot-Water Dispenser: Insinkerator Model C1300.

B. Sink, S-2:

1. Products: Subject to compliance with requirements, provide the following:

   a. Elkay Manufacturing Co.; LRAD 1517.

   b. Just Manufacturing Company.

   c. Or equal.

2. Description: (ACCESSIBLE (ADA) COMPLIANT) One-bowl, residential, accessible, stainless-steel sink.

    a. Metal Thickness: 0.050 inch.

    b. Bowl:

        1) Drain: 3-1/2-inch crumb cup.

            a) Location: Near back of bowl.

    c. Sink Faucet: SF-2.

    d. Supplies: NPS 1/2 chrome-plated copper with stops.

    e. Drain Piping: NPS 1-1/2 chrome-plated, cast-brass P-trap; 0.045-inch- thick tubular brass waste to wall; and wall escutcheon(s).

    f. Disposer: Not required.

    g. Dishwasher Air-Gap Fitting: Not required.

    h. Hot-Water Dispenser: Not required

2.13 SERVICE BASINS

A. Service Basins, SB-1:

1. Products: Subject to compliance with requirements, provide the following:

    a. Florestone Products Co., Inc.; Model 96.

    b. Stern-Williams Co., Inc., CRS-2200.

    c. Or equal.

2. Description: Flush-to-wall, floor-mounting, precast terrazzo fixture with rim guard.

    a. Shape: Radial front.

    b. Size: Subject to product selected.

    c. Height: 12 inches with dropped front.

    d. Tiling Flange: On two sides.

    e. Rim Guard: Stainless steel on all top edges.

    f. Color: Not applicable.

    g. Faucet: Sink SF-3.

h. Drain: Chrome flat strainer, grid with NPS 3 outlet.

B. Service Sink, SS-1:

1. Products: Subject to compliance with requirements, provide the following:

a. American Standard Inc.; Akron 7695.008.

b. Kohler.

c. Or equal.

2. Description: Enameled cast iron, pedestal-mounting, with rim guard.

a. Shape: Radial front.

b. Size: 24 inches by 20 inches x 12 inch deep.

c. Height: 42 inches.

d. Rim Guard: Stainless steel on top edge.

e. Color: White.

f. Faucet: Sink SF-4.

g. Drain: Cast iron “P” trap to wall and strainer for 3” iron pipe.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before plumbing fixture installation.

B. Examine cabinets, counters, floors, and walls for suitable conditions where fixtures will be installed.

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

3.02 INSTALLATION

A. Assemble plumbing fixtures, trim, fittings, and other components according to manufacturers' written instructions.

B. Install off-floor supports, affixed to building substrate, for wall-mounting fixtures.

1. Use carrier supports with waste fitting and seal for back-outlet fixtures.

2. Use carrier supports without waste fitting for fixtures with tubular waste piping.

3. Use chair-type carrier supports with rectangular steel uprights for accessible fixtures.

C. Install back-outlet, wall-mounting fixtures onto waste fitting seals and attach to supports.

D. Install floor-mounting fixtures on closet flanges or other attachments to piping or building substrate.

E. Install wall-mounting fixtures with tubular waste piping attached to supports.

F. Install floor-mounting, back-outlet water closets attached to building floor substrate and wall bracket and onto waste fitting seals.

G. Install counter-mounting fixtures in and attached to casework.

H. Install fixtures level and plumb according to roughing-in drawings.

I. Install water-supply piping with stop on each supply to each fixture to be connected to water distribution piping. Attach supplies to supports or substrate within pipe spaces behind fixtures. Install stops in locations where they can be easily reached for operation.

1. Exception: Use ball, gate, or globe valves if supply stops are not specified with fixture.

J. Install trap and tubular waste piping on drain outlet of each fixture to be directly connected to sanitary drainage system.

K. Install tubular waste piping on drain outlet of each fixture to be indirectly connected to drainage system.

L. Install flushometer valves for accessible water closets and urinals with handle mounted on wide side of compartment. Install other actuators in locations that are easy for people with disabilities to reach.

M. Install tanks for accessible, tank-type water closets with lever handle mounted on wide side of compartment.

N. Install toilet seats on water closets.

O. Install trap-seal liquid in dry urinals.

P. Install faucet-spout fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.

Q. Install water-supply flow-control fittings with specified flow rates in fixture supplies at stop valves.

R. Install faucet flow-control fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.

S. Install shower flow-control fittings with specified maximum flow rates in shower arms.

T. Install traps on fixture outlets.

1. Exception: Omit trap on fixtures with integral traps.

2. Exception: Omit trap on indirect wastes, unless otherwise indicated.

U. Install disposer in outlet of each sink indicated to have disposer. Install switch where indicated or in wall adjacent to sink if location is not indicated.

V. Install hot water dispensers in back top surface of sink or in countertop with spout over sink.

W. Install escutcheons at piping wall ceiling penetrations in exposed, finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding fittings. Escutcheons are specified in Division 22 Section "Common Work Results for Plumbing."

X. Set shower receptors and service basins in leveling bed of cement grout.

Y. Seal joints between fixtures and walls, floors, and countertops using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color.

3.03 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 Sections.

B. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.

3.04 FIELD QUALITY CONTROL

A. Verify that installed plumbing fixtures are categories and types specified for locations where installed.

B. Check that plumbing fixtures are complete with trim, faucets, fittings, and other specified components.

C. Inspect installed plumbing fixtures for damage. Replace damaged fixtures and components.

D. Test installed fixtures after water systems are pressurized for proper operation. Replace malfunctioning fixtures and components, then retest. Repeat procedure until units operate properly.

3.05 ADJUSTING

A. Operate and adjust faucets and controls. Replace damaged and malfunctioning fixtures, fittings, and controls.

B. Adjust water pressure at faucets and flushometer valves to produce proper flow and stream.

C. Replace washers and seals of leaking and dripping faucets and stops.

3.06 CLEANING

A. Clean fixtures, faucets, and other fittings with manufacturers' recommended cleaning methods and materials. Do the following:

1. Remove faucet spouts and strainers, remove sediment and debris, and reinstall strainers and spouts.

2. Remove sediment and debris from drains.

B. After completing installation of exposed, factory-finished fixtures, faucets, and fittings, inspect exposed finishes and repair damaged finishes.

3.07 PROTECTION

A. Provide protective covering for installed fixtures and fittings.

B. Do not allow use of plumbing fixtures for temporary facilities unless approved in writing by the State.

END OF SECTION

SECTION 22 45 00

EMERGENCY PLUMBING FIXTURES

PART 1 - GENERAL

1.01 SUMMARY

A. This Section includes the following emergency plumbing fixtures:

1. Eye/face wash equipment.
2. Combination units.
3. Water-tempering equipment.

B. Related Sections include the following:

1. Division 22 Section "Domestic Water Piping Specialties" for backflow preventers.
2. Division 22 Section "Sanitary Waste Piping Specialties" for floor drains.

C. Volume 1 - Contracting Requirements, and Division - 01 General Requirements apply to the Work of this Section.

1.02 DEFINITIONS

A. Accessible Fixture: Emergency plumbing fixture that can be approached, entered, and used by people with disabilities.

B. Plumbed Emergency Plumbing Fixture: Fixture with fixed, potable-water supply.

C. Tepid: Moderately warm.

1.03 ACTION SUBMITTALS

A. Submit under provisions of Sections 01 33 00.

B. Product Data: For each type of product indicated. Include flow rates and capacities, furnished specialties, and accessories.

1.04 INFORMATIONAL SUBMITTALS

A. Submit under provisions of Sections 01 33 00.

B. Field quality-control test reports.

C. Operation and Maintenance Data: For emergency plumbing fixtures to include in maintenance manuals.

1.05 QUALITY ASSURANCE

A. ANSI Standard: Comply with ANSI Z358.1, "Emergency Eyewash and Shower Equipment."

B. Regulatory Requirements: Comply with requirements in ICC A117.1, "Accessible and Usable Buildings and Facilities"; Public Law 90-480, "Architectural Barriers Act"; and Public Law 101-336, "Americans with Disabilities Act"; for plumbing fixtures for people with disabilities.

C. NSF/ANSI Standard: Comply with NSF/ANSI 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.

PART 2 - PRODUCTS

2.01 EYE/FACE WASH EQUIPMENT

A. Barrier-Free Units.

B. Eye/Face Wash Equipment (Wall Mounted):

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Guardian Equipment; GBF1724

   b. Haws Corporation.

   c. Bradley Corporation.

   d. Or approved equal.

2. Description: Barrier Free, wall mounted eye/face wash with stainless steel bowl and wall bracket, ½” U.S. made chrome plated brass stay open ball valve, powder coated cast aluminum flag handle. Unit shall have (4) polypropylene ‘GS Plus’ spray heads with integral “flip-top” dust covers, filters and 1.8-GPM flow control orifices mounted on a chrome plated brass eyewash assembly. Unit shall include ANSI compliant sign.

3. Provide thermostatic mixing valve to blend hot and cold water to deliver warm (tepid) water as required by ANSI Z358.1 (latest edition).

4. Unit shall be fully factory assembled and hydrostatically tested to meet or exceed ANSI Z358.1 (latest edition), and come with a full 2-year warranty.

C. Eye/Face Wash Equipment (Sink Deck Mounted):

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Guardian Equipment; GBF1849

    b. Haws Corporation.

    c. Bradley Corporation.

    d. Or approved equal.

2. Description: Deck mounted “AutoFlow” swivel eyewash less bowl with ½” IPS plug-type valve with Teflon coated O-ring seals. Supplied with in-line strainer to prevent debris from affecting the valve. Unit shall have (2) polypropylene ‘GS Plus’ spray heads with integral “flip-top” dust covers, filters and 1.8-GPM flow control orifices mounted on a chrome plated brass eyewash assembly. Determine head configuration during design. Activate valve by rotating 90° from stored position. Unit shall include ANSI compliant sign.

3. Provide thermostatic mixing valve to blend hot and cold water to deliver warm (tepid) water as required by ANSI Z358.1 (latest edition) and IAPMO IGC 179 (latest edition).

4. Unit shall be fully factory assembled and hydrostatically tested to meet or exceed ANSI Z358.1 (latest edition), and come with a full 2-year warranty.

2.02 COMBINATION UNITS

A. Emergency Eye/Face Wash and Shower Units:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Guardian Equipment; GBF1994.

    b. Haws Corporation.

    c. Bradley Corporation.

    d. Or approved equal.

2. Description: Barrier Free, all stainless steel construction, corrosion resistant, combination eye/face wash and shower safety station with stainless steel shower head, stainless steel bowl, stainless steel flag handle and floor flange, 1 ¼” IPS Schedule 40 stainless steel pipe and fittings, 1” IPS and ½” IPS U.S. made stainless steel stay open ball valves, and polished stainless steel pull rod. Unit shall have (4) polypropylene ‘GS Plus’ spray heads with integral “flip-top” dust covers, filters, and 1.8-GPM flow control orifices mounted on a stainless steel head assembly. Unit shall include ANSI compliant sign.

3. Provide thermostatic mixing valve to blend hot and cold water to deliver warm (tepid) water as required by ANSI Z358.1 (latest edition) and IAPMO IGC 179 (latest edition).

4. Unit shall be fully factory assembled and hydrostatically tested to meet or exceed ANSI Z358.1 (latest edition), and come with a full 2-year warranty.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine roughing-in for water and waste piping systems to verify actual locations of piping connections before plumbed emergency plumbing fixture installation.

   1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 EMERGENCY PLUMBING FIXTURE INSTALLATION

A. Assemble emergency plumbing fixture piping, fittings, control valves, and other components.

B. Install fixtures level and plumb.

C. Fasten fixtures to substrate.

D. Install dielectric fitting in supply piping to fixture if piping and fixture connections are made of different metals. Dielectric fittings are specified in Division 22 Section "Common Work Results for Plumbing."

E. Install thermometers in supply and outlet piping connections to water-tempering equipment.

A. Install escutcheons on piping wall and ceiling penetrations in exposed, finished locations.

B. Install equipment nameplates or equipment markers on fixtures and equipment signs on water-tempering equipment.

C. Emergency Eyewash Units: Locate spray outlet heads no more than 12" horizontal distance from the edge of the countertop, between 33" and 45" vertical distance from the surface on which the user stands and at least 6" from the wall or the nearest obstruction.

D. Emergency Showers: Pull rod handle shall not be higher than 69" from the surface on which the user stands. Showerhead shall be between 82" and 96" from the surface on which the user stands.

3.03 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 Sections.

B. Connect hot- and cold-water-supply piping to hot- and cold-water-tempering equipment. Connect output from water-tempering equipment to emergency plumbing fixtures.

C. Directly connect emergency plumbing fixture receptors (except deck mounted unit) with trapped drain outlet to sanitary drainage and vent piping

3.04 FIELD QUALITY CONTROL

A. Mechanical-Component Testing: After plumbing connections have been made, test for compliance with requirements. Verify ability to achieve indicated capacities and temperatures.

B. Repair or replace malfunctioning units. Retest as specified above after repairs or replacements are made.

C. Report test results in writing.

3.05 ADJUSTING

A. Adjust or replace fixture flow regulators for proper flow.

B. Adjust equipment temperature settings.

END OF SECTION

SECTION 22 47 00

WATER COOLERS

PART 1 - GENERAL

1.01 SUMMARY

A. This Section includes the following drinking fountains and water coolers and related components:

1. Pressure water coolers.

B. Volume 1 - Contracting Requirements, and Division - 01 General Requirements apply to the Work of this Section.

1.02 DEFINITIONS

A. Accessible Water Cooler: Fixture with nozzles for delivering stream of water for drinking that can be approached and used by people with disabilities.

B. Fitting: Device that controls flow of water into or out of fixture.

C. Water Cooler: Electrically powered fixture for generating and delivering cooled drinking water.

1.03 ACTION SUBMITTALS

A. No action submittals are necessary.

1.04 INFORMATIONAL SUBMITTALS

A. Submit under provisions of Section 01 33 00.

B. Product Data: For each fixture indicated. Include rated capacities, furnished specialties, and accessories.

C. Shop Drawings: Diagram power, signal, and control wiring.

D. Field quality-control test reports.

E. Operation and Maintenance Data: For fixtures to include in emergency, operation, and maintenance manuals.

1.05 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in California Electrical Code, Article 100, by a testing agency acceptable to the State, and marked for intended use.

B. Regulatory Requirements: Comply with requirements in latest California Building Code for fixtures for people with disabilities.

C. NSF/ANSI Standard: Comply with NSF/ANSI 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.

D. ARI Standard: Comply with ARI's "Directory of Certified Drinking Water Coolers" for style classifications.

E. ARI Standard: Comply with ARI 1010, "Self-Contained, Mechanically Refrigerated Drinking-Water Coolers," for water coolers and with ARI's "Directory of Certified Drinking Water Coolers" for type and style classifications.

F. ASHRAE Standard: Comply with ANSI/ASHRAE 34, "Designation and Safety Classification of Refrigerants," for water coolers. Provide HFC 134a (tetrafluoroethane) refrigerant, unless otherwise indicated.

PART 2 - PRODUCTS

2.01 PRESSURE WATER COOLERS

A. Water Cooler, EWC-1 (Area Office Building):

1. Products: Subject to compliance with requirements, provide the following:

    a. Haws Corporation, H1119.8.

    b. Elkay Manufacturing Co.

    c. Or equal.

2. Description: Barrier free wall mounted, pressure with bubblers, Hi-Lo water cooler.

    a. Material: 18 gauge, Type 304, Stainless Steel, with satin finish.

    b. Receptor Shape: Round.

    c. Bubbler: One, with adjustable stream regulator, located on each deck.

    d. Control: Push button.

    e. Supply: NPS 3/8 with ball, gate, or globe valve.

f. Filter: One or more water filters complying with NSF/ANSI 42 (latest edition) and NSF/ANSI 53 (latest edition) for cyst and lead reduction to below EPA standards; with capacity sized for unit peak flow rate. Factory installed.

g. Drain: Grid with NPS 1-1/4 minimum horizontal waste and trap complying with ASME A112.18.2 (latest edition).

h. Cooling System: Electric, with hermetically sealed compressor, cooling coil, air-cooled condensing unit, corrosion-resistant tubing, refrigerant, corrosion-resistant-metal storage tank, and adjustable thermostat.

1) Capacity: 8 gph of 50 deg F cooled water from 80 deg F inlet water and 90 deg F ambient air temperature.

2) Electrical Characteristics; 120-V ac; single phase; 60 Hz.

i. Product is compliant to California Health and Safety Code 116875 (AB 1953-2006).

j. Support: Mounting frame or brackets for attaching to substrate.

k. Ventilation Grille: Stainless steel, located below fountain.

l. Equipped with water bottle fill station.

B. Water Cooler, EWC-2 (Auto Service Area):

1. Products: Subject to compliance with requirements, provide the following:

a. Haws Corporation.

b. Elkay Manufacturing Co.

c. Or equal.

2. Description: Pressure with bubbler, surface-mounted, Hi-Lo water cooler.

a. Material: 18 gauge, Type 304, Stainless Steel, with satin finish basin.

b. Powder-coated skirt.

c. Bubbler: One, with adjustable stream regulator.

d. Control: Push pads.

e. Supply: NPS 3/8 with ball, gate, or globe valve.

f. Filter: One water filter complying with NSF/ANSI 42 and NSF/ANSI 53 for cyst and lead reduction to below EPA standards; with capacity sized for unit peak flow rate. Factory installed.

g. Drain: Grid with NPS 1-1/4 minimum horizontal waste and trap complying with ASME A112.18.2.

h. Cooling System: Electric, with hermetically sealed compressor, cooling coil, air-cooled condensing unit, corrosion-resistant tubing, refrigerant, corrosion-resistant-metal storage tank, and adjustable thermostat.

1) Capacity: 8 gph of 50 deg F cooled water from 80 deg F inlet water and 90 deg F ambient air temperature.

2) Electrical Characteristics; 120-V ac; single phase; 60 Hz.

i. Support: Mounting frame or brackets for attaching to substrate.

j. Ventilation Grille: Integral with skirt.

k. Equipped with water bottle fill station.

C. Bottle Filling Station, BFS-1

1. Products: Subject to compliance with requirements, provide the following:

a. Halsey Taylor.

b. Elkay Manufacturing Co.

c. Or equal.

2. Description: Bottle filling Station Surface Mount.

a. Filter certified to NSF 42 and 53 for lead, particulate, chlorine, taste, and odor reduction. 3000 gallon capacity.

b. Non-Refrigerated Stainless.

c. Electrical: 115V/60Hz, Full Load Amps 1.0, 15 Watts.

d. No Bubbler

e. Activation: Electronic Bottle Filler Sensor.

f. Approximate Weight: 35 lbs

g. Approximate Dimensions (L x W x H): 17” x 8” x 25”

h. Indoor Installation.

D. Certified: UL 399, ADA Compliant, NSF/ANSI 61 and 372

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine roughing-in for water and waste piping systems to verify actual locations of piping connections before fixture installation. Verify that sizes and locations of piping and types of supports match those indicated.

B. Examine walls and floors for suitable conditions where fixtures are to be installed.

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

3.02 APPLICATIONS

A. Use carrier off-floor supports for wall-mounting fixtures, unless otherwise indicated.

B. Use mounting frames for recessed water coolers, unless otherwise indicated.

C. Use chrome-plated brass or copper tube, fittings, and valves in locations exposed to view. Plain copper tube, fittings, and valves may be used in concealed locations.

3.03 INSTALLATION

A. Install off-floor supports affixed to building substrate and attach wall-mounting fixtures, unless otherwise indicated.

B. Install mounting frames affixed to building construction and attach recessed water coolers to mounting frames, unless otherwise indicated.

C. Install fixtures level and plumb. For fixtures indicated for children, install at height required by the State.

D. Install water-supply piping with shutoff valve on supply to each fixture to be connected to water distribution piping. Use ball, gate, or globe valve. Install valves in locations where they can be easily reached for operation.

E. Install trap and waste piping on drain outlet of each fixture to be connected to sanitary drainage system.

F. Install pipe escutcheons at wall penetrations in exposed, finished locations. Use deep-pattern escutcheons where required to conceal protruding pipe fittings.

G. Seal joints between fixtures and walls and floors using sanitary-type, one-part, mildew-resistant, silicone sealant. Match sealant color to fixture color.

3.04 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.

3.05 FIELD QUALITY CONTROL

A. Water Cooler Testing: After electrical circuitry has been energized, test for compliance with requirements. Test and adjust controls and safeties.

1. Remove and replace malfunctioning units and retest as specified above.

2. Report test results in writing.

3.06 ADJUSTING

A. Adjust fixture flow regulators for proper flow and stream height.

B. Adjust water cooler temperature settings.

3.07 CLEANING

A. After completing fixture installation, inspect unit. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish.

B. Clean fixtures, on completion of installation, according to manufacturer's written instructions.

END OF SECTION

SECTION 23 05 19

METERS AND GAGES FOR HVAC PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Volume 1 - Contracting Requirements, and Division - 01 General Requirements apply to the Work of this Section.

1.02 SUMMARY

A. This Section includes meters and gages for mechanical systems and water meters installed outside the building.

B. See Division 1 Section 01 91 00 “General Commissioning Requirement” for building/system commissioning requirements.

C. Related Sections include the following:

1. Mechanical equipment Sections that specify meters and gages as part of factory-fabricated equipment.

D. Utility-Furnished Products: Water meters will be furnished to site, ready for installation.

1.03 ACTION SUBMITTALS

A. No action submittals are necessary.

1.04 INFORMATIONAL SUBMITTALS

A. Product Data: Include scale range, ratings, and calibrated performance curves for each meter, gage, fitting, specialty, and accessory specified.

B. Shop Drawings: Include schedule indicating manufacturer's number, scale range, fittings, and location for each meter and gage.

C. Product Certificates: Signed by manufacturers of meters and gages certifying accuracies under specified operating conditions and compliance with specified requirements.

D. Shop Drawings: For brackets for duct-mounting thermometers.

E. Maintenance Data: For meters and gages to include in maintenance manuals specified in Division 1. Include data for the following:

1. Flow-measuring systems.

2. Flowmeters.

3. Thermal-energy flowmeters.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Bimetal Dial Thermometers:

a. Reotemp Instrument Corp.

b. Trerice: H. O. Trerice Co.

c. Weiss Instruments, Inc.

d. Or approved equal.

2. Insertion Dial Thermometers:

a. Reotemp Instrument Corp.

b. Trerice: H. O. Trerice Co.

c. Weiss Instruments, Inc.

d. Or approved equal.

3. Pressure Gages:

a. Trerice: H. O. Trerice Co.

b. Weiss Instruments, Inc.

c. WIKA Instruments Corp.

d. Or approved equal.

4. Test Plugs:

a. Sisco Manufacturing Co.

b. Trerice: H. O. Trerice Co.

c. Watts Industries, Inc.; Water Products Div.

d. Or approved equal.

5. Turbine Flowmeters:

a. Emerson Electric Co.; Brooks Instrument Div.

b. Onicon, Inc.

c. SeaFlow, Inc.

d. Or approved equal.

6. Flow Indicators:

a. Emerson Electric Co.; Brooks Instrument Div.

b. McCrometer, Inc.

c. Penberthy, Inc.

d. Or approved equal.

2.02 THERMOMETERS, GENERAL

A. Scale Range: Temperature ranges for services listed are as follows:

1. Hot Water: 20 to 240 deg F, with 2-degree scale divisions.

B. Accuracy: Plus or minus 1 percent of range span or plus or minus one scale division to maximum of 1.5 percent of range span.

2.03 BIMETAL DIAL THERMOMETERS

A. Description: ASME B40.3; direct-mounting, universal-angle dial type.

B. Case: Stainless steel with 5-inch- diameter, glass lens.

C. Adjustable Joint: Finish to match case, 180-degree adjustment in vertical plane, 360-degree adjustment in horizontal plane, with locking device.

D. Element: Bimetal coil.

E. Scale: Satin-faced non-reflective aluminum with permanently etched markings.

F. Stem: Stainless steel for separable socket, of length to suit installation.

2.04 INSERTION DIAL THERMOMETERS

A. Description: ASME B40.3, bimetal type.

B. Dial: 1-inch diameter.

C. Case: Stainless steel.

D. Stem: Dustproof and leak-proof 1/8-inch- diameter, tapered-end stem with nominal length of 5 inches.

2.05 SEPARABLE SOCKETS

A. Description: Fitting with protective socket for installation in threaded pipe fitting to hold fixed thermometer stem.

1. Material: Brass, for use in copper piping.

2. Material: Stainless steel, for use in steel piping.

3. Extension-Neck Length: Nominal thickness of 2 inches, but not less than thickness of insulation. Omit extension neck for sockets for piping not insulated.

4. Insertion Length: To extend to center of pipe.

5. Cap: Threaded, with chain permanently fastened to socket.

6. Heat-Transfer Fluid: Oil or graphite.

2.06 THERMOMETER WELLS

A. Description: Fitting with protective well for installation in threaded pipe fitting to hold test thermometer.

1. Material: Brass, for use in copper piping.

2. Material: Stainless steel, for use in steel piping.

3. Extension-Neck Length: Nominal thickness of 2 inches, but not less than thickness of insulation. Omit extension neck for wells for piping not insulated.

4. Insertion Length: To extend to center of pipe.

5. Cap: Threaded, with chain permanently fastened to socket.

6. Heat-Transfer Fluid: Oil or graphite.

2.07 DUCT THERMOMETER SUPPORT FLANGES

A. Description: Flanged-fitting bracket for mounting in hole of duct, with threaded end for attaching thermometer.

1. Extension-Neck Length: Nominal thickness of 2 inches, but not less than thickness of exterior insulation.

2. Insertion-Neck Length: Nominal thickness of 2 inches, but not less than thickness of insulation lining.

2.08 PRESSURE GAGES

A. Description: ASME B40.1, phosphor-bronze bourdon-tube type with bottom connection; dry type, unless liquid-filled-case type is indicated.

B. Case: Drawn steel, brass, or aluminum with 4-1/2-inch- diameter, glass lens.

C. Connector: Brass, NPS 1/4.

D. Scale: White-coated aluminum with permanently etched markings.

E. Accuracy: Grade B, plus or minus 2 percent of middle 50 percent of scale.

F. Range: Comply with the following:

1. Vacuum: 30 inches Hg of vacuum to 15 psig of pressure.

2. Fluids under Pressure: Two times the operating pressure.

2.09 PRESSURE-GAGE FITTINGS

A. Valves: NPS ¼ or ½" brass or bronze ball valve.

B. Syphons: For Steam only NPS 1/4 coil of brass tubing with threaded ends.

C. Snubbers: ASME B40.5, NPS 1/4 brass bushing with corrosion-resistant porous-metal disc of material suitable for system fluid and working pressure.

2.10 TEST PLUGS

A. Description: Nickel-plated, brass-body test plug in NPS 1/2 fitting.

B. Body: Length as required to extend beyond insulation.

C. Pressure Rating: 500 psig minimum.

D. Core Inserts: One or two self-sealing valves, suitable for inserting 1/8-inch OD probe from dial-type thermometer or pressure gage.

E. Core Material for Air, Water, Oil, and Gas: 20 to 200 deg F, chloro-sulfonated polyethylene synthetic rubber.

F. Core Material for Air and Water: Minus 30 to plus 275 deg F, ethylene-propylene-diene terpolymer rubber.

G. Test-Plug Cap: Gasketed and threaded cap, with retention chain or strap.

H. Test Kit: Pressure gage and adapter with probe, two bimetal dial thermometers, and carrying case.

1. Pressure Gage and Thermometer Ranges: Approximately two times the system's operating conditions.

2.11 FLOW-MEASURING SYSTEMS

A. System includes calibrated flow element, separate meter, hoses or tubing, valves, fittings, and conversion chart compatible with flow element, meter, and system fluid.

1. Flow range of flow-measuring element and meter covers operating range of equipment or system where used.

2. Display: Visual instantaneous rate of flow, with register to indicate total volume in gallons (liters).

B. Permanent Meters: Suitable for wall or bracket mounting. Include 6-inch- diameter, or equivalent, dial with fittings and copper tubing for connecting to flow element.

1. Scale: Gallons per minute.

2. Accuracy: Plus or minus 1 percent of center 60 percent of range.

C. Portable Meters: Differential-pressure gage. Include two 12-foot hoses in carrying case with handle.

1. Scale: Inches of water, unless otherwise indicated.

2. Accuracy: Plus or minus 2 percent between 20 and 80 percent of range.

D. Include complete operating instructions with each meter.

2.12 TURBINE FLOWMETERS

A. Description: Insertion type; measures flow directly in gallons per minute.

1. Construction: Bronze or stainless-steel body and plastic turbine or impeller, with integral direct-reading scale.

2. Pressure Rating: 150 psig minimum.

3. Temperature Rating: 180 deg F minimum.

4. Display: Visual instantaneous rate of flow, with register to indicate total volume in gallons.

5. Accuracy: Plus or minus 2-1/2 percent.

PART 3 - EXECUTION

3.01 METER AND GAGE INSTALLATION, GENERAL

A. Install meters, gages, and accessories according to manufacturer's written instructions for applications where used.

3.02 THERMOMETER INSTALLATION

A. Install thermometers and adjust vertical and tilted positions.

B. Install in the following locations:

1. Use test plugs for vav reheat terminal units.

2. Inlet and outlet of each hydronic coil in air-handling units and built-up central systems.

3. Inlet and outlet of each hydronic heat exchanger.

4. Outside-air, return-air, and mixed-air ducts.

5. Each duct thermometer support flange.

C. Install remote-reading dial thermometers in control panels with tubing connecting panel and thermometer bulb supported to prevent kinks. Use minimum tubing length.

D. Install separable sockets in vertical position in piping tees where fixed thermometers are indicated.

1. Install with socket extending to center of pipe.

2. Fill sockets with oil or graphite and secure caps.

E. Install thermometer wells in vertical position in piping tees where test thermometers are indicated.

1. Install with stem extending to center of pipe.

2. Fill wells with oil or graphite and secure caps.

F. Duct Thermometer Support Flanges: Install in wall of duct where duct thermometers are indicated. Attach to duct with screws.

3.03 PRESSURE-GAGE INSTALLATION

A. Install pressure gages in piping tees with pressure-gage valve located on pipe at most readable position.

B. Install dry-type pressure gages in the following locations:

1. Discharge of each pressure-reducing valve.

2. Building water-service entrance.

3. Chilled-water and condenser-water inlets and outlets of chillers.

C. Install liquid-filled-type pressure gages at suction and discharge of each pump.

D. Install pressure-gage ball valve and snubber in piping to pressure gages.

1. Exception: Install syphon instead of snubber in piping to steam pressure gages.

3.04 FLOW-MEASURING SYSTEM INSTALLATION

A. Install flowmeters in accessible and most readable positions in piping systems.

B. Install flow-measuring elements and meters where indicated.

C. Install connection fittings for attachment to portable flowmeters in accessible locations.

D. Install permanently mounted meters for flow elements on walls or brackets in accessible locations.

E. Install connections, tubing, and accessories between flow elements and meters as prescribed by manufacturer's written instructions.

3.05 FLOWMETER INSTALLATION

A. Install flowmeters and components according to manufacturer's written instructions.

3.06 CONNECTIONS

A. Piping installation requirements are specified in various Division 23 Sections. The following are specific connection requirements:

1. Install meters and gages adjacent to machines and equipment to allow service and maintenance.

2. Connect flow-measuring-system elements to meters.

3. Connect flowmeter transmitters to meters.

B. Make electrical connections to power supply and electrically operated meters and devices.

C. Install electrical connections for power and devices.

D. Electrical power, wiring, and connections are specified in Division 26 Electrical Sections.

3.07 ADJUSTING AND CLEANING

A. Calibrate meters according to manufacturer's written instructions, after installation.

B. Adjust faces of meters and gages to proper angle for best visibility.

C. Clean windows of meters and gages and clean factory-finished surfaces. Replace cracked and broken windows, and repair scratched and marred surfaces with manufacturer's touchup paint.

END OF SECTION

SECTION 23 05 29

HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.01 SUMMARY

A. Types of supports and anchors specified in this section include the following:

1. Horizontal-piping hangers and supports.
2. Vertical-piping clamps.
3. Hanger-rod attachments.
4. Building attachments.
5. Saddles and shields.
6. Spring hangers and supports.
7. Miscellaneous materials.
8. Anchors.
9. Equipment bases.
10. Seismic Restraint of piping, ductwork, and equipment.

B. Volume 1 - Contracting Requirements, and Division - 01 General Requirements apply to the Work of this Section.

1.02 SYSTEM DESCRIPTION

A. Supports, anchorage and restraints for all piping and ductwork shall be in accordance with a State of California Codes or pre-approved system such as Mason or equal. System shall have a current ‘OPM’ number and shall meet the requirements of the authority having jurisdiction. Contractor shall provide all supporting documentation required by the reviewing authority and the State. For SMACNA, use seismic hazard level "A".

B. In lieu of the above or for non-standard installations not covered in the above pre-approved systems, Contractor shall provide detail supports, attachments and restraints, and furnish supporting calculations and legible details with a stamp by a California registered structural engineer, in accordance with California Building Code Volume 2, Chapter 16A. Contractor shall use Seismic Design Category D unless noted or approved otherwise.

C. Support all piping so that it is firmly held in place by approved hangers and supports and special hangers as required. All components shall support the 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. Do not support piping or ductwork with plumbers tape, wire, rope, wood, or other makeshift devices.

1. Structural considerations:

a. Seismic forces shall be calculated per Chapter 13 of ASCE 7-16.

b. Steel or concrete roof/floor system including slabs or roof deck shall be in place and complete before installation of any mechanical piping system.

c. Space hangers so maximum individual hanger load will not exceed values listed in paragraph "pipe hanger loading".

d. Do not attach hangers to steel roof deck.

e. Attach hangers to beams whenever possible.

2. Provide electroplate or galvanized finish for all material used for support of piping.

3. Provide a bracing system analysis which has been designed and signed by a California registered structural engineer.

1.03 ACTION SUBMITTALS

A. No action submittals are necessary.

1.04 INFORMATIONAL SUBMITTALS

A. Submit under provisions of Section 01 33 00.

B. Submittals for review during construction document phase:

1. Catalog cuts, specifications, installation instructions, and dimensioned drawings for each type of support, anchor, and seal.

2. Submit pipe hanger and support schedule showing manufacturer's figure number, size, location, and features for each required pipe hanger and support.

3. Details and calculations for all non-preapproved seismic restraints and anchoring.

C. Submittals for review during construction phase:

1. Field modifications to any support or anchorage details approved during working drawing phase.

D. Submittals for closeout:

1. Submit all warranties signed by the manufacturer.

2. Provide all special tools, loose gauges and test kits and maintenance and calibration instructions.

1.05 QUALITY ASSURANCE

A. Manufacturers: Firms regularly engaged in manufacture of supports, anchors, and seals of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. UL and FM compliance: Provide products which are Underwriters' Laboratories listed and Factory Mutual approved.

C. Design and performance requirements:

1. Provide pipe hangers and supports of which materials, design, and manufacture comply with ANSI/MSS SP-58.

2. Provide pipe hangers and supports, complying with MSS SP-69.

3. Provide pipe hangers and supports, complying with MSS SP-89.

4. Terminology used in this Section is defined in MSS SP-90.

5. Provide hangers and supports in conformance with SMACNA Standards, latest edition.

PART 2 - PRODUCTS

2.01 GENERAL

A. Horizontal-piping hangers and support:

1. General:

a. Provide factory-fabricated horizontal-piping hangers and supports complying with ANSI/MSS SP-58, of one of the following MSS types listed, selected by Contractor to suit horizontal-piping systems, in accordance with MSS-SP-69 and manufacturer's published product information.

b. Use only one type by one manufacturer for each piping service.

c. Select size of hangers and supports to exactly fit pipe size for bare piping, and to exactly fit around piping insulation with saddle or shield for insulated piping.

d. Use felt-lined J hangers for installation at copper piping.

e. Adjustable steel clevises: MSS Type 1.

f. Adjustable J hanger: MSS Type 5.

g. Split pipe rings: MSS Type 11.

h. Swivel Ring Hangers SP-58 Type 10

i. Clips: MSS Type 26.

j.

k.

l. ZSI Cush-A Therm or Klo-Shure Insulation Couplings for refrigerant piping.

2. Isolate copper tubing from ferrous materials and hangers with two thicknesses of 1 inch wide 10 mil polyvinyl tape, spiral-wrapped around pipe. Total width shall be a minimum of 3 inches.

B. Hanger-rods and attachments:

1. General: Provide factory-fabricated hanger-rods and attachments complying with ANSI/MSS SP-58, of one of the following MSS types listed, selected by Contractor to suit horizontal- piping hangers and building attachments, in accordance with MSS SP-69 and manufacturer's published product information. Use only one type by one manufacturer for each piping service. Select size of hanger-rod attachments to suit hanger rods. Provide lock nuts at all threaded connections.

a. Steel turnbuckles: MSS Type 13.

b. Swivel turnbuckles: MSS Type 15.

c. Steel weldless Eye Nuts: MSS Type 7.

d. Threaded rod:

C. Pipe hanger rod size:

Pipe Size	Rod Size
2 inches and smaller	3/8 inches.
2-1/2 inches to 3-1/2 inches	1/2 inches.
4 inches to 5 inches	5/8 inches.
6 inches	3/4 inches.
8 inches to 12 inches	7/8 inches.

D. Trapeze suspension: 1-5/8 inches width channel in accordance with manufacturer's published load ratings. No deflection to exceed 1/180 of a span.

1. Trapeze supporting rods shall have a safety factory of five; securely anchor to building structure.

2. Isolate copper pipe with two thicknesses of 2 Inches wide 10 mil polyvinyl tape, 3 inches wide.

E. Building attachments:

1. 1. General: Provide factory-fabricated building attachments complying with ANSI/MSS SP-58, of one of the following types listed, selected by Contractor to suit building substrate conditions, in accordance with MSS SP-69 and manufacturer's published product information. Select size of building attachments to suit hanger rods. Provide copper-plated building attachments for copper-piping systems.

   a. Steel structure:

      1) Top beam C-clamps: MSS Type 19.

      2) Center beam clamps: MSS Type 21.

      3) Welded attachments: MSS Type 22.

      4) Malleable C-clamps: MSS Type 23.

      5) Malleable beam clamps: MSS Type 30.

   b. Provide retaining straps for all single sided beam clamps and C-clamps.

   c. Concrete structure: Do not use powder actuated fasteners for support of overhead piping unless approved by Project Consultant.

      1) Concrete insert: ISAT Blue Banger or Hilti Hilti KCM–MD Inserts.

      2) Spot inserts: B-Line B2505

      3) Equipment anchor bolt: B-Line B3022

      4) Metal deck with no concrete: ISAT RDI, Sammys for metal deck.

      5) Light duty spot inserts: B-Line B2500

F. Saddles and shields:

1. General: Provide saddles or shields under piping hangers and supports, factory-fabricated, for all insulated piping. Size saddles and shields for exact fit to mate with pipe insulation.

   a. Protection saddles: Fill interior voids with segments of insulation matching adjoining insulation.

   b. Thermal hanger shields: Constructed of 360-degree insert of high density, 100 psi, water resistant calcium silicate, encased in 360-degree sheet metal shield. Provide assembly of same thickness as adjoining insulation.

G. Spring Hangers and Supports:

1. General: Provide factory-fabricated combination coil-spring and elastomeric-insert hanger with spring and insert in compression for suspended rotating equipment.

2. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.

3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.

4. Minimum Additional Travel: 50 percent of the required deflection at rated load.

5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.

6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

7. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.

8. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.

H. Vertical-piping clamps:

1. General: Provide factory-fabricated vertical- piping clamps complying with ANSI/MSS SP-58 selected by Contractor to suit vertical piping systems, in accordance with MSS SP-69 and manufacturer's published product information. Select size of vertical piping clamps to exactly fit pipe size of bare pipe. Provide copper-plated clamps for copper-piping systems.

2. Two-bolt riser clamps: B-Line B3373 - MSS Type 8. Support vertical piping risers securely to the pipe above each floor slab, with the arms of the clamp resting on the slab or the structural supports.

3. Support pipe lines passing up through the building at each floor of the building. Bolt riser clamps securely to the floor slab.

I. Miscellaneous materials:

1. Metal framing: Provide products complying with NEMA Standard ML1.

2. Steel plates, shapes and bars: Provide products complying with ANSI/ASTM A36.

3. Cement grout: Portland cement (ANSI/ASTM C150, Type I or Type III) and clean, uniformly graded, natural sand (ANSI/ASTM C404, Size No. 2). Mix at a ratio of 1.0 part cement to 3.0 parts sand, by volume, with minimum amount of water required for placement and hydration.

4. Heavy duty steel trapezes: Fabricate from steel shapes selected for loads required; weld steel in accordance with AWS standards.

5. Pipe guides: Provide factory-fabricated guides, of cast semi-steel or heavy fabricated steel, consisting of a bolted two-section outer cylinder and base with a two-section guiding spider bolted tight to pipe. Size guide and spiders to clear pipe, insulation (if any), and cylinder. Provide guides of length recommended by manufacturer to allow required travel.

J. Seismic restraint:

1. Typical exclusions for compliance with this requirement are:

a. Piping in mechanical rooms less than 1.25 inches inside diameter.

b. All other piping less than 2½ inches inside diameter (does not apply to fire sprinkler piping).

c. All piping suspended by individual hangers 12 inches or less in length from the top of the pipe to the bottom of the support of the hanger.

d. All electrical conduit (included in Division 26) less than 2½ inches diameter.

e. All rectangular air-handling ducts less than six square feet in cross sectional area.

f. All round air handling ducts less than 28 inches in diameter.

g. All ducts suspended by individual hangers 12 inches or less in length from the top of the pipe to the bottom of the support of the hanger.

2. Seismic restraint: Brace all piping of the following systems and sizes laterally every 40 feet and simultaneously laterally and longitudinally every 80 feet, except as noted otherwise within this Specification, and within 5 feet of any change of direction.

PART 3 - EXECUTION

3.01 GENERAL

A. Install building attachments at required locations within concrete or on structural steel for proper piping support. Install additional building attachments where support is required for additional concentrated loads, including valves, flanges, guides, strainers, expansion joints, and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten insert securely to forms. Where concrete with compressive strength less than 2500 psi is utilized, install reinforcing bars through openings at top of inserts.

B. Install hangers, supports, clamps and attachments to support piping properly from building structure; comply with MSS SP-69. Arrange for grouping of parallel runs of horizontal piping to be supported together on trapeze-type hangers where possible. Where piping of various sizes is to be supported together by trapeze hangers, space hangers for smallest pipe size or install intermediate supports for smaller diameter pipe. Do not support piping from other piping. Install seismic restraints in accordance with SMACNA.

C. Locate hangers at each change of direction, within one foot of elbow, and space at or within following maximum limits:

D. Support fire protection system piping independently of other piping.

E. Prevent electrolysis of copper tubing supports by use of hanger, and supports which are copper plated, or by other recognized industry methods.

F. Install hangers and supports to allow controlled movement of piping systems and to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends and similar units.

G. Install hangers and supports so that piping live and dead loading and stresses from movement will not be transmitted to connected equipment.

H. Install hangers and supports to provide indicated pipe slopes, and so that maximum pipe deflections allowed by ANSI B31 are not exceeded.

I. Insulate piping to comply with the following installation requirements.

   1. Clamps: Attach clamps, including spacers (if any), to piping with clamps projecting through insulation; do not exceed pipe stresses allowed by ANSI B31.

   2. Shields: Where low-compressive-strength insulation or vapor barriers are utilized on cold and chilled water piping, install thermal hanger shields. For pipe 8 inches and over, install metal insulation saddles.

   3. Saddles: Where insulation without vapor barrier is utilized, install protection saddles.

J. Install anchors at proper locations to prevent stresses from exceeding those permitted by ANSI B31, and to prevent transfer of loading and stresses to connected equipment.

K. Fabricate and install anchor by welding steel shapes, plates, and bars to piping and to structure. Comply with ANSI B31 and with AWS standards.

L. Where expansion compensators are utilized, install anchors in accordance with expansion unit manufacturer's written instructions, to limit movement of piping and forces to maximums recommended by manufacturer for each unit.

END OF SECTION

SECTION 23 05 53

IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Volume 1 - Contracting Requirements, and Division - 01 General Requirements apply to the Work of this Section.

1.02 SUMMARY

A. This Section includes the following mechanical identification materials and their installation:

1. Equipment nameplates.
2. Equipment markers.
3. Equipment signs.
4. Access panel and door markers.
5. Pipe markers.
6. Duct markers.
7. Stencils.
8. Valve tags.
9. Valve schedules.
10. Warning tags.

B. See Division 1 Section 01 91 00 “General Commissioning Requirements” for building/system commissioning requirements.

1.03 ACTION SUBMITTALS

A. No action submittals are necessary.

1.04 INFORMATIONAL SUBMITTALS

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

B. Samples: For color, letter style, and graphic representation required for each identification material and device.

C. Valve numbering scheme.

D. Valve Schedules: For each piping system. Furnish extra copies (in addition to mounted copies) to include in maintenance manuals.

1.05 QUALITY ASSURANCE

A. ASME Compliance: Comply with ASME A13.1, "Scheme for the Identification of Piping Systems," for letter size, length of color field, colors, and viewing angles of identification devices for piping.

1.06 COORDINATION

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate installation of identifying devices with location of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.01 EQUIPMENT IDENTIFICATION DEVICES

A. Equipment Nameplates: Metal, with data engraved or stamped, for permanent attachment on equipment.

1. Data:

a. Manufacturer, product name, model number, and serial number.

b. Capacity, operating and power characteristics, and essential data.

c. Labels of tested compliances.

2. Location: Accessible and visible.

3. Fasteners: As required to mount on equipment.

B. Equipment Markers: Engraved, color-coded laminated plastic. Include contact-type, permanent adhesive.

1. Terminology: Match schedules as closely as possible.

2. Data:

    a. Name and plan number.

    b. Equipment service.

    c. Design capacity.

    d. Other design parameters such as pressure drop, entering and leaving conditions, and speed.

3. Size: 2-1/2 by 4 inches for control devices, dampers, and valves; 4-1/2 by 6 inches for equipment.

C. Equipment Signs: ASTM D 709, Type I, cellulose, paper-base, phenolic-resin-laminate engraving stock; Grade ES-2, black surface, black phenolic core, with white melamine subcore, unless otherwise indicated. Fabricate in sizes required for message. Provide holes for mechanical fastening.

1. Data: Instructions for operation of equipment and for safety procedures.

2. Engraving: Manufacturer's standard letter style, of sizes and with terms to match equipment identification.

3. Thickness: 1/16 inch for units up to 20 sq. in. or 8 inches in length, and 1/8 inch for larger units.

4. Fasteners: Self-tapping, stainless-steel screws or contact-type, permanent adhesive.

D. Access Panel and Door Markers: 1/16-inch-thick, engraved laminated plastic, with abbreviated terms and numbers corresponding to identification. Provide 1/8-inch center hole for attachment.

1. Fasteners: Self-tapping, stainless-steel screws or contact-type, permanent adhesive.

2.02 PIPING IDENTIFICATION DEVICES

A. Manufactured Pipe Markers, General: Preprinted, color-coded, with lettering indicating service, and showing direction of flow.

1. Colors: Comply with ASME A13.1, unless otherwise indicated.

2. Lettering: Use piping system terms indicated and abbreviate only as necessary for each application length.

3. Pipes with OD, Including Insulation, Less Than 6 Inches: Full-band pipe markers extending 360 degrees around pipe at each location.

4. Pipes with OD, Including Insulation, 6 Inches and Larger: Either full-band or strip-type pipe markers at least three times letter height and of length required for label.

5. Arrows: Integral with piping system service lettering to accommodate both directions; or as separate unit on each pipe marker to indicate direction of flow.

B. Pre-tensioned Pipe Markers: Pre-coiled semi-rigid plastic formed to cover full circumference of pipe and to attach to pipe without adhesive.

C. Shaped Pipe Markers: Preformed semi-rigid plastic formed to partially cover circumference of pipe and to attach to pipe with mechanical fasteners that do not penetrate insulation vapor barrier.

D. Self-Adhesive Pipe Markers: Plastic with pressure-sensitive, permanent-type, self-adhesive back.

E. Plastic Tape: Continuously printed, vinyl tape at least 3 mils thick with pressure-sensitive, permanent-type, self-adhesive back.

1. Width for Markers on Pipes with OD, Including Insulation, Less Than 6 Inches: 3/4 inch minimum.

2. Width for Markers on Pipes with OD, Including Insulation, 6 Inches or Larger: 1-1/2 inches minimum.

2.03 DUCT IDENTIFICATION DEVICES

2.04 Duct Markers: Engraved, color-coded laminated plastic. Include direction and quantity of airflow and duct service (such as supply, return, and exhaust). Include contact-type, permanent adhesive.

2.05 STENCILS

A. Stencils: Maintain minimum letter height of 1-1/4 inches for ducts; and minimum letter height of 3/4 inch for access panel and door markers, equipment markers, equipment signs, and similar operational instructions.

1. Stencil Material: Metal or fiberboard

2. Stencil Paint: Exterior, gloss, alkyd enamel black, unless otherwise indicated. Paint may be in pressurized spray-can form.

3. Identification Paint: Exterior, alkyd enamel in colors according to ASME A13.1, unless otherwise indicated.

2.06 VALVE TAGS

A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers, with numbering scheme approved by State. Provide 5/32-inch hole for fastener.

1. Material: 0.032-inch-thick brass.

2. Material: 0.0375-inch-thick stainless steel.

3. Material: 3/32-inch-thick laminated plastic with 2 black surfaces and white inner layer.

4. Valve-Tag Fasteners: Brass wire-link or beaded chain; or S-hook

2.07 VALVE SCHEDULES

A. Valve Schedules: For each piping system, on standard-size bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.

1. Valve-Schedule Frames: Glazed display frame for removable mounting on masonry walls for each page of valve schedule. Include mounting screws.

2. Frame: Finished hardwood.

3. Glazing: ASTM C 1036, Type I, Class 1, Glazing Quality B, 2.5-mm, single-thickness glass.

2.08 WARNING TAGS

A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags; of plasticized card stock with matte finish suitable for writing.

1. Size: 3 by 5-1/4 inches minimum

2. Fasteners: Brass grommet and wire.

3. Nomenclature: Large-size primary caption such as DANGER, CAUTION, or DO NOT OPERATE.

4. Color: Yellow background with black lettering.

PART 3 - EXECUTION

3.01 APPLICATIONS, GENERAL

A. Products specified are for applications referenced in other sections. If more than single-type material, device, or label is specified for listed applications, selection is Installer's option.

3.02 EQUIPMENT IDENTIFICATION

A. Install and permanently fasten equipment nameplates on each major item of mechanical equipment that does not have nameplate or has nameplate that is damaged or located where not easily visible. Locate nameplates where accessible and visible. Include nameplates for the following general categories of equipment:

   1. Fuel-burning units, including boilers, furnaces and heaters.

   2. Pumps, compressors, condensers, and similar motor-driven units.

   3. Heat exchangers, coils, heat recovery units, and similar equipment.

   4. Fans, blowers, primary balancing dampers, and mixing boxes.

   5. Packaged HVAC central-station and zone-type units.

B. Install equipment markers with screens or permanent adhesive on or near each major item of mechanical equipment. Data required for markers may be included on signs, and markers may be omitted if both are indicated. Locate signs where accessible and visible.

   1. Letter Size: Minimum 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

   2. Data: Distinguish among multiple units, indicate operational requirements, indicate safety and emergency precautions, warn of hazards and improper operations, and identify units.

   3. Locate markers where accessible and visible. Include markers for the following general categories of equipment:

      a. Main control and operating valves, including safety devices and hazardous units such as gas outlets.

      b. Fire department hose valves and hose stations.

      c. Fuel-burning units, including boilers.

      d. Pumps, compressors, chillers, condensers, and similar motor-driven units.

      e. Heat exchangers, coils, evaporators, cooling towers, heat recovery units, and similar equipment.

      f. Fans, blowers, primary balancing dampers, and mixing boxes.

      g. Packaged HVAC central-station and zone-type units.

      h. Tanks and pressure vessels.

      i. HEPA filters, humidifiers, water-treatment systems, and similar equipment.

C. Identify mechanical equipment with equipment markers in the following color codes:

a. Green: For cooling equipment and components.

b. Yellow: For heating equipment and components.

c. Green and Yellow: For combination cooling and heating equipment and components.

d. Brown: For energy-reclamation equipment and components.

3.03 PIPING IDENTIFICATION

A. Install manufactured pipe markers indicating service on each piping system. Install with flow indication arrows showing direction of flow.

1. Pipes with OD, Including Insulation, Less Than 4 Inches: Pre-tensioned pipe markers. Use size to ensure a tight fit.

2. Pipes with OD, Including Insulation, 4 Inches and Larger: Shaped pipe markers. Use size to match pipe and secure with fasteners.

B. Locate pipe markers and color bands where piping is exposed in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior non-concealed locations as follows:

1. Near each valve and control device.

2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.

3. Near penetrations through walls, floors, ceilings, and non-accessible enclosures.

4. At access doors, manholes, and similar access points that permit view of concealed piping.

5. Near major equipment items and other points of origination and termination.

6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.

7. On piping above removable acoustical ceilings. Omit intermediately spaced markers.

3.04 DUCT IDENTIFICATION

A. Install duct markers with permanent adhesive on air ducts in the following color codes:

1. Green: For cold-air supply ducts.

2. Yellow: For hot-air supply ducts.

3. Blue: For exhaust-, outside-, relief-, return-, and mixed-air ducts.

4. ASME A13.1 Colors and Designs: For hazardous material exhaust.

5. Letter Size: Minimum 1/4 inch for name of units if viewing distance is less than 24 inches 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

B. Stenciled Duct Marker Option: Stenciled markers, showing service and direction of flow, may be provided instead of laminated-plastic duct markers, at Installer's option, if lettering larger than 1 inch high is needed for proper identification because of distance from normal location of required identification.

C. Locate markers near points where ducts enter into concealed spaces and at maximum intervals of 50 feet in each space where ducts are exposed or concealed by removable ceiling system.

3.05 VALVE-TAG INSTALLATION

A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; plumbing fixture supply stops; shutoff valves; faucets; convenience and lawn-watering hose connections; and HVAC terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.

B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following:

1. Valve-Tag Size and Shape:

   a. Cold Water: 1-1/2 inches round.

   b. Hot Water: 1-1/2 inches round.

   c. Fire Protection: 1-1/2 inches round.

   d. Gas: 1-1/2 inches round.

   e. Steam: 1-1/2 inches round.

2. Valve-Tag Color:

   a. Cold Water: Natural

   b. Hot Water: Natural

   c. Fire Protection: Natural

   d. Gas: Natural

e. Steam: Natural

3. Letter Color:

a. Cold Water: Black

b. Hot Water: Black

c. Fire Protection: Black

d. Gas: Black

e. Steam: Black

3.06 VALVE-SCHEDULE INSTALLATION

A. Mount valve schedule on wall in accessible location in each major equipment room.

3.07 WARNING-TAG INSTALLATION

A. Write required message on, and attach warning tags to, equipment and other items where required.

3.08 ADJUSTING

A. Relocate mechanical identification materials and devices that have become visually blocked by other work.

3.09 CLEANING

A. Clean faces of mechanical identification devices and glass frames of valve schedules.

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. Test and balance of air distribution systems.

   b. Test and balance of hydronic piping systems and associated equipment and apparatus of mechanical work.

   c. Test and balance of domestic water piping systems and associated equipment.

2. Setting and adjusting speed and volume of systems, recording data, conducting tests, preparing and submitting reports, and recommending modifications to work.

3. Component types of testing, adjusting, and balancing specified in this section includes the following as applied to mechanical equipment:

   a. Fans & ventilators.

   b. Air conditioning units.

   c. Ductwork systems.

   d. Pumps.

   e. Coils.

   f. Piping systems.

   g. Balance valves for plumbing systems.

   h. Air inlets & outlets.

B. Volume 1 - Contracting Requirements, and Division - 01 General Requirements apply to the Work of this Section.

C. Related Sections include the following:

1. Section 23 08 00 “Commissioning of HVAC” for commissioning and testing of HVAC.

1.02 DEFINITIONS

A. AABC: Associated Air Balance Council.

B. NEBB: National Environmental Balancing Bureau.

C. TABB: Testing, Adjusting, and Balancing Bureau.

D. TAB: Testing, Adjusting, and Balancing program.

E. ASHRAE - American Society of Heating, Refrigerating, and Air Conditioning Engineers, Inc.

1.03 ACTION SUBMITTALS

A. No action submittals are necessary.

1.04 INFORMATIONAL SUBMITTALS

A. Submit under provisions of Section 01 33 00.

B. Qualification Data: Within 30 days of Contractor's Notice to Proceed, submit documentation that the TAB contractor and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.

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.

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. Certified TAB reports.

F. Sample report forms.

G. Instrument calibration reports, to include the following:

1. Instrument type and make.

2. Serial number.

3. Application.

4. Dates of use.

5. Dates of calibration.

H. Other as specified.

1.05 QUALITY ASSURANCE

A. Provide services and facilities of an independent agency that specializes in and deals exclusively with the testing, analysis, and balancing of hydronic systems and air distribution for heating and cooling systems.

B. Work shall be done by qualified engineering technicians and trained personnel, using instruments certified accurate to limits used in standard practice for testing and balancing of hydronic and air distribution for heating-cooling systems.

C. Agency shall field test air and hydronic flows in accordance with methods set up by Associated Air Balance Council, National Standard Volume 2.

D. TAB Contractor Qualifications: Engage a TAB entity certified by AABC or NEBB.

   1. TAB Field Supervisor: Employee of the TAB contractor and certified by AABC, NEBB.

   2. TAB Technician: Employee of the TAB contractor and who is certified by AABC, NEBB as a TAB technician.

E. TAB Conference: Meet with the Commissioning Authority on approval of the TAB strategies and procedures plan to develop a mutual understanding of the details. Require the participation of the TAB field supervisor and technicians. Provide seven days' advance notice of scheduled meeting time and location.

   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.

F. 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.

G. TAB Report Forms: Use standard TAB contractor's forms approved by the State.

H. Instrumentation Type, Quantity, Accuracy, and Calibration: As described in ASHRAE 111, Section 5, "Instrumentation."

1.06 COORDINATION

A. Notice: Schedule to be provided for entire testing agenda.

B. Perform TAB after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.01 GENERAL

A. It is important to note that before balancing can begin, all systems should be 100% operational (including installation of clean filters, all diffusers and grilles properly installed, control components calibrated and operational, etc.).

B. During the TAB phase, testing and balancing of all equipment, systems, sub-systems, and system components must be accomplished and reported.

C. If acceptable performance cannot be achieved because of design or system deficiencies, the test data must be documented in writing and distributed to the appropriate parties for resolution.

D. Likewise, if certain tests cannot be performed due to improper installation of equipment or if system components have not yet been installed, this must also be documented in writing and distributed to the appropriate parties for resolution before testing can begin.

E. The following requirements shall be applied where applicable.

1. The Articles provide various applications and how they should be tested and balanced.

2. The design consultants are required to develop the appropriate HVAC systems to meet the RFP criteria.

3. When developing the specific TAB program in conjunction with the Commissioning Authority it shall incorporate the appropriate TAB methods for the designed HVAC system and components.

4. The extent of the program shall simulate the TAB intent specified herein.

3.02 EXAMINATION

A. Examine the RFP to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment.

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 and appropriate.

C. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.

D. Examine test reports specified in individual system and equipment Sections.

E. 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.

F. Examine terminal units, such as variable-air-volume boxes, and verify that they are accessible and their controls are connected and functioning.

G. Examine strainers. Verify that startup screens are replaced by permanent screens with indicated perforations.

H. Examine three-way valves for proper installation for their intended function of diverting or mixing fluid flows.

I. Examine heat-transfer coils for correct piping connections and for clean and straight fins.

J. Examine system pumps to ensure absence of entrained air in the suction piping.

K. Examine operating safety interlocks and controls on HVAC equipment.

L. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.03 PREPARATION

A. Prepare a TAB plan that includes strategies and step-by-step procedures.

B. Provide balancing agenda prior to start of balancing work including:

1. General description of each air system with its associated equipment and operational cycles for winter heating, summer reheat, humidification, and cooling. Where different cycles are used for day and night time operation, describe separately.

2. A complete list of all flow and terminal measurements to be performed.

3. Preliminary selection points for proposed sound measurement.

4. Agenda shall also include specific procedures for determining test parameters for flow, drafts, sound levels, etc. Specify type of instruments to be used, method of instrument application and air terminal correction factors for:

a. Air terminal configuration.

b. Flow direction (supply - return or exhaust).

c. Hydronic systems test locations and balance devices.

d. Plumbing systems test procedures.

e. Furnish a copy of agenda to State prior to start of work, including qualifications of key personnel assigned to the project.

5. Agenda shall be used by balance technician, as primary means for definition of on-site work.

C. Complete system-readiness checks and prepare reports. Verify the following:

1. Permanent electrical-power wiring is complete.

2. Hydronic systems are filled, clean, and free of air.

3. Automatic temperature-control systems are operational.

4. Equipment and duct access doors are securely closed.

5. Balance, smoke, and fire dampers are open.

6. Isolating and balancing valves are open and control valves are operational.

7. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.

8. Windows and doors can be closed so indicated conditions for system operations can be met.

3.04 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" and in this Section.

1. Comply with requirements in ASHRAE 62.1-2004, 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, install test ports and duct access doors that comply with requirements in Division 23 Section "Ductwork Accessories."

2. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Division 23 Section "HVAC Insulation."

C. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.

D. Take and report testing and balancing measurements in inch-pound (IP) units.

3.05 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.

B. Prepare schematic diagrams of systems' "as-built" duct layouts.

C. For variable-air-volume systems, develop a plan to simulate diversity.

D. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.

E. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.

F. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.

G. Verify that motor starters are equipped with properly sized thermal protection.

H. Check dampers for proper position to achieve desired airflow path.

I. Check for airflow blockages.

J. Check condensate drains for proper connections and functioning.

K. Check for proper sealing of air-handling-unit components.

L. Verify that air duct system is sealed as specified in Division 23 Section "Metal Ducts."

3.06 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.

1. Measure total airflow with balance dampers open.

    a. Where sufficient space in ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow.

2. Measure fan static pressures as follows to determine actual static pressure:

    a. Measure outlet static pressure as far downstream from the fan as practical and upstream from restrictions in ducts such as elbows and transitions.

    b. Measure static pressure directly at the fan outlet or through the flexible connection.

    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 the State for adjustment of fan speed higher or lower than indicated speed.

7. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.

B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows within specified tolerances.

1. Measure airflow of submain and branch ducts.

   a. Where sufficient space in submain and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.

2. Measure static pressure at a point downstream from the balancing damper, and adjust volume dampers until the proper static pressure is achieved.

3. Remeasure each submain and branch duct after all have been adjusted. Continue to adjust submain and branch ducts to indicated airflows within specified tolerances.

C. Measure air outlets and inlets without making adjustments.

1. Measure terminal outlets using a direct-reading hood or outlet manufacturer's written instructions and calculating factors.

D. Adjust air outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using branch volume dampers rather than extractors and the dampers at air terminals.

1. Adjust each outlet in same room or space to within specified tolerances of indicated quantities without generating noise levels above the limitations prescribed by the Contract Documents.

2. Adjust patterns of adjustable outlets for proper distribution without drafts.

3.07 PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS

A. Compensating for Diversity: When the total airflow of all terminal units is more than the indicated airflow of the fan, place a selected number of terminal units at a minimum set-point airflow with the remainder at maximum-airflow condition until the total airflow of the terminal units equals the indicated airflow of the fan.

B. Select the reduced-airflow terminal units so they are distributed evenly among the branch ducts.

   1. Adjust fan speed the same as described for constant volume systems.

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.

3.08 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS

A. Prepare test reports with pertinent design data, and number in sequence starting at pump to end of system. Check the sum of branch-circuit flows against the approved pump flow rate. Correct variations that exceed plus or minus 5 percent.

B. Prepare schematic diagrams of systems' "as-built" piping layouts.

C. Prepare hydronic systems for testing and balancing according to the following, in addition to the general preparation procedures specified above:

1. Open all manual valves for maximum flow.

2. Check liquid level in expansion tank.

3. Check makeup water-station pressure gage for adequate pressure for highest vent.

4. Check flow-control valves for specified sequence of operation, and set at indicated flow.

5. Set differential-pressure control valves at the specified differential pressure. Do not set at fully closed position when pump is positive-displacement type unless several terminal valves are kept open.

6. Set system controls so automatic valves are wide open to heat exchangers.

7. Check pump-motor load. If motor is overloaded, throttle main flow-balancing device so motor nameplate rating is not exceeded.

8. Check air vents for a forceful liquid flow exiting from vents when manually operated.

3.09 PROCEDURES FOR CONSTANT-FLOW HYDRONIC SYSTEMS

A. 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.

2. Read pressure differential across the pump.

3. Convert pressure to head and correct for differences in gage heights.

4. 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 the State and comply with requirements in Division 23 Section "Hydronic Pumps."

5. Check system resistance.

6. With all valves open, read pressure differential across the pump and mark pump manufacturer's head-capacity curve.

7. Adjust pump discharge valve until indicated water flow is achieved.

    a. Monitor motor performance during procedures and do not operate motors in overload conditions.

8. Verify pump-motor brake horsepower.

9. Calculate the intended brake horsepower for the system based on pump manufacturer's performance data.

10. Compare calculated brake horsepower with nameplate data on the pump motor.

11. Report conditions where actual amperage exceeds motor nameplate amperage.

12. Report flow rates that are not within plus or minus 10 percent of design.

B. Measure flow at all automatic flow control valves to verify that valves are functioning as designed.

C. Measure flow at all pressure-independent characterized control valves, with valves in fully open position, to verify that valves are functioning as designed.

D. Set calibrated balancing valves, if installed, at calculated presettings.

E. 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.

F. Measure flow at main balancing station and set main balancing device to achieve flow that is 5 percent greater than indicated flow.

G. 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.

H. Measure pump flow rate and make final measurements of pump amperage, voltage, rpm, pump heads, and systems' pressures and temperatures including outdoor-air temperature.

I. Measure the differential-pressure-control-valve settings existing at the conclusion of balancing.

J. Check settings and operation of each safety valve. Record settings.

3.10 PROCEDURES FOR VARIABLE-FLOW HYDRONIC SYSTEMS

A. Balance systems with automatic two- and three-way control valves by setting systems at maximum flow through heat-exchange terminals and proceed as specified above for hydronic systems.

3.11 PROCEDURES FOR MOTORS

A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:

1. Manufacturer's name, model number, and serial number.
2. Motor horsepower rating.
3. Motor rpm.
4. Efficiency rating.
5. Nameplate and measured voltage, each phase.
6. Nameplate and measured amperage, each phase.
7. Starter thermal-protection-element rating.

B. Motors Driven by Variable-Frequency Controllers:

1. Test for proper operation at speeds varying from minimum to maximum.
2. Test the manual bypass of the controller to prove proper operation.
3. Record observations including name of controller manufacturer, model number, serial number, and nameplate data.

3.12 PROCEDURES FOR BOILERS

A. Hydronic Boilers: Measure and record entering- and leaving-water temperatures and water flow.

B. Steam Boilers: Measure and record entering-water temperature and flow and leaving-steam pressure, temperature, and flow.

3.13 PROCEDURES FOR HEAT-TRANSFER COILS

A. Measure, adjust, and record the following data for each water coil:

1. Entering- and leaving-water temperature.

2. Water flow rate.

3. Water pressure drop.

4. Dry-bulb temperature of entering and leaving air.

5. Wet-bulb temperature of entering and leaving air for cooling coils.

6. Airflow.

7. Air pressure drop.

3.14 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 or minus 10 percent.

2. Air Outlets and Inlets: Plus or minus 10 percent.

3. Heating-Water Flow Rate: Plus or minus 10 percent.

4. Chilled-Water Flow Rate: Plus or minus 10 percent.

3.15 FINAL REPORT

A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.

1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.

2. Include a list of instruments used for procedures, along with proof of calibration.

B. Final Report Contents: In addition to certified field-report data, include the following:

1. 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 contractor.
3. Project name.
4. Project location.
5. The State's name and address.
6. Engineer's name and address.
7. Contractor's name and address.
8. Report date.
9. Signature of TAB supervisor who certifies the report.
10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
11. Summary of contents including the following:
    a. Indicated versus final performance.
    b. Notable characteristics of systems.
    c. Description of system operation sequence if it varies from the RFP.
12. Nomenclature sheets for each item of equipment.
13. Data for terminal units, including manufacturer's name, type, size, and fittings.
14. Notes to explain why certain final data in the body of reports vary from indicated values.
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. Water and steam flow rates.

3. Terminal units.

4. Balancing stations.

5. Position of balancing devices.

E. Air-Handling-Unit Test Reports: For air-handling units with coils, include the following:

1. Unit Data:

a. Unit identification.

b. Location.

c. Make and type.

d. Model number and unit size.

e. Manufacturer's serial number.

f. Unit arrangement and class.

g. Discharge arrangement.

h. Sheave make, size in inches, 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. Outdoor-air damper position % open.

l. Return-air damper position % open.

m. Vortex damper position % open.

F. 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.

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. Water flow rate in gpm.

i. Water pressure differential in feet of head or psig.

j. Entering-water temperature in deg F.

k. Leaving-water temperature in deg F.

l. Refrigerant expansion valve and refrigerant types.

m. Refrigerant suction pressure in psig.

n. Refrigerant suction temperature in deg F.

o. Inlet steam pressure in psig.

G. Fan Test Reports: For supply, return, and exhaust fans, include the following:

1. Fan Data:

a. System identification.

b. Location.

c. Make and type.

d. Model number and size.

e. Manufacturer's serial number.

f. Arrangement and class.

g. Sheave make, size in inches, 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.

H. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:

1. Report Data:

a. System and air-handling-unit number.

b. Location and zone.

c. Traverse air temperature in deg F.

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.

I. Air-Terminal-Device Reports:

1. Unit Data:
    a. System and air-handling unit identification.
    b. Location and zone.
    c. Apparatus used for test.
    d. Area served.
    e. Make.
    f. Number from system diagram.
    g. Type and model number.
    h. Size.
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.

J. System-Coil Reports: For reheat coils and water coils of terminal units, include the following:

1. Unit Data:
    a. System and air-handling-unit identification.
    b. Location and zone.
    c. Room or riser served.
    d. Coil make and size.
    e. Flowmeter type.
2. Test Data (Indicated and Actual Values):
    a. Air flow rate in cfm.
    b. Entering-water temperature in deg F.

c. Leaving-water temperature in deg F.

d. Water pressure drop in feet of head or psig.

e. Entering-air temperature in deg F.

f. Leaving-air temperature in deg F.

K. 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.

L. Instrument Calibration Reports:

1. Report Data:

a. Instrument type and make.

b. Serial number.

c. Application.

d. Dates of use.

e. Dates of calibration.

3.16 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 RFP in the final report.

B. Final Inspection:

1. After initial inspection is complete and documentation by random checks verifies that testing and balancing are complete and accurately documented in the final report, request that a final inspection be made by the State and Commissioning Authority.

2. The TAB contractor's test and balance engineer shall conduct the inspection in the presence of the State and Commissioning Authority.

3. The State shall randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to either 10 percent of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.

4. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."

5. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.

C. TAB Work will be considered defective if it does not pass final inspections. If TAB Work fails, proceed as follows:

1. Recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection.

2. If the second final inspection also fails, the State may contract the services of another TAB contractor to complete TAB Work according to the RFP and deduct the cost of the services from the original TAB contractor's final payment.

D. Prepare test and inspection reports.

3.17 ADDITIONAL TESTS

A. Within 90 days of completing TAB, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions.

B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional TAB during near-peak summer and winter conditions.

END OF SECTION

SECTION 23 08 00

COMMISSIONING OF HVAC

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes commissioning process requirements for HVAC&R systems, assemblies, and equipment.

B. Related Sections:

1. Volume 1 - Contracting Requirements, and Division - 01 General Requirements apply to the Work of this Section.

2. Division 23 Section 23 05 93.

1.02 DEFINITIONS

A. Commissioning Plan: A document that outlines the organization, schedule, allocation of resources, and documentation requirements of the commissioning process.

B. CxA: Commissioning Authority.

C. HVAC&R: Heating, Ventilating, Air Conditioning, and Refrigeration.

D. Systems, Subsystems, Equipment, and Components: Where these terms are used together or separately, they shall mean "as-built" systems, subsystems, equipment, and components.

1.03 CONTRACTOR’S RESPONSIBILITIES

A. Perform commissioning tests in accordance with the commissioning plan.

B. Attend construction phase controls coordination meeting.

C. Attend testing, adjusting, and balancing review and coordination meeting.

D. Participate in HVAC&R systems, assemblies, equipment, and component maintenance orientation and inspection as directed by the CxA.

E. Provide information requested by the CxA for final commissioning documentation.

F. Provide measuring instruments and logging devices to record test data, and provide data acquisition equipment to record data for the complete range of testing for the required test period.

1.04 CxA's RESPONSIBILITIES

A. Provide project-specific construction checklists and commissioning process test procedures for actual HVAC&R systems, assemblies, equipment, and components to be furnished and installed as part of the construction contract. The checklist and commissioning process test procedures shall be coordinated with other testing, adjusting and balancing requirements of this specification.

B. Direct commissioning testing.

C. Verify testing, adjusting, and balancing work is performed and completed.

D. Provide test data, inspection reports, and certificates.

1.05 COMMISSIONING DOCUMENTATION

A. The Contractor shall provide the following information to the CxA for inclusion in the commissioning plan:

1. Plan for delivery and review of submittals, systems manuals, and other documents and reports.

2. Identification of installed systems, assemblies, equipment, and components including design changes that occurred during the construction phase.

3. Process and schedule for completing construction checklists and manufacturer's prestart and startup checklists for HVAC&R systems, assemblies, equipment, and components to be verified and tested.

4. Certificate of completion certifying that installation, prestart checks, and startup procedures have been completed.

5. Certificate of readiness certifying that HVAC&R systems, subsystems, equipment, and associated controls are ready for testing.

6. Test and inspection reports and certificates.

7. Corrective action documents.

8. Verification of testing, adjusting, and balancing reports.

1.06 ACTION SUBMITTALS

A. No action submittals necessary.

1.07 Informational Submittals

A. Submit under provisions of Section 01 33 00.

B. Certificates of readiness.

C. Certificates of completion of installation, prestart, and startup activities.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.01 TESTING PREPARATION

A. Certify that HVAC&R systems, subsystems, and equipment have been installed, calibrated, and started and are operating according to the RFP.

B. Certify that HVAC&R instrumentation and control systems have been completed and calibrated, that they are operating according to the RFP, and that pretest set points have been recorded.

C. Certify that testing, adjusting, and balancing procedures have been completed and that testing, adjusting, and balancing reports have been submitted, discrepancies corrected, and corrective work approved.

D. Set systems, subsystems, and equipment into operating mode to be tested (e.g., normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).

E. Inspect and verify the position of each device and interlock identified on checklists.

F. Check safety cutouts, alarms, and interlocks with smoke control and life-safety systems during each mode of operation.

G. Testing Instrumentation: Install measuring instruments and logging devices to record test data as directed by the CxA.

3.02 TESTING AND BALANCING VERIFICATION

A. Prior to performance of testing and balancing Work, provide copies of reports, sample forms, checklists, and certificates to the CxA.

B. Notify the CxA at least 7 days in advance of testing and balancing Work, and provide access for the CxA to witness testing and balancing Work.

C. Provide technicians, instrumentation, and tools to verify testing and balancing of HVAC&R systems at the direction of the CxA.

1. The CxA will notify Contractor 10 days in advance of the date of field verification. Notice will not include data points to be verified.

2. The Contractor shall use the same instruments (by model and serial number) that were used when original data were collected.

3. Failure of an item includes, other than sound, a deviation of more than 10 percent. Failure of more than 10 percent of selected items shall result in rejection of final testing, adjusting, and balancing report. For sound pressure readings, a deviation of 3 dB shall result in rejection of final testing. Variations in background noise must be considered.

4. Remedy the deficiency and notify the CxA so verification of failed portions can be performed.

3.03 GENERAL TESTING REQUIREMENTS

A. Provide technicians, instrumentation, and tools to perform commissioning test at the direction of the CxA.

B. Scope of HVAC&R testing shall include entire HVAC&R installation, from central equipment for heat generation and refrigeration through distribution systems to each conditioned space. Testing shall include measuring capacities and effectiveness of operational and control functions.

C. Test all operating modes, interlocks, control responses, and responses to abnormal or emergency conditions, and verify proper response of building automation system controllers and sensors.

D. The CxA along with the Contractor, testing and balancing Contractor, and HVAC&R Instrumentation and Control Contractor shall prepare detailed testing plans, procedures, and checklists for HVAC&R systems, subsystems, and equipment.

E. Tests will be performed using design conditions whenever possible.

F. Simulated conditions may need to be imposed using an artificial load when it is not practical to test under design conditions. Before simulating conditions, calibrate testing instruments. Provide equipment to simulate loads. Set simulated conditions as directed by the CxA and document simulated conditions and methods of simulation. After tests, return settings to normal operating conditions.

G. The CxA may direct that set points be altered when simulating conditions is not practical.

H. The CxA may direct that sensor values be altered with a signal generator when design or simulating conditions and altering set points are not practical.

I. If tests cannot be completed because of a deficiency outside the scope of the HVAC&R system, document the deficiency and report it to the State. After deficiencies are resolved, reschedule tests.

J. If the testing plan indicates specific seasonal testing, complete appropriate initial performance tests and documentation and schedule seasonal tests.

3.04 HVAC&R SYSTEMS, SUBSYSTEMS, AND EQUIPMENT TESTING PROCEDURES

A. Boiler Testing and Acceptance Procedures: Testing requirements are specified in Division 23 boiler Sections. Provide submittals, test data, inspector record, and boiler certification to the CxA.

B. HVAC&R Instrumentation and Control System Testing: Field testing plans and testing requirements are specified in Division 23 Section "Instrumentation and Controls for HVAC." Assist the CxA with preparation of testing plans.

C. Pipe system cleaning, flushing, hydrostatic tests, and chemical treatment requirements are specified in Division 23 piping Sections. HVAC&R Contractor shall prepare a pipe system cleaning, flushing, and hydrostatic testing plan. Provide cleaning, flushing, testing, and treating plan and final reports to the CxA. Plan shall include the following:

   1. Sequence of testing and testing procedures for each section of pipe to be tested, identified by pipe zone or sector identification marker. Markers shall be keyed to Drawings for each pipe sector, showing the physical location of each designated pipe test section. Drawings keyed to pipe zones or sectors shall be formatted to allow each section of piping to be physically located and identified when referred to in pipe system cleaning, flushing, hydrostatic testing, and chemical treatment plan.

   2. Description of equipment for flushing operations.

   3. Minimum flushing water velocity.

   4. Tracking checklist for managing and ensuring that all pipe sections have been cleaned, flushed, hydrostatically tested, and chemically treated.

D. Energy Supply System Testing: Provide technicians, instrumentation, tools, and equipment to test performance of gas, hot-water, and equipment at the direction of the CxA. The CxA shall determine the sequence of testing and testing procedures for each equipment item and pipe section to be tested.

E. HVAC&R Distribution System Testing: Provide technicians, instrumentation, tools, and equipment to test performance of air and hydronic distribution systems; special exhaust; and other distribution systems, including HVAC&R terminal equipment and unitary equipment.

F. Vibration and Sound Tests: Provide technicians, instrumentation, tools, and equipment to test performance of vibration isolation and seismic controls.

END OF SECTION

SECTION 23 37 13

DIFFUSERS, REGISTERS, AND GRILLES

PART 1 - GENERAL

1.01 SUMMARY

A. Volume 1 - Contracting Requirements, and Division - 01 General Requirements apply to the Work of this Section.

B. Types of outlets and inlets required for project include the following:

1. Ceiling air diffusers.

2. Ceiling registers and grilles.

3. Linear air diffusers.

4. Wall registers and grilles.

1.02 ACTION SUBMITTALS

A. Submit under provisions of Section 01 33 00.

B. Submittals for review during construction document phase:

1. Product data: Submit manufacturer's data on outlets and inlets including the following:

a. Schedule of outlets and inlets indicating drawing designation, model number, and accessories furnished.

b. Data sheet for each type of outlet and inlet, and accessory furnished; indicating construction, finish, and mounting details. Provide the test procedure for ratings of each inlet and outlet, as part of the data sheets.

c. Performance data for each type of outlet and inlet furnished, including aspiration ability, throw and drop, and noise criteria ratings. Indicate selections on data.

1.03 INFORMATIONAL SUBMITTALS

A. Submit under provisions of Section 01 33 00.

B. Submittals for review during construction phase:

1. Samples: Submit one sample of each type of air inlet and outlet. Samples will be returned after review.

C. Submittals for closeout:

1. Maintenance data: Submit maintenance instructions, including cleaning instructions for finishes. Include this data in Maintenance Manuals.

2. Submit all warranties signed by the manufacturer.

3. Provide all special tools, loose gauges and test kits and maintenance and calibration instructions.

1.04 QUALITY ASSURANCE

A. ASHRAE standards: Comply with American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc., (ASHRAE), Standard 70 "Methods of Testing for Rating the Airflow Performance of Outlets and Inlets".

B. AMCA standards: Comply with Air Movement and Control Association, Inc. (AMCA) Standard 500 "Test Method for Louvers, Dampers and Shutters".

C. ANSI/NFPA standards: Comply with National Fire Protection Association (NFPA) Standard 90A, Latest Edition "Installation of Air Conditioning and Ventilating Systems".

D. NFPA compliance: Comply with ANSI/NFPA 90A, Latest Edition "Standard for the Installation of Air Conditioning and Ventilating Systems," and ANSI/NFPA 90B, Latest Edition "Standard for the Installation of Warm Air Heating and Air Conditioning Systems."

PART 2 - PRODUCTS

2.01 GENERAL

A. Except as otherwise indicated, provide manufacturer's standard outlets and inlets; of size, shape, capacity and type required by the criteria; constructed of materials and components as specified, and as required for complete installation.

B. Performance: Provide outlets and inlets that have, as minimum, temperature and velocity traverses, throw and drop, and noise criteria ratings for each size device as listed in manufacturer's current data.

C. Ceiling, wall or floor compatibility: Provide 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 Volume 2 – Performance Criteria – Facility Design Program for types of ceiling systems which will contain each type of air outlet and inlet.

D. Grilles, registers, and diffusers shall be selected and guaranteed by manufacturer to operate without objectionable noise or draft.

E. Furnish and install sponge rubber gaskets between grilles and grounds of finished surfaces.

F. Sidewall grilles and registers shall be provided with bone white finish, unless noted otherwise. All supply diffusers, registers, and grilles located at ceiling shall have factory applied, bone white finish. Exposed mounting screws shall be painted to match.

G. Paint visible ductwork behind grilles, registers, and diffusers dull black. Paint exposed metal including washers at insulation flat black.

H. Specific requirements relative to diffusers:

1. Provide modular core, with adjustable throw pattern from 1 way to 4 ways.

2. For ceilings greater than 10 feet, provide adjustment from horizontal to vertical. (Modular core style is done by rotation of cores).

3. Perforated face diffusers shall not be used.

4. Use beveled drop face with concealed mounting for hard ceilings.

5. Diffusers installed in T-bar ceilings should be 24 x 24 full panel type.

6. OBD not required, depending on application.

I. Specific requirements relative to registers and grilles:

1. OBD not required depending on application.

2. Provide double deflection for supply, single deflection for return and exhaust. Supply should have front blades vertical, and blades should be individually adjustable. Where installed higher than 10 feet above floor, front blades should be horizontal.

3. Provide heavy duty (solid bars) steel for common areas where the grille is at low level (below 8 feet), or where otherwise subject to damage.

4. Provide aluminum for shower (or wet) areas, steel for other areas.

5. Ceiling and high sidewall return/exhaust should be 1/2 x 1/2 x 1 inch eggcrate, aluminum.

6. Consider a paintable finish for sidewall locations.

J. Specific requirements relative to linear diffusers:

1. Provide slot type for maximum adjustability.

2. Provide flex duct inlet at 5 foot intervals with volume control damper at inlet to flex duct. Flexible duct should be minimum 3 feet long to reduce excessive noise.

PART 3 - EXECUTION

3.01 GENERAL

A. Install outlets and inlets in accordance with manufacturer's written instructions and in accordance with recognized industry practices to insure that products serve intended functions.

B. Coordinate with other work, including ductwork and duct accessories, as necessary to interface installation of outlets and inlets with other work.

C. Terminals or 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.

D. Terminals or services weighing more than 56 pounds shall be supported 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.

E. Secure air inlets and outlets to main runners of ceiling suspension system with 2 sheet metal screws.

F. All return inlets into plenum ceilings shall include lined sound/vision boot to reduce noise and light from passing between ceiling cavity and occupied space.

3.02 QUALITY CONTROL

A. Refer to Section 23 05 93 Testing, Adjusting, and Balancing for HVAC for balancing of outlets and inlets.

END OF SECTION

SECTION 23 55 23

LOW-INTENSITY, GAS-FIRED, RADIANT HEATERS

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes low-intensity, gas-fired, draft-induced radiant heaters.

B. Volume 1 - Contracting Requirements, and Division - 01 General Requirements apply to the Work of this Section.

1.02 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

1.03 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans, elevations, and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Structural members to which equipment will be attached.

2. Gas piping to heater installations

3. Thermostats and wiring to heaters.

4. Heater locations and clearance requirements.

5. Other suspended ceiling components including the following:

a. Lighting fixtures.

b. Air outlets and inlets.

c. Sprinklers.

d. Vehicle Exhaust System.

B. Shop Drawings:

1. Signed, sealed, and prepared by or under the supervision of a qualified professional engineer.

2. Include plans, elevations, sections, and mounting and attachment details.

3. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

4. Detail fabrication and assembly of low-intensity, gas-fired, radiant heaters, as well as procedures and diagrams.

5. Include diagrams for power, signal, and control wiring.

C. Field quality-control reports.

D. Sample Warranty: For manufacturer's special warranties.

E. Operation and Maintenance Data: For gas-fired, radiant heaters to include in emergency, operation, and maintenance manuals.

F. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1.04 WARRANTY

A. Manufacturer's Special Warranty: Manufacturer agrees to repair or replace components of radiant heaters that fail in materials or workmanship within specified warranty period.

1. Warranty Period: All warranty periods listed below are from date of Beneficial Occupancy.

a. Burner Assembly: Three years.

b. Combustion and Emitter Tubes: Three years.

c. Heater Controls: One year.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. CSA certified, with CSA Seal and certification number clearly visible on units indicating compliance with ANSI Z83.20/CSA 2.34.

B. UL listed and labeled, with UL label clearly visible on units indicating compliance with ANSI Z83.20/CSA 2.34.

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

2.02 INFRARED RADIANT HEATERS

A. Manufacturers: Subject to compliance with requirements available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Basis-of-Design Product: Subject to compliance with requirements, provide or comparable product by one of the following:

1. Roberts-Gordon, LLC.

2. Solaronics, Inc.

3. Space-Ray; Division of Gas Fired Products, Inc.

4. SunStar Heating Products, Inc.

5. Or approved equal.

C. Description: Factory-assembled, indoor, overhead-mounted, electrically controlled, low-intensity, infrared radiant heating units using gas combustion. Heater to have all necessary factory-installed wiring and piping required prior to field installation and startup.

D. Fuel Type: Design burner for natural gas having characteristics same as those of gas available at Project site.

E. Burner Assembly:

1. Combustion-Air Inlet: Ducted horizontal to outdoors through sidewall with vent caps.

2. Burner Control Housing: Corrosion-resistant, aluminized steel.

a. Totally enclosed with steel access cover.

b. Finish: Enameled finish.

3. Burner: Stainless steel.

4. Motors: General requirements for motors are specified in Section 230513 "Common Motor Requirements for HVAC Equipment."

a. Motor: Resilient-mounted, capacitor-start-capacitor-run type with sealed ball bearings; totally enclosed, nonventilated type with internal thermal protection.

b. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

F. Combustion Chamber: 4-inch- diameter, 12-gage, aluminized steel tubing with high-emissivity, high-temperature, corrosion-resistant external finish. Chambers shall be equipped with sight glass for burner and pilot flame observation.

G. Emitter Tube: 4-inch- diameter, 16-gage, hot-rolled-steel tubing with high-emissivity, high-temperature, corrosion-resistant external finish

1. Tubing Connections: Stainless-steel threaded couplings.

2. 90-degree-bend emitter steel tubing with high-emissivity, high-temperature, corrosion-resistant external finish.

3. Exhaust Vent Termination: Horizontal though side wall with vent caps.

H. Reflector: Polished aluminum, with end caps. Shape to control radiation from tubing for uniform intensity at floor level with 100 percent cutoff above centerline of tubing. Reflectors or entire heater shall accommodate rotational adjustment from horizontal to a minimum 30-degree tilt from vertical.

I. Accessories:

1. Reflector Extension Shields: Same material as reflectors, arranged for fixed connection to lower reflector lip and rigid support to provide 100 percent cutoff of direct radiation from tubing at angles greater than 30 degrees from vertical.

2. Protective grilles mounted to reflectors to protect emitter tubing.

3. Stainless-steel flexible connector with manual valve for gas supply.

4. Hanger chain with "S" hooks.

5. 3/16-inch- diameter, galvanized-steel wire tubing hangers and reflector supports.

6. Rigid mounting kits.

7. Outdoor use conversion kit.

8. Clearance warning plaque.

J. Capacities and Characteristics:

a. As specified on the schedule of radiant heaters on the drawings.

2.03 DRAFT-INDUCED HEATERS

A. Manufacturers: Subject to compliance with requirements available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]

B. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

1. Roberts-Gordon, LLC.

2. Solaronics, Inc.

3. Space-Ray; Division of Gas Fired Products, Inc.

4. SunStar Heating Products, Inc.

5. Or approved equal.

C. Description: Factory-assembled indoor, overhead-mounted, electrically controlled, low-intensity, infrared radiant heating units using gas combustion. Heater to have all necessary factory-installed wiring and piping required prior to field installation and startup.

D. Fuel Type: Design burner for natural gas having characteristics same as those of gas available at Project site.

E. Burner Assembly:

1. Combustion-Air Inlet: Ducted horizontal to outdoors through sidewall with vent caps.

2. Burner Control Housing: Corrosion-resistant, aluminized steel.

a. Sight glass for visual inspection of burner.

b. Finish: powder-coated finish.

3. Burner: Stainless steel.

4. Ignition System: Direct spark 24/25-V ac with flame rod sensing capabilities and self-diagnostic control module.

5. Combustion Blower Fan: Dynamically balanced, direct-driven, forward-curved fan with cast-aluminum-alloy impeller and steel housing, with a minimum temperature rating of 450 deg F.

6. Motors: General requirements for motors are specified in Section 230513 "Common Motor Requirements for HVAC Equipment."

a. Motor: Resilient-mounted, capacitor-start-capacitor-run type with sealed ball bearings; totally enclosed, nonventilated type with internal thermal protection.

b. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

F. Combustion Chamber: 4-inch- diameter, 16-gage hot-rolled-steel tubing with high-emissivity, high-temperature, corrosion-resistant external finish. Chambers shall be equipped with sight glass for burner and pilot flame observation.

G. Emitter Tube: 4-inch- 16-gage hot-rolled-steel tubing with high-emissivity, high-temperature, corrosion-resistant external finish

1. Tubing Connections: Interlocking flare joints with stainless-steel draw bolts.

2. 90-degree-bend emitter steel tubing with high-emissivity, high-temperature, corrosion-resistant external finish.

H. Vacuum Exhaust Fan: Dynamically balanced, direct-driven, cast-aluminum-alloy impeller in aluminized-steel housing, isolated from emitter tubing exhaust system by high-temperature flexible vibration isolation connector. Fan and connector to have a minimum temperature rating of 450 deg F.

1. Motors: General requirements for motors are specified in Section 23 05 13 "Common Motor Requirements for HVAC Equipment."

   a. Motor: Resilient-mounted, capacitor-start-capacitor-run type with sealed ball bearings; totally enclosed, nonventilated type with internal thermal protection.

   b. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

2. Balancing Dampers: Plate type, mounted in cast, double-flange fitting with vacuum test plug.

3. Filter: Cartridge type for mounting on burner housing.

4. Exhaust Vent Termination: Horizontal though side-wall with vent caps.

I. Reflector: Polished aluminum, with end caps. Shape to control radiation from tubing for uniform intensity at floor level with 100 percent cutoff above centerline of tubing. Reflectors or entire heater shall accommodate rotational adjustment from horizontal to a minimum 30-degree tilt from vertical.

J. Accessories:

1. Reflector Extension Shields: Same material as reflectors, arranged for fixed connection to lower reflector lip and rigid support to provide 100 percent cutoff of direct radiation from tubing at angles greater than 30 degrees from vertical.

2. Protective grilles mounted to reflectors to protect emitter tubing.

3. Stainless-steel flexible connector with manual valve for gas supply.

4. Hanger chain with "S" hooks.

5. 3/16-inch- diameter, aluminized-steel wire tubing hangers and reflector supports.

6. Rigid mounting kits.

7. Outdoor use conversion kit.

8. Clearance warning plaque.

K. Capacities and Characteristics:

1. As specified on the schedule of radiant heaters on the drawings.

2.04 CONTROLS AND SAFETIES

A. Gas Control Valve: Two-stage, regulated redundant 24-V ac gas valve that contains pilot solenoid valve, electric gas valve, pilot filter, pressure regulator, pilot shutoff, and manual shutoff all in one body.

B. Failure Safeguards: 100 percent shutoff of gas flow in the event of flame or power failure.

C. Prepurge of 15 seconds of air control system prior to burner ignition.

D. Safety lockout of burner after three consecutive ignition failures.

E. Blocked Vent Safety: Differential pressure switch in burner safety circuit to stop burner operation with high discharge or suction pressure.

F. Control Panel Interlock: Stops burner if panel is open.

G. Indicator Lights: "Airflow-on" and "burner-on" indicator lights.

H. Thermostat: Single-stage, wall-mounted type with 50 to 90 deg F operating range and fan on switch.

   1. Control Transformer: Integrally mounted.

I. Thermostat: Two-stage, wall-mounted type with 50 to 90 deg F operating range and fan on switch.

   1. Control Transformer: Integrally mounted.

PART 3 - EXECUTION

3.01 EXAMINATION

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

B. Examine roughing-in for fuel-gas piping to verify actual locations of piping connections before equipment installation.

C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Equipment Installation: Install gas-fired, radiant heaters and associated gas features and systems according to NFPA 54.

B. Suspended Units: Mount to substrate using manufacturer's rigid mounting kits or custom fabricated brackets.

1. Restrain the unit to resist seismic acceleration. Comply with requirements for seismic-restraint devices specified in Section 23 05 48 "Vibration and Seismic Controls for HVAC."

2. Comply with requirements for hangers and supports specified in Section 23 05 29 "Hangers and Supports for HVAC Piping and Equipment."

C. Maintain manufacturers' recommended clearances for combustibles.

3.03 CONNECTIONS

A. Gas Piping: Comply with Section 23 11 23 "Facility Natural-Gas Piping." Connect gas piping to gas train inlet; provide union with enough clearance for burner removal and service.

1. Gas Connections: Connect gas piping to radiant heaters according to NFPA 54.

B. Where installing piping adjacent to gas-fired, radiant heaters, allow space for service and maintenance.

C. Vent Connections: Comply with Section 23 31 13 "Metal Ducts."

D. Electrical Connections: Comply with applicable requirements in Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

1. Install electrical devices furnished with heaters but not specified to be factory mounted.

3.04 FIELD QUALITY CONTROL

A. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

2. Verify bearing lubrication.

3. Verify proper motor rotation.

4. Test Reports: Prepare a written report to record the following:

a. Test procedures used.

b. Test results that comply with requirements.

c. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

B. Gas-fired, radiant heaters will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

3.05 ADJUSTING

A. Adjust initial-temperature set points.

B. Adjust burner and other unit components for optimum heating performance and efficiency.

3.06 DEMONSTRATION

A. Engage a factory-authorized service representative to train the State's maintenance personnel to adjust, operate, and maintain gas fired radiant heaters. Refer to Division 01 Section 01 70 00 "Demonstration and Training."

END OF SECTION

SECTION 23 23 00

REFRIGERANT PIPING

PART 1 - GENERAL

1.01 SUMMARY

A. Volume 1 - Contracting Requirements, and Division - 01 General Requirements apply to the Work of this Section.

B. Types of hydronic piping systems and equipment specified in this Section include the following:

1. Refrigerant piping

1.02 ACTION SUBMITTALS'

A. No action submittals are necessary.

1.03 INFORMATIONAL SUBMITTALS

A. Submit under provisions of Section 01 33 00.

B. Record drawings: At project closeout, submit record drawings of installed hydronic piping and piping products in accordance with requirements of Division

1.04 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

B. Comply with ASHRAE 15, "Safety Code for Refrigeration Systems."

C. Comply with ASME B31.5, "Refrigeration Piping and Heat Transfer Components."

PART 2 - PRODUCTS

2.01 GENERAL

A. Refrigeration Piping: Refrigeration gas and liquid piping shall be Type "L" hard drawn copper tubing with wrought copper fittings.

B. All joints shall be brazed with Sil-fos or equivalent.

C. Relief valve discharge piping shall be full size of relief discharge.

D. Furnish and install Superior, Sporlan, Alco, Henry, or equal, components per the equipment manufacturers recommendations and final design flow schematic.

PART 3 - EXECUTION

3.01 GENERAL

A. Refrigerant Piping:

1. Install refrigerant piping according to ASHRAE 15.

2. Slope refrigerant piping as follows:

   a. Install horizontal hot-gas discharge piping with a uniform slope downward away from compressor.

   b. Install horizontal suction lines with a uniform slope downward to compressor.

   c. Install traps and double risers to entrain oil in vertical runs.

   d. Liquid lines may be installed level.

3. Select system components with pressure rating equal to or greater than system operating pressure.

4. Comply with requirements for pipe hangers and supports specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

5. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

3.02 QUALITY CONTROL

A. Perform the following tests and inspections:

1. Comply with ASME B31.5, Chapter VI.

2. Test refrigerant piping, specialties, and receivers. Isolate compressor, condenser, evaporator, and safety devices from test pressure if they are not rated above the test pressure.

3. Prepare test and inspection reports.

4. Leave systems and equipment in satisfactory operating condition.

3.03 SYSTEM CHARGING

A. Charge system using the following procedures:

1. Install core in filter dryers after leak test but before evacuation.

2. Evacuate entire refrigerant system with a vacuum pump to 500 micrometers. If vacuum holds for 12 hours, system is ready for charging.

3. Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig.

4. Charge system with a new filter-dryer core in charging line.

3.04 ADJUSTING

A. Adjust thermostatic expansion valve to obtain proper evaporator superheat.

B. Adjust high- and low-pressure switch settings to avoid short cycling in response to fluctuating suction pressure.

C. Adjust set-point temperature of air-conditioning or chilled-water controllers to the system design temperature.

END OF SECTION

SECTION 23 05 00

COMMON WORK RESULTS FOR HVAC

PART 1 - GENERAL

1.01 SUMMARY

A. Types of piping specialties specified in this section include the following:

1. Pipe escutcheons.
2. Sleeves.
3. Sleeve seals.
4. Unions and flanges.
5. Cathodic protection.

B. Volume 1 - Contracting Requirements, and Division - 01 General Requirements apply to the Work of this Section.

1.02 ACTION SUBMITTALS

A. No action submittals are necessary

1.03 INFORMATIONAL SUBMITTALS

A. No informational submittals are necessary

1.04 QUALITY ASSURANCE

A. All fire stopping materials shall be U.L. listed.

B. Manufacturer's qualifications: Firms regularly engaged in manufacture of piping specialties, of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

C. Identification: Provide piping specialties with manufacturer's name (or trademark) and pressure rating clearly marked on valve body.

PART 2 - PRODUCTS

2.01 GENERAL

A. Provide chrome plated brass pipe escutcheons, with inside diameter closely fitting pipe outside diameter or outside of pipe insulation where pipe is insulated. Select outside diameter of escutcheon to completely cover pipe penetration hole in floors, walls, ceilings, or pipe sleeve extension. Furnish pipe escutcheons with nickel or chrome finish and screw or spring clamping device with concealed hinge.

   1. Pipe escutcheons for moist areas: For water resistant floors, and areas where water and condensation can be expected to accumulate, provide cast brass or sheet brass escutcheons, solid or split hinged. Split hinged type shall not be used in areas with security requirements.

   2. Pipe escutcheons for dry areas: Provide sheet steel escutcheons, solid or split hinged. Split hinged type shall not be used in areas with security requirements.

B. Where pipes pass through concrete or CMU floors or walls, install galvanized metal or plastic sleeves having not less than 1/2-inch or more than 1-inch clearance around sides of the pipe or pipe covering for the full thickness of the concrete.Extend sleeves through floors one inch above floor and seal watertight.

C. After piping has been installed through a rated assembly, fill annular space with UL listed fire stopping system, 3M, Fire Barrier, Dow Firestop or Nelson Firestop. All through-wall or floor firestop penetrations shall comply with the requirements of Section 07 84 13 “Penetration Fire Stopping”.

D. The annular space between duct openings and ducts through all rated floors and rated walls shall be fire resistant. Seal duct penetrations with an incombustible material, as approved by the SFM

E. Provide sleeve seals for sleeves located in foundation walls below grade or in exterior walls.

F. Provide unions at each threaded or soldered connection to all equipment, tanks and valves.

G. Provide insulating couplings or flanges at connections of piping with dissimilar materials. Construct couplings so that the two pipes being connected are completely insulated from each other with no metal to metal contact. Heavily line the couplings with a hard, insulating, phenolic threaded coupling in standard pipe sizes.

H. Flanges:

Type of Pipe	Flanges
Screwed black or galvanized steel pipeline, 2-1/2 inches and larger.	125 lb. cast iron screwed steel flange flat faced, black or galvanized.
Welded steel pipe, 2-1/2 inches and larger for all services	150 lb. forged steel welding flanges, 1/16 inch raised faced.

I. Provide full faced or ring type gasket material to suit facing on flanges and material carried in pipe.

PART 3 - EXECUTION

3.01 GENERAL

A. Provide unions at each threaded or soldered connection to all equipment, tanks and valves.

B. Provide flanges at each flanged connection to equipment, tanks, and valves.

C. Provide dielectric unions at all locations described herein and as required.

D. Installation of piping specialties:

1. Pipe escutcheons: Install pipe escutcheons on each pipe penetration through floors, walls, partitions, and ceilings where penetration is exposed to view and on exterior of building. Secure escutcheon to pipe or insulation so escutcheon covers penetration hole and is flush with adjoining surface.

2. Sleeves: Secure sleeves to metal or wood forms in such a manner that they will not become displaced during pouring of concrete. Fill sleeves on deck with sand. After forms have been removed from concrete, the sleeves shall remain.

3. Core drill properly sized holes in the concrete to replace metal sleeves that are crushed or knocked out of position during pouring of concrete. Coordinate core drilling with structural engineer.

4. Sleeve seals: Install in accordance with the following where required:

   a. Mastic and oakum: Fill and pack annular space between sleeve opening and pipe with oakum; caulk with mastic on both sides.

   b. Mechanical sleeve seals: Loosely assemble rubber links around pipe with bolts and pressure plates located under each bolt head and nut. Push into sleeve opening and center. Tighten bolts until links have expanded to form watertight seal.

E. Installation of unions and flanges: Install piping unions and flanges so that piping can be easily disconnected for removal of tanks, equipment, and valves. Provide three unions at each three way valve.

END OF SECTION

SECTION 23 05 13

COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Volume 1 - Contracting Requirements, and Division - 01 General Requirements apply to the Work of this Section.

1.02 SUMMARY

A. This Section includes basic requirements for factory-installed and field-installed motors.

B. See Division 1 Section 01 91 13 “General Commissioning Requirements” for building/system commissioning requirements.

C. Related Sections include the following:

1. Section 23 05 48 "Vibration and Seismic Controls for HVAC Piping and Equipment” for mounting motors and vibration isolation and seismic-control devices.

2. Sections for application of motors and reference to specific motor requirements for motor-driven equipment.

1.03 DEFINITIONS

A. Factory-Installed Motor: A motor installed by motorized-equipment manufacturer as a component of equipment.

B. Field-Installed Motor: A motor installed at Project site and not factory installed as an integral component of motorized equipment.

1.04 ACTION SUBMITTALS

A. No action submittals are necessary.

1.05 INFORMATIONAL SUBMITTALS

A. Product Data for Field-Installed Motors: For each type and size of motor, provide nameplate data and ratings; shipping, installed, and operating weights; mounting arrangements; size, type, and location of winding terminations; conduit entry and ground lug locations; and information on coatings or finishes.

B. Shop Drawings for Field-Installed Motors: Dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Include the following:

1. Each installed unit's type and details.

2. Nameplate legends.

3. Diagrams of power and control wiring. Provide schematic wiring diagram for each type of motor and for each control scheme.

C. Coordination Drawings: Floor plans showing dimensioned layout, required working clearances, and required area above and around field-installed motors. Show motor layout, mechanical power transfer link, driven load, and relationship between electrical components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate field measurements.

D. Manufacturer Seismic Qualification Certification: Submit certification that motors, accessories, and components will withstand seismic forces defined in Division 23 Section 23 05 48 "Vibration and Seismic Controls for HVAC Piping and Equipment." Include the following:

1. Basis of Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2. Dimensioned Outline Drawings of Motorized Equipment: Identify center of gravity and locate and describe mounting and anchorage provisions.

3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

E. Qualification Data: For testing agency.

F. Test Reports: Written reports specified in Parts 2 and 3.

G. Operation and Maintenance Data: For field-installed motors to include in emergency, operation, and maintenance manuals.

1.06 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent testing agency, acceptable to authorities having jurisdiction, with the experience and capability to conduct the testing indicated, as documented according to ASTM E 548.

B. Source Limitations: Obtain field-installed motors of a single type through one source from a single manufacturer.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

D. Comply with NFPA 70.

1.07 COORDINATION

A. Coordinate features of motors, installed units, and accessory devices. Provide motors that are:

1. Compatible with the following:

a. Magnetic controllers.

b. Multi-speed controllers.

2. Designed and labeled for use with variable frequency controllers, and suitable for use throughout speed range without overheating.

3. Matched to torque and horsepower requirements of the load.

4. Matched to ratings and characteristics of supply circuit and required control sequence.

B. Coordinate motor support with requirements for driven load; access for maintenance and motor replacement; installation of accessories, belts, belt guards; and adjustment of sliding rails for belt tensioning.

C. Coordinate size and location of concrete bases if required. Concrete, reinforcement, and formwork requirements are specified in Division 3.

1.08 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace motor that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Five years from date of Acceptance of Work.

PART 2 - PRODUCTS

2.01 MOTOR REQUIREMENTS

A. Motor requirements apply to factory-installed and field-installed motors except as follows:

1. Different ratings, performance, or characteristics for a motor are specified in another Section.

2. Manufacturer for a factory-installed motor requires ratings, performance, or characteristics, other than those specified in this Section, to meet performance specified.

2.02 MOTOR CHARACTERISTICS

A. Motors 3/4 HP and Larger: Three phase.

B. Motors Smaller than 3/4 HP: Single phase.

C. Frequency Rating: 60 Hz.

D. Voltage Rating: NEMA standard voltage selected to operate on nominal circuit voltage to which motor is connected.

E. Service Factor: 1.15 for open drip proof motors; 1.0 for totally enclosed motors.

F. Duty: Continuous duty at ambient temperature of 105 deg F and at altitude of 5800 feet above sea level.

G. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

H. Enclosure: Open drip proof or totally enclosed fan cooled

2.03 POLYPHASE MOTORS

A. Description: NEMA MG 1, Design B, medium induction motor.

B. Efficiency: Premium efficiency.

C. Stator: Copper windings, unless otherwise indicated.

D. Rotor: Squirrel cage, unless otherwise indicated.

E. Bearings: Double-shielded, pre-lubricated ball bearings suitable for radial and thrust loading.

F. Temperature Rise: Match insulation rating, unless otherwise indicated.

G. Insulation: Class F, unless otherwise indicated.

H. Code Letter Designation:

1. Motors 15 HP and Larger: NEMA starting Code F or G.

2. Motors Smaller Than 15 HP: Manufacturer's standard starting characteristic.

I. Enclosure: Cast iron for motors 7.5 hp and larger; rolled steel for motors smaller than 7.5 hp.

1. Finish: Gray enamel.

2.04 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

A. Motors Used with Reduced-Inrush Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.

B. Motors Used with Variable Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.

1. Designed with critical vibration frequencies outside operating range of controller output.

2. Temperature Rise: Matched to rating for Class B insulation.

3. Insulation: Class H.

4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.

C. Rugged-Duty Motors: Totally enclosed, with 1.00 minimum service factor, greased bearings, integral condensate drains, and capped relief vents. Windings insulated with non-hygroscopic material.

1. Finish: Chemical-resistant paint over corrosion-resistant primer.

D. Source Quality Control: Perform the following tests on each motor according to NEMA MG 1:

1. Measure winding resistance.

2. Read no-load current and speed at rated voltage and frequency.

3. Measure locked rotor current at rated frequency.

4. Perform high-potential test.

2.05 SINGLE-PHASE MOTORS

A. Type: One of the following, to suit starting torque and requirements of specific motor application:

1. Permanent-split capacitor.

2. Split-phase start, capacitor run.

3. Capacitor start, capacitor run.

B. Shaded-Pole Motors: For motors 1/20 hp and smaller only.

C. 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.

D. Bearings: Ball type for belt-connected motors and other motors with high radial forces on motor shaft; sealed, pre-lubricated-sleeve type for other single-phase motors.

E. Source Quality Control: Perform the following tests on each motor according to NEMA MG 1:

1. Measure winding resistance.

2. Read no-load current and speed at rated voltage and frequency.

3. Measure locked rotor current at rated frequency.

4. Perform high-potential test.

2.06 MOTOR CONTROLLERS

A. Provide Motor Controllers and motor protection of appropriate NEMA size, and as indicated on the Drawings. For units not using NEMA rating, use equivalent NEMA size.

B. Refer to Division 26 - Electrical for complete Specification.

C. Manual type:

1. Single-speed, complete with 2-pole toggle switch with overload protection and pilot light: Cutler-Hammer No. 9101 or equal.

2. For automatically operated motors, provide HOA switch and pilot lights. Provide key operated HOA switch for starters located exposed in occupied rooms.

D. Magnetic type:

1. Provide magnetic motor starters for all equipment provided under the Mechanical Work, except magnetic motor starters located in motor control centers shall be furnished under the Electrical Work.

2. Provide part-winding or reduced voltage start motors where shown or as hereinafter specified.

3. Magnetic type motor controllers shall be combination unfused disconnect switch and magnetic starter, except as noted. Provide HOA selector switch for automatically operated motors (air and refrigeration compressors excepted), wire safety controls common to both controls. Provide reset button and pilot lights.

4. Provide overload protection in each phase leg.

5. Provide horsepower-rated, external-padlocking type switches.

6. Interlock contacts: - 3NO, 4NC and hold-in interlock.

7. Provide 10 watt, 120 volt auxiliary holding coils for main line plus minimum 2-10 amp auxiliaries.

E. Provide control transformers for motors over 120 volt, with step-down control voltage to 120 volts sized for required capacity. Low-voltage side of transformers shall be complete with fuse and ground connection.

F. Fuses: similar to specified in Division 26 – Electrical.

G. Provide relays for supplementing auxiliary contacts in controllers: minimum 10 watt coil and 2 - 10 amp contacts, with auxiliary transformer, where required.

H. Enclosures: NEMA type shall be suitable for service and location.

I. Components:

1. Terminals: suitable for conductors noted and as required.

2. Controllers sized to match motors.

3. Pilot lights shall be incandescent lamps for positive indication for motors with local disconnect switches.

J. Starters for single-phase motors shall have thermal overloads and shall be equal to Westinghouse Type MSTO1SN1P, toggle-operated with pilot light, NEMA I enclosure. Locate starters inside the building adjacent to temperature control panel, as indicated on the drawings, or as directed. Starters located outdoors shall be weather protected and ambient compensated.

K. Provide OSHA label indicating the device starts automatically.

L. Available Manufacturers: Subject to compliance with requirements, manufacturers offering electric motor controllers which may be incorporated in the work include the following:

1. Allen-Bradley.

2. Westinghouse.

3. General Electric.

4. Or approved equal.

2.07 FAN DRIVES

A. Drive Design: The design horsepower rating of each drive shall be at least 1.5 times, single belt drives two times, the nameplate rating of the motor with proper allowances for sheave diameters, speed ratio, arcs of contact and belt length.

   1. All drives shall be variable speed; Dayco, Browning, Woods or approved equal.

   2. All drives for 5 horsepower motors and larger shall have a minimum of two (2) belts.

   3. Belts shall be within 1 degree 30 minutes of true alignment in all cases.

   4. All variable speed drives shall be selected to allow an increase or decrease of minimum of ten percent of design fan speed.

B. 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.

C. Belts: All belts shall be furnished in matched sets.

D. Replace fan and motor sheaves as required to provide the air quantity specified. Replace belts, if necessary to match the final selection of sheaves

2.08 VARIABLE FREQUENCY DRIVES

A. General:

   1. Furnish Variable Frequency Drives (VFDs). VFDs shall be UL or ETL listed. Deliver drives fully functional as one complete unit, warranted by a single manufacturer.

   2. Variable Frequency Drive Systems shall be compatible with motors provided. Refer to Section 26 29 23 "Variable Frequency Motor Controllers" for requirements. Size Variable Frequency Drive Systems to insure the motor full load amps does not exceed the controller continuous RMS amps.

   3. Variable Frequency Drive Systems shall be capable of interfacing with the Building EMS System and provide continuous feedback for speed and “fault”.

B. Hardware:

   1. Provide microprocessor based, fully transistorized Variable Frequency Drive Systems with a conservatively rated 3-phase full wave diode bridge input and a PWM sine coded output wave form. The input diode bridge shall offer complete immunity against voltage dips, line noise and harmonics. Test and rate VFDs for a minimum of 20 years Mean Time Between Failure (MTBF).

      a. Provide manufacturer’s test results with submittal to verify MTBF.

   2. To minimize electrical and acoustical noise and to eliminate low speed cogging, a minimum of 2500 pulses per sine shall be generated. The VFD shall not 'cog' at

frequencies above l.8 Hz. There shall be no sudden frequency shifts and associated acoustical noise shifts through the range of l.8 - 60 Hz.

3. Provide 0.98 or better input constant displacement power factor over the entire operating range. Efficiency shall be measured at 96% minimum at 100% load. Provide manufacturer's test results with submittal to verify efficiency and power factor.

4. Provide Solid State Ground Fault Protection, and adaptive electronic motor overload protection, to protect both the motor and drive at all frequencies. Electronic thermal overload circuits which properly protect the motor only at full speed shall not be acceptable. The VFD shall sense the load and speed and recalibrate the thermal trip curve to insure low speed motor protection. The initial trip point shall be adjustable from at least 40 - 100% of the VFD amperage rating.

5. Provide isolated control inputs, isolated from ground and high voltage power. Motor speed shall be directly proportional to 0 - 10 volts, 4 - 20 Ma, and variable resistance input signals.

6. The microprocessor based control board shall be common for all sizes from 1 - 200 KVA.

7. The VFD shall be suitable for installation and use under the following environmental conditions: 20 to 104°F, 0 - 90% RH, non-condensing. The VFD shall not be located in direct sunlight.

8. Drive operation options shall be software programmable or switch selectable and shall include at a minimum the following functions:

    a. Automatic speed holding if control signal is lost.

    b. DC injection braking, full speed to stop, fixed at 100% torque or adjustable (plus ‘coast to stop’ capability).

    c. Adjustable hand jog.

    d. Automatic reduction in voltage with a reduction of load. This energy saving feature shall not sacrifice acceleration torque.

    e. Provide a minimum of 16 Voltage-Frequency patterns to optimize motor efficiency under varying torque and speed conditions. Include the following:

        1) 4 – General Purpose.

        2) 4 – Variable Torque.

        3) 4 – Constant high starting torque (high Hz/V ratio at starting speeds).

        4) 4 – High speed.

f. 50, 60, 72, 90, 120 and 180 Hz maximum speeds shall be software programmable or switch selectable in each VFD.

g. Electronic motor direction reversing.

9. The VFD shall provide the following operation features:

a. Speed search transfer. The VFD shall be able to start from bypass or fault trip into a spinning load without stopping the motor or creating a fault condition. The VFD shall match the motor's speed and then drive the motor to its proper speed.

b. Adjustable current limit threshold.

c. Multiple restart upon fault trip.

d. Minimum 40:1 speed ratio.

e. Individual adjustable acceleration and deceleration patterns, adjustable from 0.1 – 1800 seconds.

f. Minimum 2 second power loss ride through without drive trip or loss of programming.

g. Provide the capability to limit power consumption of supply fan #1 and 3 drives to 50% and return fan #1 and 3 drives to 60% upon receiving a signal from generator transfer switch. Drives for those fans shall operate on emergency power for smoke management; coordinate with controls contractor.

10. Provide input line reactor to reduce harmonic distortion to 5% THD maximum and to improve displacement power factor.

11. Where VFD to motor power wiring exceeds 100 feet, provide VFD output DV/DT filters to limit voltage reflection at the motor.

C. Fault Indication and Operation:

1. The following fault conditions shall cause the VFD to shut off (trip) and shall be annunciated by LCD readout or by LED indicators on the control board: FU: Fuse Blown, OC: Instantaneous Overcurrent, OV: Overvoltage, UV: Undervoltage, OH: Overheat, EB: External Failure, CPF: Control Function Error, CPF-SEL: Control Function Selection Error, OL: Overload.

2. The VFD shall attempt to restart a minimum of 5 times after tripping on a fault. A dry contact on the VFD shall close after the fifth unsuccessful restart attempt.

D. Control Module:

1. The VFD shall be equipped with a digital operator interface which shall allow the following functions:

a. Digital frequency indication on an LCD display.

b. Digital fault indication on the LCD display. Digital fault reset. Storage and operator initiated recall of the fault conditions in the sequence of occurrence.

c. Auto/Manual operation switch.

d. Digital speed control in 0.1 Hz increments.

e. Forward/Reverse operation.

f. Jog.

g. Digital indication of Kilowatt Hours.

E. Variable Frequency Drive Bypass: Provide the following accessories for the bypass system:

1. Door interlock fused disconnect switch.

2. Three contactors (one for bypass operation and two for isolating the VFD when bypass is being utilized).

3. Manual reset motor overload relay.

4. Safety circuit terminal strip.

5. Fused control transformer.

6. “Power on” light.

7. Operation “Mode” switch with static pilot lights (drive or bypass).

8. Safety circuit “trip” indicator pilot light.

9. Normal / Off / Test switch and light indication

10. The by-pass controls shall receive the main EMS start/stop command and cycle the by-passed fan controls with the EMS system.

F. Available Manufacturers: Subject to compliance with requirements, manufacturers offering Variable Frequency Drive Systems which may be incorporated in the work include the following:

1. Danfoss

2. ABBOr approved equal

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine areas to receive field-installed motors for compliance with requirements, installation and service tolerances, and other conditions affecting performance.

B. Examine roughing-in of conduit systems to verify actual locations of conduit connections before motor installation.

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

3.02 FIELD QUALITY CONTROL

A. Prepare for acceptance tests as follows:

1. Run each motor with its controller. Demonstrate correct rotation, alignment, and speed at motor design load.

2. Test interlocks and control features for proper operation.

3. Verify that current in each phase is within nameplate rating.

B. Testing: Engage a qualified testing agency to perform the following field quality-control testing:

C. Testing: Perform the following field quality-control testing:

1. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Section 7.15.1. Certify compliance with test parameters.

2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

D. Manufacturer's Field Service: Engage a factory-authorized service representative to perform the following:

1. Inspect field-assembled components, equipment installation, and piping and electrical connections for compliance with requirements.

2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3. Verify bearing lubrication.

4. Verify proper motor rotation.

5. Test Reports: Prepare a written report to record the following:

a. Test procedures used.

b. Test results that comply with requirements.

c. Test results that do not comply with requirements and corrective action taken to achieve compliance.

3.03 ADJUSTING

A. Align motors, bases, shafts, pulleys and belts. Tension belts according to manufacturer's written instructions.

3.04 CLEANING

A. After completing equipment installation, inspect unit components. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish.

B. Clean motors, on completion of installation, according to manufacturer's written instructions.

END OF SECTION

SECTION 23 05 23

GENERAL-DUTY VALVES FOR HVAC PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Volume 1 - Contracting Requirements, and Division - 01 General Requirements apply to the Work of this Section.

1.02 SUMMARY

A. This Section includes the following general-duty valves:

1. Bronze angle valves.
2. Cast-iron angle valves.
3. Copper-alloy ball valves.
4. Ferrous-alloy ball valves.
5. Ferrous-alloy butterfly valves.
6. High-pressure butterfly valves.
7. Bronze check valves.
8. Gray-iron swing check valves.
9. Ferrous-alloy wafer check valves.
10. Spring-loaded, lift-disc check valves.
11. Bronze gate valves.
12. Cast-iron gate valves.
13. Bronze globe valves.
14. Cast-iron globe valves.
15. Cast-iron plug valves.
16. Resilient-seated, cast-iron, eccentric plug valves.
17. Chainwheel actuators.

B. See Division 1 Section 01 91 00 “General Commissioning Requirements” for building/system commissioning requirements.

C. Related Sections include the following:

1. Division 21 Fire Sprinkler System for fire-protection valves.

2. Section 23 05 53 "Identification for HVAC Piping and Equipment" for valve tags and charts.

3. Section 23 09 00 "Instrumentation and Controls for HVAC" for control valves and actuators.

4. Piping sections for specialty valves applicable to those Sections only.

1.03 DEFINITIONS

A. The following are standard abbreviations for valves:

1. CWP: Cold working pressure.

2. EPDM: Ethylene-propylene-diene terpolymer rubber.

3. NBR: Acrylonitrile-butadiene rubber.

4. PTFE: Polytetrafluoroethylene plastic.

5. SWP: Steam working pressure.

6. TFE: Tetrafluoroethylene plastic.

1.04 ACTION SUBMITTALS

A. No action submittals are necessary.

1.05 INFORMATIONAL SUBMITTALS

A. Product Data:

1. For each type of valve indicated.

2. Include body, seating, and trim materials; valve design; pressure and temperature classifications; end connections; arrangement; dimensions; and required clearances.

3. Include list indicating valve and its application. Include rated capacities; shipping, installed, and operating weights; furnished specialties; and accessories.

1.06 QUALITY ASSURANCE

A. ASME Compliance: ASME B31.9 for building services piping valves.

   1. Exceptions: Domestic hot- and cold-water piping valves unless referenced.

B. ASME Compliance for Ferrous Valves: ASME B16.10 and ASME B16.34 for dimension and design criteria.

C. NSF Compliance: NSF 61 for valve materials for potable-water service.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:

   1. Protect internal parts against rust and corrosion.

   2. Protect threads, flange faces, grooves, and weld ends.

   3. Set angle, gate, and globe valves closed to prevent rattling.

   4. Set ball and plug valves open to minimize exposure of functional surfaces.

   5. Set butterfly valves closed or slightly open.

   6. Block check valves in either closed or open position.

B. Use the following precautions during storage:

   1. Maintain valve end protection.

   2. Store valves indoors and maintain at higher than ambient dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use hand-wheels or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:

   1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the manufacturers specified.

2.02 VALVES, GENERAL

A. Refer to Part 3 "Valve Applications" Article for applications of valves.

B. Bronze Valves: NPS 2 and smaller with threaded or sweat ends, unless otherwise indicated.

C. Ferrous Valves: NPS 2-1/2 and larger with flanged ends, unless otherwise indicated.

D. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

E. Valve Sizes: Same as upstream pipe, unless otherwise indicated.

F. Valve Actuators:

1. Chainwheel: For attachment to valves, of size and mounting height, as indicated in the "Valve Installation" Article in Part 3.

2. Gear Drive: For quarter-turn valves NPS 8 and larger.

3. Handwheel: For valves other than quarter-turn types.

4. Lever Handle: For quarter-turn valves NPS 6 and smaller, except plug valves.

5. Wrench: For plug valves with square heads. Furnish State with 1 wrench for every 10 plug valves, for each size square plug head.

G. Extended Valve Stems: On insulated valves.

H. Valve Flanges: ASME B16.1 for cast-iron valves, ASME B16.5 for steel valves, and ASME B16.24 for bronze valves.

I. Valve Grooved Ends: AWWA C606.

1. Solder Joint: With sockets according to ASME B16.18.

a. Caution: Use solder with melting point below 840 deg F for angle, check, gate, and globe valves; below 421 deg F for ball valves.

2. Threaded: With threads according to ASME B1.20.1.

J. Valve Bypass and Drain Connections: MSS SP-45.

2.03 BRONZE ANGLE VALVES

A. Available Manufacturers:

1. Type 1, Bronze Angle Valves with Metal Disc:

a. Cincinnati Valve Co.

b. Crane Co.; Crane Valve Group; Stockham Div.

c. NIBCO INC.

d. Or approved equal.

2. Type 2, Bronze Angle Valves with Nonmetallic Disc:

a. Crane Co.; Crane Valve Group; Crane Valves.

b. Grinnell Corporation.

c. NIBCO INC.

d. Or approved equal.

3. Type 3, Bronze Angle Valves with Metal Disc and Renewable Seat:

a. Cincinnati Valve Co.

b. Crane Co.; Crane Valve Group; Crane Valves.

c. NIBCO INC.

d. Or approved equal.

B. Bronze Angle Valves, General: MSS SP-80, with ferrous-alloy hand-wheel.

C. Type 1, Class 125, Bronze Angle Valves: Bronze body with bronze

D. Type 1, Class 150, Bronze Angle Valves: Bronze body with bronze.

E. Type 1, Class 200, Bronze Angle Valves: Bronze body with bronze disc.

F. Type 2, Class 125, Bronze Angle Valves: Bronze body with nonmetallic disc.

G. Type 2, Class 150, Bronze Angle Valves: Bronze body with nonmetallic disc.

H. Type 2, Class 200, Bronze Angle Valves: Bronze body with nonmetallic disc.

I. Type 3, Class 125, Bronze Angle Valves: Bronze body with bronze disc and renewable seat.

J. Type 3, Class 150, Bronze Angle Valves: Bronze body with bronze disc and renewable seat.

K. Type 3, Class 200, Bronze Angle Valves: Bronze body with bronze disc and renewable seat.

2.04 CAST-IRON ANGLE VALVES

A. Available Manufacturers:

1. Type II, Cast-Iron Angle Valves with Metal Seats:

    a. Crane Co.; Crane Valve Group; Crane Valves.

    b. NIBCO INC.

    c. Or approved equal.

B. Cast-Iron Angle Valves, General: MSS SP-85, Type II.

C. Class 125, Cast-Iron Angle Valves: Bronze mounted with gray-iron body and bronze seats.

D. Class 250, Cast-Iron Angle Valves: Bronze mounted with gray-iron body and bronze seats.

2.05 COPPER-ALLOY BALL VALVES

A. Available Manufacturers:

1. One-Piece, Copper-Alloy Ball Valves:

    a. Crane Co.; Crane Valve Group; Jenkins Valves.

    b. NIBCO INC.

    c. Watts Industries, Inc.; Water Products Div.

    d. Or approved equal.

2. Two-Piece, Copper-Alloy Ball Valves:

    a. Crane Co.; Crane Valve Group; Crane Valves.

    b. NIBCO INC.

    c. Watts Industries, Inc.; Water Products Div.

    d. Or approved equal.

3. Three-Piece, Copper-Alloy Ball Valves:

    a. Grinnell Corporation.

    b. NIBCO INC.

    c. Worcester Controls.

d. Or approved equal.

4. Safety-Exhaust, Copper-Alloy Ball Valves:

a. Grinnell Corporation.

b. Milwaukee Valve Company.

c. NIBCO INC.

d. Or approved equal.

B. Copper-Alloy Ball Valves, General: MSS SP-110.

C. One-Piece, Copper-Alloy Ball Valves: Brass or bronze body with chrome-plated bronze ball, PTFE or TFE seats, and 400 psig minimum CWP rating.

D. Two-Piece, Copper-Alloy Ball Valves: Bronze body with full-port, chrome-plated bronze ball; PTFE TFE seats; and 600 psig minimum CWP rating and blowout-proof stem.

E. Three-Piece, Copper-Alloy Ball Valves: bronze body with full-port, chrome-plated bronze ball; PTFE TFE seats; and 600 psig minimum CWP rating and blowout-proof stem.

F. Safety-Exhaust, Copper-Alloy Ball Valves: Two-piece bronze body with exhaust vent opening, chrome-plated ball with vent, blowout-proof stem, locking handle, and working pressure rating of 400 psig.

2.06 FERROUS-ALLOY BALL VALVES

A. Available Manufacturers:

1. Crane Co.; Crane Valve Group; Stockham Div.

2. Milwaukee Valve Company.

3. NIBCO INC.

4. Or approved equal.

B. Ferrous-Alloy Ball Valves, General: MSS SP-72, with flanged ends.

C. Ferrous-Alloy Ball Valves: Class 150, full port.

D. Ferrous-Alloy Ball Valves: Class 300, full port.

2.07 FERROUS-ALLOY BUTTERFLY VALVES

A. Available Manufacturers:

1. Flangeless, Ferrous-Alloy Butterfly Valves:

a. Crane Co.; Crane Valve Group; Center Line.

b. NIBCO INC.

c. Watts Industries, Inc.; Water Products Div.

d. Or approved equal.

2. Single-Flange, Ferrous-Alloy Butterfly Valves:

a. Crane Co.; Crane Valve Group; Center Line.

b. NIBCO INC.

c. Watts Industries, Inc.; Water Products Div.

d. Or approved equal.

3. Flanged, Ferrous-Alloy Butterfly Valves:

a. Grinnell Corporation.

b. Watts Industries, Inc.; Water Products Div.

c. Tyco International, Ltd.; Tyco Valves & Controls.

d. Or approved equal.

4. Grooved-End, Ductile-Iron Butterfly Valves:

a. Grinnell Corporation.

b. Milwaukee Valve Company.

c. NIBCO INC.

d. Or approved equal.

2.08 BRONZE CHECK VALVES

A. Available Manufacturers:

1. Type 1, Bronze, Horizontal Lift Check Valves with Metal Disc:

a. Cincinnati Valve Co.

b. Crane Co.; Crane Valve Group; Crane Valves.

c. Walworth Co.

d. Or approved equal.

2. Type 2, Bronze, Horizontal Lift Check Valves with Nonmetallic Disc:
    a. Cincinnati Valve Co.
    b. Crane Co.; Crane Valve Group; Crane Valves.
    c. Walworth Co.
    d. Or approved equal.
3. Type 1, Bronze, Vertical Lift Check Valves with Metal Disc:
    a. Cincinnati Valve Co.
    b. Crane Co.; Crane Valve Group; Crane Valves.
    c. Red-White Valve Corp.
    d. Or approved equal.
4. Type 2, Bronze, Vertical Lift Check Valves with Nonmetallic Disc:
    a. Grinnell Corporation.
    b. . Crane Co.; Crane Valve Group; Crane Valves.
    c. Milwaukee Valve Company.
    d. Or approved equal.
5. Type 3, Bronze, Swing Check Valves with Metal Disc:
    a. Crane Co.; Crane Valve Group; Crane Valves.
    b. Grinnell Corporation.
    c. NIBCO INC.
    d. Or approved equal.
6. Type 4, Bronze, Swing Check Valves with Nonmetallic Disc:
    a. Crane Co.; Crane Valve Group; Crane Valves.
    b. NIBCO INC.
    c. Watts Industries, Inc.; Water Products Div.
    d. Or approved equal.

B. Bronze Check Valves, General: MSS SP-80.

C. Type 1, Class 125, Bronze, Horizontal Lift Check Valves: Bronze body with bronze disc and seat.

D. Type 1, Class 125, Bronze, Vertical Lift Check Valves: Bronze body with bronze disc and seat.

E. Type 1, Class 150, Bronze, Horizontal Lift Check Valves: Bronze body with bronze disc and seat.

F. Type 1, Class 150, Bronze, Vertical Lift Check Valves: Bronze body with bronze disc and seat.

G. Type 1, Class 200, Bronze, Horizontal Lift Check Valves: Bronze body with bronze disc and seat.

H. Type 1, Class 200, Bronze, Vertical Lift Check Valves: Bronze body with bronze disc and seat.

I. Type 2, Class 125, Bronze, Horizontal Lift Check Valves: Bronze body with nonmetallic disc and bronze seat.

J. Type 2, Class 125, Bronze, Vertical Lift Check Valves: Bronze body with nonmetallic disc and bronze seat.

K. Type 2, Class 150, Bronze, Horizontal Lift Check Valves: Bronze body with nonmetallic disc and bronze seat.

L. Type 2, Class 150, Bronze, Vertical Lift Check Valves: Bronze body with nonmetallic disc and bronze seat.

M. Type 2, Class 200, Bronze, Horizontal Lift Check Valves: Bronze body with nonmetallic disc and bronze seat.

N. Type 2, Class 200, Bronze, Vertical Lift Check Valves: Bronze body with nonmetallic disc and bronze seat.

O. Type 3, Class 125, Bronze, Swing Check Valves: Bronze body with bronze disc and seat.

P. Type 3, Class 150, Bronze, Swing Check Valves: Bronze body with bronze disc and seat.

Q. Type 3, Class 200, Bronze, Swing Check Valves: Bronze body with bronze disc and seat.

R. Type 4, Class 125, Bronze, Swing Check Valves: Bronze body with nonmetallic disc and bronze seat.

S. Type 4, Class 150, Bronze, Swing Check Valves: Bronze body with nonmetallic disc and bronze seat.

T. Type 4, Class 200, Bronze, Swing Check Valves: Bronze body with nonmetallic disc and bronze seat.

2.09 GRAY-IRON SWING CHECK VALVES

A. Available Manufacturers:

1. Type I, Gray-Iron Swing Check Valves with Metal Seats:

    a. Crane Co.; Crane Valve Group; Crane Valves.

    b. NIBCO INC.

    c. Watts Industries, Inc.; Water Products Div.

    d. Or approved equal.

2. Type II, Gray-Iron Swing Check Valves with Composition to Metal Seats:

    a. Crane Co.; Crane Valve Group; Crane Valves.

    b. Watts Industries, Inc.; Water Products Div.

    c. NIBCO INC.

    d. Or approved equal.

3. Grooved-End, Ductile-Iron Swing Check Valves:

    a. Grinnell Corporation.

    b. Mueller Co.

    c. Victaulic Co. of America.

    d. Or approved equal.

B. Gray-Iron Swing Check Valves, General: MSS SP-71.

C. Type I, Class 125, gray-iron, swing check valves with metal seats.

D. Type I, Class 250, gray-iron, swing check valves with metal seats.

E. Type II, Class 125, gray-iron, swing check valves with composition to metal seats.

F. Type II, Class 250, gray-iron, swing check valves with composition to metal seats.

G. 175-psig CWP Rating, Grooved-End, Swing Check Valves: Ductile-iron body with grooved or shouldered ends.

2.10 FERROUS-ALLOY WAFER CHECK VALVES

A. Available Manufacturers:

1. Single-Plate, Ferrous-Alloy, Wafer Check Valves:

    a. Techno Corp.

    b. Tyco International, Ltd.; Tyco Valves & Controls.

    c. Wheatley Gaso, Inc.

    d. Or approved equal.

2. Dual-Plate, Ferrous-Alloy, Wafer Check Valves:

    a. Crane Co.; Crane Valve Group; Crane Valves.

    b. NIBCO INC.

    c. Watts Industries, Inc.; Water Products Div.

    d. Or approved equal.

3. Dual-Plate, Ferrous-Alloy, Wafer-Lug Check Valves:

    a. Crane Co.; Crane Valve Group; Crane Valves.

    b. Gulf Valve Co.

    c. Valve and Primer Corp.

    d. Or approved equal.

4. Dual-Plate, Ferrous-Alloy, Double-Flanged-Type Check Valves:

    a. Crane Co.; Crane Valve Group; Crane Valves.

    b. Gulf Valve Co.

    c. Techno Corp.

    d. Or approved equal.

B. Ferrous-Alloy Wafer Check Valves, General: API 594, spring loaded.

C. Single-Plate, Class 125 or 150, Ferrous-Alloy, Wafer Check Valves: Flangeless body.

D. Single-Plate, Class 250 or 300, Ferrous-Alloy, Wafer Check Valves: Flangeless body.

E. Single-Plate, Class 125 or 150, Ferrous-Alloy, Wafer-Lug Check Valves: Single-flange body.

F. Single-Plate, Class 250 or 300, Ferrous-Alloy, Wafer-Lug Check Valves: Single-flange body.

G. Single-Plate, Class 125 or 150, Ferrous-Alloy, Double-Flanged Check Valves: Flanged-end body.

H. Single-Plate, Class 250 or 300, Ferrous-Alloy, Double-Flanged Check Valves: Flanged-end body.

I. Dual-Plate, Class 125 or 150, Ferrous-Alloy, Wafer Check Valves: Flangeless body.

J. Dual-Plate, Class 250 or 300, Ferrous-Alloy, Wafer Check Valves: Flangeless body.

K. Dual-Plate, Class 125 or 150, Ferrous-Alloy, Wafer-Lug Check Valves: Single-flange body.

L. Dual-Plate, Class 250 or 300, Ferrous-Alloy, Wafer-Lug Check Valves: Single-flange body.

M. Dual-Plate, Class 125 or 150, Ferrous-Alloy, Double-Flanged Check Valves: Flanged-end body.

N. Dual-Plate, Class 250 or 300, Ferrous-Alloy, Double-Flanged Check Valves: Flanged-end body.

2.11 SPRING-LOADED, LIFT-DISC CHECK VALVES

A. Available Manufacturers:

1. Type I, Wafer Lift-Disc Check Valves:

    a. Mueller Steam Specialty.

    b. Or approved equal.

2. Type II, Compact-Wafer, Lift-Disc Check Valves:

    a. Grinnell Corporation.

    b. Milwaukee Valve Company.

    c. NIBCO INC.

    d. Or approved equal.

3. Type III, Globe Lift-Disc Check Valves:

    a. Grinnell Corporation.

    b. Milwaukee Valve Company.

c. NIBCO INC.

d. Or approved equal.

4. Type IV, Threaded Lift-Disc Check Valves:

a. Grinnell Corporation.

b. NIBCO INC.

c. Watts Industries, Inc.; Water Products Div.

d. Or approved equal.

B. Lift-Disc Check Valves, General: FCI 74-1, with spring-loaded bronze or alloy disc and bronze or alloy seat.

C. Type I, Class 125, Wafer Lift-Disc Check Valves: Wafer style with cast-iron shell with diameter matching companion flanges.

D. Type I, Class 250, Wafer Lift-Disc Check Valves: Wafer style with cast-iron shell with diameter matching companion flanges.

E. Type II, Class 125, Compact-Wafer, Lift-Disc Check Valves: Compact-wafer style with cast-iron shell with diameter made to fit within bolt circle.

F. Type II, Class 250, Compact-Wafer, Lift-Disc Check Valves: Compact-wafer style with cast-iron shell with diameter made to fit within bolt circle.

G. Type III, Class 125, Globe Lift-Disc Check Valves: Globe style with cast-iron shell and flanged ends.

H. Type III, Class 250, Globe Lift-Disc Check Valves: Globe style with cast-iron shell and flanged ends.

I. Type IV, Class 125, Threaded Lift-Disc Check Valves: Threaded style with bronze shell and threaded ends.

J. Type IV, Class 150, Threaded Lift-Disc Check Valves: Threaded style with bronze shell and threaded ends.

2.12 BRONZE GATE VALVES

A. Available Manufacturers:

1. Type 1, Bronze, Non-rising-Stem Gate Valves:

a. Crane Co.; Crane Valve Group; Crane Valves.

b. NIBCO INC.

c. Watts Industries, Inc.; Water Products Div.

d. Or approved equal.

2. Type 2, Bronze, Rising-Stem, Solid-Wedge Gate Valves:

a. Crane Co.; Crane Valve Group; Crane Valves.

b. Grinnell Corporation.

c. NIBCO INC.

d. Or approved equal.

3. Type 3, Bronze, Rising-Stem, Split-Wedge Gate Valves:

a. Crane Co.; Crane Valve Group; Jenkins Valves.

b. Grinnell Corporation.

c. NIBCO INC.

d. Or approved equal.

B. Bronze Gate Valves, General: MSS SP-80, with ferrous-alloy hand-wheel.

C. Type 1, Class 125, Bronze Gate Valves: Bronze body with non-rising stem and bronze solid wedge.

D. Type 1, Class 150, Bronze Gate Valves: Bronze body with non-rising stem and bronze solid wedge.

E. Type 1, Class 200, Bronze Gate Valves: Bronze body with non-rising stem and bronze solid wedge.

F. Type 2, Class 125, Bronze Gate Valves: Bronze body with rising stem and bronze solid wedge.

G. Type 2, Class 150, Bronze Gate Valves: Bronze body with rising stem and bronze solid wedge.

H. Type 2, Class 200, Bronze Gate Valves: Bronze body with rising stem and bronze solid wedge.

I. Type 3, Class 125, Bronze Gate Valves: Bronze body with rising stem and bronze split wedge.

J. Type 3, Class 150, Bronze Gate Valves: Bronze body with rising stem and bronze split wedge.

K. Type 3, Class 200, Bronze Gate Valves: Bronze body with rising stem and bronze split wedge.

2.13 CAST-IRON GATE VALVES

A. Available Manufacturers:

1. Type I, Cast-Iron, Non-rising-Stem Gate Valves:

    a. Crane Co.; Crane Valve Group; Crane Valves.

    b. NIBCO INC.

    c. Watts Industries, Inc.; Water Products Div.

    d. Or approved equal.

2. Type I, Cast-Iron, Rising-Stem Gate Valves:

    a. Crane Co.; Crane Valve Group; Crane Valves.

    b. NIBCO INC.

    c. Watts Industries, Inc.; Water Products Div.

    d. Or approved equal.

B. Cast-Iron Gate Valves, General: MSS SP-70, Type I.

C. Class 125, NRS, Bronze-Mounted, Cast-Iron Gate Valves: Cast-iron body with bronze trim, non-rising stem, and solid-wedge disc.

D. Class 125, OS&Y, Bronze-Mounted, Cast-Iron Gate Valves: Cast-iron body with bronze trim, rising stem, and solid-wedge disc.

E. Class 125, NRS, All-Iron, Cast-Iron Gate Valves: Cast-iron body with cast-iron trim, non-rising stem, and solid-wedge disc.

F. Class 125, OS&Y, All-Iron, Cast-Iron Gate Valves: Cast-iron body with cast-iron trim, rising stem, and solid-wedge disc.

G. Class 250, NRS, Bronze-Mounted, Cast-Iron Gate Valves: Cast-iron body with bronze trim, non-rising stem, and solid-wedge disc.

H. Class 250, OS&Y, Bronze-Mounted, Cast-Iron Gate Valves: Cast-iron body with bronze trim, rising stem, and solid-wedge disc.

I. Class 250, NRS, All-Iron, Cast-Iron Gate Valves: Cast-iron body with cast-iron trim, non-rising stem, and solid-wedge disc.

J. Class 250, OS&Y, All-Iron, Cast-Iron Gate Valves: Cast-iron body with cast-iron trim, rising stem, and solid-wedge disc.

2.14 BRONZE GLOBE VALVES

A. Available Manufacturers:

1. Type 1, Bronze Globe Valves with Metal Disc:

    a. Crane Co.; Crane Valve Group; Crane Valves.

    b. Grinnell Corporation.

    c. NIBCO INC.

    d. Or approved equal.

2. Type 2, Bronze Globe Valves with Nonmetallic Disc:

    a. Crane Co.; Crane Valve Group; Crane Valves.

    b. Grinnell Corporation.

    c. NIBCO INC.

    d. Or approved equal.

3. Type 3, Bronze Globe Valves with Renewable Seat and Metal Disc:

    a. Crane Co.; Crane Valve Group; Crane Valves.

    b. Grinnell Corporation.

    c. NIBCO INC.

    d. Or approved equal.

B. Bronze Globe Valves, General: MSS SP-80, with ferrous-alloy hand-wheel.

C. Type 1, Class 125, Bronze Globe Valves: Bronze body with bronze disc .

D. Type 1, Class 150, Bronze Globe Valves: Bronze body with bronze disc.

E. Type 1, Class 200, Bronze Globe Valves: Bronze body with bronze disc.

F. Type 2, Class 125, Bronze Globe Valves: Bronze body with nonmetallic disc.

G. Type 2, Class 150, Bronze Globe Valves: Bronze body with nonmetallic disc.

H. Type 2, Class 200, Bronze Globe Valves: Bronze body with nonmetallic disc.

I. Type 3, Class 125, Bronze Globe Valves: Bronze body with bronze disc and renewable seat.

J. Type 3, Class 150, Bronze Globe Valves: Bronze body with bronze disc and renewable seat.

K. Type 3, Class 200, Bronze Globe Valves: Bronze body with bronze disc and renewable seat.

2.15 CAST-IRON GLOBE VALVES

A. Available Manufacturers:

1. Type I, Cast-Iron Globe Valves with Metal Seats:

    a. Crane Co.; Crane Valve Group; Crane Valves.

    b. Grinnell Corporation.

    c. NIBCO INC.

    d. Or approved equal.

B. Cast-Iron Globe Valves, General: MSS SP-85.

C. Type I, Class 125, Cast-Iron Globe Valves: Gray-iron body with bronze seats.

D. Type I, Class 250, Cast-Iron Globe Valves: Gray-iron body with bronze seats.

2.16 CAST-IRON PLUG VALVES

A. Available Manufacturers:

1. Lubricated-Type, Cast-Iron Plug Valves:

    a. Milliken Valve Co., Inc.

    b. Nordstrom Valves, Inc.

    c. Walworth Co.

    d. Or approved equal.

2. Non-lubricated-Type, Cast-Iron Plug Valves:

    a. Grinnell Corporation.

    b. Tyco International, Ltd.; Tyco Valves & Controls.

    c. Wheatley Gaso, Inc.

    d. Or approved equal.

B. Cast-Iron Plug Valves, General: MSS SP-78.

C. Class 125 or 150, lubricated-type, cast-iron plug valves.

D. Class 250 or 300, lubricated-type, cast-iron plug valves.

E. Class 125 or 150, non-lubricated-type, cast-iron plug valves.

F. Class 250, non-lubricated-type, cast-iron plug valves.

2.17 RESILIENT-SEATED, CAST-IRON, ECCENTRIC PLUG VALVES

A. Available Manufacturers:

   a. General Signal; DeZurik Unit.

   b. Milliken Valve Company.

   c. Val-Matic Valve & Mfg. Corp.

   d. Or approved equal.

B. Resilient-Seated, Cast-Iron, Eccentric Plug Valves, NPS 2-1/2 and Smaller: Design similar to MSS SP-108, and rated for 175-psig minimum CWP.

   1. Resilient Seating Material: Suitable for potable-water service, unless otherwise indicated.

C. Resilient-Seated, Cast-Iron, Eccentric Plug Valves, NPS 3 and Larger: MSS SP-108, and rated for 175-psig minimum CWP.

   1. Resilient Seating Material: Suitable for potable-water service, unless otherwise indicated.

2.18 CHAINWHEEL ACTUATORS

A. Available Manufacturers:

   1. Babbitt Steam Specialty Co.

   2. Roto Hammer Industries, Inc.

   3. Or approved equal.

B. Description: Valve actuation assembly with sprocket rim, brackets, and chain.

   1. Sprocket Rim with Chain Guides: Ductile iron, of type and size required for valve.

   2. Brackets: Type, number, size, and fasteners required to mount actuator on valve.

3. Chain: Galvanized Steel, of size required to fit sprocket rim.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine piping system for compliance with requirements for installation tolerances and other conditions affecting performance.

1. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

C. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

D. Examine threads on valve and mating pipe for form and cleanliness.

E. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

F. Do not attempt to repair defective valves; replace with new valves.

3.02 VALVE APPLICATIONS

A. Refer to piping Sections for specific valve applications. If valve applications are not indicated, use the following:

1. Shutoff Service: Ball, butterfly, gate or plug valves.

2. Throttling Service: Angle, ball, butterfly, or globe valves.

3. Pump Discharge: Spring-loaded, lift-disc check valves.

B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP class or CWP ratings may be substituted.

C. Heating Water Piping: Use the following types of valves:

1. Angle Valves, NPS 2 and Smaller: Type 2, Class 150, bronze.

2. Angle Valves, NPS 2-1/2 and Larger: Type II, Class 125, cast iron.

3. Ball Valves, NPS 2 and Smaller: Two-piece, 600-psig CWP rating,MSS SP-110 Bronze Threaded or Sweat ends.

4. Ball Valves, NPS 2-1/2 and Larger: Class 150, ferrous alloy.

5. Butterfly Valves, NPS 2-1/2 and Larger: 200 -psig CWP rating, MSS SP-67 Ductile Iron , Aluminum Bronze Disc with EPDM liner.

6. Grooved end Butterfly valves: Vic-300 MasterSeal.

7. Lift Check Valves, NPS 2 and Smaller: Type 2, Class 150, vertical, bronze.

8. Swing Check Valves, NPS 2 and Smaller: Type 4, Class 150, bronze.

9. Swing Check Valves, NPS 2-1/2 and Larger: Type II, Class 125, gray iron.

10. Grooved-End, Ductile-Iron, Swing Check Valves, NPS 2-1/2 and Larger: [175-psig CWP rating.

11. Wafer Check Valves, NPS 2-1/2 and Larger: Class 125 or 150, ferrous alloy.

12. Spring-Loaded, Lift-Disc Check Valves, NPS 2 and Smaller: Type IV, Class 125 .

13. Spring-Loaded, Lift-Disc Check Valves, NPS 2-1/2 and Larger: Type I or II, Class 125, cast iron. MSS SP-125

14. Gate Valves, NPS 2 and Smaller: Type 2 or 3, Class 150, bronze.

15. Gate Valves, NPS 2-1/2 and Larger: Type I, Class 125, bronze-mounted cast iron.

16. Globe Valves, NPS 2 and Smaller: Type 2, Class 150, bronze.

17. Globe Valves, NPS 2-1/2 and Larger: Type I, Class 125, bronze-mounted cast iron.

18. Resilient-Seated, Eccentric Plug Valves, NPS 3 and Larger: 175-psig CWP rating, cast iron.

D. Select valves, except wafer and flangeless types, with the following end connections:

1. For Copper Tubing, NPS 2 and Smaller: Solder-joint or threaded ends, except provide valves with threaded ends for heating hot water, steam, and steam condensate services.

2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged ends.

3. For Copper Tubing, NPS 5 and Larger: Flanged ends.

4. For Steel Piping, NPS 2 and Smaller: Threaded ends.

5. For Steel Piping, NPS 2-1/2 to NPS 4: Flanged

6. For Steel Piping, NPS 5 and Larger: Flanged

3.03 VALVE INSTALLATION

A. Piping installation requirements are specified in other sections.

B. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

C. Locate valves for easy access and provide separate support where necessary.

D. Install valves in horizontal piping with stem at or above center of pipe.

E. Install valves in position to allow full stem movement.

F. Install chainwheel operators on valves NPS 6” and larger and more than 84 inches above floor. Extend chains to 60 inches above finished floor elevation.

G. Install check valves for proper direction of flow and as follows:

1. Swing Check Valves: In horizontal position with hinge pin level.

2. Dual-Plate Check Valves: In horizontal or vertical position, between flanges.

3. Lift Check Valves: With stem upright and plumb.

3.04 JOINT CONSTRUCTION

A. Refer to Section 23 05 00 "Common Work Results For HVAC" for basic piping joint construction.

B. Grooved Joints: Assemble joints with keyed coupling housing, gasket, lubricant, and bolts according to coupling and fitting manufacturer's written instructions.

C. Soldered Joints: Use ASTM B 813, water-flushable, lead-free flux; ASTM B 32, lead-free-alloy solder; and ASTM B 828 procedure, unless otherwise indicated.

3.05 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

END OF SECTION

SECTION 23 05 48

VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Volume 1 - Contracting Requirements, and Division - 01 General Requirements apply to the Work of this Section.

1.02 SUMMARY

A. This Section includes the following:

1. Elastomeric isolation.
2. Restrained elastomeric isolation mounts.
3. Restrained spring isolators.
4. Housed spring mounts.
5. Elastomeric hangers.
6. Spring hangers.
7. Spring hangers with vertical-limit stops.
8. Thrust limits.
9. Pipe riser resilient supports.
10. Resilient pipe guides.
11. Seismic snubbers.
12. Restraining cables.
13. Vibration isolation equipment bases.

B. See Division 1 Section 01 91 00 “General Commissioning Requirements” for building/ system commissioning requirements.

1.03 DEFINITIONS

A. Seismic forces shall be calculated per Chapter 13 of ASCE 7-16.

B. OSHPD: Office of Statewide Health Planning & Development for the State of California. OSHPD assigns a unique anchorage preapproval "OPM" number to each seismic restraint it tests. The number describes a specific device applied as tested

1.04 PERFORMANCE REQUIREMENTS

A. Comply with Latest Edition of the California Building Code for appropriate seismic design category and importance factor of 1.5 (building A), 1.0 (building B & C).

1.05 ACTION SUBMITTALS

A. No action submittals are necessary.

1.06 INFORMATIONAL SUBMITTALS

A. Product Data: Include load deflection curves for each vibration isolation device.

B. Shop Drawings: Signed and sealed by a qualified professional engineer. Include the following:

1. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.

2. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, spring deflection changes, and seismic loads. Include certification that riser system has been examined for excessive stress and that none will exist.

3. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, base weights, equipment static loads, power transmission, component misalignment, and cantilever loads.

4. Seismic-Restraint Details: Detail fabrication and attachment of seismic restraints and snubbers. Show anchorage details and indicate quantity, diameter, and depth of penetration of anchors.

5. Submittals for Interlocking Snubbers: Include load deflection curves up to 1/4-inch deflection in x, y, and z planes.

C. Welding certificates.

D. Manufacturer Seismic Qualification Certification: Submit certification that all specified equipment will withstand seismic forces identified in "Performance Requirements" Article above. Include the following:

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculations.

a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

1.07 COORDINATION

A. Coordinate size and location of concrete bases where required. Concrete, reinforcement, and formwork requirements are specified in Division 3.

B. Coordinate installation of roof curbs, equipment supports, and roof penetrations as specified in Division 7.

1.08 QUALITY ASSURANCE

A. Seismic-restraint devices shall have horizontal and vertical load testing and analysis performed according to OSHPD and shall bear anchorage preapproval "R" number, from OSHPD or another agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are not available, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by a qualified professional engineer. Testing and calculations must include both shear and tensile loads and one test or analysis at 45 degrees to the weakest mode.

B. Welding: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code--Steel."

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the manufacturers specified.

2.02 VIBRATION ISOLATORS

A. Available Manufacturers:

1. California Dynamics Corp.

2. Kinetics Noise Control, Inc.

3. Mason Industries, Inc.

4. Or approved equal.

B. Elastomeric Isolator Pads (EIP): Oil- and water-resistant elastomer or natural rubber, arranged in single or multiple layers, molded with a nonslip pattern and galvanized steel baseplates of sufficient stiffness for uniform loading over pad area, and factory cut to sizes that match requirements of supported equipment.

1. Material: Standard neoprene.

2. Durometer Rating: 45.

C. Restrained Spring Isolators (RSI): Freestanding, steel, open-spring isolators with seismic restraint.

1. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to wind loads or if weight is removed; factory-drilled baseplate bonded to 1/4-inch thick, elastomeric isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.

2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.

3. Minimum Additional Travel: 50 percent of the required deflection at rated load.

4. Lateral Stiffness: More than 80 percent of the rated vertical stiffness.

5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

D. Housed Spring Mounts (HSM): Housed spring isolator with integral seismic snubbers.

1. Housing: Ductile-iron or steel housing to provide all-directional seismic restraint.

2. Base: Factory drilled for bolting to structure.

3. Snubbers: Vertically adjustable to allow a maximum of 1/4-inch (6-mm) travel before contacting a resilient collar.

E. Spring Hangers (SH): Combination coil-spring and elastomeric-insert hanger with spring and insert in compression.

1. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.

2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.

3. Minimum Additional Travel: 50 percent of the required deflection at rated load.

4. Lateral Stiffness: More than 80 percent of the rated vertical stiffness.

5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

6. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.

F. Elastomeric Hangers (EH): Double deflecting type, with molded, oil resistant rubber or neoprene isolator elements bonded to steel housings with threaded connections for hanger rods. Color code or otherwise identify to indicate capacity range.

G. Pipe Riser Resilient Support (PRRS): All-directional, acoustical pipe anchor consisting of 2 steel tubes separated by a minimum of 1/2-inch- (13-mm-) thick, 60-durometer neoprene. Include steel and neoprene vertical-limit stops arranged to prevent vertical travel in both directions. Design support for a maximum load on the isolation material of 500 psig (3.45 MPa) and for equal resistance in all directions.

H. Resilient Sleeves (RS): Maybe performed glass fiber pipe or insulated hangers such as Elmdor-Stoneman Trisolator.

I. Combination Spring and Neoprene Hanger (CSN):

1. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for maximum of 30 degrees of angular hanger rod misalignment.

2. Outside spring diameter; not less than 80 percent of the compressed height of the spring at rated load.

3. Minimum additional travel; 50 percent of the required deflection at rated load.

4. Neoprene or EPDM spring cup with a projecting bushing to percent steel to steel contact.

5. Double deflecting neoprene or EPDM upper element with projecting bushing.

2.03 SEISMIC-RESTRAINT DEVICES

A. Available Manufacturers:

1. Kinetics Noise Control, Inc.

2. Mason Industries, Inc.

3. TOLCO Incorporated.

4. Or approved equal.

B. Resilient Isolation Washers and Bushings (RIWB): 1-piece, molded, bridge-bearing neoprene complying with AASHTO M 251 and having a durometer of 50, plus or minus 5, with a flat washer face.

C. Seismic Snubbers (SS): Factory fabricated using welded structural-steel shapes and plates, anchor bolts, and replaceable resilient isolation washers and bushings.

1. Anchor bolts for attaching to concrete shall be seismic-rated, drill-in, and stud-wedge or female-wedge type.

2. Resilient Isolation Washers and Bushings: 1-piece, molded, bridge-bearing neoprene complying with AASHTO M 251 and having a durometer of 50, plus or minus 5.

D. Restraining Cables (RC): Galvanized steel aircraft cables with end connections made of steel assemblies that swivel to final installation angle and utilize two clamping bolts for cable engagement.

E. Anchor Bolts (AB): Seismic-rated, drill-in, and stud-wedge or female-wedge type. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488/E 488M.

2.04 VIBRATION ISOLATION EQUIPMENT BASES

A. Available Manufacturers:

1. California Dynamics Corp.

2. Kinetics Noise Control, Inc.

3. Mason Industries, Inc.

4. Or approved equal.

B. Steel Base (SB): Factory-fabricated, welded, structural-steel bases and rails.

1. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails. Include supports for suction and discharge elbows for pumps.

2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Bases shall have shape to accommodate supported equipment.

3. Support Brackets: Factory-welded steel angles on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.

C. Inertia Base (IB): Factory-fabricated, welded, structural-steel bases and rails ready for field-applied, cast-in-place concrete.

1. Design Requirements: Lowest possible mounting height with not less than 1-inch (25-mm) clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails. Include supports for suction and discharge elbows for pumps.

2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Bases shall have shape to accommodate supported equipment.

3. Support Brackets: Factory-welded steel angles on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.

4. Fabrication: Fabricate steel templates to hold equipment anchor-bolt sleeves and anchors in place during placement of concrete. Obtain anchor-bolt templates from supported equipment manufacturer.

2.05 FACTORY FINISHES

A. Manufacturer's standard prime-coat finish ready for field painting.

B. Finish: Manufacturer's standard paint applied to factory-assembled and -tested equipment before shipping.

1. Powder coating on springs.

2. All hardware shall be electrogalvanized. Hot-dip galvanize metal components for exterior use.

3. Baked enamel for metal components on isolators for interior use.

4. Color-code or otherwise mark vibration isolation and seismic-control devices to indicate capacity range.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine areas and equipment to receive vibration isolation and seismic-control devices for compliance with requirements, installation tolerances, and other conditions affecting performance.

B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.

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

3.02 INSTALLATION

A. Install roof curbs, equipment supports, and roof penetrations as specified in Division 7.

B. Install thrust limits at centerline of thrust, symmetrical on either side of equipment.

C. Install seismic snubbers on isolated equipment. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure.

D. Install restraining cables at each trapeze and individual pipe hanger. At trapeze anchor locations, shackle piping to trapeze. Install cables so they do not bend across sharp edges of adjacent equipment or building structure.

E. Install steel angles or channel, sized to prevent buckling, clamped with ductile-iron clamps to hanger rods for trapeze and individual pipe hangers. At trapeze anchor locations, shackle piping to trapeze. Requirements apply equally to hanging equipment. Do not weld angles to rods.

F. Install resilient bolt isolation washers on equipment anchor bolts.

3.03 EQUIPMENT BASES

A. Fill concrete inertia bases, after installing base frame, with 3000-psi concrete; trowel to a smooth finish.

1. Cast-in-place concrete materials and placement requirements are specified in Division 3.

B. Concrete Bases: Anchor equipment to concrete base according to supported equipment manufacturer's written instructions for seismic codes at Project site.

1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.

2. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base and anchor into structural concrete floor.

3. Place and secure anchorage devices. Use Setting Drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

4. Install anchor bolts to elevations required for proper attachment to supported equipment.

5. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

6. Cast-in-place concrete materials and placement requirements are specified in Division 3.

3.04 FIELD QUALITY CONTROL

A. Testing: Perform the following field quality-control testing:

1. Isolator seismic-restraint clearance.

2. Isolator deflection.

3. Snubber minimum clearances.

3.05 ADJUSTING

A. Adjust isolators after piping systems have been filled and equipment is at operating weight.

B. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

C. Attach thrust limits at centerline of thrust and adjust to a maximum of 1/4-inch movement during start and stop.

D. Adjust active height of spring isolators.

E. Adjust snubbers according to manufacturer's written recommendations.

F. Adjust seismic restraints to permit free movement of equipment within normal mode of operation.

G. Torque anchor bolts according to equipment manufacturer's written recommendations to resist seismic forces.

3.06 CLEANING

A. After completing equipment installation, inspect vibration isolation and seismic-control devices. Remove paint splatters and other spots, dirt, and debris.

3.07 INSTALLATION SCHEDULE

A. HVAC systems vibration isolation schedule

HVAC Systems Vibration Isolation Schedule					
Equipment Mark	**Design Deflect**	**Isolator Type**	**Frame or Base**	**Seismic Controls**	**Notes**
Hwp	1”	Rsi	Sb	Ss	
Ahu					Internally isolated
Piping < 3”	.2-.4”	Eh		Rc	For 1st 25 feet from vibration generating equipment
Piping < 3”		Rs		Rc	Beyond 25 feet from vibration generating equipment
Piping < 3”	½-1/6”	Csn		Rc	For 1st 50 feet from vibration generating equipment

HVAC Systems Vibration Isolation Schedule					
Equipment Mark	**Design Deflect**	**Isolator Type**	**Frame or Base**	**Seismic Controls**	**Notes**
Piping < 3” (uninsulated)		Eh		Rc	Beyond 50 feet from vibration generating equipment
Supply duct	1.2-1.6”	Csn		Rc	Within 25 feet of vibration generating equipment
Supply duct		Eh		Rc	Between 25 feet from and 50 feet from vibration generating equipment
Return/exhaust duct	1.2-1.6”	Csn		Rc	Within 20 feet of vibration equipment
Return/exhaust duct		Eh		Rc	Between 20 feet from and 40 feet from vibration equipment

END OF SECTION

SECTION 23 07 00

HVAC INSULATION

PART 1 - GENERAL

1.01 SUMMARY

A. Types of mechanical insulation products specified in this Section include the following:

1. Pipe insulation.
2. Duct insulation and wrap.
3. Equipment insulation.
4. Facings, sealants and adhesives for above.

B. Volume 1 - Contracting Requirements, and Division - 01 General Requirements apply to the Work of this Section.

1.02 ACTION SUBMITTALS

A. No action submittals are necessary.

1.03 INFORMATIONAL SUBMITTALS

A. Submit under provisions of Section 01 33 00.

B. Submittals for review during construction document phase:

1. Product data:

a. Submit manufacturer's technical product data and installation instructions for each type of mechanical insulation.

b. Submit schedule showing manufacturer's product number, K-value, thickness, density, and furnished accessories for each mechanical system requiring insulation.

c. Include complete description of installation methods with this submittal.

C. Submittals for review during construction phase:

1. Submit qualifications of manufacturer and installer, demonstrating compliance with paragraph "Quality Assurance".

D. Submittals for closeout:

1. Maintenance data: Submit maintenance data and replacement material lists for each type of mechanical insulation. Include this data and product data in maintenance manual.

2. Submit all warranties signed by the manufacturer

3. Provide all special tools, loose gauges and test kits and maintenance and calibration instructions.

1.04 QUALITY ASSURANCE

A. Manufacturer's qualifications: Firms regularly engaged in manufacture of mechanical insulation products, of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Installer's qualifications: Firm with at least 5 years successful installation experience on projects with mechanical insulation similar to that required for this project.

C. Install thermal insulation products on equipment in accordance with manufacturer's written instructions to ensure that insulation serves its intended purpose.

D. Flame/smoke ratings: Provide composite mechanical insulation (insulation, jackets, coverings, sealers, mastic, and adhesives) with flame-spread rating of 25 or less and smoke-developed index of 50 or less.

E. Building insulation shall comply with California Quality Standards for insulating material.

F. Insulation material shall be certified by the California Energy Commission.

G. Installation shall comply with the National Commercial & Industrial Insulation Standards published by Midwest Insulation Contractors Association (MICA) and endorsed by National Insulation Contractors Association (NICA) regional associations.

PART 2 - PRODUCTS

2.01 GENERAL

A. Insulation materials:

1. Insulation jackets:

a. Cover insulation exposed in conditioned areas and mechanical rooms with 30 mil thick fire-retardant PVC jacket. Provide pre-molded insulation covering on fittings. Seal cold piping, including domestic cold water, and condensate drain piping vapor tight to provide a continuous moisture resistant seal.

b. Cover insulation exposed to weather with a heavy duty, 0.016 inch thick, aluminum jacket, sealed weathertight. Secure jacket with 1/2 inch aluminum bands on 12 inch centers.

2. Cold piping (below 60 degrees F): Cover with heavy density glass fiber insulation, having factory-applied, self-sealing vapor barrier all-service jacket, molded to conform to piping, K-value at 75 degrees F, maximum 0.23 Btu-in/hr-sq ft degrees F.

3. Hot piping: Cover with heavy density glass fiber insulation, having factory-applied, self-sealing all-service jacket, molded to conform to piping, K-value at 75 degrees F, maximum 0.23 Btu-in/hr-sq ft degrees F.

4. Refrigerant piping and condensate drain pans: Cover with foamed plastic of closed cell structure, K-value at 75 degrees F, maximum 0.28 Btu-in/hr-sq ft degrees F and a maximum water vapor transmission rating of 0.1 perms. Armstrong Armaflex or Imcolock.

5. Hot equipment: Cover with rigid glass fiber insulation board, having a factory-applied all-service jacket, K-value at 75 degrees F, maximum 0.23 Btu-in/hr-sq ft degrees F, 6 pcf density.

6. Cold equipment: Cover with rigid glass fiber insulation board, having factory-applied, vapor barrier all-service jacket, K-value at 75 degrees F, maximum 0.23 Btu-in/hr-sq ft degrees F, 6 pcf density.

7. Fittings and valves: Pre-molded PVC covers installed over pre-formed insulation having same K-value as adjacent material.

8. Ductwork:

   a. Wrap all unlined supply ducts, return ducts, and outside air intake ducts to heating and cooling systems, unless indicated otherwise, with 2 inch thick, 3/4 pound density Owens Corning Fiberglass All Service faced duct wrap, or equal.

      1) Exhaust ductwork located within the building insulation envelope need not be provided with duct wrap insulation.

      2) Provide insulation, as noted above for exhaust ductwork located in attic spaces which are not within the building insulation envelope.

   b. Wrap all unlined ductwork located in fan rooms and mechanical equipment rooms, unless indicated otherwise, with 1-1/2 inch thick, Fiberglas 705 insulating board with factory applied foil facing, or equal.

   c. Cover all exposed, wrapped ductwork, including mechanical rooms, with Proto-Wrap, or equal, 0.030 LoSmoke PVC Jacketing, installed with water-based type adhesive. Install in accordance with manufacturer's printed recommendations. Flame spread and fuel contribution shall be less than 25. Smoke generated shall be less than 50.

d. Cover all standing seams and transverse joints in all ductwork with Hardcast FTA-20 adhesive and Hardcast DT-Tape, installed in accordance with manufacturer's directions before insulating to assure airtight joints. Include all connections to air inlets and outlets.

1) Provide Hardcast RTA-50 Adhesive where ductwork is exposed to weather.

e. Cover externally insulated ductwork everywhere ductwork is exposed to weather, and in mechanical rooms, with 8-ounce canvas jacket sized with two coats of lagging adhesive.

f. Allow exterior ductwork lagging adhesive to dry thoroughly and paint with aluminum paint.

9. Minimum piping thickness shall be per latest California Energy Efficiency Standards, T-24.

PART 3 - EXECUTION

3.01 GENERAL

A. Installation of piping and equipment insulation products.

1. Installation of piping insulation:

a. Install insulation products in accordance with manufacturer’s written instructions and in accordance with recognized industry practices to ensure that insulation serves its intended purpose.

2. Provide equivalent thickness insulation on all fittings, expansion loops, flanges, strainers, and valves and finish with pre-molded PVC fitting covers. Maintain vapor barrier integrity and install in accordance with manufacturer’s instructions.

3. Finish insulation neatly at hangers, supports and other protrusions. Refer to Section 23 05 29 ”Hangers and Supports for HVAC Piping and Equipment”.

4. Locate cover seams on insulation in least visible locations.

5. Do not insulate flexible connections, expansion joints, and seismic joints except on chilled water systems.

6. Terminate insulation neatly with mastic troweled on bevel.

7. Cover cold piping fittings and valves with equivalent thickness of insulation material.

a. Seal lap joints with 100 percent coverage vapor barrier and adhesive.

b. Seal butt joints with 4 inch wide strips of vapor barrier sealed with vapor barrier adhesive.

c. Cover unions, flanges, couplings, valves, etc., with pre-molded insulated PVC fitting covers.

8. Cover hot piping fittings and valves up to bonnets with equivalent thickness of insulation material.

   a. Cover unions, flanges, couplings, valves, etc., with pre-molded insulated PVC fitting covers.

9. Cover refrigerant piping, fittings, and valves up to bonnets with equivalent thickness of insulation material.

   a. Apply with edges tightly butted.

   b. Seal joints with vapor barrier sealer.

10. Equipment shall have insulation applied with edges tightly butted, joints staggered and secured in place by steel bands.

    a. Where necessary, provide suitable pin anchors welded in place.

    b. Provide sufficient clearance around openings for normal operation of equipment.

    c. Finish cold surface insulation joints with 4 inch wide strips of vapor barrier tape sealed with vapor barrier adhesive.

11. Repair separation of joints and cracking of insulation caused by thermal movement or poor workmanship.

12. Insulate pump bodies with material compatible with respective systems for which insulation is specified.

13. Construct hinged, removable pump insulation boxes in accordance with standards outlined under “Quality Assurance”.

14. Where insulation requires sealing and taping, complete required procedures at the same time insulating material is applied to assure clean surfaces exist for proper adhesion.

15. Cinch staples shall be permitted only in accordance with insulation installation instructions. Cover all staples with vapor barrier mastic.

16. Cover insulated outdoor piping systems with aluminum lagging.

17. Install insulation on pipe systems subsequent to installation of heat tracing, testing, and acceptance of tests.

18. Insulate flanges, unions and traps with removable sections of insulation.

19. The term "piping" used herein shall include pipe, valves, strainers, and fittings. Apply insulating cements to fittings, valves, and strainers, and trowel smooth to the

thickness of adjacent covering. Covering on valves shall extend up to the bonnet. The covering cement shall be of the types herein specified.

B. Installation of ductwork insulation:

1. Install insulation products in accordance with manufacturer's written instructions and in accordance with recognized industry practices to ensure that insulation serves its intended purpose. In addition, install duct insulation with all of the following:

   a. Wrap all unlined concealed supply and return ducts with fiberglass duct wrap, 1 inches thick and ¾ lb. per cubic foot density manufactured as a blanket of glass fibers factory laminated to a reinforced foil/kraft vapor retarding facing. 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.

   b. Mechanical fasteners shall be weld pins or perforated base adhesive type pins; self-adhering type pins or impact driven pins are not acceptable.

2. Extend ductwork insulation without interruption through walls, floors, and similar ductwork penetrations, except piping through fire walls and where otherwise indicated.

3. Lined Ductwork: Except as otherwise specified, omit insulation on ductwork where internal insulation or sound-absorbing linings have been installed.

END OF SECTION

SECTION 23 09 00

INSTRUMENTATION AND CONTROLS

PART 1 - GENERAL

1.01 SUMMARY

A. Volume 1 - Contracting Requirements, and Division - 01 General Requirements apply to the Work of this Section.

B. Furnish all labor, materials, equipment, and service necessary for a complete and operating Building management system (BMS), utilizing direct digital controls, and actuation devices, as shown on the drawings and as described herein. Drawings are diagrammatic only. All labor, material, equipment and software not specifically referred to herein or on the plans, that are required to meet the functional intent, shall be provided without additional cost to the State.

C. Coordination with other Sections:

1. 23 30 00 Ductwork Accessories

2. Division 26 - Electrical for power wiring and conduit.

D. The entire Building Management System (BMS) shall be comprised of a network of inter-operable, stand-alone digital controllers, host computer systems with graphical user interface software, and other devices as specified herein.

E. Specification nomenclature:

1. BMS: Building Management System

2. SDC: Stand-alone Supervisory Digital Controller

3. IDC: Inter-operable Digital Controller

4. LIDC: Lighting Interface Digital Controller

5. GDC: Gateway Digital Controller

6. GP: Graphical Programmer

7. HMI: Human Machine Interface

8. PAC: Personnel Access Controller

9. GUI: Graphical User Interface

1.02 SYSTEM DESCRIPTION

A. The Building Management System (BMS) shall not utilize the CHP network. Provide an independent dedicated Ethernet network for the BMS.

B. One laptop computer shall be provided for the maintenance staff for communication with the Building Management System. Laptop to be located in the Janitor's Office. The laptop computer shall be Intel Pentium based (minimum processing speed of 2.3 Mhz), 4 GB RAM, a minimum 128 gigabyte hard disk drive, and 2-USB ports. In addition, provide HMI to HMI communications via an IEEE 802.3 10/100 Mbps Ethernet Network Adapter. The Ethernet adapter shall support early token release for improved efficiency.

C. Open, inter-operable, integrated architectures:

1. The intent of this specification is to provide a peer-to-peer networked, stand-alone, distributed control system utilizing either or both the ANSI/ASHRAE Standard 135-2016 BACnet technology communication protocols.

2. The BMS shall utilize direct communication through the BACnet communication protocols to other microprocessor based systems. Custom, project specific gateways generated to achieve this communication are not acceptable. The BMS supplier shall provide a list of the equipment and systems for which communication will be established for this project with both the BACnet communication protocols. This list will be submitted with the DDC submittal.

3. The BMS shall interface with the fire alarm system to provide monitoring of fire alarm inputs. It is the intent of this specification that this communication will be through the BACnet communication protocols. If the fire alarm system is not provided with communication capability from either of these protocols, hard wired inputs shall be utilized to achieve this monitoring function of the BMS. The BMS shall not in either case be capable of access into the fire alarm system for any purpose other than monitoring alarm status.

4. The BMS shall support the direct integration of standard and non-standard communicating systems. At a minimum, the BMS shall deliver connectivity at the BACnet, IP, and HMI levels through standard offerings. The BMS shall offer as a standard available solution, a minimum of 50 individual communicating interfaces to 3rd party products, with the ability to increase as necessary.

5. The BMS shall provide a BACnet Network Interface that shall provide communication between the IDCs and SDC. The connection between the SDC and HMI computer shall support one of the following types of communication standards.

6. Ethernet

   a. The network interface shall directly support connectivity to a variety of cabling types. As a minimum provide the following connectivity: 10Base2 (ThinNet RG-58 A/U Coaxial cabling with BNC connectors), 10BaseT (Twisted-Pair RJ-45 terminated UTP cabling).

D. Standalone digital controllers (SDC):

1. The SDC controllers shall permit the simultaneous operation of all control, communication facilities management and operator interface software, as programmed by the temperature control sub-contractor or User. Modification of the on-board SDC controller database shall be performed on-line by the sub-contractor using the built-in interface. Systems that require the SDC to be removed from service while DDC control sequences are modified shall not be acceptable.

2. SDC controllers shall utilize true floating-point arithmetic capabilities. To accommodate totalization of large totalized values, SDCs with reporting capability shall support the calculation, accumulation and display of values within the range of +/-10 to the 10th power. The SDC shall employ a multi-tasking, multi-user operating system.

3. All programming defining the functions to be performed by the SDC, including but not limited to application programs and point database within each SDC which shall be protected from loss due to power failure for a minimum of six months. SDC software not equipped with automatic backup software shall provide a system rechargeable battery backup system sufficient to provide protection for the specified 6 month period.

4. SDC controllers shall be equipped with a minimum of one operator service port for the connection of serial devices such as the GP, HMI, etc. Connection of a service device, to a service port, shall not cause the SDC controller to lose communications with its peers or other networked device controllers. The SDC shall be able to route alarms, trends, and reports to the HMI connected to the network. Alarms shall include the time, date, and alarm condition, in addition to a user-defined detailed message detailing the condition.

5. The SDC shall provide alarming, point trending and energy report generation capabilities. Alarming points shall be uniquely definable, with multiple alarms assignable to a single point. Such alarms shall be provided with a unique 80-character maximum message.

6. The quantities of trended point values shall be limited only by total controller memory space. Each unique input or output point shall record and a minimum of 128 trend samples per point. Trending frequency for each report shall be operator definable from a sample once a second to a sample once every 24 hours. Trend reports shall be internally formatted by the SDC and shall be available for download as a formatted ASCII data file.

7. The energy reports shall not be limited in quantities only by available memory within the SDC. Each energy report shall be fully formatted and available for download as a formatted ASCII data file. At a minimum, each energy report shall provide a daily report and a monthly report with summary information such as outside air temperature and total energy consumed if applicable.

8. The SDC shall provide connectivity to the currently marketed BMS solutions offered by the manufacturer. The SDC shall be interoperable to these BMS offerings for scheduling, energy demand limiting, alarming, optimized start/stop, and systems integrations for all other data within the entire BMS. In addition, the SDC shall provide connectivity to existing DDC controllers currently marketed by the manufacturer.

9. The SDC shall be compliant with the current and previously marketed HMIs of the manufacturer, and shall be capable of full bi-directional communications through the LAN, with previously manufactured SDC controllers sold for the last ten years by the manufacturer.

E. Interoperable digital controllers:

1. Controls shall be microprocessor based Interoperable BACnet Digital Controllers (IDC), providing interoperability with all BACnet devices. IDCs shall be provided for any equipment applications as required, as shown on the drawings. The application control program shall be resident within the same enclosure as the input/output circuitry, which translates the sensor signals.

2. All IDCs shall be fully application programmable utilizing graphical objects. All control sequences programmed into the IDC shall be stored in non-volatile memory, which is not dependent upon the presence of a battery, to be retained. Systems that only allow selection of sequences from a library or table are not acceptable.

3. The IDC shall be provided with the ability to interface with the graphical programming tool through a connection to the SDC.

4. The IDCs shall communicate with the SDC at a baud rate of not less than 38.4K baud. The IDC shall have as a minimum ambient operating temperature range of 32 to 122 degrees Fahrenheit.

5. The IDC shall be fully supported by the graphical user interface (GUI).

6. All input/output signals shall be directly hardwired to the IDC. All controllers shall employ a universal input configuration that allows for flexibility in application ranging from dry contact, resistive and voltage/current-source inputs. If universal points are not available, a minimum of one spare input point (each) of the dry contact, resistive and analog voltage/current types must be provided for each input point utilized. IDC devices shall provide digital and analog output types and quantities consistent with the requirements of the application requirements. Troubleshooting of input/output signals shall be easily executed with the graphical programming tool or a volt-ohm meter (VOM). All I/O points shall be utilized by the local ILC or shall be available as I/O points for other controllers throughout the network.

F. Graphical user interface (GUI):

1. The graphical user interface shall reside on the SDC to allow the operator to view, configure, and edit values from multiple controllers on the BACnet communication bus. The GUI shall be completely programmable and shall be accessible through a contractor provided laptop computer. Operator interface shall include graphical icons associated with any displayed variable. Variables such as alarms, trends, set points, analog, and digital values may be displayed and/or edited using the GUI.

2. Multiple users shall be able to access the GUI concurrently and the GUI shall be capable of displaying common and/or unique parameters of the system controllers.

3. Each GUI shall be password protected and provide for a minimum of three unique passwords. All data residing in the GUI shall be stored in EEPROM non-volatile memory, which is not dependent upon the presence of a battery, to be retained. GUI's that do not have EEPROM shall provide a minimum 6-month battery back up, or dedicated UPS for each GUI.

G. Human-machine interface software:

1. The HMI shall be completely icon driven, multi-tasking and employing a graphical operating environment that allows the operator to perform virtually all functions through the mouse and keyboard. Up to 16 applications may collect data dynamically and simultaneously from the SDCs without HMI speed degradation.

2. Provide web-based local access to the HMI software without additional client software.

3. The HMI, through its LAN connectivity, shall support an Ethernet connection.

4. The HMI shall be utilized for real-time access to all integrated systems on the LAN as well as for information management. Information management shall mean the manipulation of all real time or archived system information, via SDC database. Complete file management and data transfer (such as copying, moving or transferring files) manually shall be provided via web browser download functionality. An inherent knowledge by the operator of the "operating system" shall not be required for the daily operation of this system.

5. The HMI shall be capable of true multi-tasking capabilities. The user shall be able to use other non-related programs in the HMI while still running all HMI applications with no interruptions, including the use of real time data in other applications. The HMI shall gather data from the SDCs dynamically, while monitoring display frames.

6. This HMI shall provide an easy method of menuing for system access. Any and all HMI programs shall be accessible only through this HMI menuing system. Systems that require the use of MS Windows 95 explorer and/or X-Tree format, as the shell or entry point to other programs, shall be rejected.

7. This menuing program shall utilize dynamic push buttons. Each pushbutton shall be user configurable to allow access to any of the HMIs applications. A push-button shall display a user selectable ICON and text describing visually the linked application. The dynamic push button shall be capable of launching an application or a specific file. As an example, a push-button may be configured to take a user to a dynamic graphic screen for a particular zone in a building or launch a non-BMS business application.

8. Predefined graphical wizards shall be provided to simplify the introduction of the HMIs operating system to the user.

9. System shall provide a point manipulation that allows the operator to define customized BMS control functions.

10. System shall automatically re-enable the HMI applications following a power failure reset of the hardware, with operator re-login required.

H. HMI system security:

1. System security shall be on an application by application basis. System administrator shall setup and define access privileges per user, per application and per set point levels. The users shall be assigned discrete password names and codes, both of which must be entered in order to have access to any particular application or function within the system. Access privileges shall also be assignable by the administrator.

I. HMI display frames:

1. The dynamic graphic portion of this HMI shall allow the operator to access any system information via a “system penetration” method. “System penetration” shall allow the operator to penetrate into the facility until the detailed color graphic display of a specific area of the facility is represented. All system travel shall be 100% accessible via the mouse and keyboard.

2. The ability to import background images for the display frames shall include as a minimum, photos, digital images, bitmaps and standard image formats. Systems that utilize a proprietary background image format are not acceptable.

3. As a minimum, a graphic display shall be provided for the overall site, for each subsystem within the site and for all individual locations associated with each subsystem. All graphics shall be logically linked to allow the operator to traverse through the overall system and at any time return immediately to the associated subsystem, or overall site plan, via a graphic element.

4. Animation of system data shall be provided via graphic elements on the display frames. A standard graphic element library shall be provided to assist the operator with implementation.

5. The ability to simultaneously display a dynamic X/Y Chart of selected points shall be provided. The chart shall be an element of the graphic display and shall automatically update with the display data. The chart shall allow for dynamic manipulation to modify the range, rate, and timeframe of view, in both a real-time as well as historical configuration. A minimum of 4 values shall be available on any chart display element. There shall not be a limit to the quantity of chart elements displayed on a graphic frame. Trace colors and X values shall be User configurable. Systems not providing this capability are required to provide an equivalent charting package with the HMI offering.

6. HMI support documentation shall be provided. It shall not be necessary to maintain printed copies of user or programming manuals. Context sensitive help files shall be provided for all applications within the BMS area of the HMI.

7. By pointing and clicking on any individual graphic element, a self-prompting pop-up window shall be displayed providing the ability to modify the selected point value. Instructions assisting the operator in their use of the pop-up window shall be provided via operator training.

8. The ability to provide graphically displayed global scheduling and editing functions shall be provided. The ability to link these functions to the associated equipment or

zone frames shall be a standard feature. A calendar shall be provided for display and modification of the SDC time clock functions. The user shall be able to view a daily, weekly, monthly, annual, special or holiday schedule from a defined display frame. A list of served areas shall be displayed on the same screen, this list shall be displayed at all times, pull down menus or other means of accessing these areas shall not be acceptable. The user shall only have to click on a scheduling widget to view time clock schedules.

J. HMI alarming:

1. The HMI shall provide, as standard, alarm annunciation of system data. On a dedicated display frame, the ability to view, acknowledge, delete and manipulate real-time and historical alarms shall be provided. The ability to provide a unique and custom alarm display for every display frame shall be provided. The ability to continuously, or upon request view, the alarm display, shall be provided.

2. Alarm conditions shall be capable of invoking, as a minimum; a display frame and response instruction display.

3. Alarm logging shall be provided in a user definable configuration. All alarms shall be displayed and/or routed as follows, as a minimum; HMI display frame, logged to file, and archived in standard format for information management. Alarm groupings shall be hierarchical in nature allowing up to 8 alarm groups and 16 sub-groups. The HMI shall not possess any limits on the quantity of alarms that can be logged, including historical data archiving. Systems possessing limits must define the restrictions and may not be acceptable.

4. Alarm provider shall be capable of providing up to 999 alarm priorities with up to 3 alarm color changes, per priority, according to alarm status.

K. HMI trending:

1. The HMI shall automatically perform time based, user defined, and periodic collection of real time point data. The data shall be presented as an X/Y Chart in the display frame. The data shall be stored and archived in a file format that allows for download, manipulation and utilization of the data by third party applications.

2. A dynamic trend shall be defined as a group of at least 4 data points, with a circular buffer of 2000 data points. A historical trend shall be defined as a group of at least 8 data points, with the sampled points limited only by archival disk space. Sampling rates shall be user selectable from instantaneous (one per second) to once a week. Collection of data shall be user selectable to start and stop on a specific time and date. There shall be no limit to the number of X/Y Charts within a display frame.

3. X/Y Charting and column and row reporting shall be an integral part of the HMI. All points shall be chartable or reportable.

4. X/Y charting shall provide for the following chart manipulation: display, zoom, scroll, centering, pen legend and export to Excel Text via web browser download.

L. HMI reporting:

1. The HMI report section shall be the window to the HMI database for all solicited and unsolicited data collected and shall provide for an easy means of reporting and information management. The HMI shall allow for daily, weekly, monthly scheduling of reports or intervals custom to the needs of the user through the trending database. The report generator shall allow an operator to easily and quickly define the contents of a report as well as define a print time and date. Information contained in the reports, as a minimum, shall be derived from trend data.

2. The operator shall be able to compile reports by user, company/department, time and date period, and point or points.

M. HMI graphic screen generation:

1. The BMS supplier shall include the generation of graphic screens on the HMI software package to depict the operation of all the systems controlled and monitored. Screens, as a minimum, shall be as described below.

2. Overall facility plan with transfers to screens depicting operations in various portions of the building(s).

3. VAV zone operation. Screens shall be generated for each group of VAV zones within a floor or area within a floor with a maximum of 20 zones indicated per graphic screen. A graphic representation of the VAV terminal shall be included with a table annunciating measured data for each zone.

4. Floor plans of each floor or area within each floor with zone thermostat locations indicated and with annunciation of each zone temperature shown.

5. Graphic screens shall be generated to illustrate the operation schedules of each mechanical equipment system that operates on a regular on-off schedule. These screens shall include a means of overriding the current schedule from that screen.

N. Other temperature control system materials:

1. Control damper actuators (where furnished by the temperature control sub-contractor): Two-position or proportional electric actuators shall be direct-mount type sized to provide a minimum of 5 in-lb torque per square foot of damper area. Damper actuators shall be spring return or fail in position type. Provide one actuator per damper minimum.

2. Control valves: Control valves shall be 2-way or 3-way pattern as shown constructed for tight shutoff and shall operate satisfactorily against system pressures and differentials. Two-position valves shall be ‘line’ size. Proportional control valves shall be sized for a maximum pressure drop of 5.0 psi at rated flow (except as may be noted on the drawings). Valves with sizes up to and including 2 inches shall be “screwed” configuration and 2-1/2 inch and larger valves shall be “flanged” configuration. Electrically controlled valves shall include spring return type actuators sized for tight shut-off against system pressures and furnished with integral switches for indication of valve position (open-closed).

3. Wall mount room thermostats: Each room thermostat shall provide temperature indication to the digital controller, provide the capability for a software-limited set point adjustment and operation override capability. An integral LCD shall annunciate current room temperature and set point as well as override status indication.

4. Duct mount, pipe mount and outside air temperature sensors: 10,000-ohm thermistor temperature sensors with an accuracy of ± 0.2ºC. Outside air sensors shall include an integral sun shield.

5. Current sensitive switches: Solid state, split core current switch that operates when the current level (sensed by the internal current transformer) exceeds the adjustable trip point. Current switch to include an integral LED for indication of trip condition and a current level below trip set point.

6. Water flow meters: Water flow meters shall be axial turbine style flow meters which translate liquid motion into electronic output signals proportional to the flow sensed. Flow sensing turbine rotors shall be non-metallic and not impaired by magnetic drag. Flow meters shall be 'insertion' type complete with 'hot-tap' isolation valves to enable sensor removal without water supply system shutdown. Accuracy shall be ±2% of actual reading from 0.4 to 20 feet per second flow velocities.

7. Temperature control panels: Furnish temperature control panels of code gauge steel with locking doors for mounting all devices as shown. Control panels shall meet all requirements of Title 24, California Administrative Code. All electrical devices within a control panel shall be factory wired. All external wiring shall be connected to terminal strips mounted within the panel. Provide engraved phenolic nameplates identifying all devices mounted on the face of control panels.

O. Control system wiring:

1. All electrical control wiring under 30 volts to the control panels shall be the responsibility of the BMS sub-contractor.

2. Power wiring to the control panels, electrical starters and motors is under Division 26.

3. All wiring shall be in accordance with Division 26, the California Electrical Code and any applicable local codes. All BMS wiring shall be installed in the conduit types specified in Division 26, unless otherwise allowed by the California Electrical Code or applicable local codes and approved by the State. Where BMS plenum rated cable wiring is allowed it shall be run parallel to, or at right angles to, the structure. Properly install and support work in a neat and workmanlike manner.

P. Minimum Control Points:

1. General:

a. Continuously monitor for indication, trend logs, temperature control, and energy management as specified, the following data and control points. Provide for addition of future points.

2. Hot Water Boiler:

a. Status.

b. Start/stop.

c. Runtime.

d. Heating water supply temperature.

e. Heating water return temperature.

3. Boiler Alarms:

a. High pressure.

b. High temperature.

c. Other alarms integral with boiler.

4. Heating Water Plant:

a. Heating water supply temperature.

b. Heating water return temperature.

c. Heating water supply reset.

5. Each Pump:

a. Status.

b. Start/stop.

c. Runtime.

6. Domestic Water pump:

a. Status.

b. Start/stop.

c. Runtime.

7. Variable Volume AC Unit:

a. Fan status.

b. Fan start/stop.

c. Fan runtime,

d. Supply air temperature.

e. Return air temperature

f. Mixed air temperature.

g. Filter dirty.

h. Outside air damper position.

i. Exhaust air damper position.

j. Return air damper position.

k. Minimum outside air damper position.

l. Minimum outside air damper reset.

1.03 ACTION SUBMITTALS

A. Submit under provisions of Section 01 33 00.

B. Submittals for review during construction document phase:

1. Complete list of equipment and materials.

2. Manufacturer's catalog data sheets and installation instructions for equipment and materials. Shop drawings shall also contain 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. Terminal identification for all control wiring shall be shown on the shop drawings. A complete written sequence of operation shall also be included with the submittal package.

3. Submittal shall also include a trunk cable schematic diagram depicting the client computer and control panel locations and a description of the communication type, media and protocol.

4. Submittal shall also include a complete point list of all connected points to the DDC system

1.04 INFORMATIONAL SUBMITTALS

A. Submittals for review during construction phase:

1. Submit manufacturer's specifications for each control device furnished, including installation instructions and start-up instructions. Submit integrated electrical diagrams to show the complete system operation. Wiring diagrams shall show the entire control system for each building with terminal identifications and a bill of materials listing that includes the manufacturer, product model and/or part numbers and quantities.

2. Submit diagrams of control panel layouts showing in a graphical manner the location and size of each device within each panel.

3. Submit a list of connected data points, including panels to which they are connected and input or output device (sensor, actuator, etc.).

B. Submittals for close out:

1. Submittal to be provided both in hardcopy form and in electronic form. Electronic drawings to be in MS Visio.

2. Submit 1 hard copy of the manufacturer's Operator's Manual and Programmer's Manual for the system to be furnished for this project bound in a 8-1/2"x11" 3-ring binder, neatly typed and organized with a table of contents and section tabs. An electronic copy Operator's Manuals shall be provided as well.

3. Submit all warranties signed by the manufacturer

4. Provide all special tools, loose gauges and test kits and maintenance and calibration instructions.

1.05 QUALITY ASSURANCE

A. General: Quality assurance for automatic control systems includes a multi-step program consisting of a pre-qualification procedure for manufacturer and installation specialist; a system engineering, products and shop drawing phase; installation; testing and adjusting; reporting; commissioning testing and verifications; operating instruction and training; and the submission of maintenance and operating manuals.

B. The manufacturer of the temperature control system shall provide documentation supporting compliance with ISO-9001 (Model for Quality Assurance in Design/Development, Production, Installation and Servicing). Product literature provided by the temperature control system manufacturer shall contain the ISO-9001 Certification Mark from the applicable registrar. Manufacturers delivering products that do not comply with the ISO-9001 certification requirement shall provide the following information to assure that quality systems are in place which are equivalent to the ISO-9001 standard:

1. Marketing specification standards.

2. Design file standards.

3. Manufacturing test standards.

4. Calibration standards.

5. Quality system standards.

6. Documented, management commitment that all employees participate in the quality programs.

7. Training procedures.

8. Methods by which corrective actions are taken for problems identity within the factory processes

C. Submittals not complying with technical requirements will be considered unacceptable.

D. Agency and code approvals:

1. All products of the BMS shall be provided with the following agency approvals. Verification that the approvals exist for all submitted products shall be provided with the submittal package. Systems or products not currently offering the following approvals are not acceptable.

a. UL-916; Energy Management Systems

b. ULC; UL - Canadian Standards Association

c. FCC, Part 15, Subpart J, Class A Computing Devices

PART 2 - (NOT USED)

PART 3 - EXECUTION

3.01 GENERAL

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.

B. All BMS wiring shall be installed in accordance with the California Electrical Code and the Division 26 requirements of these specifications. Conduit, where required, shall be provided and installed in accordance with the Division 26 requirements of these specifications.

C. The complete BMS, including operator interface panels, CPU, sensors, controls, operator interfaces, wiring and transmission networks shall be installed in accordance with BMS manufacturer's recommendations.

D. All control devices mounted on the face of control panels shall be clearly identified as to function and system served with permanently engraved phenolic labels.

E. Performance tests:

1. Perform tests to verify proper performance of components, routines, and points. Repeat tests until proper performance results.

2. Upon completion of above testing, repeat certain tests in presence of State's Representative, as required. These tests include components, routines, and points related to life safety and other tests as directed.

3. Properly schedule foregoing tests so testing is complete at time directed by State's Representative. Do not delay tests so as to delay occupancy permits or building occupancy.

F. Systems engineering: The systems engineering phase shall include the selection and integration of components into a complete system which will meet the performance and prescriptive requirements of the Contract, together with drawings, specifications, descriptions of operation, diagrams and other materials listed under “Submittals” paragraph of this Section.

G. Testing and adjusting during and after installation:

1. During testing and adjusting, each component, system, and sub-system will be tested, calibrated, adjusted, and re-tested after installation in accordance with the specified sequences of operation and other characteristics of the control system. A report on test results, including set points and operating ranges of all components shall be submitted.

H. Reporting and demonstration: This phase shall include the submission of a written report describing the results of the testing phase, and including the set points of all equipment and a demonstration that the system performs in accordance with specification requirements.

I. Commission testing and verifications: The final phase of the quality assurance program of the project is the commissioning testing and verifications. This phase is to assure that the project is fully completed and that the systems are performing in accordance to specifications from end to end of the control systems. Demonstrations of the automatic control systems to the State’s designated representative is required. A report on test results, including set points of all components, shall be submitted. Test shall include calibrations of all sensors and transducers, verification of control logic, accuracy, and control software.

1. Upon completion of the installation, the temperature control subcontractor shall load all system software and start-up the system. The temperature control subcontractor shall perform all necessary calibration, testing and de-bugging and perform all required operational checks to insure that the system is functioning in full accordance with these specifications.

2. The temperature control subcontractor shall perform tests to verify proper performance of components, routines, and points. Repeat tests until proper performance results. This testing shall include a point-by-point log to validate 100% of the input and output points of the DDC system operation.

3. Upon completion of the performance tests described above, repeat these tests, point by point as described in the validation log above in presence of State's Representative, as required. Properly schedule these tests so testing is complete at a time directed by the State's Representative. Do not delay tests so as to prevent delay of occupancy permits or building occupancy.

4. System Acceptance: Satisfactory completion is when the Contractor has performed successfully all the required testing to show performance compliance with the requirements of the Contract Documents to the satisfaction of the State’s Representative. System acceptance shall be contingent upon completion and review of all corrected deficiencies.

J. Maintenance manuals: This phase includes the submission of one hard bound copy of all manufacturers' cuts, maintenance and operating instructions, test reports and demonstration material, copies of control diagrams, and copies of the manufacturers' certifications as part of the aforementioned O&M package.

K. Instructions:

1. Instruct State's operating personnel in all aspects of system operation and maintenance. Allow for a minimum of 15 staff persons.

2. The temperature control subcontractor shall provide 16 hours of instruction to the State's designated personnel on the operation of the BMS and describe its intended use with respect to the programmed functions specified. Operator orientation of the BMS shall include, but not be limited to; the overall operation 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.

3. The training shall be in three sessions as follows.

   a. First Training: One day (8 hours total) Directly following Formal Acceptance. This session will deal with basic and advanced topics as well as answer questions.

   b. Warranty follow up: One day (8 hours total) in no less than 4 hour increments, to be scheduled at the request of the State during the one year warranty period. These sessions shall cover topics as requested by the State such as; how to add additional points, create and gather data for trends, graphic screen usage or sequence clarification.

L. The BMS shall be warranted for one year minimum from the date of Beneficial Occupancy. Any manufacturing defects arising during this warranty period shall be corrected without cost to the State.

END OF SECTION

SECTION 23 11 23

FACILITY NATURAL-GAS PIPING

PART 1 - GENERAL

1.01 SUMMARY

A. Volume 1 - Contracting Requirements, and Division - 01 General Requirements apply to the Work of this Section.

B. Type of plumbing systems specified in this section include the following:

1. Gas piping.

1.02 ACTION SUBMITTALS

A. No action submittals are necessary.

1.03 INFORMATIONAL SUBMITTALS

A. Submit under provisions of Section 01 33 00.

B. Submittals for review during construction document phase:

1. Product data for specified products.

C. Submittals for review during construction phase:

1. Provide certificate for all gas piping welders.

D. Submittals for closeout:

1. Record drawings: At project closeout, submit record drawings of installed piping systems.

2. Maintenance data: Submit maintenance data and parts lists for plumbing piping systems materials and products. Include this data, product data, shop drawings, and record drawings in maintenance manual.

3. Submit all warranties signed by the manufacturer.

4. Provide all special tools, loose gauges and test kits and maintenance and calibration instructions.

1.04 QUALITY ASSURANCE

A. Manufacturer's qualifications: Firms regularly engaged in manufacture of plumbing piping 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. Requirements of regulatory agencies: The publications listed below are a part of this Specification; comply with provisions of these publications except as otherwise specified.

   1. Plumbing code compliance: Comply with applicable portions of latest California Plumbing Code pertaining to selection and installation of plumbing materials and products.

   2. ANSI compliance: Provide natural gas piping in accordance with ANSI B31.2 "Fuel Gas Piping."

   3. NFPA compliance: Provide natural gas systems in accordance with NFPA 54, Latest Edition " National Fuel Gas Code."

   4. Utility compliance: Provide natural gas systems in accordance with local gas utility company requirements.

   5. CPC compliance: Provide natural gas systems in accordance with latest California Plumbing Code.

   6. All joints in welded gas piping shall be welded by certified gas welder as defined in latest California Plumbing Code.

PART 2 - PRODUCTS

2.01 PRODUCTS

A. Materials and products: Provide piping materials and factory fabricated piping products of sizes, types, pressure ratings, temperature ratings, and capacities as required.

B. Basic pipes and pipe fittings:

   1. Gas service piping: Black steel pipe; Schedule 40; welded fittings. Wrap all pipe installed below grade.

      a. Underground ferrous gas piping shall be electrically isolated from the rest of the gas system with listed or approved isolation fittings installed a minimum of six inches above grade.

   2. Building distribution gas piping:

      a. Pipe size 2 inches and smaller: Black steel pipe; Schedule 40; malleable iron threaded fittings.

b. Pipe size 2 1/2 inches and Larger: Black steel pipe; Schedule 40; wrought steel buttwelding fittings.

c. Connect to each item of gas fired equipment with drip leg and gas cock. Connect with rigid pipe, unless otherwise noted.

C. Basic valves:

1. Provide valves complying with Section 22 05 23, in accordance with the following listing:

a. Sectional valves:

1) 2 inches and smaller: Plug valves or ball valves.

2) 2-1/2 inches and larger: Plug valves.

b. Shutoff valves:

1) 2 inches and smaller: Plug valves or ball valves.

2) 2-1/2 inches and larger: Plug valves.

c. Gas Cocks: Lubricated plug valves, and lever handle gas cocks, or ball valves

d. Balance valves: Calibrated balance valves.

D. Gas pressure regulating valves:

1. Provide single stage, steel jacketed, corrosion resistant gas pressure regulators with atmospheric vent, elevation compensator with 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 indicated.

a. Provide low pressure cutout and internal relief for each regulator.

E. Earthquake Valves:

1. Earthquake Valves, Maximum Operating Pressure of 5 psig : Comply with ASCE 25.

a. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction.

b. Maximum Operating Pressure: 5 psig.

c. Cast-aluminum body with nickel-plated chrome steel internal parts.

d. Nitrile-rubber valve washer.

e. Sight windows for visual indication of valve position.

f. Threaded end connections complying with ASME B1.20.1.

g. Wall mounting bracket with bubble level indicator.

PART 3 - EXECUTION

3.01 GENERAL

A. Installation of natural gas piping:

1. Use sealants on metal gas piping threads which are chemically resistant to natural gas. Use sealants sparingly, and apply to only male threads of metal joints.

2. Remove cutting and threading burrs before assembling piping.

3. Ground gas piping electrically and continuously within project, and bond tightly to grounding connection.

4. Install drip legs in gas piping and where required by code or regulation.

5. Paint all gas piping installed in exposed exterior locations.

6. Maintain minimum of 12 inch clearance between gas piping and exterior jacket of steam piping and condensate return piping.

B. Gas pressure-regulating valves: 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.

C. Gas piping equipment connections:

1. Connect gas piping to each gas fired equipment item, with drip leg and manual gas shutoff valve within 72 inches of equipment. Reduce piping only at connection to equipment. Comply with equipment manufacturer's printed instructions.

a. Appliance fuel connectors, as indicated in 1202 of the CPC, are not acceptable for connection of equipment.

3.02 QUALITY CONTROL

A. Repair or replace broken, damaged, or otherwise defective parts, materials, and work. Leave entire work in condition satisfactory to State.

B. At completion, carefully clean and adjust equipment that is installed as part of this work. Leave systems and equipment in satisfactory operating condition.

END OF SECTION

SECTION 23 21 13

HYDRONIC PIPING

PART 1 - GENERAL

1.01 SUMMARY

A. Types of hydronic piping systems and equipment specified in this Section include the following:

1. Hydronic piping.

B. Volume 1 - Contracting Requirements, and Division - 01 General Requirements apply to the Work of this Section.

1.02 ACTION SUBMITTALS

A. Product Data: For each type of the following:

1. Pipe.
2. Fittings.
3. Joining materials.
4. Bypass chemical feeder.

1.03 INFORMATIONAL SUBMITTALS

A. Submittals for review during construction document phase:

1. Shop drawings dimensioned indicating components joining details and methods of support for hydronic piping systems and equipment.

B. Qualification Data: For Installer.

C. Welding certificates.

D. Field quality-control reports.

E. Submittals for closeout:

1. Record drawings: At project closeout, submit record drawings of installed hydronic piping and piping products in accordance with requirements of Division 1.

2. Maintenance data: Submit maintenance data and parts lists for hydronic piping materials and products. Include this data, product data, shop drawings, and record drawings in maintenance manual.

3. Submit all warranties signed by the manufacturer.

4. Provide all special tools, loose gauges and test kits and maintenance and calibration instructions.

1.04 QUALITY ASSURANCE

A. Codes and standards:

1. ASME compliance: Fabricate and install hydronic piping in accordance with ASME B31.9 “Building Services Piping”.

2. CMC compliance: Fabricate and install all hydronic piping in accordance with latest California Mechanical Code.

PART 2 - PRODUCTS

2.01 BASIC PIPES AND PIPE FITTINGS

A. Hot water piping, above ground:

1. ASTM A53 black steel Schedule 40.

2. On pipe sizes 2 inches and smaller, Malleable Iron threaded fittings class 150.

3. On pipe sizes 2 1/2 inches and larger, standard weight, full radius, butt welding fittings and weld neck flanges.

4. Slip on flanges will be permitted where space is limited with prior approval of the State’s designated representative.

5. All slip on flanges shall be back welded.

6. Connections to threaded equipment, valves, etc. shall be made with cast iron, threaded fittings.

7. At the Contractor's option, hot water piping and drain connections to equipment may be copper tube; ASTM B 88 Type L, hard drawn temper; wrought copper fittings and brazed joints.

B. Water and drain connections to equipment or to stubs:

1. Schedule 40 steel pipe with 150 lb., malleable iron fittings.

2. Provide dielectric unions if connections are to copper lines.

3. Pipe and fittings shall be black or galvanized as required to match piping to which connected.

C. Air vent discharge piping: Type L, hard copper tubing with wrought copper solder joint fittings and 95 percent tin, 5 percent antimony solder.

2.02 AIR VENT VALVES

A. Provide Armstrong #1AV where automatic type air vent is required. Install with shutoff valves or cocks and drain to a floor sink or drain.

B. At each high point of piping provide manual air vent connection at top of pipe.

C. Provide Milwaukee BB2 100 valve within 18 inches of ceiling in accessible location, and extend drain line to allow convenient access.

PART 3 - EXECUTION

3.01 INSTALLATION OF VALVES

A. Manual vent valves:

1. Install manual vent valves on each hydronic terminal at highest point and on each hydronic piping drop in direction of flow for mains, branches, runouts.

2. Pipe outlet to suitable plumbing drain.

3. Provide access door for each vent valve.

B. Automatic vent valves:

1. Install automatic vent valves at top of each hydronic riser.

2. Install shutoff valve between riser and vent valve, pipe outlet to suitable plumbing drain.

3. Provide access door for each vent valve.

3.02 EQUIPMENT CONNECTIONS

A. Connect hydronic piping system to mechanical equipment as required to comply with equipment manufacturer's instructions.

B. Install shutoff valve and union on supply and return; drain valve on drain connection.

C. Terminal VAV Reheat coils may be piped with Coil kits.

3.03 INSTALLATION OF HYDRONIC SPECIALTIES

A. In line air separators: Connect inlet and outlet piping.

B. Run piping to expansion tank with 1/4 inch per foot (2 percent) upward slope towards tank.

C. Diaphragm type expansion tanks: Install diaphragm type expansion tanks in accordance with manufacturer's instructions. Vent and purge air from hydronic system; charge tank with proper air charge as recommended by manufacturer.

D. Chemical feeders: Install in upright position with top of funnel not more than 48 inches above floor. Install globe valve in pump discharge line between recirculating lines. Pipe drain to nearest plumbing drain.

3.04 CLEANING:

A. Piping shall be flushed and chemically cleaned, before start up of any equipment:

B. After cleaning is complete, drain system and rinse with fresh water.

C. Fill system and remove all air. Add recommended amount of rust inhibitor to system as recommended by manufacturer. Set pH for neutral.

D. Temporary circulating pumps shall be furnished by Design-Builder. Project pumps shall not be used for this purpose.

3.05 QUALITY CONTROL

A. Prepare hydronic piping according to ASME B31.9 and as follows:

1. Leave joints, including welds, uninsulated and exposed for examination during test.

2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.

3. Flush hydronic piping systems with clean water; then remove and clean or replace strainer screens.

4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.

5. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.

B. Perform the following tests on hydronic piping:

1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.

2. While filling system, use vents installed at high points of system to release air. Use drains installed at low points for complete draining of test liquid.

3. Isolate expansion tanks and determine that hydronic system is full of water.

4. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the system's working pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength or 1.7 times the "SE" value in Appendix A in ASME B31.9, "Building Services Piping."

5. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components and repeat hydrostatic test until there are no leaks.

6. Prepare written report of testing.

C. Perform the following before operating the system:

1. Open manual valves fully.

2. Inspect pumps for proper rotation.

3. Set makeup pressure-reducing valves for required system pressure.

4. Inspect air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).

5. Set temperature controls so all coils are calling for full flow.

6. Inspect and set operating temperatures of hydronic equipment, such as boilers, chillers, cooling towers, to specified values.

7. Verify lubrication of motors and bearings.

END OF SECTION

SECTION 23 21 23

HYDRONIC PUMPS

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes: Types of pumps specified in this Section include the following:

1. Hot water pumps.

B. Volume 1 - Contracting Requirements, and Division - 01 General Requirements apply to the Work of this Section.

1.02 ACTION SUBMITTALS

A. No action submittals are necessary.

1.03 INFORMATIONAL SUBMITTALS

A. Submittals for review during construction document phase:

1. Product data for specified products.

B. Submittals for closeout:

1. Maintenance data: Submit maintenance data and parts lists for each type of pump, control, and accessory, including "trouble- shooting" maintenance guide. Include this data, product data and shop drawings in maintenance manual.

2. Submit all warranties signed by the manufacturer and contractor.

C. Provide all special tools, loose gauges and test kits and maintenance and calibration instructions.

1.04 QUALITY ASSURANCE

A. UL compliance: Provide electric components for pumps which have been listed by Underwriters Laboratories.

B. Ratio of impeller diameter to cut water volute diameter shall be limited to 85% or less for noise and vibration control.

PART 2 - PRODUCTS

2.01 MATERIAL AND WORKMANSHIP:

A. Pumping assemblies and pressure regulating valves shall be guaranteed for five years from date of shipment.

2.02 BASE MOUNTED PUMPS

A. Type: Horizontal shaft, single stage, end suction, for 175 psig maximum working pressure. Full back pull for maintenance without removing piping or motor.

B. Casing: Cast iron, with suction and discharge gage ports, renewable bronze casing wearing rings, seal flush connection, drain plug, flanged suction and discharge.

C. Impeller: Bronze, fully enclosed, keyed to shaft. Pump volute must be fully supported.

D. Bearings: Greaseable ball bearings.

E. Shaft: Alloy steel with bronze steel shaft sleeve.

F. Seal: Carbon rotating against a stationary ceramic seat, 225 degrees F maximum continuous operating temperature.

G. Drive: Flexible coupling with coupling guard.

H. Baseplate: Cast iron or fabricated steel with integral drain rim.

I. Motor: NEMA Specification Pump and Motor will be factory aligned and will be realigned after installation prior to startup.

J. Each pump will be factory tested per Hydraulic Institute Standards prior to shipment.

2.03 IN-LINE PUMPS

A. Pumps shall be horizontal, permanently lubricated, specifically designed and guaranteed for quiet operation. The pumps shall be suitable for 225 degrees F. operation at 175 psig working pressure. The pump shall be single stage, inline design, in cast-iron bronze fitted construction. The pump internals shall be capable of being serviced without disturbing the piping connections.

B. The pump shall be composed of three separable components: a motor, bearing assembly and pump end (wet end)..

C. The pumps shall have a solid SAE 1144 steel shaft supported by two sealed ball bearings. A non-ferrous shaft sleeve shall be employed to completely cover the wetted area under the seal.

D. Pumps shall be equipped with an internally flushed mechanical seal assembly. Seal assembly shall have a brass housing, Buna bellows and seat gasket, stainless steel spring, and be of a carbon ceramic design with the carbon face rotating against a stationary ceramic face.

E. The bearing assembly shaft shall connect to a cast bronze impeller. The impeller shall be both hydraulically and dynamically balanced, keyed to the shaft and secured by a locking cap screw of nut.

F. To ensure alignment, the motor shall be mounted to the bearing assembly via a bolted motor bracket assembly, and a rubber motor mount will be used to assist in aligning the motor shaft with the pump shaft.

G. Motor: NEMA Specification Pump and Motor will be factory aligned and will be realigned after installation prior to startup.

H. Each pump will be factory tested per Hydraulic Institute Standards prior to shipment.

I. Motors shall have permanently lubricated ball bearings and must be completely maintenance free. Motors shall be non-overloading at any point on the pump curve and shall meet NEMA specifications. Pump manufacturer shall be ISO-9001 certified. Pump shall be of U.S. manufacturer.

J. Pump shall be factory tested and name-plated prior to shipment. The pump shall have a three (3) year warranty from the date of Beneficial Occupancy.

PART 3 - EXECUTION

3.01 INSTALLATION OF PUMPS:

A. Install pumps 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 base-mounted pumps on minimum of 4-inch high concrete pad. Set and level pump; grout under pump base with non-shrink grout. Provide drain line to nearest floor drain or floor sink.

D. Install in-line pumps with support from overhead structure on each side of pump.

E. Piping shall be supported from the building structure so as to prevent any strain on the pump casings. A final check for perfect alignment of the piping connections shall be made after pump has been secured to its base. Provide valves, accessories, gauges, flexible connections, strainers and supports as required.

F. Check alignment, and where necessary, realign shafts of motors and pumps within recommended tolerances by manufacturer. In no case shall angular misalignment

exceed 0.003” as measured at the coupling faces. Submit for record, alignment test report for each pump.

G. Lubricate pumps before start-up. Start-up in accordance with manufacturer's instructions.

H. 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.

3.02 QUALITY CONTROL

A. Training: Provide training and orientation of State’s operating staff in proper care and operation of equipment, systems, and controls for plumbing pumps. Training shall conform to the requirements of section 01 79 00 Demonstration and Training.

B. Training shall be scheduled with at least 5 working day notice and shall occur during the workweek, Tuesday through Thursday, between the hours of 9:00 am and 2:00 pm. All training shall be coordinated with facility staff. The system shall be fully installed with all parts and components confirmed prior to training request being submitted.

C. Operation test: Test each piece of equipment to show that it will operate in accordance with indicated requirements.

D. Cleaning up: Upon completion of Work, remove materials, equipment, apparatus, tools, and the like, and leave premises clean, neat, and orderly.

END OF SECTION

SECTION 23 30 00

DUCTWORK ACCESSORIES

PART 1 - GENERAL

1.01 SUMMARY

A. Volume 1 - Contracting Requirements, and Division - 01 General Requirements apply to the Work of this Section.

B. Section includes: Types of duct accessories required for project include the following:

1. Fire and smoke dampers.
2. Fire dampers.
3. Turning vanes.
4. Duct hardware.
5. Duct access doors.
6. Flexible connections.
7. Dampers.
   a. Manual dampers.
   b. Control dampers.
   c. Counterbalanced relief dampers.
8. Duct overpressurization relief devices.

1.02 ACTION SUBMITTALS

A. No action submittals are necessary.

1.03 INFORMATIONAL SUBMITTALS

A. Submit under provisions of Section 01 33 00.

B. Submittals for review during construction document phase:

1. Product data: Submit manufacturer's specifications for each type of duct accessory, including dimensions, capacities, and materials of construction; and installation instructions.

2. Shop drawings: Submit assembly type shop drawings for each type of duct accessory showing interfacing requirements with ductwork, and proposed method of fastening or support.

C. Submittals for review during construction phase:

1. Fire dampers: Submit complete installation instructions for all types of fire damper to be used on this project, as part of main submittal.

D. Submittals for closeout:

1. Maintenance data: Submit manufacturer's maintenance data including parts list for each type of duct accessories; include this data in maintenance manuals.

2. Submit all warranties signed by the manufacturer

3. Provide all special tools, loose gauges and test kits and maintenance and calibration instructions.

1.04 QUALITY ASSURANCE

A. SMACNA compliance: Comply with applicable portions of Sheet Metal and Air Conditioning Contractor's National Association (SMACNA) duct construction standards.

B. ASHRAE standards: Comply with American Society of Heating, Refrigerating, and Air Conditioning Engineers, Inc. (ASHRAE) recommendations, latest edition, for all work in this Section.

PART 2 - PRODUCTS

2.01 DAMPERS:

A. Manual dampers: Provide dampers of single blade type or multi blade type constructed in accordance with SMACNA, "HVAC Duct Construction Standards," latest edition, except as noted herein.

1. Provide multiple dampers in ducts greater than 10 inches in height. Maximum width for multiple damper blades for use in rectangular duct shall not exceed 6 inches.

2. Single damper blades may be used in ducts up to 12 inches in height. Provide multi-blade dampers for ducts larger than 12 inches.

3. Dampers shall be 18 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.

a. Multiple blade dampers shall be equal to Ruskin CD35 Standard Control Damper.

b. Where duct velocity may be expected to exceed 1250 fpm, provide Ruskin CD-50, or equal, low leakage dampers with airfoil blades.

4. Damper blades for round ductwork shall be 16 gauge steel. Provide self-locking regulators, equal to Ventlok 641 for operation of dampers. Provide end bearings equal to Ventlok 607 at each damper, and provide continuous solid 3/8 inch square shafts.

5. Provide self-locking regulators, equal to Ventlok 641 or Duro Dyne locking regulator for operation of dampers. Provide end bearings equal to Ventlok 607 at each damper and provide continuous solid 3/8 inch square shafts.

6. Where ductwork is externally insulated, provide self locking regulators equal to Ventlok 644 for rectangular ductwork, and Ventlok 639 for round ducts.

7. Where dampers are installed above non-accessible ceilings, and are not served by access doors, provide extension rods and concealed ceiling mounted damper regulators. Regulator shall be equal to Ventlok Model 666 or Young Regulator, with miter gears and accessories as required.

B. Control dampers: Provide dampers with parallel blades for two-position control, and opposed blades for modulating control. Construct blades of 16 gauge steel, provide heavy duty molded self-lubricating nylon bearings, 1/2 inch diameter steel axles spaced on maximum 9 inch centers. Construct frame of 2 inch x 1/2 inch x 1/8 inch steel channel for face areas 25 sq ft and under; 4 inch x 1-1/4 inch x 16 gauge channel for face areas over 25 sq ft. Provide galvanized steel finish with aluminum touch-up.

1. Construct control dampers installed in round ductwork of 16 gauge steel with heavy duty molded self-lubricating nylon bearings and 3/8 inch diameter steel axles.

2. Provide airfoil blade on applications over 1250 FPM.

C. Counterbalanced relief dampers: Provide dampers with parallel blades, counterbalanced and factory set to relieve at required static pressure. Construct blades of 16 gauge aluminum, provide 1/2 inch diameter ball bearings, 1/2 inch diameter steel axles spaced on 9 inch centers. Construct frame of 2 inch x 1/2 inch x 1/8 inch steel channel for face areas 25 sq ft and under; 4 inch x 1-1/4 inch x 16 gauge channel for face areas over 25 sq ft. Provide galvanized steel finish on frame with aluminum touch-up.

1. Dampers shall be equal to Ruskin CDD2 counterbalanced backdraft damper, with gravity operation set for 0.01 inches w.g.

2.02 WALL AND FLOOR FIRE DAMPERS:

A. Fire dampers: Fire dampers shall be of folding curtain type conforming to NFPA 90A, latest edition and shall be listed under U.L. 555 for dynamic operation. Arrange dampers to close automatically upon operation of listed fusible link. Steel parts shall be factory galvanized.

1. Dampers shall be factory installed in minimum 20 gauge galvanized metal sleeves. Provide length of sleeve to suit application.

2. Sleeves shall be supported by angle frames as detailed in manufacturer's printed installation instructions. Provide minimum 12 inch long sleeve, with increased length as required to suit the requirements of the installation.

3. Shall be style B or C with blades not in direct path of airflow.

B. Provide roll formed, interlocking, 24 gauge galvanized steel blades.

C. Where required to suit the size of fire damper required, provide manufacturers standard UL Classified mullions, arranged to support multiple dampers. Assembly shall be a minimum of 16 gauge galvanized steel, complete with all accessory caps and framing members required for installation.

D. Fusible links shall have temperature rating approximately 50 degrees F. above normal maximum expected operating temperature. Nominal temperature to be 165 degrees F.; 212 degrees F. for locations near outlet of heat producing appliances.

E. Have fire damper installation instructions available at the site during construction for use by the State.

2.03 CEILING FIRE DAMPERS:

A. General: UL listed and labeled; comply with the construction details for the tested floor/roof-ceiling assemblies as indicated in the UL Fire Resistance Directory, Volume 1.

B. Frame: 20 gauge, rectangular or round, galvanized steel; style to suit ceiling construction.

C. Blades: 20 gauge galvanized steel with non-asbestos refractory insulation.

D. Fusible link: Replaceable, 165 deg F rated.

E. Provide UL Classified Thermal Blanket for all fire damper systems installed in ceilings. Install per manufacturers printed literature.

2.04 FIRE AND SMOKE DAMPERS

A. Fire/smoke dampers: Combination fire and smoke dampers shall be parallel blade type conforming to NFPA 90A and shall be UL 555S listed. Arrange dampers to close automatically upon operation of 120 volt motor. Factory galvanized steel parts. Install dampers in sleeves supported by angle frames. Install dampers in the plane of the wall, with the actuator outside of the duct. Damper manufacturer shall provide all components necessary to meet this requirement. Provide all accessories required, including end switches, relays, conduit, wiring, etc., for a complete operating system.

1. Actuator motors shall be rated for continuous on and shall be gear driven, oil immersed style not requiring any more frequent than annual cycling to maintain functionality of actuator operation.

B. Where required to suit the size of damper required, provide manufacturers standard UL Classified mullions, arranged to support multiple dampers. Assembly shall be a minimum

of 16 gauge galvanized steel, complete with all accessory caps and framing members required for installation. Provide independent motor and operator as required for each individual damper, arranged to suit UL Classification requirements.

C. Have fire damper installation instructions available at the site during construction for use by the Inspector and State.

D. Dampers may be actuated by interlocking with an area detection system or with duct mounted smoke detectors.

E. Use airfoil blade style where velocity exceeds 1250 FPM.

2.05 TURNING VANES:

A. Manufactured turning vanes: Provide turning vanes constructed of 2-inch radius curved blades set at 1-1/2 inch O.C., supported with 3/4-inch trailing edge, and set into side strips suitable for mounting in ductwork.

B. Provide fabricated turning vanes and vane runners, constructed in accordance with SMACNA "HVAC Duct Construction Standards," latest edition.

C. Acoustic Turning Vanes: Where required to meet noise criteria acoustic turning vanes constructed of airfoil shaped aluminum extrusions with perforated faces and fiberglass fill may be incorporated. Vanes shall be Duct Mate Pro Rail Turning Vanes or equal.

2.06 DUCT HARDWARE:

A. General: Provide duct hardware, manufactured by one manufacturer for all items on Project, for the following:

1. Test holes: Provide in ductwork at fan inlet and outlet, duct test holes, consisting of slot and cover, for instrument tests.

2. Quadrant locks: Provide for each damper, quadrant lock device on one end of shaft; and end bearing plate on other end for damper lengths over 12 inches. Provide extended quadrant locks and end extended bearing plates for externally insulated ductwork.

2.07 DUCT ACCESS DOORS:

A. Provide airtight hinged access doors, or sandwich type, in ducts and plenums for cleaning and repairs for ductwork, volume dampers, fire dampers and for control devices within such ductwork.

B. Access doors into 2 inch pressure class ductwork shall be made of No. 24 gauge galvanized steel minimum, 22 gauge for larger than 12 inches by 12 inches, reinforced with angle iron stiffeners. Reinforce openings for doors with structural steel.

1. Provide insulated doors for insulated ductwork. Provide flush frames for uninsulated ductwork, extended frames for externally insulated duct.

2. Provide one side hinged, other side with one cam type latch for doors 12 inches high and smaller; two cam type latches for larger doors.

C. Provide hinged style access doors for round ductwork. Access doors shall be 16 gauge galvanized steel with continuous piano hinge. Locks shall be plated steel strike and catch. Provide 1 inch x 3/8 inch polyethylene gasket all around door.

2.08 FLEXIBLE CONNECTIONS:

A. Flexible duct connections shall be pre-assembled flexible connectors constructed of coated glass fabric applied in accordance with manufacturer's recommendations. Width of flexible connections shall be sufficient to allow minimum of 2 inches of free space between two metal collars to be connected. Install sheet metal band completely around duct or fan outlet, at end of flexible connection. Fasten with metal screws through band and coated glass fabric. Space screws approximately 3 inches apart. Flexible connections to be DuroDyne Neoprene/Durolon Flex Connector or equal.

1. Coated glass fabric shall be equal to Ventfabrics Ventglas with neoprene coating for use inside building and Ventlon with hypalon coating when exposed to weather.

PART 3 - EXECUTION

3.01 GENERAL

A. Installation of manual dampers: Install dampers at each branch of ductwork and elsewhere as required for system balancing and future adjustment. Provide 18 inches long by 2 inches wide plastic strip at each manual damper operator, to allow visual identification of each damper location.

B. Installation of flexible connections:

1. Furnish and install flexible connections at following locations:

a. Duct connection of supply fans.

b. Duct connection of return fans.

c. Duct connection of exhaust fans.

d. Duct connection of factory built fan units.

e. Elsewhere as required.

C. Inspection of fire dampers:

1. Install fire dampers and combination fire/smoke dampers in accordance with manufacturer's written installation instructions, and in accordance with fire marshal requirements. Maintain copies of installation instructions on site at all times.

2. Upon completion of this work all fire dampers will be tested by the Construction Inspector. Provide spare fusible links as required to complete testing to the complete satisfaction of the local fire department and State Fire Marshal.

D. Installation of fire dampers:

1. Fire dampers and fire & smoke dampers shall be installed in strict accordance with the manufacturer's printed installation instructions. Copies of instructions shall be made available to the inspector during installation.

2. Fire damper access doors shall be installed at each fire damper. Upon request, demonstrate that the fire damper can be properly accessed through the access door provided. Label each access door with one inch high minimum stenciled letters "FIRE DAMPER".

3. Protect openings framed with wood or metal studs for fire damper sleeves with fire resistive material equal to the rating of the wall surface.

E. Installation of duct accessories:

1. Install duct accessories in accordance with manufacturer's installation instructions, with applicable portions of details of construction as shown in SMACNA standards, and in accordance with recognized industry practices to ensure that products serve intended function.

2. Install turning vanes in square or rectangular 90 degree elbows in supply and exhaust air systems, and elsewhere as required.

3. Coordinate with other work, including ductwork, as necessary to interface installation of duct accessories properly with other work.

4. Field Quality Control: Operate installed duct accessories to demonstrate compliance with requirements. Test for air leakage while system is operating. Repair or replace faulty accessories, as required to obtain proper operation and leak resistant performance.

3.02 QUALITY CONTROL

A. Inspection of fire dampers:

1. Install fire dampers and combination fire/smoke dampers in accordance with manufacturer's written installation instructions, and in accordance with fire marshal requirements. Maintain copies of installation instructions on site at all times.

2. Upon completion of this work all fire dampers will be tested by the Construction Inspector to verify full range of movement and verify that proper heat-response device

installed. Provide spare fusible links as required to complete testing to the complete satisfaction of State and local fire officials.

B. Operation test: Test each piece of equipment to show that it will operate in accordance with requirements.

C. Inspection: Examine areas and conditions under which duct accessories will be installed. Do not proceed with work until unsatisfactory conditions have been corrected.

1. Operate remote damper operators to verify full range of movement of operator and damper.

2. Inspect turning vanes for proper and secure installation.

END OF SECTION

SECTION 23 31 13

METAL DUCTS

PART 1 - GENERAL

1.01 SUMMARY

A. Volume 1 - Contracting Requirements, and Division - 01 General Requirements apply to the Work of this Section.

B. Section includes: Types of ductwork required for this project include the following:

1. Rigid sheet metal ductwork.

2. Flexible ductwork.

3. Air plenums.

1.02 SYSTEM DESCRIPTION

A. Design and performance requirements:

1. Construct all ductwork located between air handling units and air terminal units for minimum 4 inch w.g. pressure class per SMACNA, latest edition recommendations, and as listed herein. Increase pressure rating as required to accommodate specific application.

2. Construct all other ductwork for minimum 2 inch w.g. pressure class, per SMACNA requirements. Increase pressure rating as required to accommodate specific application.

3. Ducts shall be sealed to ASHRAE leakage class 6 for distribution at 2-inch w.g. or lower and leakage class 3 for distribution at over 2-inch w.g.

4. Round ductwork shall be used as much as possible to minimize friction loss.

5. Utilize the minimum number of fittings to minimize friction loss.

6. Aluminum grilles and ducting shall be utilized for wet areas such as showers. For exhaust, a minimum of 20 feet from inlet shall be 304 stainless steel.

7. Specialty exhaust such as stainless steel venting hoods shall be minimum 18 gauge of a compound appropriate for the application.

1.03 ACTION SUBMITTALS

A. No action submittals are necessary.

1.04 INFORMATIONAL SUBMITTALS

A. Submit under provisions of Section 01 33 00.

B. Submittals for review during construction document phase:

1. Product data: Submit manufacturer's specifications on manufactured products and factory fabricated ductwork, used for work of this Section. Coordinated layouts are required to amplify, expand and coordinate the information contained in the Criteria Documents.

2. Provide detailed design drawings showing all ductwork routing and diffuser layout on scaled drawings.

C. Submittals for review during construction phase:

1. Provide minimum 1/4 inch equals one foot scaled coordination drawings showing plan and pertinent section or elevation views of all piping, ductwork and electrical systems. The work represented shall be fully coordinated with the structure, other disciplines, and with all finishes. Drawings shall all be presented on a single size D (24 inches x 36 inches) sheet. Drawing graphics shall fully comply with A.I.A. Architectural Graphic Standards and ANSI Y14. Drawings shall be drawn on latest version of AutoCAD. All drawings shall have title block, key plan, north arrow and sufficient grid lines to provide cross reference to the design drawings.

2. Provide a stamp or title block on each drawing with locations for signatures from all sub-contractors involved, including but not limited to the General, HVAC, Plumbing, Fire Protection, and Electrical sub-contractors. Include statement for signature that the Contractor has reviewed the coordination drawings in detail and has coordinated the work of his trade.

3. Show on drawings the intended elevation of all ductwork in accordance with the following example:

a. B.O.D. = 9 feet-0 inches

b. OFFSET UP 6 inches

c. B.O.D. = 9 feet-6 inches

D. Submittals for closeout:

1. Record drawings: At project close-out, submit record drawings of installed ductwork, duct accessories, and outlets and inlets in accordance with requirements of Division 1.

2. Submit all warranties signed by the manufacturer

3. Provide all special tools, loose gauges and test kits and maintenance and calibration instructions.

1.05 QUALITY ASSURANCE

A. Design and installation standards:

1. SMACNA compliance: Comply with applicable portions of latest Sheet Metal and Air Conditioning National Association (SMACNA) for all work in this Section.

2. ASHRAE standards: Comply with latest American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc. (ASHRAE) recommendations for all work in this Section.

3. NFPA Compliance: Comply with ANSI/NFPA 90A, latest edition "Standard for the Installation of Air Conditioning and Ventilating Systems," and ANSI/NFPA 90B, latest edition "Standard for the Installation of Warm Air Heating and Air Conditioning Systems."

4. Latest California Mechanical Code.

5. ADC Test Code FD 72-RI, Flexible Air Duct Test Code.

6. NFPA 90A, latest edition Standard for the Installation of Air Conditioning and Ventilating Systems.

PART 2 - PRODUCTS

2.01 GENERAL

A. Galvanized sheet steel: Lock forming quality, ASTM A-525 and ASTM A-527, Coating Designation G 90. Provide mill phosphatized finish for exposed surfaces of ducts exposed to view.

B. All standing seams and transverse joints in all sheet metal ductwork shall be covered with tape and adhesive to achieve specified leakage class and maintain flame and smoke spread ratings.

1. Pressure sensitive tapes or single part sealant is not acceptable.

C. Where seams are exposed to weather, paint seams with aluminum paint over Hardcast tape.

D. Rectangular ductwork materials:

1. Internal duct lining:

a. Provide internal duct lining where required to control noise and where it is not practical to use sound traps.

b. Duct lining shall not be used for insulation; use duct wrap with suitable jacket.

c. Cement duct liner in place with nonflammable, non-hardening duct adhesive. Seal all raw edges of insulation inside ductwork with adhesive. Liner shall have facing or coating to reduce erosion of fibers into airstream.

d. Provide sheet metal weld pins and washers or clinch pins and washers on all duct work 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.

e. Duct liner and adhesive shall not exceed flame spread rating of 25 and smoke developed rating of 50, all in conformance with C.M.C. requirements.

2. Round supply ductwork shall be of the same materials, gauges, and construction as that indicated for 4 inch pressure clasp ductwork.

   a. Provide 20 gauge minimum for ductwork exposed within occupied spaces.

3. Ductwork support materials: Except as otherwise indicated, provide hot dipped galvanized steel fasteners, anchors, rods, straps, trim, and angles for support of ductwork.

E. Four-inch pressure class ductwork:

1. Spiral lock seam prefabricated factory build round and oval duct and fittings may be used wherever space permits. Shop fabricated ducts shall be used only where rectangular shaped ducts are required or where transitions and special fittings cannot be prefabricated by factory. Provide couplings to join each length of duct. Fittings for round duct shall be equal to United McGill “LoLoss”.

2. Rectangular ductwork: Construct of galvanized sheet steel complying with ANSI/ASTM A 527 in accordance with the requirements of SMACNA for 4 inch WG.

3. Round ductwork: Construct of galvanized sheet steel complying with ANSI/ASTM A 527 by the following methods and in minimum gauges listed.

3 inches to 14 inches	26	Spiral Lockseam
15 inches to 26 inches	24	Spiral Lockseam
27 inches to 36 inches	22	Spiral Lockseam
37 inches to 50 inches	20	Spiral Lockseam
51 inches to 60 inches	18	Spiral Lockseam
Over 60 inches	16	Longitudinal Seam

   a. Provide 20 gauge minimum for ductwork exposed within occupied spaces.

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.

DIAMETER	MINIMUM GAUGE
4 inches to 16 inches	24
18 inches to 22 inches	22
24 inches	20
26 inches to 30 inches	18
32 inches to 42 inches	16

6. Flat-oval ductwork: Construct of galvanized sheet steel complying with ANSI/ASTM A 527, of spiral lockseam construction, in minimum gauges listed.

MAXIMUM WIDTH	MINIMUM GAUGE
Under 25 inches	24
25 inches to 48 inches	22
49 inches to 70 inches	20
Over 70 inches	18

7. Fittings and couplings: Construct of minimum gauges listed. Provide continuous weld along seams.

MAXIMUM WIDTH	MINIMUM GAUGE
Under 37 inches	20
37 inches to 50 inches	18
Over 50 inches	16

8. Provide acoustically rated duct lining where required to satisfy the noise criteria referred to in Part 3, Chapter K of ANSI/ASTM A 527. Duct liner, if used, shall have a flame spread of less than 20, fuel contribution less than 5, and smoke development less than 5. Each joint in liner shall be completely sealed, in accordance with manufacturer's printed recommendations.

9. Internally insulated duct and fittings: Construct with outer pressure shell, 1 inch thick insulation layer, and perforated inner liner, equal to United McGill Corp Sheet Metal Division, Acousta K-27. Construct shell and liner of galvanized sheet steel complying with ANSI/ASTM A 527, of spiral lockseam construction (use longitudinal seam for over 59 inches), in minimum gauges listed.

NOMINAL DUCT DIAMETER	OUTER SHELL	INNER LINER
3 inches To 12 inches	26 ga.	24 ga.
13 inches To 24 inches	24 ga.	24 ga.
25 inches to 34 inches	22 ga.	24 ga.
35 inches to 48 inches	20 ga.	24 ga.
49 inches to 58 inches	18 ga.	24 ga.
Over 59 inches	16 ga.	20 ga.

10. Fittings and couplings: Construct of minimum gauges listed. Provide continuous weld along seams of outer shell.

NOMINAL DUCT DIAMETER	OUTER SHELL	INNER LINER
3 inches to 34 inches	20 ga.	20 ga.
36 inches to 48 inches	18 ga.	20 ga.
Over 48 inches	16 ga.	20 ga.

11. Inner liner: Perforate with 3/32 inch holes for 22 percent open area. Provide metal spacers welded in position to maintain spacing and concentricity.

12. Optional ducts and fittings: At Contractor's option, provided that certified tests by manufacturer show that rigidity and performance is equivalent to SMACNA and/or ASHRAE standard gauge ductwork, provide ducts and fittings as follows:

    a. Ducts: Construct of manufacturer's standard gauge, with spiral lock seam and intermediate standing rib.

F. Miscellaneous ductwork materials:

1. Provide miscellaneous materials and products of types and sizes as listed in SMACNA manuals, including proper connection of ductwork and equipment.

2. Fittings: 45 degree to 90 degree spiral elbows for sizes up to 24 inches; five piece, 90 degree elbows for sizes 26 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. Round fittings for round duct shall be equal to United McGill "LoLoss".

3. Duct sealant: Non-hardening, non-migrating mastic or liquid elastic sealant as compounded and recommended by manufacturer specifically for sealing joints and seams in ductwork.

4. Duct joints: Joint and seal prefabricated, factory built ducts, fittings, and couplings in strict accordance with duct manufacturer's instructions. Install duct sealers, pop rivets or sheet metal screws and glass fabric and mastic on each joint. Duct sealer shall meet required flame and smoke spread. Sheet metal screw for joints shall be minimum #10 size galvanized.

5. Duct access: Provide Ductmate or equal sandwich type access door in prefabricated, factory built ducts for access to fire dampers, control equipment, etc. as specified in Section 23 30 00 Ductwork Accessories. Access door size shall be largest available size to fit given duct diameter, width or height.

G. Flexible ducts:

1. Factory made air ducts shall be approved for the use intended. These ducts shall be UL listed, Class 1, 50 smoke generated and 25 flame spread and shall be installed in accordance with this Specification and the manufacturer's printed recommendations.

2. Flexible ducts shall consist of an exterior reinforced laminated vapor barrier, 1-1/2 inch thick fiberglass insulation (K= .25 @ 75 degrees F), encapsulated spring steel wire Helix and impervious, smooth, non-perforated interior vinyl liner.

    a. Individual lengths of flexible ducts shall contain factory fabricated steel connection collars at each end of duct, complete with drawbands for installation.

    b. 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.

    c. Ducts shall be U.L. approved and tested and meet Class 1 requirements of NFPA 90A. Make bends to maintain R/W-1.5.

3. Make connections to rigid duct and units with Panduit style draw band at inner liner material, then at outer vapor barrier material; and then provide duct tape over outside of sheath. Conical spin-ins shall be used at connections to rectangular ducts.

4. Subject to compliance with requirements, flexible ducts which may be incorporated in the work include the following:

    a. Flexible ducts upstream of air terminal units: Provide ductwork with minimum operating pressure of 6 inches positive for all sizes, and 2 inches negative pressure up to 16 inches inclusive, 1 inch negative pressure for ducts 18 inches diameter and above.

    b. Flexible ducts downstream of air terminal units as required to satisfy the noise requirements of Part 3 Chapter K of ANSI/ASTM A 527: Provide ductwork with minimum operating pressure of 4 inches positive for all sizes, and 1 inch negative for all sizes.

2.02 FABRICATION

A. Ductwork exposed to weather shall be cross broken to eliminate any possibility of standing water on the ducts.

B. Fabrication:

1. Pre-assemble work in shop to greatest extent possible, so as to minimize field assembly of systems. Disassemble systems only to extent necessary for shipping and handling. Match mark sections for reassembly and coordinated installation.

2. 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, latest edition

    b. California Mechanical Code Standards, latest edition

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 vanes with trailing edge 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.

4. Whenever possible, use wye fittings for branch take offs. When tees are required due to physical constraints, entry shall be 45°. Velocity shall be as equal as possible from main entry to branch exit.

5. Fabricate ductwork with accessories installed during fabrication to the greatest extent possible. Refer to Section 23 30 00 Ductwork Accessories for accessory requirements.

6. Fabricate round supply connections to rectangular, plenum type fittings using spin-in type fittings with conical, bellmouth inlet with damper and extractor, complete with extractor and volume control damper.

C. Shower exhaust ducts:

1. Fabricate shower exhaust ducts and supports from type 304 stainless steel for a length of 20 feet from exhaust grille or register.

PART 3 - EXECUTION

3.01 GENERAL

A. Provide sheet metal angle frame at all duct penetrations to wall, floor or ceiling.

B. Installation of ductwork:

1. 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 required service. Install each run with minimum of joints.

2. 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.

3. Applicable leakage classes:

Pressure Class	Leakage Class
2 inches W.G. or less	6
+2 inches W.G. or greater	3

4. Seal ductwork, after installation, to seal class required herein, and in accordance with method prescribed in SMACNA "HVAC Leakage Test Manual," latest edition.

5. Install concrete inserts for support of ductwork in coordination with formwork as required to avoid delays in work.

6. 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.

7. Support ductwork in manner complying with SMACNA "HVAC Duct Construction Standards," latest edition, hangers and supports sections. 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.

    a. 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.

    b. 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.

8. Locate ductwork runs, vertically and horizontally, and avoid diagonal runs wherever possible. Run ductwork in shortest route which does not obstruct usable space or block access for servicing building and its equipment. Hold ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building. Limit clearance to 1/2 inch where furring is shown for enclosure or concealment of ducts, but allow for insulation thickness, if any. Wherever possible in finished and occupied spaces, conceal ductwork from view, by locating in mechanical shafts, hollow wall construction or above suspended ceilings. Do not encase horizontal runs in solid partitions, except if run below grade or other unique situations. Coordinate layout with suspended ceiling and lighting layouts and similar finished work.

9. Electrical equipment spaces: Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.

10. Coordinate duct installations with installation of accessories, dampers, coil frames, equipment, controls and other associated work of ductwork system.

11. All ductwork running through combustible construction shall have gypsum board, of equivalent thickness to adjacent work, installed between ductwork and combustible construction.

12. 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.

13. For fire rated walls without fire dampers, fill annular space between duct and wall with UL listed Fire Stopping System, 3M, Fire Barrier, Dow Firestop or Nelson Firestop.

14. For fire rated walls without fire dampers, annular space between duct openings and ducts through all floors and walls shall be fire resistant. Seal duct penetrations with an incombustible material, 3M "Fire Barrier", 3M "Fire Dam", Dow "Fire Stop", or equal.

15. Duct lining should be used only where other means for sound attenuation are impractical. Install in accordance with manufacturer’s recommendation.

16. Provide access doors throughout the ductwork for easy inspection and cleaning. Access doors shall meet leakage requirements for the ductwork installed.

C. 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.

2. Make connection to duct with spin-in fittings, with air scoop and balance damper. Refer to 23 30 00 for requirements for balance dampers.

3.02 QUALITY CONTROL

A. Testing four inch pressure class ductwork and plenums:

1. Extreme care shall be used in fabrication and installation of ductwork to ensure that it will be airtight. All ductwork shall be tested for leaks in sections as work progresses and as directed by the State. Section to be tested shall have all open ends sealed off and shall then be tested by one of the following methods:

a. Time leakage test: Section being tested shall be placed under an air pressure of 4 inches of water. Test pressure shall be held for a period of 5 minutes after air supply to section being tested has been shut off. Air pressure in duct at end of 5 minute test period shall be not less than 2-1/2 inches of water.

b. Orifice flow test: Provide high pressure blower, orifice test pipe assembly, and manometer with necessary valves and tubing. Test in accordance with SMACNA "HVAC Air Duct Leakage Test Manual," latest edition, except as noted hereinafter. Ductwork section being tested shall be held under a constant pressure of 4 inches of water with blower while any leakage flow through orifice is measured on manometer. Manometer readings shall be converted to cfm from a calibrated test curve. Leakage shall not exceed one percent of design air flow with a maximum allowable of 500 cfm. If this method of testing is used, complete information and data on equipment to be used must be submitted to the State for approval before any tests are made.

2. Testing of any completed section of ductwork must be made before installation of finished ceiling, if any, or before ductwork is furred in inaccessible spaces and must be witnessed by the State. Any leaks found must be properly repaired or joints remade, and section retested until tight. Leaks which cause any objectionable noise must be repaired, regardless of amount of leakage.

3. Upon completion of testing, the Contractor shall complete the test report forms provided by SMACNA "HVAC Air Duct Leakage Test Manual." These forms shall be made in triplicate and forwarded to the State for review.

B. All ductwork exposed to view in furnished building shall be installed free from blemish, dents, fabrication labels and the like.

C. Cleaning and protection:

1. Ductwork to arrive at job site clean and protected. Clean external surfaces of foreign substances which might cause corrosive deterioration of metal or where ductwork is to be painted (by others)

2. Strip protective paper from stainless ductwork surfaces, and repair finish wherever it has been damaged.

3. Temporary closure: At ends of ducts which are not connected to equipment or air distribution devices at time of ductwork installation, provide temporary closure of polyethylene film or other covering which will prevent entrance of dust and debris until connections are to be completed.

END OF SECTION

SECTION 23 34 16

CENTRIFUGAL HVAC FANS

PART 1 - GENERAL

1.01 SUMMARY

A. Volume 1 - Contracting Requirements, and Division - 01 General Requirements apply to the Work of this Section.

B. Section includes:

1. Gravity ventilators.

   a. Hooded gravity ventilators.

   b. Low silhouette box type gravity ventilators.

2. Centrifugal fans.

3. In-Line centrifugal fans.

4. Utility sets.

C. Coordination with other Divisions:

1. Division 26-Electrical, for wiring and hookups.

1.02 ACTION SUBMITTALS

A. Submit under provisions of Section 01 33 00.

B. Submittals for review during construction document phase:

1. Product data: Submit manufacturer's technical data for fans and ventilators, including specifications, capacity ratings, dimensions, weights, materials, accessories furnished, and installation instructions. Indicate duty and location proposed.

1.03 INFORMATIONAL SUBMITTALS

A. Submit under provisions of Section 01 33 00.

B. Submittals for closeout:

1. Maintenance data: Submit maintenance data and parts list for each type of fan and ventilator, accessory, and control. Include this data and product data in maintenance manual, in accordance with Division 1.

2. Submit all warranties signed by the manufacturer

3. Provide all special tools, loose gauges and test kits and maintenance and calibration instructions.

1.04 QUALITY ASSURANCE

A. Regulatory requirements:

1. AMCA compliance: Provide fans and ventilators which have been tested and rated in accordance with AMCA standards, and bear AMCA Certified Ratings Seal.

2. NEMA compliance: Provide motors and electrical accessories complying with NEMA standards.

3. Supply all equipment and accessories in accordance with requirements of all applicable national, state and local codes.

PART 2 - PRODUCTS

2.01 PRODUCTS

A. Gravity ventilators:

1. General: Standard prefabricated gravity ventilator units of type and size required, modified as necessary to comply with requirements, and as required for complete installation.

2. Hooded gravity ventilators:

a. Type: Stationary, natural draft type. Provide galvanized weather resistant housings. Provide square or rectangular base to suit roof curb.

b. Bird screens: Provide bird screens.

c. Dampers: Provide gravity actuated louvered dampers in curb bases.

3. Low silhouette box type gravity ventilators: Provide low silhouette box type gravity ventilators, of size and capacity as required.

a. Construction: Design ventilators to be watertight at normal positive pressure conditions, and to withstand wind load of 30 psf. Provide collecting gutters to collect drainage from baffles and damper gutters.

1) Internal parts: Hot dip galvanized steel.

2) Exposed sides: Aluminum.

4. Dampers: Provide integral dampers, constructed for minimum 50 percent free area outlet when fully open. Damper blades shall be of aluminum construction.

5. Bird screen: Provide bird screens.

    a. .

B. Centrifugal fans:

1. All fan ratings shall be based on tests made in accordance with the ASHRAE Standard 51/AMCA Standard 210-74 and shall be licensed to bear the AMCA Seal.

2. Fan impeller diameters must conform to the recommendations in AMCA Standard 99.

3. All fans shall be capable of operating over the minimum pressure class limits, as specified in AMCA's Standard 2408-69.

4. Fan housings:

    a. Housing and bearing support shall be constructed of bolted framework.. Fans shall have housings of the following gauges:

        1) Forward curved class I & II:

            a) 12 inch - 29 inch wheel - 16 gauge sides and scroll.

            b) 30 inch - 48 inch wheel - 12 gauge sides and scroll.

        2) Backward inclined and airfoil Class I & II:

            a) 21 inch and smaller wheel - 14 ga. sides and scroll

            b) 22 inch - 29 inch wheel - 12 ga. sides and 14 ga. scroll

            c) 72 inch and larger wheel - 10 ga. sides and scroll

5. Fan wheels:

    a. All backward inclined and airfoil fan wheels shall have precision spun inlet cones providing a minimum separation in airflow. Forward curved fans shall be provided with inlet rings. Blades shall be plate type, die formed, or airfoil shaped. Where plate type blades are used, wheels shall have 12 blades minimum. All blades shall be welded to the inlet cones as well as the backplate. No partial welding will be acceptable on airfoil blades. Fan blades shall be designed to provide smooth airflow over all surfaces of the blade. Fans shall have full discharge safety cage and inlet screens.

    b. All wheels shall be "true" lined, statically and dynamically balanced on precision electronic balancers. Each wheel shall be designed for critical speeds of at least 1.25 times the maximum class speed.

c. Hubs shall be screwed to the shaft with a minimum of two set screws for positive attachment. Hubs using taper lock bushings are not acceptable.

6. Fan shafts:

   a. All sizes are to have shafts of solid AISI C-1018, 1040 or 1045 hot rolled steel accurately turned, ground, polished, and ring gauged for accuracy. Close tolerances are to be maintained where the shaft makes contact with the bearings. All shafts must be dial indicated for straightness after the keyways are cut.

   b. Shaft diameters shall have first critical speed at least 1.25 times the maximum class speed of the fan.

7. Bearings: All fans are to have heavy duty, grease lubricated, precision anti-friction ball or roller, self-aligning, pillow block type bearings. Bearings are to be selected for minimum average bearing life (AFBMA L-50) in excess of 200,000 hours when operating at maximum cataloged class conditions. All bearings shall be equipped with regreaseable zerk fittings and where necessary, extended lube lines for easy access for relubrication. Both bearings shall have same bore, type and manufacturer and at least one bearing shall be fixed.

8. Painting: Each fan component shall be thoroughly degreased and deburred before the application of a rust preventative primer. After complete assembly, a second coat of primer shall be applied to the complete assembly. Aluminum fan wheels shall not be painted.

C. Centrifugal inline fans:

1. The centrifugal inline blower shall be of the belt driven or direct driven type. The blower housing shall be of the square design and constructed of heavy gauge steel.

2. Access doors shall be located on any side with the exception of the motor side. This allows wheel, bearings, shaft and drive components to be serviced or removed without disturbing the ductwork connections.

3. The access door shall be hinged as standard.

4. The unit shall have an all aluminum centrifugal blower type wheel, featuring non-overloading backward inclined blades and a tapered inlet shroud. Wheels shall be statically and dynamically balanced.

5. The motor and drives shall be isolated from the airstream. All motors are heavy duty, permanently lubricated, sealed ball bearing type. Bearings are permanently sealed pillow block type. All shafts are ground and polished steel. Drives are sized for 150% of motor horsepower and of the cast iron type and keyed to the motor and wheel shaft. Drives are set to the required RPM at the factory.

6. The unit shall be AMCA air and sound certified and licensed to bear the AMCA seal for both air and sound.

D. Utility sets:

1. Shall be of the belt driven utility fan type, AMCA arrangement 10 with single width, single inlet housing in CW or CCW rotation as required.

2. The housing shall be constructed of heavy gauge steel with lock formed seams for no air leakage and shall be field rotatable to any of the eight standard discharge positions. The housing and bearing supports shall be constructed of welded steel members to prevent vibration and rigidly support the shaft and bears.

3. The fan wheel shall be of the forward curved or backward inclined type and be constructed of heavy gauge steel with uniform stamped steel blades.

4. Wheels shall be statically and dynamically balanced. The wheel cone and fan inlet cone shall be carefully matched for maximum performance with operating efficiency.

5. Motors shall be of the heavy duty ball bearing type. The fan shaft shall be ground and polished shafting mounted in heavy duty, permanently sealed pillow block ball bearings. Bearings shall be selected for a minimum of 200,000 hours life at maximum cataloged operating speed. Drives shall be sized for a minimum of 150% of driven horsepower. Pulleys shall be of the fully machined cast iron type keyed and securely attached to the wheel and motor shafts. The motor pulley shall be adjustable for final system balancing.

6. Fan performance shall be based on tests conducted in accordance with AMCA Standard 210 test code for air moving devices and fans shall be licensed to bear the AMCA Certified Ratings Seal.

PART 3 - EXECUTION

3.01 EXECUTION

A. Installation of fans:

1. Except as otherwise indicated or specified, install fans and ventilators in accordance with manufacturer's installation instructions and recognized industry practices to insure that ventilators serve their intended function.

    a. Coordinate ventilator work with work of roofing, walls, and ceilings, as necessary for proper interfacing.

2. Ductwork: Refer to Section 23 31 13 Metal Ducts. Connect ducts to fans and ventilators in accordance with manufacturer's installation instructions.

    a. Provide access door in duct below ventilator to service damper.

3. Roof curbs: Roof curbs shall be equal to that provided by the unit manufacturer, and shall be pitched to match slope of the roof.

4. Electrical wiring: Install electrical devices furnished by manufacturer but not specified to be factory mounted. Furnish copy of manufacturer's wiring diagram submittal to Contractor.

a. Verify that electrical wiring installation is in accordance with manufacturer's submittal and installation requirements of Division 26 sections. Verify proper rotation direction of fan wheels. Do not proceed with equipment start-up until wiring installation is acceptable to equipment installer.

5. Remove shipping bolts and temporary supports within ventilators. Adjust dampers for free operation.

3.02 QUALITY CONTROL

A. Field quality control:

1. After installation of fans and ventilators has been completed, test each unit to demonstrate proper operation of units at performance requirements specified. When possible, field correct malfunctioning units, then retest to demonstrate compliance. Replace units which cannot be satisfactorily corrected.

B. Testing and adjusting:

1. Start up and adjust fans to insure proper operation.

2. Fan systems shall be started and tested in the presence of a representative of the respective manufacturer.

3. Provide operational tests to demonstrate proper operation and adequate capacity at completion of balancing and adjusting.

4. Lubricate all bearings.

5. Check fan rotation, level bases, adjust isolators.

END OF SECTION

SECTION 23 36 00

AIR TERMINAL UNITS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Related Documents:

1. Review these documents for coordination with additional requirements and information that apply to work under this Section.

2. Provide those products specified in this Section that are applicable to the Project.

3. Volume 1 - Contracting Requirements, and Division - 01 General Requirements apply to the Work of this Section.

1.02 SUMMARY

A. This Section includes the following:

1. Shutoff single-duct air terminal units.

1.03 REFERENCES

A. General:

1. Where differences exist between codes and standards, the most stringent shall apply.

2. If the year of the adoption or latest revision is omitted from the designation, it shall mean the specification, manual or test designation in effect the date on the Agreement.

1.04 ACTION SUBMITTALS

A. Comply with Division 01 Section 01 33 00 “Submittals Procedures”.

B. Construction Documents Phase Submittals:

1. Product Data: For each type of product indicated, include rated capacities, furnished specialties, sound-power ratings, and accessories.

1.05 INFORMATIONAL SUBMITTALS

A. Comply with Division 01 Section 01 33 00 “Submittals Procedures”.

B. Construction Documents Phase Submittals:

1. Shop Drawings: Detail equipment assemblies and indicate dimensions, required clearances, method of field assembly, components, and location and size of each field connection.

   a. Include a schedule showing unique model designation, room location, model number, size, and accessories furnished.

   b. Wiring Diagrams: Power, signal, and control wiring.

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

   a. Ceiling suspension assembly members.

   b. Method of attaching hangers to building structure.

   c. Size and location of initial access modules for acoustical tile.

   d. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.

C. Construction Phase Submittals, Prior to Fabrication and Installation: None

D. Closeout Phase:

1. Operation and Maintenance Data: For air terminal units to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section 01 77 00 Closeout Procedures, include the following:

   a. Instructions for resetting minimum and maximum air volumes.

   b. Instructions for adjusting software set points.

1.06 QUALITY ASSURANCE

A. Product Options: Drawings indicate size, profiles, and dimensional requirements of air terminal units and are based on the specific system indicated. Refer to Division 01 Section 01 60 00 "Product Requirements."

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. NFPA Compliance: Install air terminal units according to NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems."

1.07 COORDINATION

A. Coordinate layout and installation of air terminal units and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

PART 2 - PRODUCTS

2.01 SHUTOFF SINGLE-DUCT AIR TERMINAL UNITS

A. Configuration: Volume-damper assembly inside unit casing with control components located inside a protective metal shroud.

B. Casing: 0.034-inch steel or 0.032-inch aluminum.

1. Casing Lining: 1-inch- thick, coated, fibrous-glass duct liner complying with ASTM C 1071; secured with adhesive. Cover liner with nonporous foil.

2. Casing Lining: Adhesive attached, 3/4-inch- thick, polyurethane foam insulation complying with UL 181 erosion requirements, and having a maximum flame-spread index of 25 and a maximum smoke-developed index of 50, for both insulation and adhesive, when tested according to ASTM E 84.

3. Air Inlet: Round stub connection or S-slip and drive connections for duct attachment.

4. Air Outlet: S-slip and drive connections, size matching inlet size.

5. Access: Removable panels for access to dampers and other parts requiring service, adjustment, or maintenance; with airtight gasket.

C. Regulator Assembly: Extruded-aluminum or galvanized-steel components; key damper blades onto shaft with nylon-fitted pivot points located inside unit casing.

1. Automatic Flow-Control Assembly: Combined spring rates shall be matched for each volume-regulator size with machined dashpot for stable operation.

2. Factory-calibrated and field-adjustable assembly with shaft extension for connection to externally mounted control actuator.

D. Regulator Assembly: System-air-powered bellows section incorporating polypropylene bellows for volume regulation and thermostatic control. Bellows shall operate at temperatures from 0 to 140 deg F; shall be impervious to moisture and fungus; shall be suitable for 10-inch wg static pressure; and shall be factory tested for leaks.

E. Volume Damper: Galvanized steel with peripheral gasket and self-lubricating bearings.

1. Maximum Damper Leakage: ARI 880 rated.

F. Attenuator Section: 0.034-inch steel or 0.032-inch aluminum sheet metal.

1. Lining: 1-inch- thick, coated, fibrous-glass duct liner complying with ASTM C 1071; secured with adhesive. Cover liner with nonporous foil.

G. Hot-Water Heating Coil: Copper tube, mechanically expanded into aluminum-plate fins; leak tested underwater to 200 psig; and factory installed.

H. DDC Controls: Bidirectional damper operators and microprocessor-based controller and room sensor shall be compatible with temperature controls specified in Division 23 Section 23 09 00 Instrumentation and Control and shall have the following features:

1. Damper Actuator: 24 V, powered closed.

2. Terminal Unit Controller: Pressure-independent, variable-air-volume controller with electronic airflow transducer with multipoint velocity sensor at air inlet, factory calibrated to minimum and maximum air volumes, and having the following features:

a. Proportional, plus integral control of room temperature.

b. Time-proportional reheat-coil control.

c. Occupied and unoccupied operating mode.

d. Remote reset of airflow or temperature set points.

e. Adjusting and monitoring with portable terminal.

f. Communication with temperature-control system specified in Division 23 Section 23 09 00 Instrumentation and Controls for HVAC.

3. Room Sensor: Wall mounting, with temperature set-point adjustment and access for connection of portable operator terminal.

I. Control Sequence:

1. Suitable for operation with duct pressures between 0.25- and 3.0-inch wg inlet static pressure.

2. Factory-mounted and -piped, 5-micron filter; velocity-resetting, adjustable, high-limit control; and amplifying relay.

3. System-powered, wall-mounting thermostat.

2.02 SOURCE QUALITY CONTROL

A. Identification: Label each air terminal unit with plan number, nominal airflow, maximum and minimum factory-set airflows, coil type, and ARI certification seal.

B. Verification of Performance: Rate air terminal units according to ARI 880.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install air terminal units level and plumb. Maintain sufficient clearance for normal service and maintenance.

3.02 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 Sections.

B. Install piping adjacent to air terminal units to allow service and maintenance.

C. Hot-Water Piping: In addition to requirements in Division 23 Section 23 21 13 Hydronic Piping, connect heating coils to supply with shutoff valve, strainer, control valve, and union or flange; and to return with balancing valve and union or flange.

D. Connect ducts to air terminal units according to Division 23 Section 23 31 13 Metal Ducts.

E. Connect wiring according to Division 26 Section 26 05 19 Low-Voltage Electrical Power Conductors and Cables.

F. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.03 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:

1. After installing air terminal units and after electrical circuitry has been energized, test for compliance with requirements.

2. Leak Test: After installation, fill water coils and test for leaks. Repair leaks and retest until no leaks exist.

3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Remove and replace malfunctioning units and retest as specified above.

3.04 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions and do the following:

   a. Verify that inlet duct connections are as recommended by air terminal unit manufacturer to achieve proper performance.

   b. Verify that controls and control enclosure are accessible.

   c. Verify that control connections are complete.

   d. Verify that nameplate and identification tag are visible.

   e. Verify that controls respond to inputs as specified.

3.05 DEMONSTRATION

A. Engage a factory-authorized service representative to train The State's maintenance personnel to adjust, operate, and maintain air terminal units. Refer to Division 01 Section 01 70 00 "Demonstration and Training."

END OF SECTION

SECTION 23 81 23

COMPUTER-ROOM AIR-CONDITIONERS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Related Documents:

1. Review these documents for coordination with additional requirements and information that apply to work under this Section.

2. Provide those products specified in this Section that are applicable to the Project.

3. Volume 1 - Contracting Requirements, and Division - 01 General Requirements apply to the Work of this Section.

1.02 SUMMARY

A. This Section includes the following types of computer-room air-conditioning units:

1. Floor-mounting units.

1.03 REFERENCES

A. General:

1. Where differences exist between codes and standards, the most stringent shall apply.

2. If the year of the adoption or latest revision is omitted from the designation, it shall mean the specification, manual or test designation in effect the date on the Agreement.

1.04 ACTION SUBMITTALS

A. Comply with Division 01 Section 01 33 00 “Submittals Procedures”.

B. Construction Documents Phase Submittals:

1. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories.

1.05 INFORMATIONAL SUBMITTALS

A. General:

1. Comply with Division 01 Section 01 33 00 “Submittals Procedures”.

2. Submit items as applicable to the Project from submittals specified in this Article.

B. Construction Documents Phase Submittals:

1. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

a. Wiring Diagrams: Power, signal, and control wiring.

C. Construction Phase Submittals, Prior to Fabrication and Installation:

1. Manufacturer Seismic Qualification Certification: Submit certification that computer-room air-conditioning units, accessories, and components will withstand seismic forces defined in Division 23 Section 23 05 48 "Vibration and Seismic Controls for HVAC Piping and Equipment." Include the following:

a. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

1) The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

b. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

c. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

2. Field quality-control test reports.

D. Closeout Phase:

1. Operation and Maintenance Data: For computer-room air-conditioning units to include in emergency, operation, and maintenance manuals.

2. Warranties: Special warranties specified in this Section.

1.06 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Code for Mechanical Refrigeration."

C. Energy-Efficiency Ratio: Equal to or greater than prescribed by 2019 California Energy Code.

D. Coefficient of Performance: Equal to or greater than prescribed by 2019 California Energy Code.

E. Units shall be designed to operate with HCFC-free refrigerants.

1.07 COORDINATION

A. Coordinate layout and installation of computer-room air-conditioning units and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

B. Coordinate installation of computer-room air-conditioning units with computer-room access flooring Installer, as applicable.

C. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section 07 41 11 "Metal Roofing Panels."

1.08 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of computer-room air-conditioning units that fail in materials or workmanship within specified warranty period.

B. Warranty Period for Compressors: Manufacturer's standard, but not less than five years from date of Beneficial Occupancy.

C. Warranty Period for Humidifiers: Manufacturer's standard, but not less than three years from date of Beneficial Occupancy.

D. Warranty Period for Control Boards: Manufacturer's standard, but not less than three years from date of Beneficial Occupancy.

1.09 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fan Belts: One set for each belt-drive fan.

2. Filters: One set of filters for each unit.

PART 2 - PRODUCTS

2.01 FLOOR-MOUNTING UNITS

A. Description and Assembly: Packaged, factory assembled, pre-wired, and pre-piped; consisting of cabinet, fans, filters, humidifier, and controls.

B. Cabinet and Frame: Welded steel, suitably braced for rigidity, supporting compressors and other mechanical equipment and fittings; with floor stand with adjustable legs and vibration isolation pads.

   1. Doors and Access Panels: Galvanized steel with polyurethane gaskets, hinges, and concealed fastening devices.

   2. Insulation: Thermally and acoustically insulate cabinet interior with 1-inch- thick duct liner.

   3. Finish of Exterior Surfaces: Baked-on, textured vinyl enamel, color as selected from manufacturer's standard colors.

   4. Floor Stand: Welded tubular steel.

C. Evaporator Fan: Double inlet, forward curved, centrifugal, and statically and dynamically balanced.

   1. Drive: V-belt drive with steel shaft with self-aligning ball bearings and cast-iron or steel sheaves, variable- and adjustable-pitch motor sheave, minimum of two matched belts, with drive rated at a minimum of two times the nameplate rating of motor.

   2. Motor: Comply with requirements in Division 23 Section 23 05 13 "Common Motor Requirements for HVAC Equipment."

      a. Noise Rating: Quiet.

D. Compressors: Semi-hermetic reciprocating with suction-gas-cooled, 1750-rpm motors; thermal overloads; oil sight glass; suction-line strainer; and reversible oil pumps, Hermetic reciprocating; or Hermetic scroll; with oil strainer, internal motor overload protection, resilient suspension system, crankcase heater, manual-reset high-pressure switch, and pump-down low-pressure switch.

   1. Refrigeration Circuits: Two, each with hot-gas mufflers, thermal-expansion valve with external equalizer, liquid-line solenoid valve, liquid-line filter-dryer, sight glass with moisture indicator, service shutoff valves, charging valves, accumulator sized for liquid seal under light load, and charge of refrigerant.

   2. Refrigerant: R-22, R-407C or R410A.

E. Evaporator Coil: Alternate-row or split-face-circuit, direct-expansion coil of seamless copper tubes expanded into aluminum fins. Mount coil assembly over stainless-steel drain pan having a condensate pump unit with integral float switch, pump-motor assembly, and condensate reservoir if required.

F. Air-Cooled Condenser: Corrosion-resistant cabinet, copper-tube aluminum-fin coils arranged for two circuits, multiple direct-drive propeller fans with permanently lubricated ball bearings, and single-phase motors with internal overload protection, integral electric control panel, and disconnect switch. Control capacity by cycling fans.

G. Filter: Pleated, lofted, non-woven, reinforced cotton fabric; supported and bonded to welded-wire grid; enclosed in cardboard frame.

1. Dust-Spot Efficiency: 65 percent.

2. Weight Arrestance: 90 to 92 percent.

3. Initial Resistance at 500-FPM Face Velocity: 0.30-inch wg.

4. Recommended Final Resistance: 1-inch wg.

H. Integral Electrical Controls: Unit-mounted electrical enclosure with piano-hinged door, grounding lug, combination magnetic starters with overload relays, circuit breakers and cover interlock, and fusible control-circuit transformer.

I. Disconnect Switch: Non-automatic, molded-case circuit breaker with handle accessible when panel is closed and capable of preventing access until switched to off position.

J. Electronic-Control System: Solid state, with start button, stop button, temporary loss of power indicator, manual-reset circuit breakers, temperature control, humidity control, and monitor panel.

1. Monitor Panel: Backlighted, with no visible indicator lights until operating function is activated; indicators include cooling, loss of airflow, change filters, high temperature, low temperature, high head pressure (each compressor), and low suction pressure (each compressor).

2. Temperature- and Humidity-Control Modules: Solid state, plug-in; with adjustable set point, push-to-test calibration check button, and built-in visual indicators to show mode of operation.

3. Location: Behind hinged door in front of unit; isolated from conditioned airstream to allow service while system is operating.

K. Microprocessor-Control System: Continuously monitors operation of process cooling system; continuously displays room temperature and room relative humidity; sounds alarm on system malfunction and simultaneously displays problem. If more than one malfunction occurs, system displays fault in sequence with room temperature and continues to display fault when malfunction is cleared until system is reset.

1. Malfunctions:

a. Power Loss.

b. Loss of Airflow.

c. Clogged Air Filter.

d. High Room Temperature.

e. Low Room Temperature.

f. Smoke/Fire.

g. Supply Fan Overload.

h. Compressor No. 1--Overload.

i. Compressor No. 1--Low Pressure.

j. Compressor No. 1--High Pressure.

k. Compressor No. 2--Overload.

l. Compressor No. 2--Low Pressure.

m. Compressor No. 2--High Pressure.

2. LED Display:

   a. Control Power On.

   b. Humidifying.

   c. Dehumidifying.

   d. Compressor No. 1 Operating.

   e. Compressor No. 2 Operating.

   f. Heat Operating.

   g. Economy Cooling.

3. Push buttons shall stop and start process cooling system, silence audible alarm, test LED indicators, and display room relative humidity.

4. Remote Signaling: Provide terminals for remote signaling of system status and alarms.

5. Additional Monitoring:

   a. Monitor constant and variable motor loads.

   b. Monitor variable frequency drive operation.

   c. Monitor cooling load.

   d. Monitor economizer cycles.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install computer-room air-conditioning units level and plumb, maintaining manufacturer's recommended clearances.

B. Install suspended components level. Coordinate wall penetrations and flashing with wall construction. Secure units to structural support with anchor bolts.

C. Install air-cooled condenser on rubber-in-shear vibration isolators.

D. Install floor-mounting units on bases designed to withstand, without damage to equipment, seismic forces required by code.

3.02 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 Sections.

B. Install piping adjacent to machine to allow service and maintenance.

C. Water and Drainage Connections: Comply with applicable requirements in Division 23 Section 22 11 16 "Domestic Water Piping." Provide adequate connections for water-cooled units, condensate drain, and humidifier flushing system.

D. Refrigerant Piping: Comply with applicable requirements in Division 23 Section 23 23 00 "Refrigerant Piping." Provide shutoff valves and piping.

E. Electrical System Connections: Comply with applicable requirements in Division 26 Sections for power wiring, switches, and motor controls.

F. Ground equipment according to Division 26 Section 26 05 26 "Grounding and Bonding for Electrical Systems."

G. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.03 FIELD QUALITY CONTROL

A. Manufacturer’s Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.

B. Perform the following field tests and inspections and prepare test reports:

1. Inspect for and remove shipping bolts, blocks, and tie-down straps.

2. After installing computer-room air-conditioning units and after electrical circuitry has been energized, test for compliance with requirements.

3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.04 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

B. Verify that computer-room air-conditioning units are installed and connected according to manufacturer's written instructions and the Volume 3 – Performance Criteria – Performance Specifications.

C. Verify that electrical wiring installation complies with manufacturer's submittal and installation requirements in Division 26 Sections.

D. Complete installation and startup checks according to manufacturer's written instructions.

E. After startup service and performance test, and change filters.

3.05 ADJUSTING

A. Adjust initial temperature set points.

B. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

C. Occupancy Adjustments: When requested within 12 months of date of Beneficial Occupancy, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to site outside normal occupancy hours for this purpose, without additional cost.

3.06 DEMONSTRATION

A. Engage a factory-authorized service representative to train the State’s maintenance personnel to adjust, operate, and maintain computer-room air-conditioning units. Refer to Division 01 Section 01 70 00 "Demonstration and Training."

END OF SECTION

SECTION 23 81 26

AIR-CONDITIONING UNITS

PART 1 - GENERAL

1.01 SUMMARY

A. Volume 1 - Contracting Requirements, and Division - 01 General Requirements apply to the Work of this Section.

B. Section includes:

1. DX Split AC units.

2. Packaged gas/electric air conditioning units.

1.02 ACTION SUBMITTALS

A. Submit under provisions of Section 01 33 00.

B. Submittals for review during construction document phase:

1. Product data: Submit manufacturer's technical product data and installation instructions for each type of material listed in this Section.

1.03 INFORMATIONAL SUBMITTALS

A. Submit under provisions of Section 01 33 00.

B. Submittals for closeout:

1. Maintenance data: Submit maintenance data and replacement material lists for each type of material listed in this Section. Include this data and product data in maintenance manual.

2. Submit all contractor warranties signed by the manufacturer

3. Provide all special tools, loose gauges and test kits and maintenance and calibration instructions.

1.04 QUALITY ASSURANCE

A. AMCA compliance: Install unit heaters in accordance with Air Movement and Control Association, Inc. (AMCA), Application Guide 15 "Piping, Trapping, and Venting Steam and Hot Water Unit Heaters", and 16 "Steam and Hot Water Unit Heaters Installation/Maintenance".

B. ARI compliance: Provide coil ratings in accordance with Air Conditioning and Refrigeration Institute (ARI) Standard 410 "Forced Circulation Air Cooling and Air Heating Coils".

C. ARI compliance: Test and rate fan coil units in accordance with Air Conditioning and Refrigeration Institute (ARI) Standard 440, "Room Fan Coil Air Conditioners".

D. ASHRAE compliance: Test coils in accordance with American Society of Heating, Refrigerating, and Air Conditioning Engineers, Inc. (ASHRAE) Standard 33 "Methods of Testing Forced Circulation Air Cooling and Heating Coils".

E. ETL compliance:

1. Construct and install DX AC units in compliance with ARI Standards 210, 240 and 270.

2. Provide electrical components for terminal units which have been listed and labeled by ETL.

1.05 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to replace components of air conditioner that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Compressors: Manufacturer's standard, but not less than 5 years from date of Beneficial Occupancy.

2. Warranty Period for Gas Furnace Heat Exchangers: Manufacturer's standard, but not less than 10 years from date of Beneficial Occupancy.

3. Warranty Period for Control Boards: Manufacturer's standard, but not less than 1 years from date of Beneficial Occupancy.

1.06 TESTS AND INSPECTIONS:

1. After installing all units and after electrical circuitry has been energized, test units for compliance with requirements.

2. Inspect for and remove shipping bolts, blocks, and tie-down straps.

3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

1.07 CLEANING AND ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Beneficial Occupancy, provide on-site assistance in adjusting system to suit actual occupied

conditions. Provide up to two visits to site during other-than-normal occupancy hours for this purpose.

B. After completing system installation and testing, adjusting, and balancing units and air-distribution systems, clean filter housings and install new filters.

1.08 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain Air conditioners.

PART 2 - PRODUCTS

2.01 SPLIT SYSTEM AIR CONDITIONERS

A. General: Furnish and install indoor unit with split condensing unit, complete with automatic controls. The units shall be a standard product of a firm regularly engaged in the manufacture of heating/cooling equipment. The equipment shall be shipped completely factory assembled, and wired internally ready for field connections. Provide thermal overload protected motors.

   1. Arrange internal controller to provide automatic restart after power failure.

   2. Provide refrigeration piping in accordance with other sections of this Specification.

B. Unit shall be E.T.L. listed. All wiring shall be in compliance with NEC. Rate units in accordance with ARI Standards 240 and 270.

C. The coils shall have aluminum fins mechanically bonded to durable copper tubes. Coils shall be pressure leak tested.

D. The compressor shall be resiliently mounted, have built-in lubrication, crankcase heater, and current and temperature sensing motor overloads.

E. High-pressure switches shall protect the system and a five-minute compressor timed off cycle controller (anti-recycle timer).

F. Cabinet: Galvanized steel with a baked on outdoor enamel paint finish. Cabinet panels where conditioned air is handled shall be fully insulated.

G. Service Access: All components, wiring, and inspection areas shall be completely accessible through removable panels.

H. Supply Air Blowers: Centrifugal blowers shall have direct drive motors. The entire assembly shall be resiliently rubber mounted. Blower wheel shall be statically and dynamically balanced.

I. Condenser Fans: Propeller type condenser fans shall discharge horizontally or vertically. Fan motor shall be totally enclosed with sleeve bearings, permanently lubricated, inherently protected. A steel guard shall protect fan.

J. Air 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.

2.02 AIR CONDITIONING UNITS

A. Provide factory assembled single packaged outdoor, electrically controlled gas or hot water heating and electric cooling unit, rated in accordance with ARI Standards 210 or 360, and UL listed and labeled, classified in accordance with UL 1995. Provide refrigerant charge R-410A, all internal wiring, piping, controls, and special features required prior to field startup. Design unit to conform to the following:

1. California NOx emission requirements

2. ASHRAE 15.

3. ASHRAE 90.1.

4. Insulation, adhesive, and all materials exposed to air stream shall meet NFPA 90A requirements for flame spread and smoke generation.

5. Unit casing shall be capable of withstanding 500-hour salt spray exposure per ASTM B117 (scribed specimen).

B. UL tested and certified

C. Unit shall be rated in accordance with ARI sound standards 270 or 370.

D. Unit shall be UL tested and certified in accordance with ANSI Z21.47 Standards as a total package.

E. Unit shall be Energy Star qualified.

F. Cabinet:

1. Provide galvanized steel unit cabinet, bonderized and coated with a baked enamel finish.

2. All airstream interior surfaces shall be insulated with a minimum 1/2 inch thick, 1 lb density foil-faced cleanable insulation. Insulation shall be encapsulated with panel design or have sealed edges.

3. Cabinet panels shall be hinged with integrated non-corrosive hinges. Provide hinged access panels for the filter, compressors, evaporator fan, and control box and heat section areas. Each panel shall have multiple latches and handles. Each external hinged access panel shall be double-wall construction and permanently attached to the rooftop unit

4. Return air filters shall be accessible through a dedicated hinged access panel.

5. Unit shall have a factory-installed internally sloped condensate drain pan

G. Fans:

1. Centrifugal supply air blower (evaporator fan) shall have rubber-isolated, cartridge type ball bearings. Provide belt-driven double inlet fan wheel, centrifugal type with forward curved or airfoil blades and adjustable sheaves.

2. Evaporator-fan motors shall be continuous operation, open drip-proof, and thermally protected. Bearings shall be sealed, permanently lubricated ball-bearing type.

3. Condenser fans shall be of the direct-driven propeller type, with corrosion-resistant aluminum blades. Fans shall be dynamically balanced and discharge air upwards. Condenser-fan motors shall be totally enclosed and thermally protected.

4. Induced-draft blower shall be of the direct-driven, single inlet, forward-curved or airfoil, centrifugal type. It shall be made from aluminized steel with a corrosion-resistant finish and shall be dynamically balanced.

H. Compressor:

1. Fully hermetic, scroll type with crank case heaters, internal high-pressure and temperature protection.

2. Factory installed vibration isolation.

3. Compressor Anti-Recycle Timer: Compressor shall be prevented from restarting for a minimum of five minutes after shutdown, with manufacturers installed compressor cycle delay.

4. Compressor shall have a five year warranty.

I. Coils:

1. Standard evaporator and condenser coils shall have aluminum plate fins mechanically bonded to seamless internally finned copper tubes with all joints brazed.

2. Condenser coils shall be single slab, single pass design.

3. Coils shall be leak tested at minimum 170 psig and pressure tested at minimum 450 psig.

J. Gas Heating Section:

1. Induced-draft combustion type with direct spark or silicon nitride hot surface ignition system.

2. Heat Exchanger:

a. The standard aluminized heat exchanger shall be of the tubular-section type constructed of a minimum of 20-gage corrosion resistant steel. Standard heat exchanger shall have a ten year warranty.

b. The optional stainless steel heat exchanger shall be of the tubular-section type, constructed of a minimum of 20-gage, type 409 stainless steel, including stainless steel tubes, vestibule plate, and collector box. Stainless steel heat exchanger shall have a fifteen year warranty.

3. Burners shall be constructed of stainless steel.

4. Units shall be suitable for use with natural gas.

5. Unit shall be equipped with anti-cycle protection with one short cycle on unit flame rollout switch or 4 continuous short cycles on the high-temperature limit switch. Fault indication shall be made using an LED.

K. Refrigerant Components:

1. Each refrigerant circuit shall include:

a. Balanced port thermostatic expansion valve (TXV).

b. Solid core refrigerant filter driers with pressure ports.

c. Refrigerant pressure gage ports and connections on suction, discharge, and liquid lines.

L. Filter Section:

1. Standard filter section shall accommodate 2 inch deep filters. Provide pleated low pressure drop MERV 13 filters (minimum).

2. Filter section shall use standard size filters.

M. Controls:

1. Microprocessor controls shall include the following, as a minimum:

a. User diagnostic interface.

b. Unit control with standard suction pressure transducers and condensing temperature thermistors.

c. Shall provide a 5° F temperature difference between cooling and heating set points to meet ASHRAE 90.1 Energy Standard.

d. Service run test capability.

e. Configurable alarm light shall be provided which activates when certain types of alarms occur.

f. Provide compressor minimum run time (3 minutes) and minimum off time (5 minutes).

g. Service diagnostic mode.

h. Economizer control.

i. Unit shall have 0° F low ambient cooling operation.

j. Time delay relay.

N. Safeties:

1. Unit shall incorporate a solid-state compressor lockout that provides optional reset capability at the space thermostat, should any of the following safety devices trip and shut off compressor:

   a. Compressor lockout protection provided for either internal or external overload.

   b. Low-pressure protection.

   c. Freeze protection (evaporator coil).

   d. High-pressure protection (high pressure switch or internal).

   e. Compressor reverse rotation protection.

   f. Loss of charge protection.

   g. Start assist on singe-phase units.

2. Supply-air sensor shall be located in the unit and detect both heating and cooling operation.

3. Induced draft heating section shall be provided with the following minimum protections:

   a. High-temperature limit switch.

   b. Induced-draft motor speed sensor.

   c. Flame rollout switch.

   d. Flame proving controls.

4. Phase Protection: Provide unit-mounted “SymCom” Motor Saver three phase voltage monitor, model 201A or equal, adjustable voltage range for each unit, install per manufacturer's recommendations, mount in NEMA 3R enclosure if exposed to the weather.

   a. Units shall provide the following features:

      1) Low voltage fault trip and reset.

2) Voltage unbalance/phasing fault trip and reset.

3) High voltage fault trip and reset.

4) Transient Protection (Internal).

5) Automatic restart.

b. Provide each unit with 600V socket, “SymCom” model OT08.

O. Operating Characteristics:

1. Unit shall be capable of starting and running at 125° F ambient outdoor temperature per maximum load criteria of ARI Standards 210 or 360.

2. Unit with factory controls will operate in cooling down to an outdoor ambient temperature of 0° F. Electro-mechanical controls shall operate down to 25° F.

3. Unit shall be provided with fan time delay to prevent cold air delivery in heating mode.

P. Electrical Requirements:

1. All unit power wiring shall enter unit cabinet at a single location - standard side or alternate bottom.

Q. Motors:

1. Compressor motors shall be cooled by refrigerant gas passing through motor windings and shall have line break thermal and current overload protection.

2. Evaporator fan motor shall have permanently lubricated, sealed bearings and inherent automatic-reset thermal overload protection or manual reset calibrated circuit breakers.

3. All evaporator fan motors 5 hp and larger shall meet the minimum efficiency requirements as established by the Energy Policy Act of 1992 (EPACT),

4. Totally enclosed condenser-fan motor shall have permanently lubricated, sealed bearings, and inherent automatic-reset thermal overload protection.

5. Induced-draft motor shall have permanently lubricated sealed bearings and inherent automatic-reset thermal overload protection.

R. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:

1. Carrier Corporation.

2. Trane Inc.

3. Johnson Controls, Inc.

PART 3 - EXECUTION

3.01 \INSTALLATION OF AIR CONDITIONING UNITS:

A. Install units in accordance with manufacturer's installation instructions.

B. Hang units from building substrate, not from piping. Mount as high as possible to maintain greatest headroom possible.

C. Support units with rod type hangers anchored to building substrate.

D. Install base mounted units on neoprene isolators.

E. Verify that piping to be installed adjacent to roof mounted equipment allows service and maintenance.

F. Verify that gas piping will be installed with sufficient clearance for burner removal and service.

G. G. Connect supply and return air ducts to horizontal discharge equipment with flexible duct connectors.

3.02 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Tests and Inspections:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.

2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Remove and replace malfunctioning units and retest as specified above.

1. Prepare test and inspection reports.

3.03 STARTUP SERVICE

A. Complete installation and startup checks according to manufacturer's written instructions.

3.04 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain units.

END OF SECTION

DIVISION 26

ELECTRICAL

26 00 00	ELECTRICAL DESIGN CRITERIA
26 00 01	ELECTRIC VEHICLE CHARGING STATION
26 05 02	SUPPORTING FROM STRUCTURE
26 05 19	LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600V & LESS)
26 05 26	GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS
26 05 29	HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS
26 05 34	CONDUITS
26 05 35	J-HOOKS
26 05 36	CABLE TRAYS FOR ELECTRICAL SYSTEMS
26 05 37	ELECTRICAL BOXES
26 05 53	IDENTIFICATION FOR ELECTRICAL SYSTEMS
26 05 73	OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY
26 05 74	ARC FLASH STUDY
26 08 00	ELECTRICAL COMMISSIONING
26 09 13	ELECTRICAL POWER MONITORING AND CONTROL
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26 22 00	LOW-VOLTAGE TRANSFORMERS
26 24 00	SERVICE AND DISTRIBUTION GENERAL CRITERIA
26 24 13	SWITCHBOARDS
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26 27 16	ELECTRICAL CABINETS AND ENCLOSURES
26 27 26	WIRING DEVICES
26 28 12	SURGE PROTECTION FOR LOW-VOLTAGE ELECTRICAL POWER CIRCUITS
26 28 13	FUSES
26 28 17	ENCLOSED CIRCUIT BREAKERS
26 28 18	ENCLOSED SWITCHES
26 29 23	VARIABLE-FREQUENCY MOTOR CONTROLLERS
26 31 00	PHOTOVOLTAIC SYSTEM
26 32 13	STANDBY POWER SYSTEM
26 32 15	ABOVE GROUND FUEL STORAGE TANKS FOR EMERGENCY GENERATOR
26 33 53	STATIC UNINTERRUPTIBLE POWER SUPPLY
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26 41 13	LIGHTNING PROTECTION FOR STRUCTURES
26 51 01	LIGHTING
26 51 02	OCCUPANCY SENSORS
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26 81 15	EMERGENCY RESPONDER RADIO ANTENNA/REPEATER SYSTEM

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