SECTION 02 41 00

DESTRUCTION

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. This section includes selective demolition, alteration and remodeling work indicated or required to produce finished results shown and includes the following:
   1. Demolition and removal of selected portions of a building.
   2. Demolition and removal of selected site elements.
   3. Patching and repairs.

1.02 RELATED SECTIONS

A. Section 01 11 00: Summary of Work.
B. Divisions 22 and 23: sections for cutting, patching, or relocating Mechanical and Plumbing items.
C. Divisions 26, 27 and 28: sections for cutting, patching, or relocating Electrical, Telecom, Security, and Fire Alarm items.

1.03 DEFINITIONS

A. Remove: Remove and legally dispose of items except those indicated to be reinstalled, salvaged, or to remain the Owner's property.
B. Remove and Salvage: Items indicated to be removed and salvaged remain the Owner's property. Remove, clean, and pack or crate items to protect against damage. Identify contents of containers and deliver to Owner's designated storage area.
C. Remove and Reinstall: Remove items indicated; clean, service, and otherwise prepare them for reuse; store and protect against damage. Reinstall items in the same locations or in locations indicated.
D. Existing to Remain: Protect construction indicated to remain against damage and soiling during selective demolition. When permitted by the Architect, items may be removed to a suitable, protected storage location during selective demolition and then cleaned and reinstalled in their original locations.

1.04 MATERIALS OWNERSHIP

A. Except for items or materials indicated to be reused, salvaged, reinstalled, or otherwise indicated to remain the Owner's property, demolished materials shall become the Contractor's property and shall be removed from the site with further disposition at the Contractor's option.

1.05 SUBMITTALS

A. Comply with pertinent portions of Section 01 33 00.
B. Prior to cutting which affects structural safety, submit written request to the Architect for permission to proceed with cutting.
C. Record Drawings: Submit at project closeout according to Section 01 78 00.
   1. Identify and accurately locate capped utilities and other subsurface structural, electrical, or mechanical conditions.

1.06 QUALITY ASSURANCE

A. Demolition Firm Qualifications: Engage an experienced firm that has successfully completed selective demolition Work similar to that indicated for this Project.

B. Regulatory Requirements: Comply with governing EPA notification regulations before starting selective demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.
   1. Comply with California Building Code, Title 24, Part 9, California Fire Code, Article 87, Fire Safety During Construction, Alteration or Demolition of a Building.

1.07 PROJECT CONDITIONS

A. Occupancy: Owner will occupy buildings immediately adjacent to alteration areas. Conduct alteration work in manner that will minimize need for disruption of Owner's operations. Provide minimum 72 hours advance notice to Owner of demolition activities that will affect Owner's operations.

B. Owner assumes no responsibility for actual condition of buildings to be altered.
   1. Conditions existing at time of inspection for bidding purpose will be maintained by Owner as far as practical.

C. Asbestos or Hazardous Waste: It is understood and agreed that this contract does not contemplate the handling of asbestos or any hazardous waste material except as done by a properly qualified subcontractor. If asbestos or any hazardous waste material is encountered, notify the Owner immediately. Do not disturb, handle or attempt to remove.

D. Traffic: Conduct demolition operations and debris removal in a manner to ensure minimum interference with roads, streets, walks, and other adjacent occupied or used facilities.
   1. Do not close, block or otherwise obstruct streets, walks or other occupied or used facilities without written permission from authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by governing regulations.

E. Utility Service: Maintain existing utilities indicated to remain in service and protect them against damage during selective demolition operations.

PART 2 - PRODUCTS

2.01 PRODUCTS FOR PATCHING, EXTENDING AND MATCHING

A. Provide same products or types of construction as that in existing structure, as needed to patch, extend or match existing work.
   1. Where identical materials are unavailable or cannot be used for exposed surfaces, use materials that visually match existing adjacent surfaces to the fullest extent possible.
   2. Use materials whose installed performance equals or surpasses that of existing materials.
   3. Generally Contract Documents will not define products or standards of workmanship present in existing construction; Contractor shall determine products by inspection and any necessary testing, and workmanship by use of the existing as a sample of
comparison.

B. Presence of a product, finish, or type of construction, requires that patching, extending or matching shall be performed as necessary to make work complete and consistent to identical standards of quality.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine existing conditions, including elements subject to movement or damage during remodeling work.

B. After uncovering the work, examine conditions affecting installation of new work.

C. Discrepancies:
   1. If uncovered conditions are not as anticipated, immediately notify the Architect and secure needed directions.
   2. Do not proceed in areas of discrepancy until such discrepancies have been fully resolved.

D. Time extensions or increase or decrease of costs resulting from such changes will be adjusted in the manner provided in the General Conditions.

3.02 UTILITY SERVICES

A. Maintain existing utilities indicated to remain, keep in service, and protect against damage during demolition operations.
   1. Do not interrupt existing utilities serving occupied or used facilities, except when authorized in writing by authorities having jurisdiction. Provide temporary services during interruptions to existing utilities, as acceptable to governing authorities.
   2. Provide not less than 72 hours notice to Owner if shutdown of service is required during changeover.

B. Utility Requirements: Locate, identify, disconnect, and seal or cap off indicated utility services serving building to be selectively demolished.
   1. Owner will arrange to shut off indicated utilities when requested by Contractor.
   2. Where utility services are required to be removed, relocated, or abandoned, provide bypass connections to maintain continuity of service to other parts of the building before proceeding with selective demolition.
   3. Cut off pipe or conduit in walls or partitions to be removed. Cap, valve, or plug and seal the remaining portion of pipe or conduit after bypassing.

C. Utility Requirements: Refer to Division 15 or 16 Sections for shutting off, disconnecting, removing, and sealing or capping utility services. Do not start selective demolition work until utility disconnecting and sealing have been completed and verified in writing.

3.03 PREPARATION

A. Conduct demolition operations to prevent injury to people and damage to adjacent buildings and facilities to remain. Ensure safe passage of people around selective demolition area.
   1. Erect temporary protection, such as walks, fences, railings, canopies, and covered passageways, where required by authorities having jurisdiction.
2. Protect existing site improvements, appurtenances, and landscaping to remain.
3. Erect a plainly visible fence around drip line of individual trees or around perimeter drip line of groups of trees to remain.
4. Provide temporary weather protection, during interval between demolition and removal of existing construction, on exterior surfaces and new construction to ensure that no water leakage or damage occurs to structure or interior areas.
5. Protect walls, ceilings, floors, and other existing finish work that are to remain and are exposed during selective demolition operations.

B. Provide and maintain interior and exterior shoring, bracing, or structural support to preserve stability and prevent movement, settlement or collapse of structures to be selectively demolished.
   1. Cease operations and notify the Owner's Representative immediately if safety of structure appears to be endangered. Take precautions to support structure until determination is made for continuing operations.
   2. Strengthen or add new supports when required during progress of selective demolition.

C. Cover and protect furniture, furnishings, equipment and fixtures that have not been removed.

D. Provide and maintain barricades and guard rails as required by applicable regulatory agency to protect occupants of building and workers.

E. Where demolition, removal or rework occurs, take all necessary precautions to protect finished work from damage. Finished work damaged by operations under this contract shall be repaired or replaced to the acceptance of Owner and Architect at no extra cost to the Owner.

F. Site Access and Temporary Controls: Conduct selective demolitions and debris. Remove operations to ensure minimum interference with roads, street, walk, bridges, balcony and other adjacent occupied and used facilities.

3.04 POLLUTION CONTROLS

A. Use water mist, temporary enclosures, and other suitable methods to limit the spread of dust and dirt. Comply with governing environmental protection regulations.
   1. Do not use water when it may damage existing construction or create hazardous or objectionable conditions, such as ice, flooding, and pollution.

B. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
   1. Remove debris from elevated portions of building by chute, hoist, or other device that will convey debris to grade level.

C. Clean adjacent structures and improvements of dust, dirt, and debris caused by selective demolition operations. Return adjacent areas to condition existing before start of selective demolition.

3.05 SELECTIVE DEMOLITION, ALTERATIONS

A. Cut, drill, alter, remove, or temporarily remove and replace existing construction as necessary for performance of work under the contract. Work that is replaced shall match similar existing work.

B. Unless otherwise noted on the drawings or specified do not cut or alter structural members without authorization of the Architect or Structural Engineer.

C. Demolish and remove existing construction only to the extent required by new construction and as indicated. Use methods required to complete Work within limitations of governing...
regulations.

1. Repair all demolition performed in excess of that required, at no cost to the Owner.

D. Work remaining in place which is damaged or defaced during this contract shall be restored to the condition at time of award of contract.

E. If removal of existing work exposes discolored or unfinished surfaces, or work out of alignment, refinish such surfaces or replace the material as necessary to make contiguous work uniform.

F. Neatly cut openings and holes plumb, square, and true to dimensions required. Use cutting methods least likely to damage construction to remain or adjoining construction. To minimize disturbance of adjacent surfaces, use hand or small power tools designed for sawing or grinding, not hammering and chopping. Temporarily cover openings to remain.

G. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.

H. Do not use cutting torches until work area is cleared of flammable materials. At concealed spaces, such as duct and pipe interiors, verify condition and contents of hidden space before starting flame-cutting operations. Maintain portable fire-suppression devices during flame-cutting operations.

I. Maintain adequate ventilation when using cutting torches.

J. Remove decayed, vermin-infested, or otherwise dangerous or unsuitable materials and promptly dispose of off-site.

K. Remove structural framing members and lower to ground by method suitable to avoid free fall and to prevent ground impact or dust generation.

L. Locate selective demolition equipment throughout the structure and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.

M. Dispose of demolished items and materials promptly. On-site storage or sale of removed items is prohibited.

N. Cut finish surfaces such as concrete, masonry, tile, plaster or metals, by methods to terminate surfaces in a straight line at a natural point of division.

O. Where new work joins existing construction, ensure that jointing is weather tight, sound and even in appearance.

P. Fixtures and outlets to be removed shall have their utility lines capped within walls or floors. Utility lines encountered in the work shall be capped, extended or reworked as necessary for completion of alterations.

3.06 PATCHING AND REPAIRS

A. Promptly patch and repair holes and damaged surfaces caused to adjacent construction by selective demolition operations.

B. Where repairs to existing surfaces are required, patch to produce surfaces suitable for new materials.

1. Completely fill holes and depressions in existing masonry walls to remain with an approved masonry patching material, applied according to manufacturer's printed recommendations.

C. Restore exposed finishes of patched areas and extend finish restoration into adjoining construction to remain in a manner that eliminates evidence of patching and refinishing.
D. Patch and repair floor and wall surfaces in the new space where demolished walls or partitions extend one finished area into another. Provide a flush and even surface of uniform color and appearance.
   1. Closely match texture and finish of existing adjacent surface.
   2. Patch with durable seams that are as invisible as possible. Comply with specified tolerances.
   3. Where patching smooth painted surfaces, extend final paint coat over entire unbroken surface containing the patch after the surface has received primer and second coat.
   4. Remove existing floor and wall coverings and replace with new materials, if necessary, to achieve uniform color and appearance.
   5. Inspect and test patched areas to demonstrate integrity of the installation, where feasible.

E. Patch, repair, or re-hang existing suspended ceilings as necessary to provide an even-plane surface of uniform appearance.

3.07 DISPOSITION OF MATERIALS
A. Promptly remove from the site all materials resulting from demolition and alteration which are not to be reused.
B. Do not allow demolished materials to accumulate on-site.
C. Burning of materials on site is not permitted.
D. Remove and transport debris in a manner that will prevent spillage on adjacent surface and areas.
E. Store items to be reused in a protected location until reinstallation.
F. Remove debris from all elevated portions of building by chute, hoist, or other device that will convey debris to grade level in a controlled descent.
G. Disposal: Transport demolished materials off Owner’s property and legally disposes of them.

3.08 SALVAGE OF MATERIALS
A. Work Performed by Owner: Prior to start of construction, Owner will do following work: Removal of moveable furniture and equipment.
B. Salvage by Contractor for Owner’s Use: Contractor shall salvage, by removing in good condition, and stock piling as directed, on the site, for Owner warehousing, following items not incorporated in new work: Electric panels, Novar control systems and finish door hardware.
C. Salvage by Contractor for his Own Use: Contractor may remove for his own salvage the balance of materials not claimed by the Owner.

3.09 CLEAN-UP AND REPAIR
A. Perform periodic and final cleaning.
B. Upon completion of alteration work, remove tools, equipment and demolished materials from site. Remove protections and leave interior areas broom clean.
C. Clean adjacent structures and improvements of dust, dirt and debris caused by selective demolition operations. Return adjacent areas to condition existing before selective demolition operations began.
D. Upon completion of alteration work, change filter on air-handling equipment.
END OF SECTION
SECTION 03 20 00

CONCRETE REINFORCEMENT AND EMBEDDED ASSEMBLIES

PART 1 - GENERAL

1.1 GENERAL

Work of this Section shall conform to requirements of Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification sections.

1.2 SCOPE

Provide all labor, materials, equipment, services and transportation for reinforcing steel, accessories, embedments and miscellaneous anchorage accessories, joint fillers, and waterstops for cast-in-place concrete work as shown on Drawings, as specified herein, and as required by the job conditions.

1.3 RELATED WORK SPECIFIED IN OTHER SECTIONS

Submittals Division 1
Quality Control Division 1
Concrete Formwork Section 03 10 00
Cast-in-Place Concrete Section 03 30 00

1.4 CODES AND STANDARDS

A. Building Code: Concrete work shall conform to the requirements of the Building Code identified on the Structural General Notes, and OSHA requirements, except where more stringent conditions or criteria occur in the latest editions of the standards referenced below and on the drawings.
B. Standards:

3. ACI 315 – Details and Detailing of Concrete Reinforcement.
4. ACI 318 – Building Code Requirements for Reinforced Concrete.
6. ASTM D3963 Fabrication and Jobsite Handling of epoxy Coated Steel Reinforcing Bars.
7. AWS D1.1 – Structural Welding Code-Steel.
8. AWS D1.4 – Structural Welding Code-Reinforcing Steel.
11. Concrete Reinforcing Steel Institute "Manual of Standard Practice"

C. Definitions:

1. The term “Contract Documents” in this specification is defined as the design drawings and the specifications.
2. The term “SER” in this specification is defined as the Structural Engineer of Record for the structure in its final condition.
3. The term “Design Professionals” in this specification is defined as the Owner’s Architect and SER.
4. The term “Contractor” in this specification is defined to include any of the following: General Contractor and their sub-contractors, Construction Manager, Concrete Contractor and their sub-contractors.
5. The term “Owner’s Testing Agency” in this specification is defined as an independent testing and inspection service engaged by the Owner for quality assurance observation and testing of concrete construction in accordance with applicable building code provisions and any additional activities listed in the Contract Documents.

6. The terms “for record” and “submit for record” in this specification are defined as Contractor submittals that do not require a response from the Design Professionals.

7. Working Days: Monday through Friday, excluding federal or state holidays.

1.5 QUALITY ASSURANCE

A. Reinforcing steel shall not be permitted to rust where there is danger of staining exposed surfaces of adjacent concrete. The Contractor shall replace rust-stained concrete at his expense.

B. The Owner’s Testing Agency will:

1. Provide tests in accordance with the California Building Code (CBC) Section 1913A.2.

2. Collect mill test reports for reinforcement.

3. Take samples from bundles at fabricators:
   a. When bundles are indentified by the heat number and accompanied by mill analysis, two specimens shall be taken from each ten (10) tons, or fraction thereof, of each size and grade.
   b. When reinforcement is not positively identified by the heat numbers or when random sampling is intended, two specimens shall be taken from each 2-1/2 tons, or thereof, of each size and grade.
   c. All costs associated with the test of reinforcing that not have mill test reports will be at the contractor’s expense.

4. Test for tensile and bending strengths.

5. The Owner’s Testing Agency will inspect shop and field welding of reinforcing bars per CBC Chapter 17A.

6. Provide inspection of welding, including prior fit-up, welding equipment, weld quality and welder certification in accordance with AWS D1.4. When reinforcement is to be welded, chemical analysis sufficient to determine carbon
equivalent and minimum preheat temperature shall be performed when reinforcement does not conform to low-alloy steel requirements of American Society for Testing and Materials (ASTM) A706.
1.6 CONTRACTOR QUALIFICATIONS

A. The work of this section shall be performed by a fabricator specializing in reinforcing steel fabrication of type for cast-in-place concrete work required for this Project, with a minimum of 10 years of documented successful experience, and have the facilities capable of meeting all requirements of Contract Documents.

1. Welders shall be qualified in accordance with AWS D1.4, within 12 months before starting the work.
   a. Make qualification records available to the Design Professionals upon request.

2. Work shall be performed in compliance with Owner’s insurance underwriters’ requirements.

B. Manufacturers shall specialize in manufacturing the types of concrete accessories required for cast-in-place concrete work, with a minimum of 10 years of documented successful experience and shall have the facilities capable of meeting all requirements of Contract Documents as a single-source responsibility and warranty for each type of accessory.

1.7 SUBMITTALS

A. Where the SUBMITTALS section of this specification is in conflict with Division 1 Submittals, the more stringent requirements for the Contractor apply. Do not submit items not requested.

1. Submittal Schedule: See Section 03 30 00.

2. Shop Drawings: Submit shop drawings that shall clearly indicate, but not be limited to:
   a. All details, dimensions and information required for fabrication and placement of concrete reinforcement in accordance with Contract Documents, prepared in accordance with ACI 315 recommendations.
   b. Elevations, plans, sections, and dimensions of concrete work with required reinforcement clearances.
   c. Ledges, brackets, openings, sleeves, anchor rods, embedments, prefabricated bent-in dowel keyway systems, electrical conduit and items of other trades including interference with reinforcing materials.
d. Sizes, grade designations, spacing, locations, and quantities of wire fabric, reinforcement bars, temperature and shrinkage reinforcement dowels.
   i. Do not use dimensions scaled from Contract Drawings to determine bar lengths.
   ii. Hooks and bends not specifically dimensioned shall be detailed per ACI 318.

e. Bending and cutting schedules, assembly diagrams, splicing and connection requirements, details, and laps.

f. Each type of supporting and spacing devices, including miscellaneous accessories.

g. Construction joint type, details and locations. Contractor shall coordinate with concrete pour schedule and submit for action by the Design Professionals.

h. Submit comprehensive (a single drawing per area/element) layout/placement drawings. Drawings shall consolidate the work of all trades and shall be coordinated by the Contractor. Submit with or prior to reinforcement submittal for same element/area. Drawings shall include:
   i. Concrete accessories and embedded items, including fabrication details of items to be placed (exclusive of reinforcement.)
   ii. Opening in structural members, including floor slab, shearwalls, columns and beams.

i. Reproduction of structural drawings is not permitted.

3. Product Data – Submit for record for each type of product identified in Part 2. Product Data shall be clearly marked to indicate all technical information which specifies full compliance with this section and Contract Documents, including published installation instructions and I.C.C reports, where applicable, for products of each manufacturer specified in this section.

   a. For each heat or melt of steel prior to delivery of material to the job site.
   b. Where reinforcing is to be welded, mill test reports shall verify the weldability of the reinforcing.
5. Reinforcement Strain Test: For Grade 75 reinforcement, submit for record certification that steel has a yield strength of no less than 75 ksi as measured by both ASTM A615 and ACI 318 Section 3.5.3.2 procedures.

6. Hazardous Materials Notification: Submit for record. In the event no product or material is available that does not contain hazardous materials as determined by the Owner, a "Material Safety Data Sheet" (MSDS) equivalent to OSHA Form 20 shall be submitted for that proposed product or material prior to installation.

B. Submittal Process: See Section 03 30 00

C. SER Submittal Review: See Section 03 30 00

D. Substitution Request: See Section 03 30 00

E. Request for Information (RFI): See Section 03 30 00

1.8 DELIVERY, HANDLING, STORAGE

A. Comply with General Conditions and Division 1, including the following:

1. Deliver reinforcing steel to Project site bundled, tagged and marked.
   a. Use weatherproof tags indicating bar sizes, lengths and other information corresponding to markings shown on placement diagrams.
   b. Take precautions to maintain identification after bundles are broken.


3. During construction period, properly store reinforcing steel and accessories to assure uniformity throughout the Project.

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

5. Immediately remove from site materials not complying with Contract Documents or determined to be damaged.

6. Store reinforcing steel above ground so that it remains clean.
   a. Maintain steel surfaces free from rust, grease, dirt, or other materials and coatings that might impair bond.
   b. Keep covered.
   c. Protect against corrosion or deterioration of any kind.
1.9 WARRANTY

A. Comply with General Conditions, agreeing to repair or replace specified materials or Work that has failed within the warranty period. Failures include but are not limited to the following:

1. Bars with kinks or bends not indicated on drawings or on approved shop drawings.
2. Bars damaged due to bending, straightening or cutting.
3. Bars heated for bending.

PART 2 - PRODUCTS

2.1 REINFORCEMENT

A. Reinforcing Steel:

1. Type: Deformed billet steel bars, ASTM A 615, Grade 60 or 75 as indicated on drawings.
2. Size: As indicated on structural drawings.
3. Where indicated on drawings, reinforcing steel shall be hot-dipped galvanized after fabrication in accordance with ASTM A 767, Class II, with galvanizing material protected from embrittlement during galvanizing process in accordance with ASTM A 143.
   a. Galvanized finish shall meet the bend and shear test requirements of ASTM A 615.
4. Epoxy-Coated: ASTM A 775 where indicated on drawings.
5. Weldable reinforcement: ASTM A 706 where indicated on drawings.

B. Welded Wire Reinforcement:

3. Epoxy-Coated Welded Wire Reinforcement: ASTM A 884, Class A.
4. Steel wire, plain finish, ASTM A 82.
5. Steel wire, deformed, ASTM A 496.

6. Size: As indicated on structural drawings.

7. Where indicated on drawings, welded wire reinforcement shall be hot-dipped galvanized after fabrication in accordance with ASTM A 767, Class II, with galvanizing material protected from embrittlement during galvanizing process in accordance with ASTM A 143.

   a. Galvanized finish shall meet the bend and shear test requirements of ASTM A 615.

C. Shear Reinforcement At Slab-Column Connections:

1. Type: Steel studtrail assemblies for shear reinforcement at slab-column connections shall be DECON STUDRAILS supplied by DECON USA, Medford New Jersey.

   a. Shear studs shall be in accordance with ASTM A108, Grade C1015.

   b. Rails shall be low carbon steel Type 44W.

   c. Studs shall be welded in accordance with AWS D1.1, latest edition.

2. Size: As indicated on structural drawings.

3. Installation: Per manufacturer's instructions.

4. Supports: Use plastic molded plastic chairs as provided by the manufacturer to maintain the bottom rebar cover as specified on the drawings. Tie studtrails to adjacent top bars to maintain vertical position.

2.2 ACCESSORIES

A. Tie Wire and Spirals:

1. Type: Minimum 16 gauge annealed steel wire, ASTM A510 and ASTM A853.

2. Wire Bar Type: Comply with CRSI.

B. Mechanical Bar Terminators:

1. For bar sizes #11 (ø36) or smaller where specifically detailed on drawings, mechanical bar terminators shall be used.
2. Provide headed reinforcement with a valid ICC-ES report from one of the following manufacturers: HRC 555 Headed Bars by Headed Reinforcement Corp.; Bartec by Dextra; or equal product substituted per Section 01 25 00.

C. Supports for Reinforcement:

1. Types: Bolsters, chairs, spacers, clips, chair bars, and other devices for properly placing, spacing, supporting, and fastening the reinforcement, hot-dip galvanized after fabrication, in accordance with ASTM A123, or epoxy coated to match supported reinforcement.

2. For Contact with Forms: Use types with not less than 3/32" (2.5mm) of plastic between metal and concrete surface.
   a. Plastic tips shall extend not less than 1/2" (12mm) on metal legs.

3. Individual and continuous slab bolsters and chairs shall be of type to suit various conditions encountered and must be capable of supporting 300 pound (1.5kN) load without damage or permanent distortion.

4. Unless otherwise indicated on drawings, bottom reinforcing bars in footings shall be supported by precast concrete bricks or individual high chairs with welded sand plates on bottom.

5. Slabs on Grade reinforcement to be supported by precast concrete bricks or supports with sand plates or horizontal runners where base material will not support chair legs.

D. Dovetail Anchor Slots:

1. Type: Formed 22 gauge (0.85mm) galvanized steel manufactured by Heckmann Building Products/Chicago, Illinois or Hohmann and Barnard/Hauppauge, New York.

2. Location of Use: Continuous installation of anchor slots, full height of masonry walls, where masonry walls abut poured concrete walls.

3. Fill slot with temporary filler or cover face opening to prevent intrusion of concrete or debris.


5. Stainless steel anchors are acceptable.

E. Welding Electrodes:

1. All welding shall be in conformance with AWS D1.4 and AWS A5.1.
2. Welded joints of ASTM A615, grade 60 bars shall be made with low hydrogen weld filler metals classified as E90 electrodes with a minimum tensile strength of 90 ksi.

3. Welded joints of ASTM A706, grade 60 bars shall be made with low hydrogen weld filler metals classified as E80 electrodes with a minimum tensile strength of 80 ksi.

2.3 JOINT FILLERS

A. Permanent Compressible Joint Filler:

1. Type: W. R. Meadows: “Ceramar” closed-cell expansion joint filler, ultraviolet stable, minimal moisture absorption, non-impregnated, nonstaining and nonbleeding, inert and compatible with cold-applied sealants.

2. Location of Use: Slabs and curbs as indicated on drawings or required.

3. Thickness: As indicated on drawings or required.

B. Temporary Compressible Joint Filler:

1. Type: White molded polystyrene beadboard.

2. Location of Use:
   a. In slabs, curbs, and walls which must be removed prior to joint sealant installation.
   b. Vertically to isolate walls from columns or other walls.

C. Noncompressible Joint Filler:

1. Type: Dow Chemical's "STYROFOAM 40" rigid closed-cell extruded polystyrene board, square edges, 40 psi (275kPa) compressive strength, ASTM C 578, Type IV.

2. Thickness: As indicated on drawings.

3. Location of Use: As indicated on drawings or required.

D. Asphalt-Impregnated Joint Filler:


2. Thickness: ⅛" (12mm) maximum, as indicated on drawings or required.
3. Location of Use: Sidewalks at foundation walls and as indicated on drawings or required.

E. Asphalt-impregnated fiberboard expansion joint filler for interior work:
   1. Type: ASTM D1751.

F. Self-expanding cork board expansion joint filler for exterior work:
   1. Type: ASTM D1752.

G. Construction Joints:
   1. Type: Tongue and groove type profile of galvanized steel, with knock-out holes at 6" (150mm) on center to receive dowelling, complete with anchorage.

2.4 WATERSTOPS

A. Preformed Bentonite Waterproofing Strips especially formulated for concrete cold joints at footings, walls, or slabs.
   1. Acceptable Products:
      a. Volclay Waterstop RX by CETCO Building Materials Group, Hoffman Estates, IL
      b. Adcor ES by W. R. Grace & Co., Cambridge, MA
   2. Size: 3/4" (20mm) by 3/8" (10mm) strips minimum, 25 ft. (7.5m) long, and weighing at least 0.165 lbs/ft (0.245kg/m).
   3. Location of Use: Concrete cold joints at footings, walls and slab joints.
   4. Comply with manufacturer product application and installation instructions.

B. Polyvinyl Chloride Waterstops:

PART 3 - EXECUTION

3.1 FABRICATION
A. Reinforcing Steel Fabrication:
   1. Fabricate in accordance with approved shop drawings, ACI 315 and Contract Documents.
   2. Heating of Reinforcement: Will be permitted only with specific prior approval of the SER.
      a. Employ shielded metal-arc method and conform to AWS D1.4.
      b. Ensure equipment supplies proper current and voltage and is adjustable to suit arrangement and thickness of items welded.
      c. Only welders specifically certified for reinforcing steel in accordance with AWS D1.4 shall perform welding of reinforcing steel.
   4. Tolerances: Comply with ACI 117.
   5. Unacceptable Materials: Reinforcement with any of following defects will not be permitted in Work.
      a. Bar lengths, depths, and bends exceeding ACI fabrication tolerances.
      b. Bends or kinks not indicated on Drawings or final shop drawings.
      c. Bars with reduced cross-section due to excessive rusting or other cause.

B. Welded Wire Reinforcement:
   1. Type: As fabricated in accordance with CRSI, unless otherwise noted.

C. Templates:
   1. Required for all footing and column dowels, and where required for proper alignment of reinforcing.

3.2 INSTALLATION OF REINFORCEMENT

A. General:
   1. Perform the work of this section in accordance with approved shop drawings, ACI 318 and CRSI recommended practice for “Placing Reinforcing Bars”, for details and methods of reinforcement placement and supports, and as specified.
2. Before placing reinforcement steel, inspect forms for proper fitting and compliance with allowable tolerances.

3. Reinforcement shall be free of form coatings, sealers, powdered and scaled rust, loose mill scale, earth, ice, and other materials which will reduce or destroy bond with concrete.

4. Do not place concrete until the completed reinforcement steel work has been observed and accepted by Owner's Testing Laboratory.

5. Reinforcement steel is not permitted to be “floated into position”.

6. Bend bars cold.
   a. Do not heat or flame cut bars.
   b. No field bending of bars is permitted, unless specifically approved by the SER and tested by Independent Testing Laboratory for cracks.

7. Weld only as indicated.
   b. See structural drawings for additional requirements.

8. Tag reinforcement steel for easy identification.

9. Contractor shall coordinate the placement of the reinforcing indicated on the drawings to avoid interference while maintaining minimum cover requirements.

10. All reinforcement shall be continuous. See drawings for lap splice schedule. Stagger splices where possible. Contact lap splices shall be securely wired together to maintain alignment.

11. Ensure placement will permit concrete protection in conformance with CRSI or to extent shown.

12. Do not bend bars around openings or sleeves. Wherever conduits, piping, inserts, sleeves, etc. interfere with placing of reinforcement, obtain the Architect's approval of placing before placing concrete.

B. Placement of Reinforcement Bars:


2. Accurately position, support and secure reinforcement in a manner to prevent displacement before and during placement of concrete.
a. Place reinforcement bars within tolerances specified in ACI 117 and ACI 318 Section 7.5.

b. Locate and support reinforcement by metal chairs, runners, bolsters, spacers, hangers and other accessories for fastening reinforcing bars and welded wire reinforcement in place.

3. If bars are displaced beyond specified tolerance when relocating the bars to avoid interference with other reinforcement or embedded items, notify the Design Professionals for approval prior to concrete placement.

4. Avoid cutting or puncturing vapor retarder during reinforcement placement.
   a. Repair damages before placing concrete.

5. Concrete Coverage: Maintain concrete cover around reinforcement as indicated on drawings.


7. Tie Wires: After cutting, turn tie wires to the inside of section and bend so that concrete placement will not force ends to be exposed at face of concrete.

C. Placement of Wire Reinforcement:

1. Install in lengths as long as practicable.

2. Support in position adequately to prevent bending of reinforcement between supports before and during placement of concrete.

3. Overlap the wire reinforcement 6" (150mm) or one panel width + 2" (50mm), whichever is larger.
   a. Securely tie together with wire.

4. Offset laps of adjoining widths to prevent continuous laps in either direction.

5. Locate wire fabric in the top third of slabs, unless noted otherwise on structural drawings.
D. At Construction Joints:

1. Reinforcement bars and wire reinforcement shall be continuous through construction joints, unless otherwise indicated on Drawings. See Drawings for scheduled lap splices.

E. At Expansion Joints:

1. Reinforcing bars and wire fabric shall not be continuous through expansion joints, unless otherwise indicated on drawings.

3.3 INSTALLATION OF ACCESSORIES

A. Install concrete accessories in accordance with manufacturer's published instructions and Contract Documents.

1. Set and secure embeddings, including embedded plates, bearing plates, and anchor bolts, per approved setting drawings and in such a manner to prevent movement during placement of concrete and to allow removal of formwork without damage.

2. Inspect locations to receive concrete accessories.

3. Immediately report to the Design Professionals in writing of conditions that will adversely affect the Work or fails to meet Contract Document requirements.

4. Do not place concrete until reinforcement, accessories and other built-in items have been inspected and accepted by Owner's Testing Laboratory.

B. Construction and Contraction (Control) Joints:

1. Construction and contraction (control) joints indicated on drawings are mandatory and must not be omitted.

   a. Provide construction joints in accordance with ACI 318.

2. Provide waterstops in construction joints as indicated on the Contract Documents in sizes to suit joint.

3. Install waterstops to form continuous diaphragm in each joint.

4. Support and protect exposed waterstops during progress of Work.

5. Field-fabricate joints in waterstops according to manufacturer’s printed instructions.
C. Coordinate the installation of pipes, bolts, hangers, anchors, flashing and other embedded items with the work of other trades.

3.4 FIELD QUALITY CONTROL

A. General: The Owner’s Testing Laboratory shall test and inspect concrete reinforcement and embedded assemblies as Work progresses. Failure to detect any defective work or material shall not in any way prevent later rejection when such defect is discovered nor shall it obligate the Design Professionals for final acceptance.

B. Owner’s Testing Laboratory shall provide qualified personnel at site to inspect reinforcement and embeds using the latest Drawings and reviewed shop drawings, as follows:

1. Prior to placement, inspect reinforcement and embeds for grade, quality of material, absence of foreign matter, and for suitable storage.

2. Provide continuous inspection of reinforcement and embedded assemblies during placement and immediately prior to concreting operations for: size, quantity, vertical and horizontal spacing and location, correctness of bends and splices, mechanical splices, clearances, compliance with specified tolerances, security of supports and ties, concrete cover, and absence of foreign matter.

3. Inspect epoxy-coated reinforcement for coating damage and required applied coatings.

C. Owner’s Testing Laboratory shall submit inspection, observation, and/or test reports to the Design Professionals as required herein and shall provide an evaluation statement in each report stating whether or not concrete reinforcement and embedded assemblies conforms to requirements of Specifications and Drawings and shall specifically note deviations there from.

D. Immediately report deficiencies to the Contractor. Contractor shall prepare proposed remedy for deficiency. Contractor shall present proposal to the Design Professionals for approval. After an approved proposal is accepted by the Design Professionals, the Contractor shall correct the deficiency at no cost to the Owner.

END OF SECTION
SECTION 03 30 00
CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 GENERAL

Work of this Section shall conform to requirements of Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification sections.

1.2 SCOPE

Provide all labor, materials, equipment, services and transportation required to complete all concrete work as shown on Drawings, as specified herein, and as required by the job conditions. This specification is not intended to address the particular requirements of Architectural Concrete.

1.3 RELATED WORK SPECIFIED IN OTHER SECTIONS

<table>
<thead>
<tr>
<th>Submittals</th>
<th>Division 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quality Control</td>
<td>Division 1</td>
</tr>
<tr>
<td>Concrete Reinforcement and Embedded Assemblies</td>
<td>Section 03 20 00</td>
</tr>
<tr>
<td>Structural Steel Framing</td>
<td>Section 05 12 00</td>
</tr>
<tr>
<td>Metal Fabrications</td>
<td>Section 05 50 00</td>
</tr>
</tbody>
</table>

1.4 CODES AND STANDARDS

A. Building Code: Concrete work shall conform to the requirements of the Building Code identified on the Structural General Notes, and OSHA requirements, except where more stringent conditions or criteria occur in the standards referenced below and on the drawings.

B. Standards, latest edition of each:

2. ACI 301 – Standard Specifications for Structural Concrete.
3. ACI 304 -- Recommended Practice for Measuring, Mixing and Placing Concrete.
5. ACI 318 – Building Code Requirements for Structural Concrete.
6. American Concrete Institute "Manual of Concrete Practice", various committee reports as referenced herein.


8. ASTM C1202 – Standard Test Method for Electrical Indication of Concrete’s Ability to Resist Chloride Ion Penetration

9. AASHTO T318 – Standard Method of Test for Water Content of Freshly Mixed Concrete Using Microwave Oven Drying.


C. Definitions:

1. The term “Contract Documents” in this specification is defined as the design drawings and the specifications.

2. The term “SER” in this specification is defined as the Structural Engineer of Record for the structure in its final condition.

3. The term “Design Professionals” in this specification is defined as the Owner’s Architect and SER.

4. The term “Contractor” in this specification is defined to include any of the following: General Contractor and their sub-contractors, Construction Manager, Concrete Contractor and their sub-contractors.

5. The term “Testing Agency” in this specification is defined as an independent testing and inspection service engaged by the Owner for quality assurance observation and testing of concrete construction in accordance with applicable building code provisions and any additional activities listed in the Contract Documents.

6. The terms “for record” and “submit for record” in this specification are defined as Contractor submittals that do not require a response from the Design Professionals.

7. Working Days: Monday through Friday, excluding federal or state holidays.

1.5 CONCRETE CONTRACTOR QUALIFICATIONS

A. Contractor’s Testing Agency Services: Required as specified in Division 1, and herein.
B. Materials and installed work may require testing and retesting at anytime during progress of work, as directed by Design Professionals. Tests, including retesting of rejected materials for installed work will be done at Contractor's expense.

1.6 SUBMITTALS

A. Where the SUBMITTALS section of this specification is in conflict with Division 1 Submittals, the more stringent requirements for the Contractor apply. Do not submit items not requested.

1. Submittal Schedule: The contractor shall submit for approval a schedule at least twenty (20) working days prior to commencing submittals.

   a. This schedule shall include a list, in order of date to be submitted, of all drawings and other required submittal items scheduled to be submitted. The schedule shall list the proposed submittals for each week, as well as their formats. Once shop drawing submissions have commenced any modification or addition to this schedule must be submitted for approval at least twenty (20) working days before the modification or addition is proposed to take place.

   b. If at any time the total number of shop drawings received in any one week period exceeds the amount in the approved schedule by more than 10% for that week, the Design Professionals have the right to add two days to the average turnaround time for each 20% increment in excess of the scheduled quantity for that week's submissions. For example if the weekly total exceeds the schedule by 10% to 20%, two days may be added; if it is exceeded by 21% to 40%, four days may be added. The return dates for subsequent submittals may be extended based on the additional review time stated above.


3. Mix Designs: Submit concrete mix designs for each type and strength of concrete required for this Project at least thirty (30) days before placing concrete. The Contractor shall perform test or assemble the necessary data indicating conformance with specifications.

   a. Mix designs shall be prepared or reviewed by an approved independent testing agency retained by the Contractor in accordance with requirements of ACI 301 and ACI 318, signed by a registered design professional licensed to practice as a Professional Engineer in the state where the project is located, and shall be coordinated with design requirements and Contract Documents.

   b. Before submitting to Owner's Testing Agency, submit complete mix design data for each separate mix to be used on the Project in a single submittal.

   c. Provide a completed "Concrete Mix Design Submittal Form" (attached to the end of this Specification Section) for each proposed concrete mix.

   d. Data shall be from the same production facility that will be used for this Project.
e. Samples shall be provided only as requested by the Architect.
   i. Certification from vendor that samples originate from and are
      representative of each lot proposed for use.

f. Mix Design data shall include but not be limited to the following:
   i. Locations on the Project where each mix design is to be used
      corresponding to Structural General Notes on the Drawings.
   ii. Design Compressive Strength: As indicated on the Drawings.
   iii. Proportions: ACI 301 and ACI 318.
   iv. Gradation and quality of each type of ingredient including fresh (wet)
       unit weight, aggregates sieve analysis.
   v. Water/cementitious material ratio.
   vi. Certification that portland cement meets Specification requirements.
   vii. Evaluate and classify fly ash in accordance with ASTM D 5759.
   viii. Report chemical analysis of fly ash in accordance with ASTM C 311.
   ix. Classify blast furnace slag in accordance with ASTM C 989.
   x. Slump: ASTM C 143.
   xi. Air content of freshly mixed concrete by the pressure method, ASTM
       C 231, or the volumetric method, ASTM C 173.
   xii. Unit Weight of Concrete: ASTM C 138.
   xiii. Design strength at 28, 56 or 90 days, as indicated on Contract

   a) Document strength based on basis of previous field experience
      or trial mixtures per ACI 318 Chapter 5. Proportioning by
      Water-Cement Ratio is not permitted.

   b) Submit strength test records, mix design materials, conditions,
      and proportions for concrete used for record of tests, standard
      deviation calculation, and determination of required average
      compressive strength.

   c) If early concrete strengths are required, contractor shall submit
      trial mixture results as required.

xiv. Test records to support proposed mixtures shall be no more than 24
     months old and use current cement and aggregate sources. Test
     records to establish standard deviation may be older if necessary to
     have the required number of samples.

xv. Manufacturer's product data for each type of admixture.

xvi. Manufacturer's certification that all admixtures used are compatible
     with each other.

xvii. Whether mixture is pumpable.

xviii. All information indicating compliance with Contract Documents
      including method of placement and method of curing.

xix. Normalweight Concrete: Density per ASTM C 138. Design the mix to
     produce the strength, modulus of elasticity and density as indicated
     on the Contract Documents.

xx. Lightweight Concrete: Density per ASTM C 138.

   a) Lightweight concrete mix design shall include an estimate of
      dry density per ASTM C567.
xxi. Certification from a qualified testing agency indicating absence of deleterious expansion of concrete due to alkali aggregate reactivity in accordance with ASTM C 33

4. Hot and Cold Weather Procedures: Submit for record to Design Professional's written procedures for placement of concrete in hot and cold weather conditions. Hot and Cold weather are as defined in the Concrete Placement section of this specification.

5. Product Data: Submit product data clearly marked to indicate all technical information which specifies full compliance with this section and Contract Documents, including published application instructions, product characteristics, compatibility and limitations for each of the following:
   a. Bonding agents.
   b. Curing compound and liquid sealer densifier. Submit for record to Design Professionals a written statement guaranteeing that the compound will not leave discoloration on concrete to be left exposed, or affect the bond for paint or other applied finishes. Include provision in written statement that in the event of failure of applied finishes to bond to membrane cured concrete, to remove the curing compound and leave suitable surfaces for bonding such finishes.
   c. Absorptive covers and moisture retaining covers.
   d. Vapor Retarder: See Division 7, Thermal and Moisture Protection.
   e. Self-leveling concrete topping.
   f. Grout: Submittal of Grout not by manufacturers listed herein must be accompanied by independent certification of ASTM C 1107 compliance without modification of standard methods.
   g. Other products proposed by contractor

6. Submit Concrete Weighmaster affidavit if continuous inspection of batch plant has been waived per Section 1.9 F.

7. Concrete Joint Locations: Submit plans indicating locations and details of construction joints, contraction joints, waterstops, sleeves, embedments, etc that interact with the joints. Contractor to coordinate joint location with reinforcement shop drawings. Reinforcement shop drawings shall indicate additional reinforcement bars where required at construction joints. Joint locations for concrete slabs to receive a terrazzo or similar finish subject to reflective cracking must be coordinated with layout of finish drawings.

8. Preconstruction Survey: Submit for record. Where interface with existing construction occurs, before related shop drawings are prepared survey the existing construction and submit the survey prepared by a professional surveyor employed by the Contractor to the Design Professionals.

9. Survey of Flat Plate or Flat Slab Concrete Floors during construction: Submit for record. Survey requirements are described on Drawings. Based on survey results, SER may propose adjustments to formwork and camber.
10. Survey of As-built Floor Conditions: Submit for Record. Survey and report flatness (FF), levelness (FL), and final elevations of finished floors prior to shoring removal. For slabs that include camber, do not test for levelness (FL). Perform FF/FL testing in accordance with ASTM E 1155 requirements.


12. Patching Defective Concrete Finishes: Submit procedures and product information.

13. Hazardous Materials Notification: Submit for Record. In the event no product or material is available that does not contain hazardous materials as determined by the Owner, a "Material Safety Data Sheet" (MSDS) equivalent to OSHA Form 20 shall be submitted for that proposed product or material prior to installation. Submit for Record.

B. SER Submittal Review

1. The Design Professionals’ review and approval of shop drawings and other submittals shall be for general conformance with the design intent of the work and with the information given in the Contract Documents only and will not in any way relieve the Contractor or the Contractor’s Engineer from:

   a. Conforming to the Contract Documents.
   b. Coordination with other trades.
   c. Responsibility for all required detailing and proper fitting of construction work.
   d. The necessity of furnishing material and workmanship required by drawings and specifications which may not be indicated on the shop drawings.
   e. Control or charge of construction means, methods, techniques, sequences or procedures, for safety precautions and programs in connection with the work.

2. TYPE 1 Stamp - For shop drawings for building elements designed by the SER, the responses on the shop drawing review stamp used by the SER require the following actions:

   a. APPROVED indicates that the SER has found that the information presented on the shop or erection drawing appears to conform to the requirements of the Contract Documents. Fabrication, manufacture or construction of the elements of work shown in the shop drawing may proceed, provided that work is in compliance with the Contract Documents.
   b. APPROVED AS NOTED indicates that the SER requires the shop or erection drawing to be corrected to reflect the notes and comments shown. Fabrication, manufacture or construction of the elements of work shown in the shop drawing may proceed, provided that work is in compliance with the notations shown on the shop drawings and the Contract Documents. Promptly resubmit the corrected shop or erection drawing for record.
c. REVISE and RESUBMIT indicates that the SER requires resubmission of the shop or erection drawing after correction per notes and comments. None of the elements of work shown on the shop drawing shall be fabricated, manufactured or constructed until the Contractor has received a returned shop drawing marked Approved or Approved as Noted.

d. NOT APPROVED indicates that the shop or erection drawing does not conform to the Contract Documents and must be extensively revised before re-submittal. None of the elements of work shown on the shop drawing shall be fabricated, manufactured or constructed until the Contractor has received a returned shop drawing marked Approved or Approved as Noted.

3. TYPE 2 Stamp - For submittals for building elements which are not designed by the SER but are performance specified, for items that do not form part of the completed structural system but impose loads on the structure, and for construction items or activities which have an effect on the final structure, a second stamp will be used. The responses on the stamp used by the SER require the following actions:

a. NO EXCEPTION TAKEN indicates that the SER has found that the information presented on the submittal appears to conform to the requirements of the Contract Documents. Fabrication, manufacture or construction of the elements of work shown in the shop drawing may proceed, provided that work is in compliance with the Contract Documents.

b. EXCEPTIONS NOTED indicates that the SER requires the submittal be corrected to reflect the notes and comments shown. Fabrication, manufacture or construction of the elements of work shown in the shop drawing may proceed, provided that work is in compliance with the notations shown on the shop drawings and the Contract Documents. Promptly resubmit the corrected document for record.

c. REJECTED indicates that the SER requires resubmission of the submittal after correction per notes and comments. None of the elements of work shown on the shop drawing shall be fabricated, manufactured or constructed. Contractor to revise and resubmit until SER response of No Exceptions or Exceptions Noted is received.

C. Substitution Request

1. Requests for any departure from Contract Documents must be submitted in writing by the Contractor and accepted in writing by the Design Professionals, prior to receipt of submittals.

2. All substitutions must be requested using the structural substitution request form included at the end of this section. Acceptance using the structural substitution request form indicates acceptability of the structural concept only. Contractor must submit shop drawings reflecting accepted substitutions for review in accordance with this Specification. The structural substitution request form, even if accepted, does not constitute a change order.
3. Accepted substitutions or modifications shall be coordinated and incorporated in the work at the sole expense of the Contractor.

4. The acceptance by the Design Professionals of a specific and isolated request by the contractor to deviate from these requirements does not constitute a waiving of that requirement for other elements of, or locations in the project, unless specifically addressed as such and permitted by the Design Professionals in writing.

5. Compensation for Additional Services: Should additional work by Design Professionals such as design, drafting, meetings and/or visits be required which are necessitated for the review and/or incorporation of the Contractor-requested substitution, including indirect effects on other portions of the work, the Contractor is responsible for paying for additional work performed by the Design Professionals at the standard billing rates plus out-of-pocket expenses incurred at cost + 10%. Additional costs for testing and inspection by the Owner shall also be compensated by the Contractor.

6. Contractor is responsible for means and methods and any impacts on other portions of the work that may arise from this substitution.

D. Request for Information (RFI)

1. RFIs shall be submitted by the General Contractor or Construction Manager. RFIs submitted by other entities will be returned with no response.

2. Limit RFI to one subject.

3. Submit RFI immediately upon discovery of the need for interpretation or clarification of the Contract Documents. Submit RFI within timeframe so as not to delay the Construction Schedule while allowing the full response time described below.

4. The response time for answering an RFI depends on the category in which it is assigned.

   a. Upon receipt by the SER, each RFI will be assigned to one of the following categories:
      i. No cost clarification
      ii. Shown in Contract Documents
      iii. Change to be issued in future document revision
      iv. Previously answered
      v. Information needs to be provided by others.
      vi. Request for corrective field work
      vii. Request for substitution

   b. RFIs in categories 1, 2, 3, 4 and 5 will be turned around by the SER on average of five (5) working days.

   c. RFIs in categories 6 and 7 will be rejected and must be submitted as submittals or requests for substitution.
1.7 STORAGE, HANDLING AND DELIVERY

A. Comply with General Conditions and Division 1.

B. Storage:

1. Store materials in accordance with ACI 304R.

2. Store cement and supplementary cementitious materials in weathertight buildings, bins or silos that will exclude moisture and contaminates.

3. Store admixtures to avoid contamination, evaporation, damage, and in accordance with manufacturer’s temperature and other recommendations.

4. Keep packaged material in original containers with seals unbroken and labels intact until time of use.

C. Handling:

1. Handle fine and coarse aggregates as separate ingredients.

2. Arrange aggregate stockpiles to avoid excessive segregation, and prevent contamination with other materials or with other sizes of like aggregates.

3. Do not use frozen or partially frozen aggregates.

4. Allow sand to drain until it has reached relatively uniform moisture content before use.

5. Protect liquid admixtures from freezing and temperature changes that would adversely affect characteristics, and in accordance with manufacturer’s recommendations.

1.8 PRE-INSTALLATION CONFERENCE

A. At least 30 working days prior to the start of concrete construction, the Contractor shall hold a meeting to review the approved concrete mix designs and to determine the procedures for producing proper concrete construction. The Contractor shall notify the Design Professionals of the meeting and require responsible representatives of every party who is concerned with the concrete Work to attend the conference, including but not limited to the following:

1. Contractor.

2. Owner’s Testing Agency representative

3. Concrete Subcontractor.

5. Admixture manufacturer(s).

B. Minutes of the meeting shall be recorded and distributed by the Contractor to all parties concerned within five working days of the meeting. One copy of the minutes shall also be furnished to the following:

1. Design Professionals.

2. Owner's Representative.

C. The minutes shall include a statement by the concrete contractor and admixture manufacturer(s) indicating that the proposed mix design and placing, finishing, and curing techniques can produce the concrete properties and quality required by these specifications.

1.9 QUALITY ASSURANCE BY OWNER'S TESTING AGENCY

A. Quality assurance is testing and inspection to assist the Owner in evaluating the Contractor's performance.

B. Cost: Except as specifically noted otherwise, the testing agencies for quality assurance shall be engaged and paid by the Owner.

C. Coordination with Owner's Testing Agency: The Contractor shall have sole responsibility for coordinating their work with the testing agency to assure that all test and inspection procedures required by the Contract Documents and Public Agencies are provided. The Contractor shall cooperate fully with the Owner's Testing Agency in the performance of their work and shall provide the following:

1. Information as to time of starting field construction and concrete placement schedule, one week prior to the beginning of the work. This information shall be shared with the Architect.

2. Site File: At least one copy of each approved shop drawing shall be kept available in the contractor's field office. Drawings not bearing evidence of approval and release for construction by the Design Professionals shall not be kept on the job.

3. Full and ample means of assistance for testing and inspection of material

4. Proper facilities, including scaffolding, temporary work platforms, safety equipment etc., for inspection of the work in shop and field

D. Duties of the Owner's Testing Agency:

1. Reports: The Testing Agency shall prepare daily reports of the concrete work including progress and description/area of work, tests made and results. The daily reports shall be collected and delivered to the Design Professionals, Contractor, concrete producer, DSA, Building Official and Owner weekly.
2. Rejection: The Owner's Testing Agency has the right to reject any material, at any time, when it is determined that the material or workmanship does not conform to the Contract Documents. The Testing Agency shall report deficiencies to Owner, Design Professionals, and Contractor immediately.

3. Remedial Work: The Testing Agency shall indicate to the Contractor where remedial work must be performed and will maintain a current list of work not in compliance with the Contract Documents. This list shall be submitted to the Design Professionals and Owner on a weekly basis.

4. Certification: When all work has been approved by the Testing Agency, the Testing Agency shall certify in a letter to the Design Professionals and Owner that the installation is in accordance with the design and specification requirements.

E. Waiver of Batch Plant Inspection

1. Continuous batch plant inspection may be waived in accordance with CBC Section 1705A.3.3 if the plant complies with ASTM C94 and has been certified by an agency acceptable to DSA to comply with the requirements of the National Ready Mix Concrete Association.

2. When batch plant inspection is waived, the following requirements shall apply:
   a. Approved inspector of the testing agency shall check the first batching at the start of work and furnish mix proportions to the licensed weighmaster.
   b. Licensed weighmaster to positively identify materials as to quantity and certify to each load by a ticket.
   c. Tickets shall be transmitted to the inspector of record by a truck driver with load identified thereon. The inspector will not accept the load without a load ticket identifying the mix and will keep a daily record of placements, identifying each truck, its load and time of receipt and approximate location of deposit in the structure and will transmit a copy of the daily record to the enforcement agency.
      i. Exception: (DSA-SS) The term "inspector of record" is synonymous with "project inspector".
   d. At the end of the project, the weighmaster shall furnish an affidavit to the enforcement agency certifying that all concrete furnished conforms in every particular to proportions established by mix designs.

F. Field Quality Assurance

1. General: The Owner's Testing Agency shall test and inspect concrete materials and operations as Work progresses. Failure to detect any defective work or material shall not in any way prevent later rejection when such defect is discovered nor shall it obligate the Design Professional for final acceptance. Perform testing in accordance with ACI 318 and CBC Section 1903A, 1905A, 1913A and 17A.
2. Owner's Testing Agency is responsible for monitoring concrete placement as follows:

a. Owner's Testing Agency shall provide qualified personnel at site to monitor concreting operations as follows:
   i. Verify use of required design mix
   ii. Record location of point of concrete discharge of each batch truck tested, cross referenced to grid lines.
   iii. Record temperature of concrete at time of placement.
   iv. Record weather conditions at time of placement, including temperature, wind speed, relative humidity, and precipitation.
   v. Record types and amounts of admixtures added to concrete batches, including that added after departure of concrete trucks from batch plant.
   vi. Record amounts of and monitor dosing of high-range water-reducing admixtures added at site for site-added admixtures and redosing for plant-added admixtures.
   vii. Record amounts of and monitor dosing of high-range water-reducing admixtures added at site for site-added admixtures and redosing for plant-added admixtures.
   viii. Record amount of water added at the site and verify that total water content does not exceed amount specified in the mix design. Addition of water at the site is subject to prior approval by the Design Professional.
   ix. Monitor consistency and uniformity of concrete.
   x. Monitor preparation for concreting operations, placement of concrete, and subsequent curing period for conformance with Specifications for following procedures:

      a) Concrete curing.
      b) Hot weather concreting operations.
      c) Cold weather concreting operations.

3. Owner's Testing Agency shall conduct tests of concrete as follows and in accordance with ASTM C 1077:

a. Testing frequency: Sample sets for all tests listed below of each concrete design mix placed each day shall be taken not less than once a day, nor less than once for each 50 cu.yd. of concrete, nor less than once for each 2500 square feet of surface area for slabs or walls. Additional tests shall be performed if deemed necessary by the Owner's Testing Agency and Design Professionals. Sample all columns, regardless of other frequencies listed above. In addition, sample each truckload used for columns, regardless of other frequencies listed above. Testing frequency shall conform to CBC section 1905A.1.2.

b. Obtain each test sample from different batches selected on a strictly random basis before commencement of concrete placement. Record location in structure of sampled concrete.
c. Determine air content of normal weight concrete in accordance with either ASTM C 231 or ASTM C 138. Determine air content of lightweight concrete in accordance with ASTM C 173.
d. Determine unit weight of normal weight concrete in accordance with ASTM C 138 and lightweight concrete in accordance with ASTM C 567.
e. For concrete with air content specified in Contract Documents, conduct one test for air content for each strength test required or for every 50 cubic yards of fly ash concrete placed, whichever is less. Test in accordance with ASTM C 173 or ASTM C 231.
f. The water content of freshly mixed concrete will be tested on a random basis, a minimum of once per 100 cubic yards or every 5000 square feet of concrete placement, during placement in accordance with AASHTO T 318 for the following concrete types:
   i. Architecturally exposed hard troweled slabs
   ii. Slab to receive a bonded finish floor material
   iii. Concrete with specified compressive strength exceeding 6000 psi
g. Conduct slump tests in accordance with ASTM C 143 and ASTM C172.
   Take samples for slump test at the point of placement of concrete.
h. Conduct slump tests for concrete enhanced with high-range water-reducing admixtures as follows:
   i. Concrete with plant added high-range water-reducing admixtures shall be sampled immediately upon arrival at job site. Batches delivered to site with slumps in excess of the range defined in the mix design submittal or with excessive segregation as defined in the ACI Manual of Standard Practice Part I shall be rejected.
   ii. Concrete with site added high-range water-reducing admixtures shall be sampled immediately upon arrival at job site and after addition of high-range water-reducing admixtures for conformance to initial water slump and final slump requirements.
   iii. Concrete shall also be sampled at point of initial discharge for conformance to slump and/or slump-flow requirements. Visually observe slump-flow at point of concrete placement. If slump loss is visually observed to exceed the range specified for mix design, perform additional slump test at point of discharge from concrete pump hose.
   i. Conduct strength tests of concrete as follows:
      i. Test concrete for required compressive strength in accordance with ACI 318 Chapter 5 and CBC Section 1905A.1.2.
      ii. Secure sample sets in accordance with ASTM C 172.
     iii. Mold cylinders in accordance with ASTM C 31 and cure under standard moisture and temperature conditions in accordance with ASTM C 31, Section 7 (a). Quantity of cylinders listed below is based on a cylinder size of 4 inch diameter x 8 inches long. If 6 inch diameter by 12 inch long cylinders are used, the total quantity of cylinders may be reduced by one with two cylinders instead of three tested at the age designated for determination of f’c.
      iv. Transport specimen cylinders from job to laboratory after cylinders have cured for 24-hours on site.
v. Test cylinders in accordance with ASTM C 39. For specified concrete strength of 10,000 psi and above, cylinders shall be ground and not capped.

vi. For 28 day mixes mold five cylinders. Test one cylinder at seven days and three cylinders at 28 days. The 28 day strength shall be the average of the three 28 day cylinders. One cylinder shall be retained in reserve for later testing if required.

vii. If one cylinder in a test manifests evidence of improper sampling, molding or other damage, discard cylinder and base test results on that of remaining cylinder.

4. Owner’s Testing Agency shall evaluate concrete for conformance with Specifications as follows:

a. Slump:
   i. Owner’s Testing Agency shall maintain a slump moving average, comprised of the average of all batches or most recent five (5) batches tested, whichever is fewer.

b. Strength test:
   i. Owner’s Testing Agency shall maintain a compressive strength moving average, comprised of three (3) consecutive strength test results, for each mix design used in Work.
   ii. Strength level of concrete will be considered satisfactory provided averages of all sets of three (3) consecutive strength test results (i.e. moving average) equal or exceed specified 28-day strength, and no individual strength test result falls below specified 28-day strength by more than 500 psi.
   iii. If strength tests fail to meet minimum requirements, concrete represented by such tests shall be considered questionable and shall, if deemed appropriate by the SER, be subject to further evaluation by core testing as specified herein.

c. Conduct core tests on questionable concrete in accordance with ACI 318 and ASTM C 42. Contractor to pay the Owner’s Testing Agency for the cores.
   i. Location of cores shall be coordinated with Design Professionals so as to least impair strength of structure. Before testing cores, discard and replace any that show evidence of having been damaged subsequent to or during removal from structure or which have reinforcement present.
   ii. Cores from structure exposed to soil or constant moisture in service (e.g. basement walls, retaining walls, slab-on-grade, piers, footings, etc.) shall be tested in a fully saturated condition. Cores for all other concrete may be tested dry. Prior to commencement of coring, verify with Design Professionals whether cores are to be tested wet or dry.
   iii. Fill core holes with low slump concrete or mortar with a strength equal to or greater than that specified for area cored.

d. Concrete in area represented by core test will be considered adequate if average strength of cores is equal to at least 85% of, and if no single core is less than 75% of, specified strength.
5. Floor flatness and levelness tolerance compliance testing is to be performed within 72 hours of concrete placement by Owner's Testing Agency, and prior to the removal of shores and forms.

G. Owner's Testing Agency shall submit inspection, observation, and/or test reports to the Owner, Contractor, concrete producer, DSA, Building Official and Design Professionals, as required herein and shall provide an evaluation statement in each report stating whether or not concrete placement conforms to requirements of Specifications and Drawings and shall specifically note deviations therefrom.

H. Immediately report deficiencies to the Contractor, Owner and Design Professionals.

1.10 QUALITY CONTROL BY CONTRACTOR

A. The Contractor shall provide a program of quality control to ensure that the minimum standards specified herein are attained. The Contractor shall bear burden of proof that concrete meets minimum requirements.

B. The Owner's general review during construction and activities of the Owner's Testing Agency are undertaken to inform the Owner of performance by the Contractor but shall in no way replace or augment the Contractor's quality control program or relieve the Contractor of total responsibility for quality control.

C. The Contractor shall immediately report to the Design Professionals any deficiencies in the work which are departures from the Contract Documents. The Contractor shall propose corrective actions and their recommendations in writing and submit them for review by the Design Professionals. After proposed corrective action is accepted by the Design Professionals and Owner, the Contractor shall correct the deficiency at no cost to the Owner.

1.11 OBSERVATIONS AND CORRECTIONS BY DESIGN PROFESSIONALS

A. Review: The Design Professional will observe the construction for general compliance with the provisions of the Contract Documents during various phases of construction.

B. Compensation for Additional Services: Should additional work by Design Professionals such as design, drafting, meetings and/or visits be required which are necessitated by failure of the Contractor to perform the work in accordance with the Contract Documents, the Contractor is responsible for paying for the additional work at the Design Professionals' standard firm-wide billing rates plus out-of-pocket expenses incurred at cost + 10%. Additional costs for testing and inspection by the Owner shall also be compensated by the Contractor.

1.12 PERMITS AND WARRANTY

A. Permits: The Contractor shall apply for, procure, renew, maintain, and pay for all permits required by City, State, or other governing authorities, necessary to execute work under this Contract. Contractor shall furnish copies of all permits to the Owner and Design Professionals.
B. Warranty: Comply with General Conditions, agreeing to repair or replace specified materials or Work that has failed within the warranty period. Failures include but are not limited to the following:

1. Oily, waxy or loose residue which may interfere with the bonding or discoloration of various applied Architectural finish materials.

2. Discoloration of concrete surfaces scheduled to remain exposed as a finish.

3. Areas which show surface failure or defects.

4. Areas which puddle water.

5. Areas which are not properly prepared to receive Architectural finish materials. If necessary, the Contractor, at his own expense, shall have the Owner's Testing Agency perform appropriate tests for bond and discoloration.

6. Patches that become crazed, cracked or sound hollow when tapped.

7. Self-leveling concrete topping that has cracked, spalled and/or not performed in accordance with manufacturer's design criteria.

PART 2 - PRODUCTS

2.1 CONCRETE MATERIALS & PRODUCTION

A. Portland Cement:

1. ASTM C150, Type I

2. Provide the same brand of Portland Cement produced in the United States from a single source throughout the project, as required to meet Design Professionals' requirements.

B. Aggregates for Normalweight Concrete:

1. ASTM C 33

2. Coarse Aggregates: Crushed stone or gravel. It shall be free from oil, organic matter or other deleterious substances and shall not contain more than two percent by weight of shale or cherty material. Cleanliness value shall not be less than 75 when tested per CalTrans California Test 227 and conforming to CBC Section 1903A.6.

3. Fine Aggregate: Natural sand, or sand prepared from stone or gravel, clean, hard, durable, uncoated and free from silt, loam and clay. Sand equivalent shall be not less than 75 when tested as per ASTM D2419.
4. If the source of aggregates is changed during the Project, the Contractor shall supply test data showing that the new aggregates have a successful history of use with the portland cement used on the job.

5. The acceptability of aggregates for the work will depend on proof that their potential alkali reactivity is not deleterious to the concrete.

6. Do not use fine or coarse aggregates that contain substances that cause spalling.

7. Maximum coarse aggregate size shall conform to the requirements as specified in ACI 301 but shall not exceed the following:

Size no. 67 for all other locations

8. Contractor shall furnish concrete with maximum 3/8" aggregate at no additional cost to the Owner if areas of high reinforcement density require it for placement and consolidation.


C. Aggregates for Lightweight Concrete:
   1. ASTM C 330.
   2. Expanded shale type with cleanliness value and sand equivalent not less than 75.
   3. Classification of Aggregates: As required to meet Design Professionals' requirements.
   4. Provide aggregates from a single source throughout the project for exposed concrete.
   5. Aggregate shall contain the minimum absorbed moisture content recommended by the manufacturer for the project prior to batching.
   6. Maximum coarse aggregate size shall conform to the requirements as specified in ACI 301 but shall not exceed 3/4".

D. Water: ASTM C 94 and ASTM C 1602. Clean, and free from injurious amounts of oil, acids, alkali, salts, organic material, or other deleterious materials.

E. Supplementary Cementitious Material
   1. Fly Ash:
      a. ASTM C 618, Class F.
      b. Shall not be used unless part of an approved mix design.
      c. Limit Loss on Ignition to 2.5%

2. Slag cement
   a. ASTM C 989 Grade 100 or Grade 120.
   b. Shall not be used unless part of an approved mix design.

3. Silica Fume (Microsilica):
a. ASTM C 1240
b. Shall not be used unless part of an approved mix design.
c. Example acceptable products:
   i. "Force 10,000"; W.R. Grace & Co.
   ii. "Eucon MSA"; The Euclid Chemical Co.
   iii. MasterLife SF 100" (formerly "Rheomac SF100"); BASF Corporation.
   iv. Sika Corporation "Sikacrete 950 DP"

4. Limit the maximum content of supplementary cementitious materials for concrete exposed to deicing chemicals to values shown in ACI 318, Table 4.4.2.

5. The exact percentages used shall be based on successful test placement on site. Resubmit mix design if percentages change based on test placement.

6. The fly ash or natural pozzolan supplier shall have an effective quality control program in place to guard against contamination of the fly ash and assure compliance with specifications.

7. Fly ash and GGBFS used shall be from one source throughout the project. Substitution of sources will be acceptable only if testing of concrete mixes containing the substituted material show similar test results and if the color of concrete produced with the substituted material matches the color of previously poured concrete to the satisfaction of the Architect.

F. Ready Mixed Concrete:

1. Shall be batch-mixed and transported in accordance with ASTM C 94.

2.2 CONCRETE MIX DESIGN

A. Concrete Strength:

1. Shall be as indicated on the Structural Drawings

2. Mix shall be designed, tested, and adjusted if necessary in ample time before first concrete is scheduled to be placed.

B. Concrete Density (Unit Weight):

1. Shall be as indicated on the Structural Drawings.

2. The range for lightweight concrete shall be +/- 3pcf of the density specified in the General Notes.

C. Air Entrainment

1. For concrete exposed to freeze/thaw cycles or deicing chemicals, and concrete intended to be watertight, provide entrained air content according to ACI 318
Table 4.4.1, unless specified otherwise. This includes, but is not limited to, concrete at the following locations:

a. Concrete at the exterior of the structure with at least one surface exposed to weather, such as exterior face of grade beams and foundation walls.
b. Concrete in parking garages.
c. Ramps and loading docks.

2. For lightweight concrete less than 120 pcf density, air content may be up to 7% regardless of exposure condition.
3. For concrete with a specified compressive strength (f’c) greater than 5000 psi, required air content required by ACI 318 Table 4.4.1 may be reduced by 1%.
4. Entrained air content noted above shall occur at point of delivery.
5. No entrained air content is required in concrete placed in the foundation with no surface exposed to weather.
6. All interior steel trowel finished, normalweight slabs shall have a maximum air content of 3%.

D. Water-Cementitious Materials (W/cm) Ratio for Normalweight Concrete
1. Unless lower limits are stated in the contract documents, all concrete exposed to freezing and thawing in moist condition and/or required to be watertight or used in slabs-on-grade shall have a maximum W/cm ratio of 0.45.
   a. Where the above mixes are to be pumped, water-reducing admixture (low- or high-range as required) shall be used.
2. All concrete exposed to deicing salts, brackish water seawater or spray from these sources shall have a maximum W/cm ratio of 0.40.
3. Absent the above conditions, all concrete with required strength of 4000 psi or higher shall have a maximum W/cm ratio of 0.50.
4. The water-cementitious materials ratio shall not exceed values indicated, including any water added to meet specified slump in accordance with the requirements of ASTM C 94.
5. Weight of fly ash or pozzolanic admixtures shall be included with the weight of cementitious materials used to determine the water-cementitious materials ratio.

E. Slump

1. Concrete design mixes shall be proportioned to meet the following slump limitations. Slump should be measured as described in the owner’s testing agency responsibilities:
   a. Concrete without high range water-reducing admixture to have a maximum slump of 8". Variation from slump value provided by Contractor to be according to ASTM C94.
   b. Concrete for drilled piers: 6" +/-1” maximum.
   c. Concrete with high range water-reducing admixture: Concrete slump prior to addition of high range water-reducing admixture shall not exceed 3" for normal weight concrete and 4" for lightweight concrete. After addition of water-reducing admixture, the concrete shall have a maximum slump of 9" unless otherwise approved by the SER.
F. Chloride Ion Content
   1. The total water-soluble chloride ion content of the mix including all constituents shall not exceed the limits defined in ACI 318 Table 4.3.1 unless corrosion inhibiting admixtures are added to the mixture to offset the additional chloride.
   2. If the specified level of water-soluble chloride ion content cannot be maintained, appropriate level of corrosion inhibiting admixture shall be added to the mix in accordance with the manufacturer's recommendation to offset the excess amount of chloride at no additional cost to the Owner.

G. Durability Requirements
   1. Where concrete is noted as “durable” on contract documents, limit chloride ion permeability to [1200] coulombs, when tested at 56 days according to either ASTM C 1218, or AASHTO T277.

2.3 ADMIXTURES

A. General:
   1. Admixtures specified below can be used only when established in the mix design with Design Professionals' prior written approval.
   2. Each admixture approved by Design Professionals shall be used in strict compliance with manufacturer's published instructions.
   3. Concrete supplier shall certify all admixtures to be compatible with each other. (See Submittals Section in Part 1)

B. Air Entraining Admixture:
   1. ASTM C 260
   2. Example acceptable product: BASF Corporation “MasterAir AE 200” (formerly "MICRO-AIR") or “MasterAir AE 90” (formerly “MB-AE-90”)
   3. Example acceptable product: W. R. Grace’s “Darex Series” or “Daravair Series”
   4. Example acceptable product: Euclid Chemical's “AEA –92 or Air 40”.
   5. Example acceptable product: Sika Corporation “Sika Air Series” or “Sika AEA Series”

C. Water-Reducing Admixture:
   1. ASTM C 494, Type A
   2. Example acceptable product: BASF Corporation “MasterPozzolith 200”, “MasterPozzolith 322”, “MasterPozzolith 700” (formerly "POZZOLITH" Series)
   3. Example acceptable product: Euclid Chemical's “EUCON NW” or “EUCON WR 91”
   4. Example acceptable product: W. R. Grace’s “WRDA’ Series or “Zyla” Series
   5. Example acceptable product: Sika Corporation “Plastocrete Series”

D. Retarding Admixture:
1. ASTM C 494, Type B
2. Example acceptable product: BASF Corporation “MasterSet R 100”, “MasterSet R 300”, (formerly “POZZOLITH” Series) or “MasterSet DELVO”, “MasterSet DELVO ESC” (formerly “DELVO” Series)
3. Example acceptable product: The Euclid Chemical Company “EUCON RETARDER 100”
4. Example acceptable product: W. R. Grace’s “Daratard 17”
5. Example acceptable product: Sika Corporation “Plastiment Series”

E. Water-Reducing and Retarding Admixture:

1. ASTM C 494, Type D
2. Example acceptable product: BASF Corporation “MasterSet R 100”, “MasterSet R 300”, (formerly “POZZOLITH” Series) or “MasterSet DELVO”, “MasterSet DELVO ESC” (formerly “DELVO” Series)
3. Example acceptable product: The Euclid Chemical Company “EUCON RETARDER 75” or “EUCON DS”
4. Example acceptable product: W. R. Grace’s “Daratard 17”
5. Example acceptable product: Sika Corporation “Plastiment Series”

F. Water-Reducing and Accelerating Admixture:

1. ASTM C 494, Type E
2. Example acceptable product: BASF Corporation “MasterSet FP 20” (formerly “POZZUTEC 20+”)
3. Example acceptable product: The Euclid Chemical Company “ACCELGUARD 80” or “ACCELGUARD 90”
4. Example acceptable product: W. R. Grace’s “Libronic NCA”
5. Example acceptable product: Sika Corporation “Sikaset NC” or “Plastocrete 161 FL”

G. Mid-Range Water-Reducing Admixture:

1. ASTM C 494, Type A
2. Example acceptable product: W. R. Grace’s “Daracem” or “Mira” Series
3. Example acceptable product: Sika Corporation “Sikaplast Series”
4. Example acceptable product: Euclid Chemical Company: “Eucon MR” or “Eucon MRX”
5. Example acceptable product: BASF Corporation “MasterPolyheed” Series (formerly “PolyHeed” Series)

H. High-Range Water-Reducing Admixture (Super-plasticizer):

1. ASTM C 494, Type F
2. Example acceptable product: BASF Corporation “MasterRheobuild 1000” (formerly "RHEOBUILD 1000") or “MasterGlenium” Series (with the exception of “MasterGlenium 150” and “MasterGlenium 3040”, which are ASTM C494 Type G, not Type F) (formerly “GLENIUM” SERIES)
3. Example acceptable product: Euclid Chemical’s “EUCON 37” or “PLASTOL SERIES”
4. Example acceptable product: W. R. Grace’s “Daracem” or “ADVA” Series
5. Example acceptable product: Sika Corporation “Viscocrete Series” or “Sikament Series”

I. High-Range Water-Reducing and Retarding Admixture (Super-plasticizer):

1. ASTM C 494, Type G
2. Example acceptable product: The Euclid Chemical Company “EUCON 537”
3. Example acceptable product: W. R. Grace “Daracem Series” or “Adva Series”
4. Example acceptable product: BASF MasterRheobuild 561

J. Viscosity Modifying Admixture (VMA) for Self-Consolidating Concrete (SCC):

1. Example acceptable product: BASF Corporation “MasterMatrix VMA” Series (formerly “Rheomac VMA” Series)
2. Example acceptable product: W. R. Grace “V-MAR3”
3. Example acceptable product: “EUCON ABS” or “EUCON WO” or “Visctrol”, The Euclid Chemical Company
4. Example acceptable product: Sika Corporation “Sika Stabilizer Series”

K. Corrosion Inhibiting Admixtures:

1. ASTM C 494, Type C, 30% + 2% solution of Calcium Nitrite
2. Example acceptable product: W.R. Grace’s “DCl or DCl-S”
3. Example acceptable product: The Euclid Chemical Company’s “EUCON CIA”
4. Example acceptable product: Sika Chemical “Sika CNI”
5. Example acceptable product: BASF Corporation “MasterLife CI 30” (formerly Rheocrete CNI)

L. Shrinkage Reducing Admixtures:

1. ASTM C 157
2. Example acceptable product: W.R. Grace “Eclipse 4500” (for use with air-entrained concrete exposed to freeze/thaw), or “Eclipse Floor 200”
3. Example acceptable product: The Euclid Chemical Company’s “EUCON SRA” or “Conex”
4. Example acceptable product: Sika Corporation “Sika Control 40”
5. Example acceptable product: BASF Corporation “MasterLife SRA 20”
2.4 ADHESIVES

A. Bonding agents and adhesives shall meet the volatile organic compounds (VOC) requirements of CalGreen Section 5.504.4.1.

B. Bonding Agent for Cured Concrete:

1. ASTM C 881 Type I and IV, Grade 3, Class B and C.
2. Example acceptable product: BASF "MasterEmaco ADH 327", Class C Only
3. Example acceptable product: BASF “MasterEmaco ADH 326”, Class C Only for bonding topping
4. Example acceptable product: Euclid Chemical’s “EUCO #452 EPOXY SYSTEM”.
5. Example acceptable product: Euclid Chemical’s “DURALCRETE SERIES”.
6. Example acceptable product: Euclid Chemical Company “FLEXOCRETE System” for bonding topping

C. Bonding Agent for Uncured Concrete (existing concrete damp or dry, less than 28 days old, no surface water):

1. ASTM C 881, Type II and V, Grade 2, Class B and C.
2. Example acceptable product: BASF " MasterEmaco ADH 326", Class C Only
3. Example acceptable product: Euclid Chemical’s “DURALCRETE SYSTEM”.
4. Example acceptable product: Sika Corporation “Sikadur 32 Hi-Mod”

D. Anti-Corrosive Epoxy Cementitious Bonding Compound and Corrosion Protection of Reinforcement (bonding agent for existing concrete saturated surface dry, no surface water):

1. This adhesive shall be a water-based epoxy/cementitious compound for adhesion and corrosion protection of reinforcing members (20 hour maximum open time).
2. Example acceptable product: Euclid Chemical Company “DURALPREP AC”
3. Example acceptable product: Sika Corporation “ARMATEC 110”
4. Example acceptable product: BASF “MasterEmaco P124”

E. Adhesive Between Cured Concrete Elements:

1. ASTM C 881 Type I and IV, Grade 3, Class B and C
2. Example acceptable product: Sika Corporation “Sikadur 31 Hi-Mod Gel (1:1 Mix Ratio)
3. Example acceptable product: BASF “MasterEmaco ADH 327”

2.5 CURING COMPOUNDS AND SEALERS

A. Curing compounds and sealers shall meet the volatile organic compounds (VOC) requirements of CalGreen Section 5.504.4.3.

B. Interaction with finishes:
1. See architectural drawings for finish material applied over concrete.
2. Use only curing and sealer compounds that are compatible with finish material.
3. Manufacturer's certification is required.
4. Where finish material is liquid rubberized asphalt, use only strippable type curing compound.

C. Curing and Sealing Compound (VOC Compliant, 350 g/l ) :
   1. ASTM C1315, Type I, Class A and ASTM C 309, Type I, Class A or B
   2. Example acceptable product: Euclid Chemical's "Super Diamond Clear VOX"
   3. Example acceptable product: Symons "Kure 1315"
   4. Example acceptable product: BASF “MasterKure CC 1315”
   5. Example acceptable product: Creteseal “New Pour CS2000”

D. Curing Compound (Strippable):
   1. ASTM C 309, Type I, Class A or B
   2. Example acceptable product: Euclid Chemical's “Kurez DR VOX” (Dissipating) or “Kurez RC” in combination with “KUREZ RC-Off”.

2.6 SEALERS

A. Sealers shall meet the volatile organic compounds (VOC) requirements of CalGreen Section 5.504.4.3.

B. Surface Sealer:
   1. ASTM C 309, Type I, Class A or B, no stearates, no darkening or change of color allowed.
   2. Example acceptable product: Euclid Chemical's "DIAMOND CLEAR VOX"
   3. Example acceptable product: BASF “MasterKure CC 160WB”
   4. Example acceptable product: Symons “Spec-Cure C309”

C. Liquid Densifier/Sealer:
   1. The liquid densifier compound shall be a siliconate based sealer which penetrates concrete surfaces, increases abrasion resistance and provides a “low-sheen” surface that is easy to clean and eases the problem of tire mark removal. The compound must contain a minimum solids content of 20% of which 50% is siliconate. No stearates, no darkening or change of color.
   2. Example acceptable product: The Euclid Chemical Company “Euco Diamond Hard”

D. Wax Sealer:
1. Heavy penetrating type as manufactured by approved manufacturer of clear hardener.

2.7 DRY SHAKE HARDENERS

A. Mineral Aggregate Hardener:

1. The specified mineral aggregate hardener shall be formulated, processed and packaged under stringent quality control at the manufacturer's owned and controlled factory. The hardener shall be a factory-blended mixture of specially processed graded mineral aggregate, selected Portland cement and necessary plasticizing agents.

2. Example acceptable product: The Euclid Chemical Company's, "Surflex" to be used with "Kurez DR VOX"

3. Example acceptable product: BASF', "Mastercron" to be used with "Masterkure CC 160WB"

4. Example acceptable product: L&M Construction Chemicals “Ferrocon FF” to be used with “Dress & Seal WB 30”

B. Non-Oxidizing Metallic Hardener:

1. The specified non-oxidizing metallic floor hardener shall be formulated, processed and packaged under stringent quality control at the manufacturer's owned and controlled factory. The hardener shall be a mixture of specially processed non-rusting aggregate, selected Portland cement and necessary plasticizing agents.

2. Example acceptable product: The Euclid Chemical Company's, “Diamond-Plate” to be used with “Kurez DR VOX”

3. Example acceptable product: BASF, “MasterTop 210 COR/Lumiplate” to be used with “MasterKure CC 160WB”

2.8 MISCELLANEOUS CONCRETE PRODUCTS

A. Nonshrink Grout

1. Provide pre-packaged natural aggregate grout, high-precision, nonshrink, ready-to-use, complying with the following requirements:
   a. Grout minimum compressive strength shall be 6500 psi.
   b. Grout shall conform to ASTM C 1107

2. All material used including water, mixer and pre-packaged grout must be initially at the 45°F and 90°F limits when testing is initiated.

3. Example acceptable product: BASF "MASTERFLOW 928"

4. Example acceptable product: Euclid Chemical's “HI-FLOW GROUT”

5. Example acceptable product: Five Star Products “Five Star Grout”

6. Example acceptable product: Sika Chemicals “Sikagrount 328”

B. Self-Leveling Concrete Topping - Underlayment for Interior Applications:
1. Use self-leveling underlayment concrete formulated to level concrete floors without shrinking, cracking or spalling, and capable of being placed from feathered edge to 1" thickness without aggregate in one pour. If greater than 1" thickness is required, aggregate shall be used in accordance with manufacturer's requirements. Appropriate primer shall be utilized for all underlayment applications.

2. Example acceptable product: Ardex Engineered Cements "ARDEX K-15"
3. Example acceptable product: Euclid Chemical’s "Flo-Top or Super Flo-Top"
4. Example acceptable product: Sika Corporation "Sika Level Series"
5. Example acceptable product: BASF "MasterTop 110SL"

2.9 MISCELLANEOUS PRODUCTS

A. Evaporation Retarder:
   1. Example acceptable product: BASF "MasterKure ER 50"
   2. Example acceptable product: Euclid Chemical "Eucobar".
   3. Example acceptable product: Sika Corporation "Sika Film"

B. Moisture-Retaining Covers:

Conforming to ASTM C171. A naturally colored, non-woven polypropylene fabric with a 4-mil non-perforated reflective (white) polyethylene coating containing stabilizers to resist degradation from ultraviolet light. Fabric shall exhibit low permeability and high moisture retention and be fungus resistant.

   1. Hydracure S-16 by PNA Construction Technologies, Inc., Matthews, NC
   2. Transguard 4000 by Reef Industries (Armorlon Division), Incorporated, Houston TX

C. Sand Cushion: Clean, manufactured or natural sand.

D. Structural Polystyrene used as formwork only.

   1. Material: Extruded polystyrene foam insulation board.
   2. Comply with the requirements of ASTM C 578, Type IV.
   3. Compressive strength, 25 psi at 0.1-inch deformation when tested in accordance with ASTM D 1621.
   4. Flexural strength, 50 psi, ASTM C 203.
   5. Thickness as indicated on drawings.
   6. Example acceptable product: Styrofoam Deckmate Plus, The Dow Chemical Company

E. Vapor Retarder: See Division 7, Thermal and Moisture Protection

   1. [Minimum 15-mil thick polyolefin geomembrane
   2. Manufactured with prime virgin resins
   3. Water Vapor Retarder: ASTM E 1745, meets or exceeds Class A
   4. Water Vapor Transmission Rate: ASTM E 96, 0.008 gr./ft²/hr. or lower
5. Permeance Rating: ASTM E 96, 0.03 Perms or lower for new material and after conditioning tests in accordance with applicable sections of ASTM E 154
6. Puncture Resistance: ASTM E 1745, minimum 2400 grams
7. Tensile Strength: ASTM E 1745, minimum 45.0 lbs./in.
8. Example acceptable product: W.R.Grace’s “Florprufe 120”
11. Example acceptable product: Raven Industries, “Raven Vapor Block 15”.

F. Semi Rigid Joint Filler:
1. Example acceptable product: Euclid Chemical “Euco 700”
2. Example acceptable product: Euclid Chemical “Euco QWIKjoint 200”
3. Example acceptable product: Sika Chemical Corporation “Sikadur 51 SL”
5. Example acceptable product: BASF “MasterSeal CR190”

G. Dowels:
1. Example acceptable product: Diamond Plate Dowels: PNA’s “Diamond Dowel System.”

2.10 CONCRETE REPAIR MATERIALS

A. Polymer Repair Mortar

1. The following patching mortars may be used when color match of the adjacent concrete is not required. Prior approval by the Design Professionals is required.
2. Example acceptable products (Horizontal Repairs): “Thin Top Supreme or Tammspatch II” by Euclid Chemical Company (for 1/16” to 3/8” thickness), or “Concrete Top Supreme” (for 3/8” to 2” thickness).
3. Example acceptable products (Horizontal Repairs): “Sikatop 121 Plus” or “Sikatop 122 Plus” by Sika Chemical Corporation.
4. Example acceptable products: (Horizontal Repairs): BASF “MasterEmaco T 1060 or T 1061” (for 3/8” to 2” thickness).
5. Example acceptable products: (Horizontal Repairs): BASF “MasterEmaco T310”
6. Example acceptable products (Vertical and Overhead Repairs): Verticoat, Verticoat Supreme, or Duraltop gel by Euclid Chemical Corporation
8. Example acceptable products: (Vertical and Overhead repairs): BASF “MasterEmaco N425”

B. High Strength Flowing Repair Mortar

1. For forming and pouring structural members, or large horizontal repairs, provide the flowable one-part, high strength microsilica modified repair mortar with 3/8” aggregate.
2. The product shall achieve 9000 psi @ 28-days at a 9-inch slump.
3. Prior approval by the Design Professionals is required for cold weather applications
4. Example acceptable product: The Euclid Chemical Company’s, “Eucocrete”
5. Example acceptable product: BASF “MasterEmaco S440 or S440MC”
6. Example acceptable product: Sika Corporation “Sika Repair 211 SCC Plus”

C. Repair Topping
1. Latex and microsilica modified cementitious mortar topping, which meets or exceeds the bond strength requirements of ASTM C 1059.
2. Resistance to wear: The finished topping shall show a depth of wear of 0.02 mm (0.0079”) or less when tested at 28 days with a Chaplin Abrasion Tester.
3. Example acceptable product: The Euclid Chemical Company, “Thin-Top Supreme or Tammspatch II”
4. Example acceptable product: Sika Corporation “Sika Repair 211 SC Plus”

D. Epoxy Injection:
1. ASTM C881, moisture insensitive maximum viscosity 350 cps at 77°F (25°C).
2. Epoxy shall meet the volatile organic compounds (VOC) requirements of CalGreen Section 5.504.4.1.
3. Acceptable Product: BASF “MasterInject 1380”
5. Acceptable Product: Sika Corporation “Sikadur 35, LV, LPL”

E. Pressure-Injected Foam Resin:
1. Acceptable Product: DeNeef “HA Sealform”
2. Acceptable Product: 3M “ScotchSeal 5600”
3. Acceptable Product: Sika Corporation “SikaFix HH”

F. Semi Rigid Epoxy:
1. Epoxy shall meet the volatile organic compounds (VOC) requirements of CalGreen Section 5.504.4.1.
3. Acceptable Product: BASF “MasterSeal CR190”

G. Methyl Methacrylate (MMA)
1. MMA shall meet the volatile organic compounds (VOC) requirements of CalGreen Section 5.504.4.1.
H. Sealant:
   1. Silicone or Polyurethane Sealant (as selected based on project requirements such as loading, traffic, bond, coatings, etc.).
   2. Sealant shall meet the volatile organic compounds (VOC) requirements of CalGreen Section 5.504.4.1.
   3. Joint to be routed and cleaned per manufacturer’s written directions.

PART 3 - EXECUTION

3.1 PREPARATION

A. General:
   1. Ensure availability of sufficient labor, equipment and materials to place concrete correctly in accordance with scheduled casting. Verify conveying equipment is clean and properly operating.
   2. Confirm that the Architect has reviewed formwork and reinforcing steel and that preparations have been checked with the Project Inspector.
   3. Protect finished surfaces adjacent to concrete-receiving places.
   4. Clean transportation and handling equipment at frequent intervals and flush thoroughly with water before each day’s run. Do not discharge wash water into concrete form.

B. Subgrade:
   1. Dampen subgrades not covered with membrane by sprinkling immediately before placing concrete. Do not saturate.
      a. Omit when subgrade is already damp.
   2. Do not place on water-saturated subgrade unless placing can be done without damage to subgrade (surface is stable) and loading the subgrade does not drive free water to the surface.
   3. Do not place concrete on frozen ground.
   4. Verify depths of depressed slab conditions are correct for delayed finish noted and for proper bonding to concrete.

C. Forms:
   1. Coordinate with Section 03 10 00 Concrete Formwork.
2. Verify that construction of formwork is complete and form ties at construction joints are tight.

3. Remove dirt, sawdust, nails and other foreign material from formed space.

4. Dampen wood forms by sprinkling immediately before placing.

5. Cool metal forms by sprinkling immediately before placing.

D. Concrete Accessories:

1. Coordinate with Section 03 10 00 Concrete Formwork.

2. Ensure required reinforcement, inserts, and embedded items are in place.

E. Dewatering:

1. Remove water from concrete formwork.

2. Divert any flowing water to sump and remove by pumping.

3. Refer to Division 1 for additional dewatering requirements.

F. Vapor Retarder Placement: See Division 7, Thermal and Moisture Protection.

1. Vapor retarder installation shall be in accordance with manufacturer’s instructions and ASTM E 1643.

2. Place vapor retarder under slabs-on-grade in position with longest dimension parallel with direction of pour.

3. Joints: Lap 6" minimum and seal with manufacturer’s recommended mastic or pressure-sensitive tape.

4. Prevent damage to moisture barrier.

5. If moisture barrier is damaged, place a piece of moisture barrier over damaged area (6" larger all around) and tape in place with type of tape recommended by moisture barrier manufacturer.

6. Seal laps and intersections of walls with compatible trowel mastic or pressure-sensitive sealing tape.

7. Seal around pipes and other penetrations with compatible trowel mastic.

8. The vapor barrier must be approved prior to concrete placement.
3.2 **MIXING**

A. **Measurement of Materials:** Conforming to ASTM C 94

B. **Mixing:** All concrete shall be ready-mixed conforming to ASTM C 94 except as follows:

1. Provide concrete materials, proportions and properties as herein specified in lieu of ASTM C 94.
2. Method of mixing shall comply with CBC Section 1905A.8.
3. Adjust grading to improve workability; do not add water at batch plant unless otherwise directed.
4. Measure fine and coarse aggregates separately according to approved method that provides accurate control and easy checking.
5. Thoroughly clean concrete equipment before use for architectural concrete mixes to avoid contamination.
6. Use automatic metering dispenser to introduce admixture into mix. Dispenser shall be recommended and calibrated by admixture manufacturer.
7. Water, beyond that required by the mix design, shall not be added at the Project site. Addition of water at the Project site shall be made only in the presence of the Owner's Testing Agency.
8. Furnish delivery ticket with each load of concrete delivered to the site to the Contractor conforming to the requirements of ASTM C 94.
9. Mix concrete in transit mixers five minutes immediately prior to discharge in addition to mixing as called for by ACI 304 and ASTM C94.

C. Unless otherwise permitted, time for completion of discharge shall comply with ASTM C94/C94M. When discharge is permitted after more than 90 minutes have elapsed since batching or after the drum has revolved 300 revolutions, verify that air content of air-entrained concrete, slump, and temperature of concrete are as specified. When discharge is permitted after more than 90 minutes have elapsed since batching or after the drum has revolved 300 revolutions, no water may be added.

3.3 **CONCRETE PLACEMENT**

A. **Prior to Concrete Placement:**

1. Mechanical vibrators are required and must be available for placing concrete. Ensure availability of spare vibrators in case of failures.
2. Place no concrete where weather conditions prevent proper finishing and curing.
3. Remove debris from space to be occupied with concrete.
4. Notify Design Professionals (and OSHPD/DSA) and Owner’s Testing Agency 48 hours prior to starting concrete placement.
5. Approved mix designs must be maintained on file in Contractor's Field Office.
6. Reinforcement and accessories shall be in proper locations, clean, free of loose scale, dirt or other foreign coatings that may reduce bond to concrete, and in accordance with Section 03 20 00 and Drawings.
7. Fog spray forms, reinforcing steel, and subgrade just before pouring concrete.
8. Do not place concrete having a slump outside of allowable slump range.
9. Place concrete before initial set has occurred, but in no event after it has been discharged from the mixer more than 30 minutes. All concrete shall be placed upon clean, damp surfaces, free from puddled water, or upon properly consolidated fills, undisturbed soil or Controlled Low-Strength Material with a minimum strength of 1200 psi. Placement upon soft mud or dry earth is not permitted.
10. Unless adequate protection is provided, concrete shall not be placed during rain.
11. Rain water shall not be allowed to increase mixing water or to damage the surface finish.
12. Do not use equipment in placing and finishing concrete that contain aluminum in the finishing edges that come in contact with the concrete surface.
13. Keep subgrade moisture uniform without puddles or dry areas.
14. Place vapor retarder directly below slabs on grade as specified in contract documents.

B. For Conduits and Pipes Embedded in Concrete:

1. For concrete slab, wall, beam or column, conform to requirements of ACI 318, Chapter 6. For variations from these requirements, submit a written request for Design Professionals’ review and response.
2. Conduits and pipes shall not be embedded in concrete slabs on steel deck without approval of Design Professional.
3. Provide sleeves for pipes passing vertically through concrete.
4. Do not embed aluminum materials.
5. Do not cut, bend or displace the reinforcement to facilitate placement of embedded pipes and conduits.

C. Pumping: Pumping shall be done in strict accordance with ACI 304.2R.

1. The Contractor shall demonstrate that the pumping equipment has a record of satisfactory performance under similar conditions and using a similar mix.

D. Placing Concrete in Forms:

1. Clean and prepare forms as specified in Section 03 10 00/Concrete Formwork.
2. Place concrete continuously without interruption between predetermined construction and contraction joints in walls.
3. Deposit concrete in forms in horizontal layers no deeper than 24” and in a manner to avoid inclined construction joints. Level top surface upon stopping work.
4. Where placement consists of several layers, place each layer while preceding layer is still plastic to avoid cold joints.
5. Avoid free falls in excess of six feet where reinforcement will cause segregation and in typical conditions unless the Architect approves otherwise.
6. Consolidate placed concrete by mechanical vibrating equipment supplemented by hand-spading, rodding or tamping.
   a. Use equipment and procedures for consolidation of concrete in accordance with ACI 309R.
7. Do not use vibrators to move fresh concrete laterally inside forms from discharge point; shift discharge point as needed.
8. Insert and withdraw vibrators vertically at uniformly spaced locations no farther than the visible effectiveness of the machine to achieve timely consolidation around reinforcement, embedded items and into corners of forms.
9. Place vibrators to rapidly penetrate placed layer and at least 6" into preceding layer.
10. Do not insert vibrators into lower layers of concrete that have begun to set.
11. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing segregation of mix.
12. Do not vibrate Self-Consolidating Concrete (SCC).
13. Employ concrete mix with smaller aggregates as required by CBC 1905A.10.1.

E. Placing Concrete on Steel Decks

1. Exercise care during concrete placement on steel decks to prevent concentrated loads or high pile-ups of concrete and to avoid impacts caused by dumping or dropping of concrete on steel decks.
2. Do not use buggies on unprotected areas of deck. If buggies are used to place concrete, furnish and install planked runways to protect deck from damage.

F. Placing Concrete at Construction Joints:

1. To secure full bond at construction joints, surfaces to receive concrete in a subsequent placement shall be left in a roughened state or intentionally roughened by raking while plastic or brushing and chipping immediately after removal.
2. Before new concrete is placed in contact, surfaces of hardened concrete already placed shall be thoroughly cleaned of foreign materials and laitance.
3. At hardened concrete at joints where no bonding agents are used, dampen concrete to achieve a saturated surface dry condition. Leave no standing water. Place and vibrate concrete (slump 7 inches or greater) against horizontal joints. Place and vibrate flowing concrete (slump 8 to 10 inches) while maintaining pressure against vertical joints by confinement.
4. At hardened concrete with joints not meeting conditions required for no bonding agents, apply appropriate specified bonding agent for conditions present including age and moisture per manufacturer’s specifications. Place new concrete while the bonding agent is still tacky.

G. Hot-Weather Placement:
1. Hot weather is defined as air temperature at the time of delivery, protection and
curing which exceeds 90°F or any combination of high temperature, low humidity
and/or high wind velocity which causes a rate of evaporation in excess of 0.2
pounds per square feet per hour as determined by ACI 305.1.
2. When hot weather conditions exist, place concrete in compliance with ACI 305R
and as specified in this section.
3. Cool ingredients before mixing to maintain concrete temperature at time of
placement below [90°F (32°C)].
4. Mixing water may be chilled, or chopped ice may be used to control temperature,
provided water equivalent of ice is calculated to total amount of mixing water.
5. Use of liquid nitrogen to cool concrete is Contractor's option.
6. When concrete placement will occur late in the day and reinforcing steel will be
heated by the sun, cover reinforcing steel with water-soaked burlap so that steel
temperature will not exceed ambient air temperature immediately before
embedding in concrete.
7. When concrete operations must be performed in direct sun, wind, high
temperatures, low relative humidity, or other adverse placing conditions, the
specified evaporation retarder shall be applied one or more times during the
finishing operation to prevent plastic cracking.

3.4 CONCRETE FINISHES

A. General:

1. Comply with recommendations for concrete finishing established by ACI 302.1R
and ACI 304R.
2. Comply with dimensional tolerance limitations given by ACI 117 except as
modified in the Construction Documents.
3. Insure removal of bituminous materials, form release agents, bond breakers,
curing compounds if permitted and other materials employed in work of
concreting which would otherwise prevent proper application of sealants, liquid
waterproofing, and other delayed finishes and treatments.
4. Where cleaning is required, take care not to damage surrounding surfaces or
leave residue from cleaning agents.
5. Where fiber reinforcement is used, remove exposed fibers from concrete surface
to the satisfaction of the Architect.
6. For shored floor or slab on grade construction: Floor flatness/floor levelness
tolerance compliance testing is to be performed prior to the removal of shores
and forms but not later than [72] hours of concrete placement by Owner's
Testing Agency.
7. See architectural drawings for locations of the various finishes listed below.
8. Comply with slab FF and FL values specified below:

a. If an individual test section measures less than either of the specified
minimum local FF/FL numbers, that section may be rejected and remedial
measures may be required as specified in CONCRETE SURFACE
REPAIRS.
b. If the composite value of the test surface measures less than either of the specified overall FF/FL numbers, then the entire slab may be rejected and remedial measures may be required.

c. FL numbers shall not apply to unshored slabs or shored slabs with camber.

B. Finish for monolithic slab surfaces to receive concrete floor topping or mortar setting beds for tile and other bonded applied cementitious finish flooring material, as indicated on architectural drawings:

1. Scratch Finish. Apply scratch finish to monolithic slab surfaces that are to receive concrete floor topping or mortar setting beds for tile, portland cement terrazzo, and other bonded applied cementitious finish flooring material, and as otherwise indicated.

   a. Finish surface to overall value of FF=20 and FL=15 and minimum local value of FF = 14 and FL=10 measured according to ASTM E 1155.

   b. Slope surfaces uniformly to drains where required.

   c. After leveling, roughen surface before final set with stiff brushes, brooms, or rakes.

C. Finish for monolithic slab surfaces to be covered with membrane or elastic waterproofing, membrane or elastic roofing, sand-bed terrazzo as indicated on architectural drawings:

1. Float Finish.

   a. After screeding, consolidating, and leveling concrete slabs, do not work surface until ready for floating.

   b. Begin floating, using float blades or float shoes only, when surface water has disappeared, or when concrete has stiffened sufficiently to permit operation of power-driven floats, or both.

   c. Consolidate surface with power-driven floats or by hand-floating if area is small or inaccessible to power units.

   d. Finish surfaces to overall value of FF=20 and FL=15 and minimum local value of FF=14 and FL=10 measured according to ASTM E 1155.

   e. Cut down high spots and fill low spots.

   f. Uniformly slope surfaces to drains.

   g. Immediately after leveling, refloat surface to a uniform, smooth, granular texture.

D. Finishes for Pedestrian Sidewalks and Ramps, Exterior Platforms, Steps, as indicated on architectural drawings:

1. Sidewalks and Curbs: Light-to-medium broom finish applied with fiber-bristle broom perpendicular to direction of main traffic route immediately after float finishing.

2. Ramps: Scored finish as applied perpendicular to direction of main traffic route immediately after float finishing.
3. Finish surface to overall value of FF=20 and FL=15 and minimum local value of FF = 14 and FL=10 measured according to ASTM E 1155.
4. Texture shall be approved by the Design Professionals from sample panels.

E. Finish for interior floor slab and stair surfaces exposed to view and slab surfaces to be covered with resilient flooring, carpet, ceramic or quarry tile on thick-set mortar, paint or another thin film-finish coating system, as indicated on architectural drawings:

1. Trowel Finish.
   a. After floating, begin first trowel-finish operation using a power-driven trowel.
   b. Begin final troweling when surface produces a ringing sound as trowel is moved over surface.
   c. The final hand-troweling operation shall result in a smooth surface, free of trowel marks, uniform in texture and appearance.
   d. Grind smooth any surface defects that would telegraph through applied floor covering system.

2. Finish surface to overall value of FF=25 and FL=20 and minimum local value of FF=17 and FL=14 measured according to ASTM E 1155.
3. Floor Slopes: Where drains occur, slope floor slabs uniformly to drains, maintaining scheduled slab thickness.
4. Floor Edges at Expansion Joints: Tool edges minimum 3/8".
5. Defects: Remove defects of sufficient magnitude to show through floor covering by grinding.
6. Floor Hardener: Use only where scheduled and in accordance with manufacturer's published instructions.
7. Dry Cement: Shall not be used during finishing.

F. Finishes for Parking Garage Deck, Ramps, Loading Docks, Stairs:

1. Highway straight edge immediately after screening concrete.
2. Finish surface to overall values of FF=20 and FL=15 and minimum local value of FF = 14 and FL=10 measured according to ASTM E 1155.
3. For Slabs Not Receiving Deck Coating: Medium broom finish with ridges not to exceed 1/8" in height. Texture shall be as approved by the Design Professionals from sample panels.
4. For Slabs Scheduled to Receive Deck Coating: Smooth floated finish which must be verified with coating manufacturer before finishing the slab.
   a. Coordinate with deck coating specified in Division 7.
5. Auto Ramps: Rough texture applied perpendicular to direction of traffic. Texture shall be as approved by the Design Professionals from sample panels.
6. Finish stairs to profiles shown with cove at base of risers and radius at top: tool grooves at edge of treads as detailed.

G. Tolerances at Slab Discontinuities

Within 2 ft of slab boundaries, construction joints, isolation joints, block-outs, penetrations or other similar discontinuities, where required for travel paths, installation of finishes and partitions, or any other requirements indicated in the contract documents, the following equivalent straightedge tolerances shall apply:
Specified local FF = 14, use ½” over 4 ft, no offset greater than 1/16”
Specified local FF = 20, use 1/8” over 4 ft, no offset greater than 1/32”

H. Dry Shake Finish:
   1. Non-slip aggregate where indicated on drawings.
   2. Non-oxidizing metallic hardener on loading docks at a rate of 1.5 lbs. per sq. ft.
      and in other locations so noted on the drawings.
   3. Mineral aggregate hardener at a rate of 1.2 lbs. per sq. ft. where noted on the
      drawings.
   4. Final finish type, method and tolerance as applicable by location and use.
   5. Dry shake finish will be applied only where scheduled and in accordance with the
      manufacturer's published instructions and the methods and procedures agreed
      upon at the pre-installation conference.

I. Rough Formed Finish:
   1. Acceptable for formed concrete surfaces not exposed-to-view in the finish work
      or by other construction, unless otherwise indicated.
   2. Concrete surface shall have texture imparted by form-facing material used, with
      tie holes and defective areas repaired and patched, and fins and other
      projections exceeding 1/4” in height rubber down or chipped off.

J. Smooth Formed Finish:
   1. Required for formed concrete surfaces exposed to view, or scheduled to be
      covered with a coating material applied directly to concrete, or a covering
      material applied directly to concrete, such as waterproofing, dampproofing,
      veneer plaster, painting, or other similar system, as indicated on architectural
      drawings:
   2. Surface is an as-cast concrete surface obtained with selected form-facing
      material, arranged in an orderly and symmetrical manner with a minimum of
      seams.
   3. Repair and patch tie holes and defects. Remove fins and other projections
      completely.

K. Smooth Rubbed Finish:
   1. "Smooth Rubbed" finish shall consist of a finish free of fins, joint marks smoothed
      off, blemishes removed and surfaces left smooth and unmarred.
   2. Provide smooth rubbed finish to scheduled concrete surfaces, as indicated on
      architectural drawings, which have received smooth form finish treatment not
      later than one day after form removal.
   3. Moisten concrete surfaces and rub with carborundum brick or other abrasive until
      a uniform color and texture is produced.
      a. Do not apply cement grout other than that created by the rubbing process.

L. Grout-Cleaned Finish:
1. Provide grout-cleaned finish on scheduled concrete surfaces, as indicated on architectural drawings, that have received smooth-formed finish treatment.
2. Combine one part portland cement to one and one-half parts fine sand by volume, and a 50:50 mixture of acrylic or styrene butadiene-based bonding admixture and water to form the consistency of thick paint.
3. Blend standard portland cement and white portland cement in amounts determined by trial patches so that final color of dry grout will match adjacent surfaces.
4. Thoroughly wet concrete surfaces, apply grout to coat surfaces, and fill small holes.
5. Remove excess grout by scraping and rubbing with clean burlap.
6. Keep surface damp by fog spray for at least 36 hours after rubbing.

M. Unformed Surfaces:

1. At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike-off smooth and finish with a texture matching adjacent formed surfaces.
2. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces, unless otherwise indicated.

3.5 CURING AND PROTECTION

A. Normal Conditions:

1. Protect concrete from premature drying, excessive hot or cold temperature, and damage.
2. After concrete has taken its initial set, care shall be exercised to avoid jarring forms or placing any strain on ends of projecting reinforcement.
3. Concrete shall be kept continuously moist and above 50°F (10°C) for seven days (ASTM C 150 Type I cement) or for 10 days (ASTM C 150 Type II cement). High early strength concrete usage shall be maintained over 50°F (10°C) for three days.
4. The architect may recommend longer periods based on temperature, wind and humidity conditions.
5. Concrete and concrete patching materials shall be cured according to manufacturers published recommendations.
6. Begin curing as soon as free water has disappeared from concrete surface and finishing has been completed.
7. Comply with ACI 318 Section 5.11.
8. Do not permit curing method to affect adversely finishes or treatments applied to finish concrete.
9. Curing Methods: Cure concrete by curing compound, by moist curing, by moisture-retaining cover curing, or by combining these methods, as specified.

a. Apply curing compound on exposed interior slabs and on exterior slabs, walks, and curbs as follows:
   i. Apply curing compound to concrete slabs as soon as final finishing operations are complete (within 2 hours and after surface water
sheen has disappeared). Curing compound should be applied at
upper end of manufacturer’s range of application.

ii. Apply uniformly in continuous operation by power spray or roller
according to manufacturer's directions.

iii. Recoat areas subjected to heavy rainfall within 3 hours after initial
application.

iv. Maintain continuity of coating and repair damage during curing
period.

v. Use curing and sealing compounds that will not affect surfaces to be
covered with finish materials applied directly to concrete.

vi. Floors to receive covering shall be cleaned thoroughly using a power
scrubber and industrial strength detergent.

vii. Hand-brooming and sweeping is not sufficient.

viii. Strippable curing compound may be used in lieu of a moist curing
method when approved by the Design Professionals.

b. Provide moist curing by the following methods:

i. Keep concrete surface continuously wet by covering with water.

ii. Use continuous water-fog spray.

iii. Cover concrete surface with specified absorptive cover, thoroughly
saturate cover with water, and keep continuously wet. Place
absorptive cover to provide coverage of concrete surfaces and
edges, with a 4" lap over adjacent absorptive covers.

c. Provide moisture-retaining cover curing as follows:

i. Cover concrete surfaces with moisture-retaining cover for curing
concrete, placed in widest practicable width with sides and ends
lapped at least 3" and sealed by waterproof tape or adhesive.

a) Immediately repair any holes or tears during curing period
using cover material and waterproof tape

10. Cure slabs on grade, concrete toppings, concrete pour strips, supported slabs,
walls and columns, not subject to conditions of hot or cold weather concreting, in
accordance with ACI 308.

11. Cure surfaces exposed to deicing salts, brackish water, etc, such as loading dock
slabs, parking garage slabs and ramps in accordance with ACI 308
recommendations for moist curing.

12. Curing Formed Surfaces: Cure formed concrete surfaces, including underside of
beams, supported slabs, and other similar surfaces, by moist curing with forms in
place for the full curing period or until forms are removed.

a. If forms are removed, continue curing by methods specified above, as
applicable.

B. Cold-Weather Protection:

1. When concrete is placed under conditions of cold weather concreting (defined as
a period when the mean daily temperature drops below 40°F for more than 3
successive days), take additional precautions as specified in ACI 306R when
placing, curing, monitoring and protecting the fresh concrete.

C. Hot-Weather Protection:
1. When concrete is placed under conditions of hot weather concreting, provide extra protection of the concrete against excessive placement temperatures and excessive drying throughout the placing and curing operations with an evaporation retarder.
   a. Apply according to manufacturer’s instructions after screeding and bull floating, but before power floating and troweling.
2. Hot weather curing is required if hot weather conditions occur within a 24-hour period after completion of concrete placement.

D. Floor surfaces, wherever indicated by weather conditions, shall be sprinkled during the interval between finishing operation and the start of curing to positively ensure against the possibility of surface drying.

3.6 CONCRETE REPAIRS

A. Where concrete is under strength, out of line, level or plumb, or shows objectionable cracks, honeycombing, rock pockets, voids, spalling, exposed reinforcement, signs of freezing or is otherwise defective, and, in the Architect’s judgment, these defects impair proper strength or appearance of the work, the Architect will require its removal and replacement at the Contractor’s expense.

B. Perform patching and repairs in accordance with ACI 301.

C. Contractor shall submit patching and repair methods and materials for review by Design Professionals.

D. When complete, all patches and repairs shall match color and texture of adjoining surfaces.

E. At surfaces that are exposed to view, prepare test areas at inconspicuous locations for review by design professionals to verify repair color and texture match before proceeding with repair.

F. Apply all patching and repair materials in accordance with manufacturer’s specifications.

G. Repairing Cracks In Formed and Unformed Surfaces:

1. Contractor shall notify Design Professionals of all cracks wider than 0.02” (0.50mm) and all cracks wider than 0.01” (0.25mm) that occur in a group of at least three cracks within twelve inches (300mm), in concrete. If Design Professionals deem repairs necessary, Contractor shall be responsible for repairing all such cracks per Design Professionals recommendation at no expense to the Owner. Repairs will generally require one or more of the following: Epoxy Injection, Semi-Rigid Epoxy, Pressure Injected Foam Resin, Methyl Methacrylate and/or Sealant with joint routed and cleaned. See Concrete Repair Materials section of this Specification for acceptable products

H. Repairing Formed Surfaces

1. Immediately after stripping forms, patch all honeycombing, defective joints, voids, etc. before the concrete is thoroughly dry.
2. Remove all burrs, fins, and ridges before the concrete is thoroughly dry.
3. Remove stains from rust, grease and oils, from release agents, etc.
4. Remove and replace concrete having defective surfaces if defects cannot be repaired to satisfaction of the Design Professionals.
   a. Surface defects, include color and texture irregularities, cracks as defined above, spalls, air bubbles, honeycomb, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning.
   b. Chip away defective areas, honeycomb, rock pockets, voids over 1/4" (6mm) in any dimension and holes left by tie rods and bolts, down to solid concrete but in no case to a depth less than 1" (25mm) and saw-cut edges to prevent feather edging of fill material.

5. Repair concealed formed surfaces, where possible, containing defects that affect the durability of concrete. If defects cannot be repaired, remove and replace concrete.

6. Clean out form tie holes and fill with dry pack mortar or precast cone plugs secured in place with bonding agent.

7. If honeycombing exposes reinforcement, chip to provide clear space at least 3/4" (20mm) wide all around steel to allow proper bond.

I. Repairing Unformed Surfaces:

1. High and Low areas in concrete surfaces which are in excess of specified tolerances shall be leveled or ground-smooth.
   a. Correct high areas by grinding after concrete has cured at least 14 days.
   b. Correct low areas by applying leveling material. Finish leveling material as specified in this section.

2. Repair surfaces containing defects that affect durability of concrete.
   a. Surface defects include crazing, cracks as defined above, spalling, popouts, honeycombs, rock pockets, and other objectionable conditions.

3. Repair defective areas, except random cracks and single holes not exceeding 1" (25mm) in diameter, by cutting out and replacing with fresh concrete.
   a. Remove defective areas with clean, square cuts and expose reinforcing steel with at least 3/4" (20mm) clearance all around.

J. Filling In: Fill in holes and openings left in concrete for passage of work by other trades, unless otherwise shown or directed, after work of other trades is in place.

3.7 EVALUATION AND ACCEPTANCE OF CONCRETE

A. In accordance with ACI 301, except where otherwise specified.
B. If, at any time during construction, the concrete resulting from the approved mix design deviates from Specification requirements for any reason, such as lack of workability, or insufficient strength, the contractor shall have his laboratory verify the deficiency and modify the mix design, until the specified concrete is obtained. Modified mix to be submitted for approval per Part 1 - SUBMITTALS.
3.8 COORDINATION & CORRECTIVE MEASURES

A. Conflicts: The contractor shall be solely responsible for errors of detailing, fabrication, and placement of reinforcement steel; placement of inserts and other embedded items; and the structural adequacy of all formwork.

B. Reimbursement for Additional Services: Should additional work and/or visits be required which are necessitated by failure of the Contractor to perform his work in accordance with the contract documents, or if additional design or drafting time is required for corrective measures caused by failure to perform in accordance with the contract documents, the Contractor shall reimburse the Architect and Engineer at the rate of direct personnel expense plus 150% overhead plus out-of-pocket traveling expenses incurred.

3.9 CLEAN UP

A. Perform Work under this Section to keep affected portions of building site neat, clean, and orderly. Remove, immediately upon completion of Work under this Section, surplus materials, rubbish, and equipment associated with or used in performance. Be aware that failure to perform clean-up operations within 24 hours of notice by Architect will be considered adequate grounds for having work done by others at no added expense to the Owner.

END OF SECTION
CONCRETE MIX DESIGN SUBMITTAL FORM

Project: 
City: 
General Contractor: 
Concrete Contractor: 
Concrete Strength: 
Use/Location on Job: 
Supplier’s Mix Designation: 

Design Mix Information

(Please check one): Refer to ACI 301 for requirements of data used to substantiate strength calculations.

Field Experience (Based on Standard Deviation Analysis):

Trial Mixture Test Data:

Design Characteristics:

Density: Pcf
Strength: Psi (28 day)
Air: % (specified)

<table>
<thead>
<tr>
<th>Materials</th>
<th>Type/Source</th>
<th>Specific Gravity</th>
<th>Weight (lb)</th>
<th>Absolute Vol. (cu. ft.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cement</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fly ash</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Slag (GGBFS)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Microsilica</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coarse Aggregate</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fine Aggregate</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Air</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TOTAL:</td>
<td></td>
<td></td>
<td></td>
<td>27.0 cu. ft.</td>
</tr>
</tbody>
</table>

Water/Cementitious Material Ratio (lbs. water / lbs. cementitious material) = %
### Admixtures:

<table>
<thead>
<tr>
<th>Admixture</th>
<th>Manufacturer</th>
<th>ASTM</th>
<th>Dosage (oz/cwt)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water Reducer</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Air Entraining Agent</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High Range Water Reducer</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-corrosive Accelerator</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Slump before HRWR: __________________ Inches  
Slump after HRWR: __________________ Inches

### Standard Deviation Analysis (from experience records):

<table>
<thead>
<tr>
<th>No. of Test Cylinders Evaluated:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard Deviation:</td>
<td></td>
</tr>
</tbody>
</table>

**Required Average Strength f'c,r**

**Average Strength by Tests**

**Equation Used (ACI Chapter 5)**

(Refer to ACI 318 for increased deviation factor when less than 30 tests are available)

### TRIAL MIXTURE TEST DATA

<table>
<thead>
<tr>
<th>Compressive Strength:</th>
<th>Age (days)</th>
<th>Mix #1</th>
<th>Mix #2</th>
<th>Mix #3</th>
</tr>
</thead>
<tbody>
<tr>
<td>28 [56] [90] psi</td>
<td>psi</td>
<td>psi</td>
<td>Psi</td>
<td></td>
</tr>
<tr>
<td>28 [56] [90] psi</td>
<td>psi</td>
<td>psi</td>
<td>Psi</td>
<td></td>
</tr>
<tr>
<td>28 [56] [90] psi</td>
<td>psi</td>
<td>psi</td>
<td>Psi</td>
<td></td>
</tr>
</tbody>
</table>

**Required Average Strength f'c,r**

**Average Strength by Tests**

**Equation Used (ACI Chapter 5)**
REQUIRED ATTACHMENTS

- Coarse Aggregate Gradation Report
- Fine Aggregate Gradation Report
- Combined Aggregate Gradation Report: (8% - 18% for large top size aggregates (1½ in.) or 8% - 22% for smaller top size aggregates (1 in. or ¾ in.) retained on each sieve below the top size and above the No. 100) (See Section 2.3.B.)
- Fly Ash (or other Supplementary Cementitious Material) Certification
- Concrete Compressive Strength Data or Trial Mixture Test Data
- Admixture Compatibility certification letters
- Chloride Ion Content Certification
- Alkali Aggregate Reactivity Certification
- Shrinkage Test Reports

SUBMITTED BY:

- Name:
- Address:
- Phone no.:
- Main Plant Location:
- Miles from Project:
- Secondary Plant Location:
- Miles from Project:
- Date:
- Certification by Concrete Supplier:
- Signature:
- Print Name:
- PE License Number and Expiration Date (print or stamp)
Structural Substitution Request Form – to be completed by Contractor

<table>
<thead>
<tr>
<th>Project:</th>
<th>Substitution Request #</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date:</td>
<td></td>
</tr>
<tr>
<td>Requesting Contractor:</td>
<td>Pages Attached (including this form)</td>
</tr>
</tbody>
</table>

1. Description of Requested Substitution:

2. Related Drawings and Specification Sections:

3. Rationale or Benefit Anticipated:

4. Effect on Construction Schedule¹ (check one):  
   □ NONE  □ See Attached

5. Effect on Owner’s Cost² attach data (check one):  
   □ CREDIT TO OWNER  □ EXTRA

6. Effect on Construction Documents³ (design work anticipated):  
   □ NONE  □ See Attached

7. Requesting Contractor Agrees to Pay for Design Changes (check):  
   □ YES  □ NO  □ NOT APPLICABLE

8. Effect on Other Trades⁴:

9. Effect of Substitution on Manufacturer’s Warranty (check):  
   □ NONE  □ See Attachment

Signature⁵: Date:

Company:

General Contractor Signature⁵: Date:

Notes:
1. Contractor is responsible for means and methods and any problems that may arise from making the requested substitution.
2. This is NOT A CHANGE ORDER FORM. A separate form is required to adjust costs and/or schedules.
3. Contractor is responsible for any design impacts that may arise from this substitution, including redesign efforts.
4. Contractor is responsible for effects on other trades from this substitution;
   General Contractor must review and agree effects on other trades are fairly represented in items 4-9.
5. Signature by a person having authority to legally bind his/her company to the above terms. Otherwise this request is void
6. All items in form must be completed for substitution request to be considered.

Request Review Responses (completed by Architect and/or Engineer(s)):

<table>
<thead>
<tr>
<th>ACCEPTED</th>
<th>ACCEPTED AS NOTED</th>
<th>REJECTED</th>
<th>INSUFFICIENT DATA TO SUPPORT REQUEST</th>
<th>ENGINEER / ARCH / MEP SIGNATURE</th>
<th>DATE</th>
</tr>
</thead>
</table>

Engineer/Architects Comments:
SECTION 03 54 13

GYPSUM CONCRETE FLOOR FILL

PART 1 - GENERAL

1.1 SUMMARY
   A. Section includes gypsum concrete floor fill complete, primer, and sealer.
   B. Related Requirements: Division 03 for structural concrete.

1.2 SUBMITTALS
   A. Data: Manufacturer’s Product Data for the gypsum concrete floor fill.

1.3 QUALITY ASSURANCE
   A. Applicator’s qualifications: Licensed by the gypsum concrete manufacturer.

1.4 HANDLING
   A. Deliver materials in their original unopened packages and protect from damage and exposure from the elements.

1.5 PROJECT CONDITIONS
   A. Do not place concrete fill when the substrates are covered with water.
   B. Follow manufacturer’s instructions for placing, finishing, curing and protecting concrete fill when the air temperature is below 50 degrees F.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS
   A. Compressive strength: 2000 to 3200 psi, ASTM C 472.
   B. Dry density: 115 lbs/ft³.
   C. Point loading: Up to 2,500 lbs. on a one-inch diameter disc.
   E. Minimum impact insulation class: 50 IIC, ASTM E 492 and E 1007.

2.2 MANUFACTURER/PRODUCT
   A. Gypsum concrete:
      1. Gyp-Crete 2000/3.2K by Maxxon Corp. (basis of design).
      2. Rapid Floor Ultra by Grace Construction Products.
      3. Firm-Fill by Hacker Industries, Inc.

2.3 MATERIALS
   A. Gypsum cement: Gyp-Crete underlayment compound.
   B. Sand: Washed, clean, complying with ASTM C 144.
   C. Water: Fresh, potable.
2.4 MIX DESIGN

A. Provided by the Contractor to obtain a homogenous cementitious mass that will flow freely and screed to a smooth, even surface, and will have a minimum compressive strength of 2,000 psi when tested in compliance with ASTM C 472.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine surfaces to receive gypsum concrete fill.
B. Correct detrimental conditions before proceeding with installation.

3.2 PLACING

A. Repair damages in the substrates. Fill voids and cracks with gypsum board patching compound.
B. Prime subfloor leaving no bare spots.
C. Place the gypsum concrete fill in compliance with its manufacturer instructions in one continuous operation without cold joints. Screed to required levels suitable to receive finish flooring materials.
D. Do not place gypsum concrete specified herein where ceramic floor tile is indicated.
E. Finish concrete fill so that it contacts a 10-foot straightedge with a tolerance of not more than 1/8 inch at any location.
F. Seal fill where required.

3.3 PROTECTING/PATCHING

A. Do not permit traffic on the concrete fill until it has developed sufficient strength to withstand traffic without damage (5 to 7 days with temperatures over 60-degree F and normal humidity).
B. Patch damaged surfaces flush with adjacent areas in compliance with manufacturer’s printed recommendations.

3.4 FIELD QUALITY CONTROL

A. Density tests:
   1. Have 2-inch cubes tested by a reputable and recognized testing laboratory, in compliance with ASTM C 472, to determine compliance with compressive strength specified.
   2. Submit test results to the Architect at completion of this work.
B. Dryness test: Before floor finish is installed over concrete floor fill, verify that it is sufficiently dry to receive the finish and its installation materials.

SECTION 03 54 13

GYPSUM CONCRETE FLOOR FILL
1. Use the Delmhorst Pin Meter to determine floor dryness, or use the rubber pad method by covering floor with a 24-inch square rubber mat. If no condensation appears under the mat after 72 hours, the floor fill is dry enough for installation of floor finish.

2. Do not use the calcium chloride test.

END OF SECTION
SECTION 03 54 16

SELF-LEVELING CEMENTITIOUS UNDERLAYERMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes self-leveling Portland cement underlayment where monolithic concrete floor slabs to be covered by a finish material do not comply with substrate requirements of applied finish materials.
B. Related Requirements: Division 03 for structural concrete, and for concrete finishes.

1.2 SUBMITTALS

A. Data: Manufacturer Product Data for product proposed for use.
B. Tests: Test results as specified below.

1.3 QUALITY ASSURANCE

A. Installer qualifications: Licensed and approved in writing by the underlayment manufacturer.
B. Sample panel:
   1. Provide, on a floor slab at the job site, a 10-foot square sample panel of the cementitious underlayment to demonstrate texture of finish surface and test levelness of finish assembly.
   2. Make such modifications as necessary to achieve a mockup satisfactory to the Architect, or remove and construct additional sample panel(s).
   3. Approved sample panel shall serve as the standard for the same work on the building.

1.4 JOB CONDITIONS

A. Do not place underlayment when the floor is covered with standing water or if surface temperature is 50 degrees or below.
B. Follow these Specifications and the self-leveling underlayment manufacturer’s instructions for placing, finishing, curing and protecting self-leveling underlayment when the conditions require hot weather installation.

1.5 SPECIAL WARRANTY

A. Warrant underlayment not to delaminate and crack (under normal traffic), and not lose its compressive strength for 5 years after Substantial Completion.
B. Replace defective underlayment, including finish flooring materials thereon, at no cost to the Owner.
PART 2 - PRODUCTS

2.1 MANUFACTURER/MATERIALS

A. Ardex, Inc., Ardex K-15" (basis of design.)
B. Atlas Tech Products “Tech-Level Premier.”
C. Mapei “UltraPlan 1.”
D. Dayton “Levelayer 1.”
E. Or approved equal.

2.2 MATERIALS

A. Cementitious material: Ardex K-15, Portland cement-based, high-strength, fast-setting, non-shrinking material with total of 80 percent cement binder per ASTM C 114.
B. Water: Fresh, potable.
C. Primer: Ardex P-51.

2.3 MIX DESIGN

A. As recommended by the underlayment manufacturer’s instructions to obtain a homogenous concrete mass that will flow freely, self-level and screed to a smooth, even surface within the tolerance specified, and will meet the following:

1. Minimum compressive strength: 4,000 psi at 28-day when tested in accordance with ASTM C 109 MOD.
2. Minimum flexural strength: 1,000 psi at 20-day when tested in accordance with ASTM C 348.

PART 3 - EXECUTION

3.1 EXAMINATION/PREPARATION

A. Verify substrates to receive underlayment.
B. Remove loose and foreign materials. Sweep or vacuum clean.
C. Correct other conditions detrimental to the proper and timely completion of this work before proceeding with installation.

3.2 PLACEMENT

A. Prime subfloor leaving no bare spots.
B. Install screeds as recommended by manufacturer and as required to meet tolerance specified below. Set screeds with a laser level.

1. Set screeds so that the minimum thickness of underlayment will be at least 1/8 inch.
2. Where underlayment covers only a small area, grind, chisel and undercut slab, if required, so that the minimum thickness will not be less than 1/8 inch.

C. Place the underlayment in accordance with its manufacturer's instructions in one continuous operation without cold joints. Screed to required level suitable for subsequent application of finish flooring materials.

D. Finish underlayment so that it contacts a 10-foot straightedge with a tolerance not exceeding the following at any location:

1. 1/16 inch under wood flooring.
2. 1/8 inch elsewhere.

3.3 PROTECTING/PATCHING

A. Do not permit traffic on the underlayment until it has developed sufficient strength to withstand traffic without damage (minimum of 24 hours).

B. Patch damaged surfaces flush with adjacent areas in accordance with manufacturer's recommendations.

3.4 FIELD QUALITY CONTROL

A. The Contractor shall have 2-inch cubes tested by a reputable and recognized testing laboratory, in accordance with ASTM C 109 MOD., to determine compliance with compressive strength specified.

END OF SECTION
SECTION 051200
STRUCTURAL STEEL

PART 1 - GENERAL

1.1 GENERAL

Work of this Section shall conform to requirements of Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification sections.

1.2 SCOPE

The work covered by this Section shall include all labor, material, equipment, permits, engineering and other services necessary for the fabrication and installation of structural steel and related work, complete, in accordance with the Drawings and as specified herein. For structural steel related to the Seismic Force Resisting System, see Section 051210.

1.3 RELATED WORK SPECIFIED IN OTHER SECTIONS

- Submittals: Division 1
- Quality Control: Division 1
- Concrete Reinforcement and Embedded Assemblies: Section 032000
- Cast-In-Place Concrete: Section 033000
- Structural Steel-Additional Seismic Requirements: Section 051210
- Metal Fabrication: Section 055000
- Miscellaneous Metals: Division 5
- Fireproofing: Division 7
- Painting: Division 9

1.4 CODES AND STANDARDS

A. Building Code: Structural steel work shall conform to the requirements of the Building Code identified on the Structural General Notes, and OSHA requirements, except where more stringent conditions or criteria occur in the standards referenced below and on the Drawings.

B. Standards:

1. American Institute of Steel Construction (ANSI/AISC 360-10) "Specification for Structural Steel Buildings"
a) In item 3.1.2 delete all references to item 4.4 and replace with the requirements of the project Specification.
b) Item 3.6 shall be deleted.
c) Item 4.4 shall be deleted, and replaced with the requirements of the project Specification.
d) The second paragraph of item 7.10.3 shall be revised from “... owner's designated representatives for design and construction” to “owner's designated representative for construction or as indicated in the Contract Documents”
e) The last sentence of items 8.5.2 and 8.5.4 shall be deleted.
f) Item 8.5.3 shall be deleted. Where a conflict exists between the Code of Standard Practice and the Contract Documents, the Contract Documents shall govern.


C. Definitions:

1. The term "Contract Documents" in this Specification is defined as the design Drawings and the Specifications.
2. The term "SER" in this Specification is defined as the Structural Engineer of Record for the structure in its final condition.
3. The term "Design Professionals" in this Specification is defined as the Owner's Architect and SER.
4. The term "Contractor" in this Specification is defined to include any of the following: General Contractor and their sub-contractors, Construction Manager, Structural Steel Fabricator or Structural Steel Erector.
5. The term "Heavy Shapes" in this Specification is defined to include hot rolled steel shapes with flanges exceeding 2 inches (50mm) in thickness and built up cross sections with plates exceeding 2 inches (50mm) in total thickness.
6. The term "High Restraint Weld" describes welds in which there is almost no freedom of movement for members joined due to geometry or material thickness.
7. The term "Testing Agency" in this Specification is defined as an independent testing and inspection service engaged by the Owner for quality assurance observation and testing of steel construction in accordance with applicable building code provisions and any additional activities listed in the Contract Documents.
8. The terms "for record" and "submit for record" in this Specification are defined as Contractor submittals that do not require a response from the Design Professionals.
9. Working Days: Monday through Friday, except for federal or state holidays.
10. Nondestructive Testing: Nondestructive testing (NDT) includes magnetic particle testing (MT), penetrating testing (PT), radiographic testing (RT), and ultrasonic testing (UT). The terms nondestructive examination (NDE) and nondestructive testing (NDT) are synonymous.

1.5 CONTRACTOR QUALIFICATIONS

A. The term Structural Steel Contractor refers to any or all of the following parties, regardless of their contractual relationships: Structural Steel Fabricator, Structural Steel Detailer, Structural Steel Erector and Contractor’s Engineer.

B. Qualification Data: Submit qualification data (personnel and firm resumes, and project lists with references) for the Structural Steel Fabricator (“Fabricator”), Structural Steel Detailer (“Detailer”), Contractor’s Engineer(s) and Structural Steel Erector (“Erector”).

C. The Fabricator shall have 10 years of comparable experience in installations of this type and shall employ labor and supervisory personnel familiar with the type of installation, experienced in fabrication and erection of structural steel for projects of similar size and complexity. At the time of bid the Fabricator shall be AISC certified to the Standard for Steel Building Structures (STD) and must submit proof of these qualifications. The Fabricator’s qualifications shall be subject to review by the Design Professionals and Owner.

D. The Detailer shall have 10 years experience preparing detailed steel shop drawings for structures of this type and complexity. The detailer’s qualifications shall be subject to review by the Design Professionals and Owner.

E. The Contractor’s Engineer(s) shall be qualified to perform the type of work required by the project. The Engineer(s) shall be a Licensed Structural Engineer(s) in California. The Contractor’s Engineer(s) shall have 10 years of experience being in responsible charge of work of this nature. The proposed Engineer(s) shall be subject to approval of Design Professionals and Owner.

F. The Erector shall have 10 years of successful experience erecting structural steel for structures of this type and complexity in the region of the project. At the time of bid the Erector shall be an AISC Certified Steel Erector (CSE) and must submit documentation of this qualification.

G. Welding: Welders shall have a valid Welding Performance Qualification Record (WPQR) for each welding procedure to be performed. Qualify the welding procedures, shop welders, field welders, welding operators and tackers in accordance with AWS D1.1 and for the following periods of effectiveness of certification:
1. Certification and qualification, including period of effectiveness of welding personnel shall be as specified by AWS D1.1. Certification shall remain in effect for duration of work provided welders are continuously engaged in performing the type of welding for which they are certified, unless welders fail to perform acceptable welding, as determined by the Owner's Testing Agency. Certification and re-certification of welding personnel is subject to verification by the Testing Agency. Re-testing for re-certification will be the Contractor's responsibility.

1.6 SUBMITTALS

A. Required Submittals - Where the SUBMITTALS section of this Specification is in conflict with Division 1 Submittals, the more stringent requirements for the Contractor apply. Required submittal items are listed here; see below for detailed requirements. Do not submit items not requested.

   (1) Calculations, Shop Drawings and Erection Drawings
   (2) Pre-construction Survey
   (3) Quality Control Program
   (4) Product Data
   (5) Samples
   (6) Welding Procedures Specification (WPS)
   (7) Welder Certifications
   (8) Mill Reports
   (9) LEED Submittals

2. Shop Drawings and Erection Drawings (including Field Work drawings): Submit for approval required connection calculations, shop drawings and erection drawings for all structural steel indicated on the Contract Documents.

   a) Material shall not be fabricated or delivered before the shop and erection drawings have been approved or approved as noted by the Design Professionals and returned to the Contractor.
   b) Structural Steel Shop Drawings: Submitted shop drawings shall include layouts and details for each member showing the steel type and grade, size, connections, cuts, coping holes, bolts, welds, surface treatments (cleaning, shop paint, etc.) and provisions for the connection of other work. Steel type, grade and size for all attached elements shall also be shown.
   c) Shop and erection drawings shall contain complete dimensional and geometric information, based on established dimensions shown on Contract Documents, and shall not be scaled from Contract Documents. The shop drawings shall clearly distinguish between shop and field welds and bolts, identify pretensioned high strength bolts and identify surface preparation requirements at slip critical connections.

051200-4 Structural Steel
d) Welds: All welds shall be indicated by standard welding symbols in the "Standard Code for Arc and Gas Welding in Building Construction" or as accepted by the SER. Shop and erection drawings shall show the size, length, and type of each weld, including the electrode type to be used.

e) Bolts: Details for bolt assemblies shall indicate bolt size, length, type and the presence, type and location of washers where required as part of the assembly; distinguish between N and X bolts, distinguish between slip-critical and bearing bolts; and distinguish between shop and field bolts. Also, indicate bolt orientation where required by the Contract Documents.

f) Erection Drawings: The erection drawings shall include plans showing exact locations of base and bearing plates, and/or anchor rods and other embedded items. All field connections not specifically shown on shop drawings shall be shown on erection drawings, including field bolt size, type, number, location and any special installation requirements, and field weld size, type, length and location.

3. Quality Control Program: Submit for record complete details of the Contractor's quality control program including the names of the personnel responsible for this work.

4. Product Data: Submit manufacturers' specifications, test reports and applicable standards for all products listed under Part 2: Products. Standard literature shall be edited to suit job conditions.

5. Samples: Material samples shall be provided as requested by the Owner’s Testing Agency.

6. Welding Procedures Specification (WPS): Submit for approval and record written welding procedures for all AWS D1.1 prequalified joints, and qualification procedures for all joints not prequalified by Section 3 of AWS D1.1. Submit supporting Procedure Qualification Record (PQR) as required by AWS D1.1. Submit written welding procedures developed by Contractor's welding consultant for heavy shapes and High Restraint Welds described in this Specification. Use the forms in AWS D1.1, Annex N. Submit weld sequence procedures indicating field welding sequence for each type of connection with multiple field-welded joints, and the sequence of such connections to be filed welded at each level. Where shrinkage is likely to cause distortion or other problems, submit a mitigation plan. Submit all welding and qualification procedures to the Owner's Testing Agency for approval before submitting to the Design Professionals. This submittal requires the approval of the SER, the Owner's Testing Agency, and DSA prior to the start of welding.

7. Welder Certification: Submit for record certification that the welders have passed qualification tests acceptable to the governing authority using AWS procedures.

a) A certification shall be submitted in standard AWS format.
b) Each certification shall state that the welder has been doing satisfactory welding of the required type within the six-month period prior to the subject work.

For any welder whose period of certification effectiveness has lapsed or whose workmanship is subject to question in the opinion of the Design Professionals or Testing Agency, immediate testing for recertification will be required. Tests, when required, shall be conducted at the sole expense of the Contractor.

8. **Mill Reports**: Submit for record certified copies of all mill reports, two (2) to the Design Professionals and one (1) to the Testing Agency, covering the chemical and physical properties of all structural steel and accessories (as defined in this Specification) for the project.

a) Such certificates shall be obtained from the mills producing the steel and shall certify in a cover letter submitted with the certificates, that the steel meets the minimum requirements as to physical properties, inspection, marking and tests for structural steel as defined by the current edition of the relevant ASTM Standard Specifications. Any steel that does not meet the ASTM requirements must be clearly identified in a cover letter submitted with the certificates.

b) Prior to commencing steel erection, the contractor shall deliver certificates to the Owner in number and form as may be required by the local Building Department or other local and State agencies having jurisdiction.

B. **Submittal Process**

1. Submittal of shop and erection drawings and other submittals by the Contractor shall constitute Contractor's representation that the Contractor has verified all quantities, dimensions, specified performance criteria, installation requirements, materials, catalog numbers and similar data with respect thereto and reviewed or coordinated each drawing with other Drawings and other trades. The Contractor shall place their shop drawing stamp on all submittals confirming the above.

2. Shop and erection drawings: Submit in complete packages so that individual parts and the assembled unit may be reviewed together. This Specification Section and the applicable drawings used in the development of the shop and erection drawings shall be referenced on each shop and erection drawing to facilitate checking. Unless the piece marks are self-indexing, furnish index sheets with the shop drawings, relating piece marks for all beam, girder and column details to the sheet numbers on which they are located.

3. The Contractor shall submit to the Design Professionals (1) electronic copy for shop drawing review. If the Contractor and Design Team agree to process shop drawings electronically, Contractor shall submit one hardcopy and one electronic copy to the SER. The naming convention of

051200-6 Structural Steel
each drawing must follow the submittal numbering system and include the submittal #, specification #, revision # and drawing # in the prefix of the drawing name.

4. The Contractor shall allow at least ten (10) working days between receipt and release by the SER for the review of shop and erection drawings.

5. All modifications or revisions to submittals, shop drawings and erection drawings must be clouded, with an appropriate revision number clearly indicated. The following shall automatically be considered cause for rejection of the modification or revision whether or not the drawing has been approved by the Design Professionals:

   a) Failure to specifically cloud modifications
   b) Unapproved revisions to previous submittals
   c) Unapproved departure from Contract Documents

6. The Contractor shall deliver to the Design Professionals at the completion of the job two (2) electronic versions of the final as-built shop drawings on a CD-ROM or other media acceptable to the Design Professionals.

7. Resubmittals: Completely address previous comments prior to resubmitting a drawing. Resubmit only those drawings that require resubmittal.

8. Resubmittals Compensation: The Contractor shall compensate the Design Professionals for submittals that must be reviewed more than twice due to contractors’ errors. The Contractor shall compensate the Design Professionals at the standard billing rates plus out-of-pocket expenses incurred at cost + 10%.

C. SER Submittal Review

1. The review and approval of shop and erection drawings and other submittals by the Design Professionals shall be for general conformance with the design intent of the work and with the information given in the Contract Documents only and will not in any way relieve the Contractor or the Contractor’s Engineer from:

   a) Responsibility for all required detailing.
   b) Responsibility for the proper fitting of construction work in strict conformance with the contract requirements.
   c) The necessity of furnishing material and workmanship required by contract Drawings and Specifications which may not be indicated on the shop and erection drawings.
   d) Conforming to the Contract Documents.
   e) Coordination with other trades.
   f) Control or charge of construction means, methods, techniques, sequences or procedures, for safety precautions and programs in connection with the work.
2. TYPE 1 Stamp - For shop drawings for building elements designed by the SER, the responses on the shop drawing review stamp used by the SER require the following actions:

a) APPROVED indicates that the SER has found that the information presented on the shop or erection drawing appears to conform to the requirements of the Contract Documents. Fabrication, manufacture or construction of the elements of work shown in the shop drawing may proceed, provided that work is in compliance with the Contract Documents.

b) APPROVED AS NOTED indicates that the SER requires the shop or erection drawing to be corrected to reflect the notes and comments shown. Fabrication, manufacture or construction of the elements of work shown in the shop drawing may proceed, provided that work is in compliance with the notations shown on the shop drawings and the Contract Documents. Promptly resubmit the corrected shop or erection drawing for record.

c) REVISE and RESUBMIT indicates that the SER requires resubmission of the shop or erection drawing after correction per notes and comments. None of the elements of work shown on the shop drawing shall be fabricated, manufactured or constructed until the Contractor has received a returned shop drawing marked Approved or Approved as Noted.

d) NOT APPROVED indicates that the shop or erection drawing does not conform to the Contract Documents and must be extensively revised before re-submittal. None of the elements of work shown on the shop drawing shall be fabricated, manufactured or constructed until the Contractor has received a returned shop drawing marked Approved or Approved as Noted.

3. TYPE 2 Stamp - For submittals for building elements which are not designed by the SER but are performance specified, for items that do not form part of the completed structural system but impose loads on the structure, and for construction items or activities which have an effect on the final structure, a second stamp will be used. The responses on the stamp used by the SER require the following actions:

a) NO EXCEPTIONS indicates that the SER has found that the information presented on the submittal appears to conform to the requirements of the Contract Documents. Fabrication, manufacture or construction of the elements of work shown in the shop drawing may proceed, provided that work is in compliance with the Contract Documents.

b) EXCEPTIONS NOTED indicates that the SER requires the submittal be corrected to reflect the notes and comments shown. Fabrication, manufacture or construction of the elements of work shown in the shop drawing may proceed, provided that work is in compliance with the notations shown on the shop drawings and
the Contract Documents. Promptly resubmit the corrected document for record.

c) REJECTED indicates that the SER requires resubmission of the submittal after correction per notes and comments. None of the elements of work shown on the shop drawing shall be fabricated, manufactured or constructed. Contractor to revise and resubmit until SER response of No Exceptions or Exceptions Noted is received.

D. Substitution Request

1. Requests for any departure from Contract Documents must be submitted in writing by the Contractor and accepted in writing by the Design Professionals, prior to receipt of submittals.

2. All substitutions must be requested using the structural substitution request form included at the end of this section. Acceptance using the structural substitution request form indicates acceptability of the structural concept only. Contractor must submit shop drawings reflecting accepted substitutions for review in accordance with this Specification. The structural substitution request form, even if accepted, does not constitute a change order.

3. Such substitutions or modifications, if acceptable to the Design Professionals shall be coordinated and incorporated in the work at the sole expense of the Contractor.

4. The acceptance by the Design Professionals of a specific and isolated request by the contractor to deviate from these requirements does not constitute a waiving of that requirement for other elements of, or locations in the project, unless specifically addressed as such and permitted by the Design Professionals in writing.

5. Compensation for Additional Services: Should additional work by Design Professionals such as design, drafting, meetings and/or visits be required which are necessitated for the review and/or incorporation of the Contractor-requested substitution, including indirect effects on other portions of the work, the Contractor is responsible for paying for additional work performed by the Design Professionals at the standard billing rates plus out-of-pocket expenses incurred at cost + 10%. Additional costs for testing and inspection by the Owner shall also be compensated by the Contractor.

6. Contractor is responsible for means and methods and any impacts on other portions of the work that may arise from this substitution.

E. Request for Information (RFI)

1. RFI shall originate with the Contractor. RFI submitted by entities other than that Contractor will be returned with no response.

2. Limit RFI to one subject.

3. Submit RFI immediately upon discovery of the need for interpretation or clarification of the Contract Documents. Submit RFI within timeframe so
as not to delay the Construction Schedule while allowing the full response
time described below.

4. The response time for answering an RFI depends on the category in
which it is assigned.

a) Upon receipt by the SER, each RFI will be assigned to one of the
following categories:

i. Category 1: No cost clarification
ii. Category 2: Shown in Contract Documents
iii. Category 3: Change to be issued in future bulletin
iv. Category 4: Previously answered
v. Category 5: Information needs to be provided by others.
vi. Category 6: Request for corrective field work
vii. Category 7: Request for substitution

b) RFIs in categories 1, 2, 3, 4 and 5 will be turned around by the
SER on average of five (5) working days.

c) RFIs in categories 6 and 7 will be rejected and must be submitted
as submittals or requests for substitution.

1.7 TEMPORARY SUPPORT OF STRUCTURAL STEEL FRAME

The structure as shown on the Contract Documents is designed to withstand the design
loads only when all structural elements are installed and fully connected. The contractor
shall be responsible for the analysis of all components and assemblies for stresses and
displacements that may be imposed by fabrication, shipping, handling, erection,
temporary conditions, construction loads, etc. The analysis of such shall be performed
by the Contractor’s Engineer.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Delivery: Unload all structural steel promptly upon arrival and store in an area
designated and approved by the Owner at the site of the work. The Contractor
shall be responsible for any charges from failure to unload material promptly.

B. Storage: Store structural steel to drain properly. Provide weep holes and clean
cut out as required to keep steel free from water. Provide adequate protection and
shoring to prevent distortion and other damage. Store structural steel on timber;
do not lay on mud, directly on ground or cinders, or otherwise handle in a manner
that damages finishes. Stored sections shall be readily accessible for inspection.

C. Store fasteners in a protected place.

D. Welding materials to be in moisture resistant, undamaged package. Maintain
packages effectively sealed until electrode is required for use. Storage and
handling shall be per AWS D1.1.
1.9 STRUCTURAL STEEL PRE-ERECTION CONFERENCE:

A. At least twenty (20) working days prior to the commencing of steel erection the Contractor shall hold a meeting to review the detailed requirements of the steel erection.

B. The Contractor shall prepare an agenda and require responsible representatives of every party who is concerned with the steel erection to attend the conference, including but not limited to the following:

1. General Contractor/Construction Manager
2. Steel Erector / Steel Fabricator
3. Erector's Surveyor
4. Steel Deck Contractor
5. All Testing and Inspection Agencies
6. Design Professionals
7. Owner
8. Precast or Cladding Contractor as appropriate.

C. Minutes of the meeting shall be recorded, typed and distributed by the Contractor to all parties listed above within 5 working days of the meeting.

D. The minutes shall include a detailed outline of the erection procedure including a schedule of milestone dates for surveys and sign-offs on erection stages which represents an agreement reached by all parties involved. It shall also include the surveying program and submission schedule for approval.

E. Notwithstanding any provision of the Specification, the SER shall not be responsible for and not have charge over any safety programs or precautions at the site of the Project.

1.10 QUALITY ASSURANCE BY OWNER’S TESTING AGENCY

A. Quality assurance is testing and inspection to assist the Owner in evaluating the Contractor's performance in the fabrication shop and field. It is not a substitute for the testing and inspection which is required as part of the Contractor's quality control program (see the following section on quality control).

B. Cost: Except as specifically noted otherwise, the testing agencies for quality assurance shall be engaged and paid by the Owner.

C. The Owner has negotiated inspection services based upon the assumption that all fabrication work shall be performed at one single fabrication shop. Costs associated with work being performed in additional shops will require reimbursement to the Owner.

D. Coordination with Owner’s Testing Agency: The Contractor shall have sole responsibility for coordinating their work with the testing agency to assure that all test and inspection procedures required by the Contract Documents and Public
Agencies are provided. The Contractor shall cooperate fully with the Owners testing agencies in the performance of their work and shall provide the following:

1. Information as to time and place of starting shop fabrication and a field construction and erection schedule, one week prior to the beginning of the work.
2. Site File: At least one copy of each approved shop drawing shall be kept available in the contractor’s field office and the drawings not bearing evidence of approval and release for construction by the Design Professionals shall not be kept on the job. Provide drawings for the work to be performed in the shop or field one week prior to the start of work.
3. Representative sample pieces requested by the inspection agency for testing, if necessary.
4. Full and ample means of assistance for testing and inspection of material.
5. Proper facilities, including scaffolding, temporary work platforms, safety equipment etc., for inspection of the work in shop and field.

E. Duties of the Owner’s Testing Agencies:

1. Reports: The Testing Agency shall prepare daily reports of the structural steel work including progress and description/area of work, tests made and results. Reports of inspection of welding shall include deficiencies noted and corrections made, and other items pertinent to acceptance or rejection of the work. The reports shall state whether specimens comply with or deviate from contract requirements. The daily reports shall be collected and delivered to the Design Professionals, Contractor, DSA and Owner weekly.
2. Rejection: The Owner’s Testing Agency has the right to reject any material, at any time, when it is determined that the material or workmanship does not conform to the Contract Documents. The Testing Agency shall report deficiencies to Owner, Design Professionals, and Contractor immediately.
3. Structural steel work and general testing requirements: The Testing Agency shall perform the following shop and field inspections in addition to any other inspections enumerated above or specified on the Contract Documents:
   a) Shop inspection of steel shall include alignment and straightness of members, camber, preparation for connections, dimensional checks, testing of shop bolts, witnessing of welding procedures, testing of cuts, weld access holes and copes of heavy shapes as defined in this Specification, examination and testing of completed welds, headed studs and deformed bar anchors, cutting of heavy shapes, finishing of column ends, cleaning, painting and storage of material. All shop fabrication shall be inspected in the shop. Camber shall be verified in a minimum of 10% of all members requiring camber. If, in the opinion of the SER and Testing Agency this testing discloses a large ratio (10% or more) of
unacceptable cambers, the required percentage of tested cambers may be increased by the SER to 100% at no expense to the Owner.

b) Field inspection of steel shall include connections, proper tensioning of bolts, levelness, plumbness and alignment of the frame, conformance to AWS welding methods, examination of surface before welding, examination and testing of completed welds, headed studs and deformed bar anchors and field painting, including touch-up.

c) Check qualifications of the following:
   i. Shop welding procedures and personnel
   ii. Shop stud welding setup and operators
   iii. Shop bolting procedure and crew

d) Where testing is required for less than 100% of locations, select test locations at random and throughout the project.

e) Review mill certifications for compliance with the Contract Documents. Where certification is questionable, test material.

f) Visually inspect seam welds of tube and pipe for evidence of cracking or lack of fusion. At each end piece of tube or pipe, inspect interior face of seam weld for evidence of cracking, lack of fusion, or less than full flashing.

4. High Strength Bolting: The Testing Agency inspector shall inspect high strength bolted construction in accordance with RCSC "Specification for Structural Joints using ASTM A 325 or A 490 Bolts," including but not limited to:

   a) Surface preparation and bolt type conforms to plans and Specifications prior to start of bolting operations.

   b) Proper bolt storage and handling procedures per codes and standards referenced by this Specification are being followed.

   c) Visually inspect all bolted connections.

   d) For all bolted connections that are indicated as snug tight, connections are properly compacted and brought to the snug tight condition progressing outward from the most rigid part.

   e) For all bolted connections that are indicated as pretensioned or slip critical, pre-installation verification testing is performed by the inspector in cooperation with the contractor in accordance with RCSC section 9.2 and section 7.

   f) For all bolted connections that are indicated as pretensioned or slip critical, through routine observation, as defined in RCSC 9.2.1, 9.2.3 or 9.2.4, that the pretensioning methods of RCSC 8.2.1, 8.2.3, or 8.2.4, as appropriate, are performed.
i. "Routine observation" is defined as observation of 10 bolts for every 100 bolts with a minimum of 2 bolts per connection.

g) Retest bolted connections that fail initial inspection after correction by the Fabricator or Erector.

5. Welding:

a) Review of submittals: Welding procedures including prequalification, qualifications test and, for heavy shapes and high restraint welds, the welding procedure prepared by the Contractor's Engineer or Welding Consultant.

b) Complete joint penetration welds: Test all complete joint penetration welds for soundness by means of either radiographic or ultrasonic testing in accordance with AWS D1.1 and ASTM E164 procedures. For all complete joint penetration welds at top flange of cantilever beams and splices in beam flanges, test for soundness by means of ultrasonic testing and magnetic particle testing. All flaws in plate or flange material revealed during such tests shall be repaired by the Contractor at the Contractor's expense.

c) Fillet welds: Visually inspect all fillet welds. For all fillet welds at top flange of cantilever beams and splices in beam flanges, test for soundness by means of magnetic particle testing. In addition test ten percent (10%) of all fillet welds at other location using a non-destructive method, such as dye penetrant or magnetic particle. Select test locations randomly throughout the structure, but test at least one weld in each location with 6 or more welds per connection. If, in the opinion of the SER and Testing Agency this testing discloses a large ratio (10% or more) of unacceptable welds, the required percentage of tested welds may be increased by the SER to 100%, all at the Contractor's expense.

d) Inspection and Testing by the Testing Agency of high restraint welds and where Heavy Shapes are to be joined by partial or full penetration welds in tension:

i. Joint Preparation: Monitor fit up and joint preparation (bevel angle, etc.) for conformance to the submitted welding procedures including preheat and interpass temperature. Monitor base metal temperature during welding operations.

ii. Test Full Penetration Welds in accordance to the requirements of this Specification section, ultrasonically in accordance with AWS D1.1 procedures. On T or corner joints, pay careful attention to the heat affected zone and base metal where the weld shrinkage stresses are in the through thickness direction.
iii. Test Partial Penetration Butt Joints in accordance with this Specification section by the magnetic particle method. At T or corner joints, in addition to the magnetic particle testing, ultrasonically scan the heat affected zone and adjacent base metal from face "C" per AWS D1.1 Table 6.7 and Annex K-7 to detect lamellar tears and shall be done with a compression wave. The Testing Agency shall submit a testing procedure that includes evaluation (acceptance criterion) procedures to the Design Professionals for review.

e) Inspect Heavy Sections:

i. Heavy Section flanges shall be ultrasonically examined at locations to be groove-welded, for evidence of laminations, inclusions, or other discontinuities, in accordance with ASTM A898, Straight Beam Ultrasonic Examination of Rolled Steel Structural Shapes (Level 1 criteria). Examination shall include entire area within 3" of such joints.

ii. For plates, ultrasonically examine in accordance with ASTM A435, Straight Beam Ultrasonic Examination of Steel Plates.

iii. Any discontinuity causing a total loss of back reflection that cannot be contained within a circle with a diameter of the greater of 3" or one-half the plate or flange thickness, shall be cause for rejection.

f) At heavy shapes and high restraint welds: provide pre-production sample testing of heat treatment, observe fabrication, welding and heat treatment of the samples for conformance with submitted welding procedures. Establish locations of testing coupons following AWS procedures. Test coupons following AWS procedures to verify satisfactory results using the welding procedure and heat treatment.

g) Comply with the requirements of DSA IR 17-3.

6. Headed Studs, Threaded Studs and Deformed Bar Anchors: Visually inspect all headed studs and deformed bar anchors for complete fusion and full 360-degree weld flash (or fillet).

a) At the beginning of the work shift or any change of operator, equipment, position or setting, perform pre-production testing per AWS D1.1, on the two studs or anchors. Verify that two consecutive studs or anchors have satisfied pre-production testing prior to starting production welding of studs or anchors.

b) For production studs and anchors, visually inspect all head studs and deformed bar anchors for complete fusion and full 360 degree
weld flash (or fillet) per AWS D1.1. Check all studs and anchors with incomplete fusion or which have been repaired by welding, by bending to an angle of 15 degrees from its original axis (away from any missing flash). Torque test all threaded studs with incomplete fusion. If more than twenty percent of studs fail on one member, check all studs or anchors on member.

c) In addition to studs and anchors that fail visual inspection, test at random five studs or anchors at each of six members per floor. Test additional member for each member with any defective studs or anchors.

d) Contractor to replace any studs that crack or break. Contractor to only straighten studs that would foul other work or have less than 1 inch (25mm) cover in bent position.

7. Cleaning & Painting:

a) Prior to shop painting, examine all fabricated pieces to verify proper cleaning in accordance with this Specification.

b) Examine all shop painting to verify conformance with this Specification.

c) Examine loading and unloading of steel to visually observe that damage does not occur during shipping and handling.

8. Remedial Work: The Testing Agency shall indicate to the Contractor where remedial work must be performed and will maintain a current list of work not in compliance with the Contract Documents. This list shall be submitted to the Design Professionals and Owner on a weekly basis.

9. Certification: When all work has been approved by the Testing Agency, the Testing Agency shall certify in a letter to the Design Professionals and Owner that the installation is in accordance with the design and Specification requirements (including applicable codes).

1.11 QUALITY CONTROL BY CONTRACTOR

A. The Contractor shall provide a program of quality control to ensure that the minimum standards specified herein are attained.

B. Structural Steel shall be identified in accordance with the requirements contained in AISC 360.

C. The Contractor shall immediately report to the Design Professionals any deficiencies in the work which are departures from the Contract Documents which may occur during construction. The Contractor shall propose corrective actions and their recommendations in writing and submit them for review by the Design Professionals. After proposed corrective action is accepted by the Design Professionals and Owner, the Contractor shall correct the deficiency at no cost to the Owner.
D. The Owner's general review during construction and activities of the Owner's Testing Agency are undertaken to inform the Owner of performance by the Contractor but shall in no way replace or augment the Contractor's quality control program or relieve the Contractor of total responsibility for quality control.

1.12 OBSERVATIONS AND CORRECTIONS BY DESIGN PROFESSIONALS

A. Review: The Design Professionals will observe the construction for general compliance with the provisions of the Contract Documents during various phases of construction.

B. Compensation for Additional Services: Should additional work by Design Professionals such as design, drafting, meetings and/or visits be required which are necessitated by failure of the Contractor to perform the work in accordance with the Contract Documents, the Contractor is responsible for paying for additional work performed by the Design Professionals at their standard firm-wide billing rates plus out-of-pocket expenses incurred at cost + 10%. Additional costs for testing and inspection by the Owner shall also be compensated by the Contractor.

1.13 PERMITS AND WARRANTY

A. Permits: The Contractor shall apply for, procure, renew, maintain, and pay for all permits required by City, State, or other governing authorities, necessary to execute work under this Contract. Contractor shall furnish copies of all permits to the Owner and Design Professionals.

B. Structural Steel shall be identified in accordance with requirements contained in AISC 360.

C. Warranty: Upon completion of all work to be performed under this Contract, the Contractor shall execute and deliver in a satisfactory form a warranty that all workmanship and materials used in the performance of this Contract shall remain free from defects for a period of one (1) year from the date of execution of the Warranty.

PART 2 - PRODUCTS

2.1 STRUCTURAL STEEL

A. Structural steel shall conform to the requirements listed on the Structural General Notes.

2.2 SHOP COATINGS

A. Standard Primer: Rust inhibitive, universal phenolic alkyd metal primer 2-4mls. Color to be determined by Architect. Primer shall be compatible with, and from the same manufacturer as, top coats specified in Division 9 specification.
B. Zinc Rich Primer: SSPC-Paint 20, Type I or Type II, Zinc rich primer utilizing either an organic or inorganic binder with a minimum zinc content of 80 percent by weight in the dry film. The primer shall provide a surface meeting AISC Slip Critical Class B (slip coefficient =0.50 min) requirements. Color to be determined by Architect. Primer shall be compatible with, and from the same manufacturer as, top coats specified in Division 9 specification.

C. Hot Dip Galvanizing: ASTM A123, weight of coating shall average not less than 2.3 oz per square foot (0.70 kg/ m²), with no individual thickness less than 2.0 oz per square foot (0.61 kg/m²).

D. Galvanizing Repair Paint: ZRC Cold Galvanizing Compound, or other complying with SSPC-Paint 20.

2.3 ACCESSORIES

A. High Strength Bolts: Conform to the provisions of the Research Council on Structural Connections (RCSC) "Specifications for Structural Joints using ASTM A325 or A490 Bolts" except that nuts shall be ASTM A563 Grades DH or DH3 (hardened) for both A325 and A490 bolts. Twist off type bolts (Tension Control bolts) shall additionally conform to ASTM F1852 or ASTM F2280.

B. All bolts shall be new, and not re-used.

C. Where A325 galvanized bolts nuts and washers are required, they shall be in accordance with ASTM F2329 and ASTM A153, Class C. Where A588 steel is used, bolts, nuts and washers shall be Type 3.

D. Direct Tension Indicators: Meet requirements of ASTM F959.

E. Anchor Rods: Per structural General Notes.

F. Washers:

1. Round washers shall conform to American Standard B 27.2 type b
2. Washers in contact with high-strength bolt heads and nuts shall be hardened in accordance with ASTM Standard F436.
3. Beveled washers shall be square, smooth and sloped so that contact surfaces of the bolt head and nut are parallel.
4. The diameter of the hole of square beveled washers shall be 1/16 inch (1.5mm) greater than the bolt size for bolts smaller than one inch (25mm), and shall be 1/8 inch (3.0mm) greater than the bolt size for bolts larger than one inch (25mm).
5. Comply with requirements of RCSC for all washers including thickness, size and hardness, depending on connection details.

G. Welding Electrodes: Electrodes shall be low hydrogen and shall be selected from Table 4.1.1 of AWS D1.1.
1. Shielded Metal-Arc Welding: Welding electrodes for manual shielded metal-arc welding shall conform to the specification for Mild Steel Covered Arc-Welding Electrodes, AWS A5.1 E70 or 80, or the specification for Low-Alloy Steel Covered Arc-Welding Electrode, AWS A5.5.

2. Submerged-Arc Welding: Bare electrodes and granular flux used in submerged-arc welding shall conform to F70 or F80 AWS flux classifications of the specification for Gare Mild Steel Electrodes and Fluxes for submerged-arc Welding, AWS A5.17.

H. Headed Studs (shear connectors) shall be per Structural General Notes.

I. Deformed Bar Anchors shall be as specified in Structural General Notes.

J. Steel Castings shall conform to ASTM A27, Grade 65-35, medium strength carbon steel.

K. Post-installed Anchors shall be per Structural General Notes.

PART 3 - EXECUTION

3.1 PREPARATION

A. Work by Others: Examine all work prepared by others to receive work of this Section and report any defects affecting installation to Design Professionals. Commencement of work will be construed as complete acceptance of preparatory work by others. The Contractor alone shall be responsible for checking the dimensions and coordination of the structural steel work with other trades.

B. Anchor Rods: Anchor rods shall be set in conformance with Section 7.5 of AISC 303. At least 20 working days prior to the start of the structural steel erection, the Contractor shall ascertain by accurate survey the existing location, alignment, and elevation of the anchor rods embedded in the concrete by others. The Contractor shall immediately bring to the attention of the Design Professionals any discrepancies observed between the Contract Documents and the as-built conditions. Steel erection shall not start until corrective measures, if required, have been performed.

3.2 FABRICATION

A. Fabricate and assemble structural steel in the shop to the greatest extent possible.

B. Tolerances:
1. Conform to the tolerances of the AISC "Code of Standard Practice," compensate for the difference between the temperature at time of fabrication and the mean temperature in service.

2. Elevator shafts used for temporary hoists shall conform to the detailed requirements of the hoist manufacturer.

C. Holes: Holes shall be provided in members to permit connections to the work of other trades or contracts, and for passage through the member of work of other trades. All holes shall be accurately drilled or punched at right angles to the surface of the metal in accordance with AISC Specifications. Holes shall not be made or enlarged by burning. Burning or drifting unfair holes will not be permitted. Holes that must be enlarged shall be reamed, but only up to the next larger bolt size. Where unfairness exceeds the maximum, weld hole in base material solid and drill hole of proper size. Drift pins will be allowed only to bring together the several parts for connection. Holes in base plates shall be drilled. Holes shall be clean-cut without torn or ragged edges. Outside burrs resulting from drilling operations shall be removed with a suitable tool.

D. Camber: Provide camber as indicated on the Contract Documents. Where no camber is indicated, provide natural camber up.

E. Cutting: Manual gas-cutting in the shop may be used only if automatic or semi-automatic methods are not possible. If manual shop cutting is required, it shall be done only with a mechanically guided torch, except that an unguided torch may be used where the cut is more than 1/2 inch (12mm) from the finished dimension and final removal is completed by means such as chipping or grinding to produce a gouge-free surface of quality equal to that of the base metal. At restrained joints and as indicated elsewhere, weld access holes shall be ground smooth.

F. Cutting of Heavy Shapes: Where "Heavy Shapes" as defined in this Specification are to be joined by partial or full penetration welds in tension, preheating shall be required for all thermal cutting operations. Preheat shall be sufficient to prevent cracking but in no case less than 150 degrees F (65°C). Weld access holes and copes shall be ground to a smooth radius after cutting and tested for cracks by the magnetic particle method. All cut edges shall be free of sharp notches and gouges.

G. Anchor Rods: Rigid steel templates and anchor rods shall be furnished, labeled and shipped in sets indicating sizes and locations of columns, together with instructions for setting of anchor rods. Plate washers per Typical Details shall be provided.

H. Bolting: Bolts shall be driven accurately into the holes without damaging the threads. Bolt heads shall be protected from damage during driving. Bolt heads and nuts shall rest squarely against the metal. Where bolts are to be used on beveled surfaces having slopes greater than 1 in 20 with a plane normal to the
bolt axis, beveled washers shall be provided to give full bearing under the head or nut.

I. Bolts indicated as “finger tight” on the Contract Documents shall be prevented from backing off by using lock nuts, thread compound or deformed threads.

J. Welding of Structural Steel:

1. Pre-Weld Inspection: The surface to be welded and the filler material to be used shall be subject to inspection before welding is performed.

2. Welds indicated on the Contract Documents or the approved shop or erection drawings shall be created by electric arc welding processes that comply in all respects with the codes and specifications herein noted covering the design, fabrication, and inspection of welded structures and the qualifications of welders and supervisors. Control the heat input, weld length, weld sequence and cooling process to prevent distortion of the completed assembly.

3. Each welder's work shall be traceable.

4. Special Requirements: For high restraint welds and welds at heavy shapes, follow approved welding procedures for weld process, sequence, pre-heating and cooling. Use stress relieving techniques where shown in the approved procedure developed by the Contractor's Welding Consultant.

   a) Special Procedures: Prior to the start of production welding, the contractor shall demonstrate to the Testing Agency that preheat can be maintained without relying on heat from the arc. For field welding, the contractor shall provide a shelter to protect each joint from inclement weather (rain, snow, etc.), from start until completion of the joint.

   b) Preheat and Postheat: Preheat shall be sufficient to prevent cracking, but in no case less than required by AWS D1.1. For high-restraint welds, minimum preheat shall be 225 degrees F (105°C). The preheat shall be maintained throughout the thickness of the material for a distance equal to twice the material thickness on both sides of the joint at a minimum. Where different thicknesses of steel are being joined, the greater thickness shall govern. Preheat shall be measured on the face opposite the side of the heat application. Preheat shall be applied uniformly in a manner that does not harm the surface of the material nor cause surface temperatures to exceed 1100 degrees F (600°C). Should stress relief heat treatment be required, the contractor shall submit a written procedure.

5. Supplemental Welding Requirements:

   a) Nonfusible Backing: The use of nonfusible backing materials, including ceramic and copper, is permitted only with satisfactory
welder qualification testing performed using the type of backing proposed for use and using the test plate shown in AWS D1.1, Figure 4.21, except that groove dimensions shall be as provided in WPS and PQR. For nonfusible weld tabs and short segments of nonfusible weld backing used at the ends of welds between shear plates and column faces, or at the ends of continuity plate welds, special welding personnel and welding procedure qualification testing is not required.

6. Welded Joint Details:

a) Welding Backing: The use of weld backing shall be in accordance with AES D1.1. Weld backing shall be removed where required by the Contract Documents or for the WPS by AWS D1.1

i. If groove weld backing is permitted to remain, the backing shall not exceed 3/8” thickness.
ii. Heavy Section Splices Requiring Removal of Weld Backing: All welded splices of Heavy Sections, shall have the weld backing removed. Where fusible backing material is used, the root pass area shall be backgouged after backing bar removal, backwelded until flush or with slight reinforcement. The surface shall then be ground Extra Smooth.

b) Weld Tabs:

i. Use of Weld Tabs: Welds shall be terminated at the end of a joint in a manner that will ensure sound welds. Whenever necessary, this shall be done by use of weld tabs.

(1) Weld tabs shall extend beyond the edge of the jointing a distance equal to a minimum of the part thickness, but not less than 1”.
(2) Weld tabs shall be oriented parallel to the joint preparation and to the weld direction.
(3) Nonfusible weld tabs may be used in applications and locations where qualified in accordance with AWS D1.1, Section 4.

ii. Heavy Section Joint Weld Tab Removal and Finish: All welded tension splices in Heavy Sections, shall have the weld tabs removed and ground smooth.

c) Weld toes: Weld toes, whether groove welds or fillet welds, shall provide a smooth transition between the weld and base metal.
The as-welded profile is adequate provided it satisfies the criteria of AWS D1.1, Section 5.24.

d) Weld access holes:

i. Weld access holes shall meet the dimensional, surface finish, and testing requirements of AISC 360 Chapter J1.6 and AWS D1.1, except as otherwise required by the Contract Documents.

ii. Where the height of the weld access hole exceeds the quantity $k - tf + 1\frac{1}{2}''$ or where the length of the weld access hole exceeds $4\;tf$ (where $k$ and $tf$ are defined in AISC 360), welded reinforcement is required. Notify the Design Professionals for specific instruction.

e) Welding for Moment Connections shall be sequenced so as to minimize residual stresses in the joint.

7. Deficient Welds: Welds found deficient in dimensions but not in quality may be enlarged by additional welding. Any weld found deficient in quality shall be removed and repaired in accordance with AWS D1.1, Section 5.26.

K. Heavy Sections:

1. General: See AISC 360 Chapter A3.1c for materials requirements.

2. Applicability of Provisions: All requirements of AISC 360 for Group 4 and 5 shapes shall apply to Heavy Sections as defined in this Specification.

3. Access Hole Requirements: Access holes shall conform to the requirements of AISC 360, Chapter J1.6. Weld access holes must be preheated to a minimum of 150° prior to thermal cutting, ground to an Extra Smooth finish. Inspect holes for cracks using either penetrant testing (PT) or magnetic particle testing (MT). Optionally, weld access holes may be made by drilling and saw-cutting without grinding, but PT or MT of the cut surface is still required.

4. Welding: The minimum preheat and interpass temperature shall be as specified by AISC 360, Chapter J2.8 Weld tabs and weld backing shall be removed, ground to an Extra Smooth finish, with reinforcement not to exceed 1/8", at a transition slope not to exceed 1:10. See AISC 360, J2.8 for preheat requirements and J1.5 for weld tab and backing bar removal requirements.

5. Splices shall conform to the requirements of AISC 360, Chapter J1.5.

L. Surface Finish

1. Flush Surfaces: Welds in butt joints required to be flush shall be finished so as to not reduce the thickness of the thinner base metal or weld metal by more than 1/16" or 5% of the material thickness, whichever is less. Remaining reinforcement shall not exceed 1/32" in height. However, all
reinforcement shall be removed where the weld forms part of a faying or contact surface. All reinforcement shall blend smoothly into the plate surfaces with the transition areas free from undercut.

2. Finish Methods and Values: Chipping and gouging may be used, provided these methods are followed by grinding. Where surface finishing is required, surface shall be Extra Smooth, unless otherwise noted or specified in this document. Measurement of surface finish values by visual appearance or tactile comparison is acceptable.

M. Repair of Gouges: Gouges are not permitted in areas requiring and Extra Smooth finish surface, or where specifically prohibited by AWS D1.1 or this Specification. Repair of gouges shall meet the following requirements, unless otherwise noted:

1. Shallow Gouges: Gouges up to 3/16" deep shall be removed by grinding as per D1.1, or to a radius of not less than 3/8".

2. Deep Gouges: Gouges deeper than 3/16" shall be repaired by welding. Prior to welding, gouges shall be ground to provide an Extra Smooth contour with a radius not less than 3/8". The repair area shall be preheated to a temperature between 400° F and 550°F, measured at the point of welding approximately one minute after removal of the heating source, or shall be preheated in accordance with AWS D1.1 Annex I for high restraint. A written repair WPS for the application shall be followed. Following completion of welding, the area shall be ground Extra Smooth, with fairing of the welded surface to adjoining surfaces where applicable, and shall be inspected using magnetic particle testing (MT).

3. The transitional slope after gouge removal shall not exceed 1:5.

N. Bearing:

1. Bearing ends of columns shall be milled or sawn square perpendicular to axis of the column.

2. Finish bearing areas of base plates per AISC M2.8.

O. Stiffeners: Fitted stiffeners shall be ground to fit closely against flanges.

P. Cleaning and Preparation of Steel Surfaces:

1. Clean all steel work in accordance with the Steel Structures Painting Council (SSPC). Method specified herein that corresponds to its location and exposure. Steel work to be painted shall be painted within the same day that it is cleaned.

   a) Interior, Not Exposed to View (above suspended ceilings, under sprayed-on fireproofing, steel to be encased in concrete): SSPC-SP-2, Hand Tool Cleaning.
b) Interior, Exposed in the Finished Building: SSPC-SP-6, Commercial Blast Cleaning, unless noted otherwise on the Drawings.

c) Exterior (exposed to weather or in unconditioned space): SSPC-SP-6, Commercial Blast Cleaning, unless noted otherwise on the Drawings.

d) Architecturally Exposed Structural Steel where indicated on the Contract Documents as “AESS”: SSPC-SP-10, Near White Blast.

e) Members to be Hot Dipped Galvanized: SSPC-SP3, Power Tool Cleaning, before galvanizing.

Q. Shop Coating:

1. Where painting is specified, paint all steel work in accordance with the Steel Structures Painting Council (SSPC) Method specified herein that corresponds to its location and exposure and in accordance with manufacturer's written instructions. Paint steel work the same day that it is cleaned.

   a) Interior, Not Exposed to View (above suspended ceilings, under sprayed-on fireproofing, steel to be encased in concrete): No Paint.

   b) Interior, Exposed in the Finished Building: SSPC – Paint 25

   c) Exterior (exposed to weather or in unconditioned space): SSPC – Paint 20

   d) Architecturally Exposed Structural Steel (AESS) to receive a 2 or 3 coat paint system.

2. Protect finished bearing surfaces with a rust-inhibiting coating which is to be removed immediately prior to erection.

3. Do not paint:

   a) Surfaces within six (6) inches (150mm) of field welds

   b) Surfaces to be encased in concrete or to receive cementitious fireproofing

   c) Contact surfaces of high-strength bolted Slip Critical connections (unless surface prep and paint has been specifically prequalified by the contractor or approved for use in this location by the SER)

   d) Surfaces required for testing and preheat, until all testing and preheat has been performed

   e) Finished bearing surfaces (use removable rust-inhibiting coating)

   f) Top flange of the beam where steel deck or headed studs are to be attached

4. Paint shall be applied thoroughly and evenly to dry surfaces only when surface temperatures are above dew-point, in strict accordance with manufacturer's instructions.
5. Surfaces of exterior members which are inaccessible after assembly or erection shall receive their second coat of the approved paint, in a different shade, in the shop.

6. Hot-dip galvanize the following steel members:
   
   a) All angles, steel plates and shims supporting exterior masonry or exposed to the weather, including shelf, arch and relieving angles
   
   b) All connections between the above angles and steel plates and the supporting structural member, including clip angles and hardware
   
   c) Any other steel members indicated as "Galvanized" on the Contract Documents.
   
   d) All miscellaneous metal, angles, clips, etc. on exterior masonry walls.

3.3 ERECTION

A. Tolerances: Erect all work plumb, square and true to lines and levels in strict accordance with the structural requirements of the building within tolerances of the AISC Code of Standard Practice, unless otherwise indicated on the Contract Documents. Compensate for the difference between the temperature at time of erection and the mean temperature in service.

B. Bracing: Brace the frame during erection in accordance with the Contractor's erection procedure.

C. Errors: Immediately report to the Design Professionals any errors in shop fabrication, deformations resulting from handling and transportation, and improper erection that affects the assembly and fitting of parts. Prepare details for corrective work and obtain approval of the method of correction. Approved corrections shall be made expeditiously at the sole expense of the Contractor.

D. Column Base Plates: Support and align on steel shims or setting bolts. After the supported members have been plumbed and properly positioned, tighten anchor rod nuts in preparation for grouting. Cut off wedges and shims flush with edges of plates and leave in place. The use of leveling plates will not be permitted.

E. Grouting: Refer to General Notes. Grout base plates immediately after the first tier of columns are plumbed. Do not proceed with steel erection above the first tier until base plates are grouted.

F. Bolting and Welding of Structural Steel: See Section on "Fabrication".

G. Bearing Surface: Clean bearing surfaces and surfaces that will be in permanent contact before the members are assembled.

H. Splices: Splices will be permitted only where indicated on the Contract Drawings or the reviewed shop drawings. Fasten splices of compression members only
after surfaces are cleaned and abutting surfaces have been brought completely into contact. Fill any remaining gaps with steel shims driven into place and cut flush. Tack weld shims to each other and to members. Use runoff tabs at bevel weld splices. Cut off runoff tabs and ground smooth after weld completion.

I. Driftpins: Driftpins may be used only to bring together the several parts, and shall not be used in such a manner as to distort or damage the metal. Correct poor matching of holes by drilling to the next larger size and using a larger size bolt. Plug welding and redrilling will not be permitted, unless a specific instance arises and is approved by the SER.

J. Erection bolts: On exposed welded construction, remove erection bolts, fill holes with plug welds and grind smooth at exposed surfaces. On non-exposed welded construction, remove erection bolts.

K. Hammering: Hammering which may damage or distort the members will not be permitted.

L. Do not use cutting torches in the field without the specific approval of the SER for each application. Where cutting torch use is permitted, all the requirements of the Section on "Fabrication" shall apply.

M. Additional Material and Labor: If the Contractor furnishes additional material and labor for the purpose of erection or if the erection method requires that material be added to certain members, the required modifications shall be at the sole expense of the Contractor.

N. Alignment: Following erection, accurately align, level, and adjust all members prior to final fastening. Conform to AISC standard tolerances unless otherwise noted in the Contract Documents.

O. Touch-Up and Field Applied Paint: After erection, clean all damaged areas in the shop coat, exposed surfaces of bolts, bolt heads, nuts and washers and all field welds and unpainted areas adjacent to field welds according to manufacturers recommendations and paint with the same paint used for the shop coat. Match the touch up and field applied paint color to the as-built paint color. After touch up, at exterior (exposed to the weather or in unconditioned space) steel members apply a full coat of the specified paint in a different shade than the shop applied coat.

P. After erection, clean all damaged galvanized areas, welds and areas adjacent to welds and paint with the specified galvanizing repair paint.

Q. Clean all steel members of mud and debris and construction residue prior to erection.

R. Headed Studs and Deformed Bar Anchors:
1. End weld headed studs and deformed bar anchors with an automatic process in accordance with section 7 of AWS D1.1.
2. Areas to which studs are to be attached must be free of foreign material, such as rust, oil, grease, paint etc. When mill scale is sufficiently thick to cause difficulty in obtaining proper welds, remove by grinding or sand blasting.
3. Remove ceramic ferrules from studs and work after welding.
Structural Substitution Request Form – to be completed by Contractor

| Project: | | | Substitution Request # |
|----------|----------------------------|----------------------------|
| Date: | | | |
| Requesting Contractor: | | | Pages Attached (including this form) |

1. Description of Requested Substitution:

2. Related Drawings and Specification Sections:

3. Rationale or Benefit Anticipated:

4. Effect on Construction Schedule⁴ (check one):  □ NONE  □ See Attached

5. Effect on Owner’s Cost² attach data (check one):  □ CREDIT TO OWNER  □ EXTRA

6. Effect on Construction Documents³ (design work anticipated):  □ NONE  □ See Attached

7. Requesting Contractor Agrees to Pay for Design Changes (check):  □ YES  □ NO  □ NOT APPLICABLE

8. Effect on Other Trades⁴:

9. Effect of Substitution on Manufacturer’s Warranty (check):  □ NONE  □ See Attachment

Signature⁵:

Company:

General Contractor Signature⁵:  Date:

Notes:
1. Contractor is responsible for means and methods and any problems that may arise from making the requested substitution.
2. This is NOT A CHANGE ORDER FORM. A separate form is required to adjust costs and/or schedules.
3. Contractor is responsible for any design impacts that may arise from this substitution, including redesign efforts.
4. Contractor is responsible for effects on other trades from this substitution; General Contractor must review and agree effects on other trades are fairly represented in items 4-9.
5. Signature by a person having authority to legally bind his/her company to the above terms. Otherwise this request is void.
6. All items in form must be completed for substitution request to be considered.

| Request Review Responses (completed by Architect and/or Engineer(s)): | |
| --- | --- | --- | --- | --- | --- |
| ACCEPTED | ACCEPTED AS NOTED | REJECTED | INSUFFICIENT DATA TO SUPPORT REQUEST | ENGINEER / ARCH / MEP SIGNATURE | DATE |

051200-29  Structural Steel
Engineer/Architect Comments:

END OF SECTION
SECTION 05 40 00

COLD-FORMED METAL FRAMING

PART 1 - GENERAL

1.01 DESCRIPTION

A. Section Includes: Provision of light-gauge steel stud and joist framing. Work includes, but is not necessarily limited to the following:

1. Interior stud wall and ceiling framing with studs 18-gauge and heavier.
2. Framing accessories.

B. Related Sections:
2. Gypsum Board: Section 09 29 00.

1.02 REFERENCES

A. Requirements of the GENERAL CONDITIONS and DIVISION NO. 1 apply to all Work in this Section.

B. Published specifications, standards, tests, or recommended methods of trade, industry, or governmental organizations apply to Work of this Section where cited by abbreviations noted below (latest editions apply).

5. American Iron and Steel Institute (AISI): "Specifications for the Design of Cold-Formed Steel Structural Members".
6. Metal Stud Manufacturer’s Association (MSMA).
7. Metal Lath Association (MLA): "Specifications for Metal Lath and Furring".
8. Steel Structures Painting Council (SSPC): "Painting Manual".

1.03 QUALITY ASSURANCE

A. Regulatory Requirements:

1. Comply with fire-resistance ratings as indicated and as required by governing authorities and codes.
2. Provide materials, accessories, and application procedures which have been listed by an approved testing agency or tested according to ASTM E119 for the type of construction shown.
3. Comply with CBC Section 2210A.4 and AISI requirements for design and identification of cold-formed steel.
4. Framing system shall conform to ICC-ES Report for stud gauge and spacing for all wall conditions.

B. Steel stud system shall conform to referenced AISI documents.

C. Installer: Company specializing in performing the work of this Section with minimum 3 years’ documented experience.
D. Welders: Qualified in accordance with AWS D1.3 for welding process, position, type of weld and type of steel.

1.04 SUBMITTALS
A. Shop Drawings: Include plans and elevations at not less than 1/4-inch to 1'-0" scale, and details at not less than 3-inches to 1'-0" scale.
   1. Indicate wall stud and ceiling joist layout.
   2. Indicate component details, framed openings, bearing, anchorage to structure, type and location of fasteners and accessories, and items required of related work for complete installation of steel stud system.
B. Product Data: Manufacturer's ICC ER report, specifications and installation instructions for steel studs, fasteners, and accessories.
C. Experience of installer if requested by Architect.

1.05 PRODUCT DELIVERY, STORAGE AND HANDLING
A. Protect framing from rusting and damage.
B. Deliver in manufacturer's unopened containers or bundles fully identified with name, brand, type and grade.
C. Store inside a dry, ventilated space, and protect framing from rust and damage.

1.06 JOB CONDITIONS
A. Coordinate stud sizes and layouts with the work of the various trades. Where ductwork, conduit, piping, casework, and other such items exceed indicated available space, increase stud sizes or make other minor modifications as necessary to accommodate the work at no change in cost of the Work.

PART 2 - PRODUCTS

2.01 MANUFACTURERS
A. Acceptable Manufacturers: Any member of Steel Stud Manufacturer's Association (ICC ER-4943P).
   4. Substitutions: See Section 01 33 00 – Substitutions.

2.02 MATERIALS
A. Sheet Steel: ASTM A570, Grade 50.
B. Studs: C-studs with punched web, unless otherwise noted, formed of gauge as specified on the Drawings.
   1. Provide ASTM A570, Grade 50 and 33 as noted, shop-coat with manufacturer's standard rust-inhibitive primer after fabrication.
   2. Minimum properties for each size stud shall be as indicated on Drawings.
C. Floor Tracks: Formed from same gauge and grade of steel as used for studs: 1-1/4-inch legs.
   1. Provide ASTM A653, Grade D, or shop-coat with rust-inhibitive primer after fabrication.
D. Ceiling Tracks: Formed from 16-gauge steel, 2-inch legs or as indicated on the Dwgs.
   1. Provide ASTM A653, Grade D, or shop-coat with rust-inhibitive primer after fabrication.

E. Partition Stiffeners or Bridging: Unpunched channel shape, formed of 16-gauge steel to required dimensions.

F. Power-Driven Fasteners: As indicated on the Drawings.

H. Expansion Bolts: As indicated on the Drawings.

I. Welding Electrodes: AWS low hydrogen, rod number and diameter as approved by the Owner’s Testing Agency.

J. Bracing: Provide cross diagonal 3-inch wide by 14-gauge straps, welded as indicated on the Drawings and per stud manufacturer’s specifications for frame stability.

K. Touch-up Primer for Galvanized Surfaces: SSPC Paint 20 zinc rich.

L. Metal Screws: As indicated on the Drawings.

M. Bracing, Furring, Bridging: Formed sheet steel, thickness determined for conditions encountered; finish to match framing components.

PART 3 - EXECUTION

3.01 PREPARATION

A. Coordinate details and requirements of other Work which adjoins or fastens to studs and requires backing or special support framing included in this Section.
   1. Items requiring backing or support include, but are not necessarily limited to casework, wall-specialties, and similar items.
   2. Obtain Architect’s approval of backing method proposed to satisfy requirements of this Section which differs from methods noted or shown.

3.02 EXAMINATION

A. Examine all parts of the supporting structure and the conditions under which studs will be installed.

B. Notify the Architect, in writing, of any conditions detrimental to the proper and timely completion of the Work.

C. Do not proceed with the installation of steel studs until unsatisfactory conditions have been corrected.

3.03 INSTALLATION

A. Tracks shall be securely anchored to supporting structure, with fasteners specified at not more than 24-inches on center.

B. Complete, uniform, and level bearing support shall be provided for the bottom track at each bearing-stud location. Install full metal shims below bottom track at stud locations as needed or set bottom track in high-strength grout.

C. Abutting or intersecting pieces of track shall be securely anchored to a common structural element or spliced together.
   1. Splices or butt welds shall be used at all butt joints in the runner track.
   2. Do not splice studs.
D. Framed wall openings shall include a header and multiple studs at each edge of opening as indicated on Drawings.
E. Diagonal bracing shall be installed at locations indicated for frame stability.
F. Install bridging as indicated on Drawings.
G. Form corners and intersections of partitions with three studs. Provide additional studs as indicated or required.
H. Connections of members shall be made with welding or sheet metal screws; wire tying of framing members shall not be permitted.
I. Wire tying of framing members shall not be permitted.
J. Welded connections shall be made by resistance spot fusion welding, fillet welding, or plug welding and shall be done in accordance with the latest recommended procedures and practices of the American Welding Society.
K. Do not cut or notch stud flanges or cut additional opening in stud web.
L. Field abrasions and welds shall be touched up with zinc rich primer.
M. Tolerance: Install members to provide surface plane with maximum variation of 1/8-inch in 10-feet in any direction. Space individual framing members no more than plus or minus 1/8-inch from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.
N. Provide all angles, clips and other miscellaneous pieces necessary to attach light gauge framing to building structure or to attach other materials to light gauge framing.

3.04 INSTALLATION OF FIRE-RATED ASSEMBLIES
A. Install studs which are components of fire-rated wall assemblies as indicated.

3.05 BACKING IN STUD PARTITIONS
A. Securely weld or screw cut sections of unpunched stud to at least three stud or furring supports, leaving flat surface of backing stud web to receive attachment of object to be secured.
B. Verify that any pre-drilling of backing and attachment of spacers to prevent crushing of collateral material is done prior to application of collateral material.
C. If it is determined by the Architect that backing was not provided for any items as required, the Contractor shall remove the finish material and install backing. The Contractor shall patch and refinish surface to match adjacent area and finish.

3.06 FIELD QUALITY CONTROL
A. The Owner's Testing Agency will:
   1. Provide continuous inspection of welding, including prior fit-up, welding equipment, weld quality, and welder certification in accordance with AWS and CBC Section 1701A.5.
   2. Provide continuous inspection during installation as required to establish conformity of Work requirements.

3.07 ERECTION TOLERANCES
A. Maximum Variation from True Position: ¼-inch.
B. Maximum Variation of any Member from Plane: ¼-inch.
END OF SECTION
SECTION 055150

LADDERS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Aluminum ship's ladders.

1.2 RELATED SECTIONS

A. Section 05500 – Metal Fabrications: Fasteners and installation requirements used to attach ladders to structure.

1.3 REFERENCES

A. AA – Aluminum Association.


D. OSHA 1910.27 – Fixed Ladders.

1.4 SUBMITTALS

A. Submit under provisions of Section 01300.

B. Product Data: Manufacturer's data sheets on each product.

C. Shop Drawings:

1. Detail fabrication and erection of each ladder indicated. Include plans, elevations, sections, and details of metal fabrications and their connections.

2. Provide templates for anchors and bolts specified for installation under other Sections.

3. Provide reaction loads for each hanger and bracket.

D. Qualification Data:

1. Refer to Quality Assurance provisions for submittal requirements evidencing
experience, certifications and resources.

E. Selection Samples: For each finish specified, two complete sets of color chips representing manufacturer's full range of available colors.

F. Verification Samples: For each finish specified, two samples, minimum size 6 inches (150 mm) square, represent actual product color.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: A firm experienced in producing aluminum metal ladders similar to those indicated for this Project.
   1. Record of successful in-service performance.
   2. Sufficient production capacity to produce required units.
   3. Professional engineering competent in design and structural analysis to fabricate ladders in compliance with industry standards and local codes.

B. Installer Qualifications: Competent and experienced firm capable of selecting fasteners and installing ladders to attain designed operational and structural performance.

C. Product Qualification: Product design shall comply with OSHA 1910.27 minimum standards for ladders.

D. Mock-Up: Provide a mock-up for evaluation of surface preparation techniques and application workmanship.
   1. Install ladder in area designated by Architect.
   2. Do not proceed with remaining work until workmanship and installation are approved by Architect.
   3. Rework mock-up as required to produce acceptable work.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store products in manufacturer's unopened packaging until ready for installation.

1.7 PROJECT CONDITIONS

A. Field Measurements: Verify dimensions by field measurement before fabrication.
   1. Established Dimensions: Where field measurements cannot be made without delaying the Work, indicate established dimensions on shop drawing submittal and proceed with fabrication.
1.8 WARRANTY

A. Manufacturer has responsibility for an extended Corrective Period for work of this Section for a period of 5 years commencing on the shipment date of the product against all the conditions indicated below, and when notified in writing from Owner, manufacturer shall promptly and without inconvenience and cost to Owner correct said deficiencies.

1. Defects in materials and workmanship.

2. Deterioration of material and surface performance below minimum OSHA standards as certified by independent third party testing laboratory. Ordinary wear and tear, unusual abuse or neglect excepted.

3. Within the warranty period, the manufacturer shall, at its option, repair, replace, or refund the purchase price of defective ladder.

B. Manufacturer shall be notified immediately of defective products, and be given a reasonable opportunity to inspect the goods prior to return. Manufacturer will not assume responsibility, or compensation, for unauthorized repairs or labor. Manufacturer makes no other warranty, expressed or implied, to the merchantability, fitness for a particular purpose, design, sale, installation, or use, of the ladder; and shall not be liable for incidental or consequential damages, losses of or expenses, resulting from the use of ladder products.

1.9 EXTRA MATERIALS

A. Furnish touchup kit for each type and color of paint finish provided.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturer: O’Keeffe’s, Inc.; 100 N Hill Drive, Suite 12, Brisbane, CA 94005. Toll Free Tel: (888) 653-3333. Tel: (415) 824-4900. Fax: (415) 824-5900. Email: info@okeeffes.com. Web: http://www.okeeffes.com.

B. Substitutions: Not permitted.

C. Requests for substitutions will be considered in accordance with provisions of Section 01600.

2.2 APPLICATIONS/SCOPE

A. Ship Ladder:

1. Ship Ladder with Platform and Return.

   a. Model 522 as manufactured by O’Keeffe’s Inc.

2. Incline:
2.3 FINISHES

A. Clear Anodic Finish: AA-M10C22A41 Mechanical finish as fabricated. Architectural Class I, clear coating 0.018 mm or thicker.

2.4 MATERIALS

A. Aluminum Sheet: Alloy 5005-H34 to comply with ASTM B209.

B. Aluminum Extrusions: Alloy 6063-T6 to comply with ASTM B221.

2.5 FABRICATION

A. Rungs: Not less than 1-1/4 inches (32 mm) in section and 18–3/8 inches (467mm) long, formed from tubular aluminum extrusions. Squared and deeply serrated on all sides.
   1. Rungs shall withstand a 1,500 pound (454 kg) load without deformation or failure.

B. Channel Side Rails: Not less than 1/8 inch (3 mm) wall thickness by 3 inches (76 mm) wide.

C. Heavy Duty Tubular Side Rails: Assembled from two interlocking aluminum extrusions no less than 1/8 inch (3 mm) wall thickness by 3 inches (76 mm) wide. Construction shall be self-locking stainless steel fasteners, full penetration TIG welds and clean, smooth and burr-free surfaces.

D. Ship Ladders: Not less than 1-1/4 inches (32mm) high, 4-1/8 inch (105 mm) deep and 2 feet (610 mm) wide; tread spacing shall be 1 foot (305 mm) on center. Handrails shall be aluminum pipe, not less than 1-1/2 inches (38 mm) in diameter with hemispheric end caps.

E. Walk-Through Rail and Roof Rail Extension: Not less than 3 feet 6 inches (1067 mm) above the landing and shall be fitted with deeply serrated, square, tubular grab rails.

F. Landing Platform: 1-1/2 inches (38 mm) or greater diameter, tubular aluminum guardrails and decks of serrated aluminum treads.

G. Ship Ladder Seismic Bottom Support: Manufacturer’s standard; two isolation bearings per stringer.

PART 3 EXECUTION

3.1 EXAMINATION

A. Coordinate anchorages. Furnish setting drawings, templates, and anchorage structural loads for fastener resistance.
B. Do not begin installation until supporting structure is complete and ladder installation will not interfere with supporting structure work.

C. If supporting structure is the responsibility of another installer, notify Architect of unsatisfactory supporting work before proceeding.

3.2 INSTALLATION

A. Install in accordance with manufacturer’s instructions and in proper relationship with adjacent construction.

3.3 PROTECTION

A. Protect installed products until completion of project.

B. Touch-up, repair or replace damaged products before Substantial Completion.

END OF SECTION
SECTION 06 10 00
ROUGH CARPENTRY

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Roof nailers and curbs.
B. Blocking in wall and roof openings.
C. Wood furring and grounds at roof and exterior walls.
D. Fire retardant treatment of wood.
E. Telephone and electrical panel boards.
F. Miscellaneous blocking referenced in drawings.

1.02 RELATED SECTIONS

A. Section 09111 - Non-Loadbearing Metal Framing: For sheet metal backing inside building.

1.03 REFERENCES

C. AWPA C20 - Structural Lumber -- Fire Retardant Treatment by Pressure Processes; American Wood-Preservers’ Association; 2002.
D. AWPA C27 - Plywood -- Fire-Retardant Treatment by Pressure Processes; American Wood-Preservers’ Association; 2002.
F. PS 1 - Construction and Industrial Plywood; National Institute of Standards and Technology (Department of Commerce); 1995.
G. PS 20 - American Softwood Lumber Standard; National Institute of Standards and Technology (Department of Commerce); 2005.
H. RIS (GR) - Standard Specifications for Grades of California Redwood Lumber; Redwood Inspection Service; 2000.
I. SPIB (GR) - Grading Rules; Southern Pine Inspection Bureau, Inc.; 2002.
J. WCLB (GR) - Standard Grading Rules for West Coast Lumber No. 17; West Coast Lumber Inspection Bureau; 2004.
K. WWPA G-5 - Western Lumber Grading Rules; Western Wood Products Association; 2005.

1.04 SUBMITTALS

A. See Section 01330 - Submittals, for submittal procedures.
B. Product Data: Provide technical data on wood preservative materials.
1.05 QUALITY ASSURANCE
   A. Lumber: Comply with PS 20 and approved grading rules and inspection agencies.
      1. Acceptable Lumber Inspection Agencies: RIS, SPIB, WCLB, and WWPA.
   B. Plywood: Comply with PS 1.

PART 2 PRODUCTS
2.01 GENERAL REQUIREMENTS
   A. Lumber fabricated from old growth timber is not permitted.

2.02 DIMENSION LUMBER
   A. Grading Agency: Western Wood Products Association (WWPA).
   B. Sizes: Nominal sizes as indicated on drawings, S4S.
   C. Moisture Content: S-dry or MC19.
   D. Miscellaneous Blocking, Furring, and Nailers:
      1. Lumber: S4S, No. 2 or Standard Grade.
      2. Boards: Standard or No. 3.

2.03 FACTORY WOOD TREATMENT
   A. Treated Lumber and Plywood: Comply with requirements of AWPA U1 - Use Category System
      for wood treatments determined by use categories, expected service conditions, and specific
      applications.
   B. Fire Retardant Treatment, Exterior Type: AWPA Use Category UCFB, Commodity Specification
      H (Treatment C20 for lumber and C27 for plywood), chemically treated and pressure
      impregnated, maximum flame spread rating of 25 when tested in accordance with ASTM E 84
      and with no evidence of significant combustion when test is extended for an additional 20
      minutes both before and after accelerated weathering test performed in accordance with ASTM
      D 2898; kiln dried after treatment to maximum moisture content of 19 percent for lumber and 15
      percent for plywood.
      1. Basis of Design: Product: Exterior Fire-X manufactured by Hoover Treated Wood
   C. Fire Retardant Treatment, Interior Type A: AWPA Use Category UCFB, Commodity
      Specification H (Treatment C20 for lumber and C27 for plywood), low temperature (low
      hygroscopic) type, chemically treated and pressure impregnated, maximum flame spread rating
      of 25 when tested in accordance with ASTM E 84 and with no evidence of significant
      combustion when test is extended for an additional 20 minutes; kiln dried after treatment to
      maximum moisture content of 19 percent for lumber and 15 percent for plywood.
      1. Basis of Design: Product: Pyro-Guard manufactured by Hoover Treated Wood Products,

PART 3 EXECUTION
3.01 FRAMING INSTALLATION
   A. Set members level and plumb, in correct position.
   B. Place horizontal members with crown side up.
C. Construct curb members of single pieces.
D. Space framing and furring members 16 inches o.c.
E. Curb roof openings except where prefabricated curbs are provided. Form corners by alternating lapping side members.
F. Coordinate curb installation with installation of decking and support of deck openings.
G. Provide miscellaneous members as indicated or as required to support finishes, fixtures, specialty items, and trim.

3.02 INSTALLATION OF CONSTRUCTION PANELS

A. Install telephone and electrical panel back boards made of plywood or other acceptable structural panels at locations indicated. Size back boards to be minimum 96 inches beyond size of telephone and electrical panels.

3.03 SCHEDULES

A. Roof Blocking: S/P/F species, 19 percent maximum moisture content, pressure preservative treatment.
B. Telephone and Electrical Panel Boards: 1/4 inch thick, plywood or particleboard, fire retardant treated.
C. Data Room: 3/4 inch thick x 4'-0" x 8'-0" fire retardant treated.
   1. Install over gypsum board partitions.
   2. Install plywood panels from 6 inches AFF to 8'-6" AFF on walls indicated on drawings. Plywood to run continuously from left to right on each wall.

END OF SECTION
SECTION 06 16 43

GYPSUM SHEATHING

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Fiberglass-mat faced, moisture and mold resistant gypsum sheathing.

B. Related Sections:
   1. Section 05 40 00 Cold-Formed Metal Framing
   2. Section 09 23 00 Gypsum Board.

1.02 REFERENCES

A. ASTM International (ASTM):
   3. ASTM C1002 Standard Specification for Steel Self-Piercing Tapping Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs.
      10. ASTM C1396 Standard Specification for Gypsum Board


1.03 SUBMITTALS

A. Product Data: Manufacturer’s specifications and installation instructions for each product specified.

1.04 WARRANTY

A. Provide products that offer twelve months of coverage against in-place exposure damage (delamination, deterioration and decay) commencing with the date of installation of the product in such structure.
B. Manufacturer’s Warranty:
1. Five years against manufacturing defects from the date of purchase of the product for installation
2. 12 years against manufacturing defects when used as a substrate in architecturally specified EIFS.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Georgia-Pacific Gypsum LLC:
2. Fiberglass-Mat Faced Gypsum Sheathing, Type X for Fire Rated Designs: DensGlass Fireguard Sheathing.

2.02 MATERIALS

A. Fiberglass-Mat Faced Gypsum Sheathing: ASTM C1177:
1. Thickness: 5/8 inch.
2. Width: 4 feet.
3. Length: [8 feet] [9 feet] [10 feet].
4. Weight: 1.9 lb/sq. ft.
5. Edges: Square.
6. Surfacing: Fiberglass mat on face, back, and long edges.
7. Racking Strength (Ultimate, not design value) (ASTM E72): Not less than 540 pounds per square foot, dry.
11. R-Value (ASTM C518): 0.56.
14. Acceptable Products:
   a. 5/8 inch and 1/2 inch DensGlass Sheathing, Georgia-Pacific Gypsum LLC.

B. Fire-Rated Fiberglass-Mat Faced Gypsum Sheathing: ASTM C1177, Type X:
1. Thickness: 5/8 inch.
2. Width: 4 feet.
3. Length: [8 feet] [9 feet] [10 feet].
4. Weight: 2.5 lb/sq. ft.
5. Edges: Square.
6. Surfacing: Fiberglass mat on face, back, and long edges.
7. Racking Strength (Ultimate, not design value) (ASTM E72): Not less than 654 pounds per square foot, dry.
14. Acceptable Products:
   a. 5/8 inch and 1/2 inch DensGlass Fireguard Sheathing, Georgia-Pacific Gypsum LLC.

2.03 ACCESSORIES
   A. Screws: ASTM C1002, corrosion resistant treated.

PART 3 EXECUTION

3.01 EXAMINATION
   A. Verification of Conditions:
      1. Inspection: Verify that project conditions and substrates are acceptable, to the installer, to begin installation of work of this section.

3.02 INSTALLATION
   A. General: In accordance with GA-253, ASTM C1280 and the manufacturer’s recommendations.
      1. Manufacturer’s Recommendations:

3.03 PROTECTION
   A. Protect gypsum board installations from damage and deterioration until date of Substantial Completion.

END OF SECTION
SECTION 07 21 00

THERMAL INSULATION

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Thermal insulation at exterior walls and roof.
B. Concealed acoustical insulation at interior partitions where indicated.
C. Semi-rigid mineral wool insulation board, at spandrel glass.
C. Miscellaneous accessories

1.02 RELATED REQUIREMENTS
A. Section 05 40 00 – Cold-Formed Metal Framing: Board insulation as wall sheathing.
B. Section 09 22 26 – Ceiling and soffit suspensions systems.

1.03 REFERENCE STANDARDS

1.04 SUBMITTALS
A. See Section 01 33 00 - Submittals, for submittal procedures.
B. Product Data: Provide data on product characteristics, performance criteria, and product limitations.
C. Manufacturer’s Installation Instructions: Include information on special environmental conditions required for installation and installation techniques.
D. Manufacturer’s Certificate: Certify that products meet or exceed specified requirements.
E. Samples: Provide two 12 by 16 inch samples of acoustical insulation representing actual product, color, and patterns.

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

1.06 SEQUENCING
A. Sequence work to ensure fireproofing and firestop materials are in place before beginning work of this section.
PART 2 PRODUCTS

2.01 APPLICATIONS

A. R19 thermal insulation for exterior metal framed walls.
B. R30 thermal insulation for roof deck.
C. Acoustical sound attenuation insulation.
D. Semi-rigid insulation board.

2.02 BATT INSULATION MATERIALS

A. Thermal Insulation - Exterior metal framed walls.
   1. Foil faced mineral fiber blanket insulation: Friction fir, thermal insulation combining mineral fibers manufactured from glass with thermosetting resins to comply with ASTM C665, type III, Class B, having thermal resistance rating of R-19 when tested in accordance with ASTM C518, width to fit stud space.

B. Thermal Insulation - Roof
   1. Foil Faced Mineral Fiber Blanker Insulation: Friction fit, thermal insulation combining mineral fiber manufactured from glass with thermosetting resins to comply with ASTM C665, Type III, Class B, having thermal resistance rating of R-30 when tested in accordance with ASTM C518, width to fit stud space.

C. Acoustical Sound Attenuation Insulation.
   1. Unfaced, friction-fit, fiberglass batts, 3-1/2 inches, 5-1/2 inches thick and 9 inches thick as indicated, conforming to ASTM C665, Type I, ASTM EE119, and UL listed for 1 hour fire rating and having the following fire resistive requirements when tested in accordance with ASTM E84:
      a. Flame Spread: 25 or less.
      b. Smoke Developed: 450 or less.

2.03 SEMI-RIGID INSULATION MATERIALS

A. Non-combustible, semi-rigid mineral wool insulation board, meets ASTM C 612,:
   1. Faced; Thickness: As noted on contract documents. size to fit in (E) window frames, R-Value: 4.0 per inch. Black Mat Facing density: 3.5 pcf.
   2. Manufacturer: Thermafiber VersaBoard 35, or equal.
2.04 ACCESSORIES
   A. Tape: Bright aluminum self-adhering type, mesh reinforced, 2 inch wide.
   B. Weathermate flashing for seams in rigid board insulation.
   C. Wire Mesh: Galvanized steel, hexagonal wire mesh.
   D. Adhesive: Type recommended by insulation manufacturer for application.
   E. Hangers: Thermafiber impasse vertical, horizontal hangers and locking washers.

PART 3 EXECUTION

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

3.02 THERMAL BATT INSTALLATION
   A. Install insulation in accordance with manufacturer's instructions.
   B. Install in exterior wall spaces without gaps or voids. Do not compress insulation.
   C. Trim insulation neatly to fit spaces. Insulate miscellaneous gaps and voids.
   D. Fit insulation tightly in cavities and tightly to exterior side of mechanical and electrical services within the plane of the insulation.
   E. Retain insulation batts in place with wire mesh secured to framing members.

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

   END OF SECTION
SECTION 07 41 00
METAL WALL PANELS

PART 1 GENERAL
1.01 SECTION INCLUDES
A. Manufactured metal panels for exterior walls with related flashings, and accessory components.

1.02 RELATED REQUIREMENTS
A. Section 05400 - Cold-Formed Metal Framing: Wall panel substrate.
B. Section 07273 - Air Barrier: Air barrier under wall panels.
C. Section 07620 - Sheet Metal Flashing and Trim.
D. Section 07900 - Joint Sealers.

1.03 REFERENCE STANDARDS
B. ASTM A 792

1.04 SUBMITTALS FOR REVIEW
A. See Section 01330 Submittals, for submittal procedures.
B. Shop Drawings: Indicate dimensions, layout, construction details, methods of anchorage, and flashing:
   1. Indicate dimensions, layout, joints, construction details, methods of anchorage, and flashing.
   2. Include metal thickness and finishes, panel lengths, joining details, anchorage details, flashings and special fabrication provisions for termination and penetrations.
   3. Indicate relationships with adjacent and interfacing work.
   4. Indicate fastener types and spacing; and provide fastener pullout values. Shop drawings must be completed by the wall panel manufacturer's engineering department.
C. Product Data: Include manufacturer's detailed material and system description, concealed anchor clips, sealant and closure installation instructions, and finish specifications. Indicate fastener types and spacing; and required fastener pullout values.
D. Samples: Provide full-size samples of the following materials and system components. Samples shall be of identical material type, thickness, panel width, and material grade/alloy as the system specified for this project.
   1. Submit sample of panel section, at least 12 inches long x full panel width showing panel profile and also a sample of color selected.
   2. Submit sample of foam closure strips to fit inside and outside specified panel profile.
   3. Submit sample of panel fasteners.

1.05 QUALITY ASSURANCE
A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum ten (10) years of documented experience.
B. Installer Qualifications: Company specializing in performing the work of this section with minimum five (5) years of experience.
C. Source Limitations: Obtain all components of the wall panel system from a single manufacturer. Secondary products that are required shall be recommended and approved in writing by the Manufacturer.

1.06 DELIVERY, STORAGE, AND HANDLING
A. Protect panels from accelerated weathering by removing or venting sheet plastic shipping wrap.
B. Store prefinished material off ground and protected from weather. Prevent twisting, bending, or abrasion, and provide ventilation to stored materials. Slope metal sheets to ensure drainage.

1.07 WARRANTY
A. See Section 01740 - Warranties and Guarantees for additional warranty requirements.
B. See Section 01770 - Contract Closeout Procedures, for additional warranty requirements.
C. Provide a finish warranty for a thirty (20) year period starting at Substantial Completion for degradation of panel finish for fluoropolymer finish, including color fading caused by exposure to weather.
D. Provide a finish warranty for a ten (20) year period after Substantial Completion for degradation of panel finish for Granitestone finish.
E. Correct defective Work within a twenty (20) year period after Substantial Completion, including defects in water tightness and integrity of seals.
F. Installer's two (2) year warranty covering wall panel system installation.
G. Warranties shall commence on date of Substantial Completion.

PART 2 PRODUCTS

2.01 MANUFACTURERS
A. Basis of Design(to match existing): Centria Architectural Systems, "FormaBond Metal Composite Wall Systems", Alucobond; Reynobond; Alpolic, or approved equal.
B. Other Acceptable Manufacturers with matching profile:

2.02 MANUFACTURED METAL PANELS
A. Type C - Aluminum Sheets
   1. Base Metal: Metal panels shall be fabricated from 2 sheets of 0.032inch thick aluminum with thermo set, polymeric core, formed by Reaction Injection Molding process, with no glues or adhesive between dissimilar materials. 8mm total sheet thickness
      a. Extrusion material shall be 6063, T-5 aluminum. Minimum thickness shall be 1/6 inch for trim pieces and 3/32 inch for structural units.
      b. Materials used in the manufacture of the aluminum composite metal shall be made in the USA and aluminum face and liner shall be manufactured form 80 percent recycled aluminum.
   2. Integrated Panels:
B. Subgirts:
   1. 16 gage thick formed steel sheet.
   2. Exterior applications: Hot-dipped galvanized.
   3. Interior applications: shop-primed.
   4. Profile as indicated; to attach panel system to building.

C. Internal and External Corners: Same material, thickness, and finish as exterior sheets; flat profile to suit system; shop cut and factory mitered to required angles.

D. Trim: Same material, thickness and finish as exterior sheets; brake formed or extruded to provide required profiles.

E. Extruded Aluminum Trim, manufacturer's standard, as indicated on Drawings.

F. Anchors: Stainless steel.

2.03 MATERIALS

A. Precoated Steel Sheet: Galvalume 40 ksi pre-finished steel per ASTM A 792; continuous coil-coated on exposed surfaces with specified finish coating and on panel back with specified panel back coating.

B. Panel Finishes:
   1. Fluoropon Finishes (Face)
      a. Three coat coil-applied baked-on full-strength (70% resin) fluorocarbon coating system (polyvinylidene fluoride, PVDF), applied by manufacturer's approved applicator.
      b. Coating system shall provide nominal 1.5 mil dry film thickness, consisting of primer, color coat and top coat.
   2. Granitestate Coating:
      a. Prepare galvalume steel coil in accordance with manufacturers recommendations to properly bond factory coating systems.
      b. Apply manufacturer's roll-coated chemically resistant primer to the exposed side of the galvalume steel and dry to a minimum of 0.20 to 0.25 mil.
      c. Apply manufacturers factory applied finish coat of air dried 100% acrylic binder with natural silica aggregate, minimum 12 mils dry film thickness, finish to resemble sprayed stucco.
      d. Color of the exterior finish: As indicated on drawings.
      e. Durability: Provide coating that has been tested under normal range of weathering conditions for a minimum of 10 years without significant peel, blister, flake, chip, crack, or check in finish

2.04 ACCESSORIES

A. Gaskets: Manufacturer's standard type suitable for use with system, permanently resilient;
ultraviolet and ozone resistant.

B. Sealants: Specified in Section 07900. Manufacturer’s standard type suitable for use with installation of system; non-staining; color as selected.

C. Fasteners: Manufacturer’s standard type to suit application; with soft neoprene washers, stainless steel. Fastener cap same color as exterior panel.

D. Field Touch-up Paint: As recommended by panel manufacturer.

2.05 FABRICATION

A. Panels shall be factory roll-formed from the specified metal. Field rolled panels will not be allowed.

B. All fabrication shall be in accordance with Metal Construction Association “Preformed Metal Wall Panel Guidelines”.

C. Form sections true to shape, accurate in size, square, and free from distortion or defects.

D. Panel shall have interlocking seams which conceal fasteners.

E. Panel Depth (Concealed Leg Height): 2 11/16".

F. Form pieces in longest practicable lengths.

G. Fabricate corners in one continuous piece with minimum 18 inch returns.

PART 3 EXECUTION

3.01 PREPARATION

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

3.02 INSTALLATION

A. Install panels on walls in accordance with manufacturer’s instructions.

B. Isolate dissimilar metals and concrete from metals with bituminous coating or layer of neoprene as indicated on Drawings. Use gasketed fasteners where required to prevent corrosive action between fastener, substrate, and panels.

C. Fasten panels to structural supports; aligned, level, and plumb.

D. Locate joints over supports. Lap panel ends minimum 2 inches.

E. Seal and place gaskets to prevent weather penetration. Maintain neat appearance.

3.03 TOLERANCES

A. Maximum Offset From True Alignment Between Adjacent Members Butting or In Line: 1/16 inch.

B. Maximum Variation from Plane or Location Indicated on Drawings: 1/4 inch.

3.04 CLEANING

A. Remove site cuttings from finish surfaces.

B. Clean and wash prefinished surfaces with mild soap and water; rinse with clean water.
C. Remove and properly dispose of waste products generated during construction. Comply with requirements of authorities having jurisdiction.

END OF SECTION
SECTION 07 51 11
BUILT-UP ASPHALT ROOFING

PART 1 GENERAL

1.01 SUMMARY
A. Section Includes
   1. Built-up asphalt roofing system.
   2. Roof insulation.
   3. Roof surfacing consisting of mineral granulated cap sheet.
B. General provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
C. Related Sections
   1. Section 06100 – Rough Carpentry: For wood nailers, cants, curbs, and blocking.
   2. Section 07620 – Sheet Metal Flashing and Trim: For metal roof penetration flashings, flashings, and metal flashings, counterflashing, coping covered under the warranties and service agreement specified in this section.

1.02 DEFINITIONS
A. Roofing Terminology: Refer to ASTM D1079 and glossary of NRCA’s “The NRCA Roofing and Waterproofing Manual” for definition of terms related to roofing work in this Section.
B. Hot Roofing Asphalt: Roofing asphalt heated to its equi-viscous temperature, the temperature at which its viscosity is 125 centipoise for mopping application and 75 centipoise for mechanical application, within a range of plus or minus 25 degrees Fahrenheit, measured at the mop cart or mechanical spreader immediately before application.

1.03 PERFORMANCE REQUIREMENTS
A. FMG Listing: Provide roofing membrane, base flashings, and component materials that comply with requirements in FMG 4450 and FMG 4470 as part of a roofing system and that are listed in FMG’s “Approval Guide” for Class 1 or noncombustible construction, as applicable. Identify materials with FMG markings.
   1. Fire/Windstorm Classification: Class 1A-90.
B. General: Provide installed roofing membrane and base flashings that remain watertight; do not permit the passage of water; and resist specified uplift pressures, thermally induced movement, and exposure to weather without failure.
C. Material Compatibility: Provide roofing materials that are compatible with one another under conditions of service and application required, as demonstrated by roofing manufacturer based on testing and field experience.
D. Roofing Membrane Load-Strain Properties
   1. Provide a roofing membrane identical to component systems that have been successfully tested by a qualified independent testing and inspecting agency to meet the following minimum load-strain properties at membrane failure when testing according to ASTM D2523:
a. Tensile strain at failure 432 lbf machine direction; 383 lbf cross-machine direction.

E. Flashings: Comply with requirements of the Drawings, detail flashings and component materials that comply with requirements and recommendations of Section 07620, Sheet Metal Flashing and Trim. Provide base flashings and perimeter flashings of the following:
1. FMG 1-49 Loss Prevention Data Sheet for Perimeter Flashings.
2. FMG 1-29 Loss Prevention Data Sheet for Above Deck Roof Components.
3. NRCA Roofing and Waterproofing Manual (Fifth Edition) for construction details and recommendations.

1.04 SUBMITTALS

A. Samples for Verification: For the following products:
   1. 12 inch by 12 inch square of base sheet, and ply sheet.
   2. 12 inch by 12 inch square of mineral-granule-surfaced cap sheet, of color specified.
   3. 12 inch by 12 inch square of roof insulation.
   4. 12 inch by 12 inch square of walkway pad.
   5. 12 inch by 12 inch square of flashing material.

B. Installer Certificates: Signed by roofing system manufacturer certifying that installer is approved, authorized, or licensed by manufacturer to install roofing system.

C. Manufacturer Certificates: Signed by roofing manufacturer certifying that roofing system complies with requirements specified in "Performance Requirements" Article.

D. Submit evidence of meeting performance requirements, including FMG listing.

E. Maintenance Data and Training Materials: For roofing system to include in maintenance manuals and District's training library.

F. Inspection Report: Copy of roofing system manufacturer's inspection report of completed roofing installation.

1.05 QUALITY ASSURANCE

A. Qualifications
   1. Installer: A qualified firm that is approved, authorized, or licensed by roofing system manufacturer to install manufacturer's product and that is eligible to receive manufacturer's warranty.
   2. Manufacturer: A qualified manufacturer that has FMG approval for roofing system identical to that used for this Project.
   3. Technical Inspector: Engage an experienced technical inspector to perform Work of this Section who has specialized in inspecting roofing similar to that required for this Project; who is employed by the roofing system manufacturer to inspect manufacturer's project. If the manufacturer does not employ full-time technical inspectors, approved inspector must be certified as a Registered Roof Observer by the Roof Consultants Institute.

B. Source Limitations: Obtain components for roofing system from or approved by roofing system manufacturer.

C. Fire-Test-Response Characteristics: Provide roofing materials with the fire-test-response characteristics indicated as determined by testing identical products per test method below by
UL, FMG, or another testing and inspecting agency acceptable to authorities having jurisdiction. Materials shall be identified with appropriate markings of applicable testing and inspecting agency.

1. Fire-Resistance Ratings: ASTM E119, for fire-resistance rated roof assemblies of which roofing system is a part.

D. Preliminary Roofing Conference: Before starting roof deck construction, conduct conference at Project site. Comply with requirements for pre-installation conferences in Division 1 Section “Project Management and Coordination.” Review methods and procedures related to roof deck construction and roofing system including, but not limited to, the following:

1. Meet with the District, Architect, District’s insurer if applicable, testing and inspecting agency representative, roofing Installer, roofing system manufacturer’s representative, deck Installer, and installers whose work interfaces with or affects roofing including installers of roof accessories and roof-mounted equipment.
2. Review methods and procedures related to roofing installation, including manufacturer’s written instruction.
3. Review and finalize construction schedule and verify availability of materials, Installer’s personnel, equipment, and facilities needed to make progress and avoid delays.
4. Examine deck substrate conditions and finishes for compliance with requirements, including flatness and fastening.
5. Review structural loading limitations of roof deck during and after roofing.
6. Review base flashings, special roofing details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that will affect roofing system.
7. Review governing regulations and requirements for insurance and certificates if applicable.
8. Review temporary protection requirements for roofing system during and after installation.
9. Review roof observation and repair procedures after roofing installation.

E. Pre-installation Conference: Conduct conference at Project site. Comply with requirements in Division 1, Section “Project Management and Coordination.” Review methods and procedures related to roofing system including, but not limited to, the following:

1. Meet with the District, Architect, District’s insurer if applicable, testing, and inspecting agency representative, roofing Installer, roofing system manufacturer’s representative, deck Installer, and installers whose work interfaces with or affects roofing including installers of roof accessories and roof-mounted equipment.
2. Review methods and procedures related to roofing installation, including manufacturer’s written instructions.
3. Review and finalize construction schedule and verify availability of materials, Installer’s personnel, equipment, and facilities needed to make progress and avoid delays.
4. Examine deck substrate conditions and finishes for compliance with requirements, including flatness and fastening.
5. Review structural loading limitations of roof deck during and after roofing.
6. Review base flashings, special roofing details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that will affect roofing system.
7. Review governing regulations and requirements for insurance and certificates if applicable.
8. Review temporary protection requirements for roofing system during and after installation.
9. Review roof observation and repair procedures after roofing installation.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver roofing materials to Project site in original containers with seals unbroken and labeled with manufacturer’s name, product brand name and type, date of manufacture, and directions for storage.
B. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by roofing system manufacturer. Protect stored liquid material from direct sunlight.
   1. Discard and legally dispose of liquid material that cannot be applied within its stated shelf life.

C. Protect roof insulation materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources. Store in a dry location. Comply with insulation manufacturer’s written instructions for handling, storing, and protecting during installation.

D. Handle and store roofing materials and place equipment in a manner to avoid permanent deflection of deck.

1.07 PROJECT CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit roofing system to be installed according to manufacturer’s written instructions and warranty requirements.

1.08 WARRANTY

A. Special Warranty: Manufacturer’s standard form, without monetary limitation, in which manufacturer agrees to repair or replace components of roofing system that fail in materials or workmanship within specified warranty period. Failure includes roof leaks.
   1. Special warranty includes roofing membrane, base flashings, roofing membrane accessories roof insulation, walkway products and other components of roofing system.
   2. Special Roofing Warranty: Manufacturer must provide a comprehensive warranty that covers both the Built-Up Roof system specified in Section 07511 and the Single Ply CSPE specified in Section 07532; and is in compliance with all other warranty requirements.
   3. Warranty Period: 15 years from date of Substantial Completion.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Basis of Design Product: Product requirements in this Section are based upon Tremco, Inc. products named in other Part 2 articles. Subject to compliance with requirements, provide the named product or an approved comparable system.

B. Manufacturers: Subject to compliance with requirements, provide products by 1 of the following:
   1. Built-up Asphalt Roofing:
      a. Tremco, Inc.
      c. Or Architect approved equal.

2.02 BASE-SHEET MATERIALS

A. Base Sheet: ASTM D4601, Type II, Asphalt-coated polyester/glass fiber/polyester laminated ply sheet, complying with ASTM D4601, with the following minimum properties:
   1. Burmastic Composite Ply
      a. Weight: 3.1 lb/sq. ft
      b. Breaking Strength: 135 lb/in MD
      c. Tear Strength: 345 lbf MD

BUILT-UP ASPHALT ROOFING
075111-4
2.03 ROOFING MEMBRANE PLYS

A. Ply Sheet: ASTM D2178, Type VI, asphalt-impregnated, glass-fiber felt.

B. Cap Sheet: ASTM D6163, SBS Modified asphalt-impregnated, glass-fiber cap sheet, with white coarse mineral-granule top surfacing and fine mineral surfacing on bottom surface, with the following minimum properties:
   1. PowerPoly Standard FR
      a. Breaking Strength: 120 lb/in MD  ASTM D 6163

2.04 FLASHING MATERIALS

A. Flashing Membrane: Hypalon – Reinforced CSPE, 0.045-inches thick complying with ASTM D5019.

B. Cold Applied Flashing Adhesive: Roofing system manufacturer's standard 1 part asbestos free, cold-applied adhesive specially formulated for compatibility and use with CSPE reinforced flashing membrane.

C. Stripping Ply: ASTM D4601, Type II, Asphalt-coated polyester/glass fiber/polyester laminated ply sheet, complying with ASTM D4601, with the following minimum properties:
   1. Burmastic Composite Ply
      a. Weight: 3.1 lb/sq. ft  ASTM D228
      b. Breaking Strength: 135 lb/in MD  ASTM D146
      c. Tear Strength: 345 lbf MD  ASTM D146

2.05 ASPHALT MATERIALS

A. Asphalt Primer: ASTM D41.
   1. TremPrime WB.

B. Roofing Asphalt: ASTM D312, Type III.
   1. Premium Type III Asphalt.

2.06 AUXILIARY ROOFING MEMBRANE MATERIALS

A. General: Auxiliary materials recommended by roofing system manufacturer for intended use and compatible with built-up roofing.

B. Mastic Sealant: Polyisobutylene, plain or modified bitumen, non-hardening, non-migrating, non-skinning, and non-drying.

C. Metal Flashing Sheet: Metal flashing sheet is specified in Section 07620, Sheet Metal Flashing and Trim.

D. Miscellaneous Accessories: Provide miscellaneous accessories recommended by roofing system manufacturer.

2.07 ROOF INSULATION

A. General: Provide preformed roof insulation boards that comply with requirements and referenced standards, selected from manufacturer's standard sizes and of thicknesses indicated.

B. Cellulosic-Fiber Board Insulation: ASTM C208, Type II, Grade 1, fibrous-felted wood fiber or other cellulosic-fiber and water-resistant binders, asphalt impregnated, chemically treated for deterioration (minimum ¾-inch).
   1. Available Manufacturers:
b. Georgia-Pacific Corporation.
c. Temple – Inland Inc.

C. Provide performed saddles, crickets, tapered edge strips, and other insulation shapes where indicated for sloping to drain. Fabricate to slopes indicated.

2.08 INSULATION ACCESSORIES

A. General: Roof insulation accessories recommended by insulation manufacturer for intended use and compatible with membrane roofing.

B. Insulation Cant Strips: ASTM C208, Type II, Grade 1, cellulosic-fiber insulation board.

C. Wood Nailer Strips: Comply with requirements in Section 06100, Rough Carpentry.

2.09 WALKWAYS

A. Walkway pads: Mineral-granule-surfaced, reinforced asphaltic composition, slip-resisting pads, manufactured as a traffic pad for foot traffic and acceptable to roofing system manufacturer, ½-inch thick, minimum.

1. Pad Size: 36 inches by 48 inches.

2.10 PRECAST CONCRETE ROOF PAVERS

A. Heavyweight Roof Pavers: Heavyweight, hydraulically pressed, concrete units, square edged, factory cast for use as roof pavers; absorption not greater than 5 percent, ASTM C140; no breakage and maximum 1 percent mass loss when tested for freeze-thaw resistance, ASTM C67; and as follows:

1. Size: 24 inches by 24 inches by 2 inches thick. Manufacture pavers dimensional tolerances of plus or minus 1/16-inch in length, height, and thickness.
2. Weight: 18 lb/sq. ft.
3. Compressive Strength: 7500 psi, minimum.
5. Paver Supports: Paver manufacturer’s standard SBR rubber, high-density polyethylene, or polyurethane paver support assembly, including shims, and spacer tabs for joint spacing of 3/16-inch.

PART 3 EXECUTION

3.01 EXAMINATION

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

1. Verify that roof openings and penetrations are in place and set and braced and that roof drains are securely clamped in place.
2. Verify that wood cants, blocking, curbs, and nailers are securely anchored to roof deck at penetrations and terminations.
3. Verify that concrete curing compounds that will impair adhesion of roofing components to roof deck have been removed.
4. Verify that concrete substrate is visibly dry and free of moisture. Test for capillary moisture by plastic sheet method according to ASTM D4263.
5. Proceed with installation only after unsatisfactory conditions have been corrected.

BUILT-UP ASPHALT ROOFING

075111-6
3.02 PREPARATION

A. Clean substrate of dust, debris, moisture, and other substances detrimental to roofing installation according to roofing system manufacturer's written instructions. Remove sharp projections.

B. Prevent materials from entering and clogging roof drains and conductors and from spilling or migrating onto surfaces of other construction. Remove roof-drain plugs when no work is taking place or when rain is forecast.

C. Prime surface of concrete deck with asphalt primer at a rate of 3/4 gal./100 sq. ft. and allow primer to dry.

3.03 INSULATION INSTALLATION

A. Coordinate installing roofing system components so insulation is not exposed to precipitation or left exposed at the end of the workday.

B. Comply with roofing system manufacturer's written instructions for installing roof insulation.

C. Insulation Cant Strips: Install and secure preformed 45-degree insulation cant strips at junctures of built-up roofing membrane system with vertical surfaces or angle changes greater than 45 degrees.

D. Install insulation with long joints of insulation in a continuous straight line with end joints staggered between rows, abutting edges and ends between boards. Fill gaps exceeding 1/4-inch with insulation.
   1. Cut and fit insulation within 1/4-inch of nailers, projections, and penetrations.

E. Trim surface of insulation where necessary at roof drains so completed surface is flush and does not restrict flow of water.

F. Install tapered edge strips at perimeter edges of roof that do not terminate at vertical surfaces.

G. Adhered Insulation: Install each layer of insulation and adhere to substrate as follows:
   1. Set insulation in hot asphalt per manufacturers written instructions.
   2. Adhere insulation according to requirements in FMG's "Approval Guide" for specified Windstorm Resistance Classification.

3.04 ROOF MEMBRANE INSTALLATION, GENERAL

A. Install built-up roofing membrane system according to roofing system manufacturer's written instructions and applicable recommendations of ARMA/NRCA's "Quality Control Guidelines for the Application of Built-up Roofing."

B. Start installation of built-up roofing membrane in presence of roofing system manufacturer's technical personnel.

C. Cooperate with testing and inspecting agencies engaged or required to perform services for installing built-up roofing system.

D. Coordinate installing roofing system components so insulation and roofing membrane sheets are not exposed to precipitation or left exposed at the end of the workday or when rain is forecast.
   1. Provide tie-offs at end of each day's work to cover exposed roofing membrane sheets and insulation with a course of coated felt set in roofing cement or hot roofing asphalt with joints and edges sealed.
   2. Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of roofing system.
   3. Remove and discard temporary seals before beginning work on adjoining roofing.
E. Asphalt Heating: Heat roofing asphalt and apply within plus or minus 25 deg F of equiviscous temperature unless otherwise required by roofing system manufacturer. Do not raise roofing asphalt temperature above equiviscous temperature range more than one hour before time of application. Do not exceed roofing asphalt manufacturer’s recommended temperature limits during roofing asphalt heating. Do not heat roofing asphalt within 25 degrees Fahrenheit of flash point. Discard roofing asphalt maintained at a temperature exceeding finished blowing temperature for more than 4 hours.

3.05 ROOFING MEMBRANE INSTALLATION

A. Install 1 lapped course of base sheet, extending sheet over and terminating beyond cants. Attach base sheet as follows:
   1. Adhere to substrate in a solid mopping of hot roofing asphalt.

B. Install 2 ply sheets starting at low point of roofing system. Align ply sheets without stretching. Shingle side laps of ply sheets uniformly to achieve required number of plies throughout thickness of roofing membrane. Shingle in direction to shed water. Extend ply sheets over and terminate beyond cants.
   1. Embed each ply sheet in a solid mopping of hot roofing asphalt applied at rate required by roofing system manufacturer, to form a uniform membrane without ply sheets touching.

C. Surfacing Application
   1. Prior to application of surfacing, contractor shall inspect roof with manufacturer’s technical representative and repair any deficiencies.

D. Cap Sheet: Install lapped granulated cap sheet starting at low point of roofing system. Offset laps from laps of preceding ply sheets and align cap sheet without stretching. Lap in direction to shed water. Extend cap sheet over and terminate beyond cants.
   1. Embed cap sheet in a solid mopping of hot roofing asphalt applied at rate required by roofing system manufacturer.

E. Roof-pavers: Install roof pavers on pedestals set according to pedestal manufacturer’s written instructions.

3.06 FLASHING AND STRIPPING INSTALLATION

A. Install base flashing over cant strips and other sloping and vertical surfaces, at roof edges, and at penetrations through roof, and secure to substrates according to roofing system manufacturer’s written instructions and as follows:
   1. Flashing Sheet Application: Adhere flashing sheet to substrate in flashing adhesive, apply adhesive at rate required by roofing system manufacturer.

B. Extend base flashing up walls or parapets a minimum of 8 inches above roofing membrane and 4 inches onto field of roofing membrane.

C. Mechanically fasten top of base flashing securely at terminations and perimeter of roofing.

D. Install stripping, according to roofing system manufacturer’s written instructions, where metal flanges and edgings are set on built-up roofing.
   1. Flashing-Sheet Stripping: Install flashing-sheet stripping in a continuous coating of asphalt roofing cement or in a solid mopping of hot roofing asphalt applied at not less than 425 deg F, and extend onto roofing membranes.
E. Roof Drains: Set 30-by-30 inch metal flashing in bed of asphalt roofing cement on completed roofing membrane. Cover metal flashing with stripping and extend a minimum of 4 inches beyond edge of metal flashing onto field of roofing membrane. Clamp roofing membrane, metal flashing, and stripping into roof-drain clamping ring. Install stripping of not less than two roofing membrane ply sheets, each set in a continuous coating of asphalt roofing cement or in a solid mopping of hot roofing asphalt.

3.07 WALKWAY INSTALLATION

A. Walkway Pads: Install walkway pads using units of size indicated or, if not indicated, of manufacturer's standard size according to walkway pad manufacturer's written instructions.
   1. Sweep away loose aggregate surfacing and set walkway pads in additional flood coat of hot roofing asphalt.

3.08 FIELD QUALITY CONTROL

A. Technical Representative: Contractor will engage a qualified technical representative, as defined under Quality Assurance in this section, for a minimum of 5 days to perform roof tests and inspections and to prepare test reports.

B. Final Roof Inspection: Arrange for roofing system manufacturer's technical personnel to inspect roofing installation on completion and submit report to Architect.
   1. Notify Architect or District 48 hours in advance of date and time of inspection.

C. Repair or remove and replace components of roofing system where test results or inspections indicate that they do not comply with specified requirements.

D. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.09 PROTECTING AND CLEANING

A. Protect roofing system from damage and wear during remainder of construction period. When remaining construction will not affect or endanger roofing, inspect roofing for deterioration and damage, describing its nature and extent in a written report, with copies to Architect and Owner.

B. Clean all deficiencies in or remove roofing system that does not comply with requirements, repair substrates, and repair or reinstall roofing system to a condition free of damage and deterioration at time of Substantial Completion and according to warranty requirements.

C. Clean overspray and spillage from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION
SECTION 07 52 20

RE-ROOFING

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Roof tear-off.
B. Roof re-covers preparation.
C. Removal of base flashings.
D. Protection of existing roofing system that is not re-roofed.
E. Close coordination with removal of existing lightweight insulating concrete fill, dust removal and installation of Cold Fluid Applied Protected Membrane Roofing.

1.02 RELATED WORK

A. Section 07 52 00 - Modified Bituminous Membrane Roofing

1.03 ADMINISTRATIVE REQUIREMENTS

A. Preliminary Re-roofing Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Management and Coordination." Review methods and procedures related to roofing system including, but not limited to, the following:
1. Meet with Architect, Owner’s Representative, and roofing system manufacturers’ representatives; roofing system installers for Modified Bituminous Membrane Roofing, including project manager, superintendent, and foreman; and installers whose work interfaces with or affects re-roofing, including lightweight insulating concrete remover and installers of roof accessories and roof-mounted equipment; and Technical Inspector.
   a. Technical Inspector: see Section 07555 for technical inspector requirements.
2. Review methods and procedures related to re-roofing preparation, including membrane roofing system manufacturer's written instructions.
3. Review roof drainage during each stage of re-roofing and review roof drain plugging and plug removal procedures.
4. Review and finalize construction schedule, and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
5. Review procedures to determine condition and acceptance of existing deck and base flashing substrate for reuse.
6. Review structural loading limitations of deck during re-roofing.
7. Review base flashings, special roofing details, drainage, penetrations, equipment curbs, and condition of other construction that will affect re-roofing.
8. Review HVAC shutdown and sealing of air intakes.
9. Review governing regulations and requirements for insurance and certificates if applicable.
10. Review existing conditions that may require notification of Owner before proceeding.

1.04 MATERIALS OWNERSHIP

A. Except for items or materials indicated to be reused, reinstalled, or otherwise indicated to remain Owner's property, demolished materials shall become Contractor's property and shall be removed from Project site.

1.05 DEFINITIONS

A. Roofing Terminology: Refer to ASTM D 1079 and glossary in NRCA's "The NRCA Roofing and
Waterproofing Manual" for definition of terms related to roofing work in this Section.

B. Existing Membrane Roofing System: Built-up asphalt roofing membrane, surfacing, and components and accessories between deck and roofing membrane.

C. Roof Re-Cover Preparation: Existing roofing membrane that is to remain and be prepared for reuse.

D. Roof Tear-Off: Removal of existing membrane roofing system from existing lightweight insulating concrete fill over structural concrete deck.

E. Remove: Detach items from existing construction and legally dispose of them off-site unless indicated to be removed and reinstalled.

F. Existing to Remain: Existing items of construction that are not indicated to be removed.

1.06 PROJECT CONDITIONS

A. Owner will occupy portions of building immediately below re-roofing area. Conduct re-roofing so Owner's operations will not be disrupted. Provide Owner with not less than 72 hours notice of activities that may affect Owner's operations.

1. Coordinate work activities daily with Owner so Owner can place protective dust or water leakage covers over sensitive equipment or furnishings, shut down HVAC and fire-alarm or -detection equipment if needed, and evacuate occupants from below the work area if desired.

2. See Section 01416 Special Procedures for scheduling work off-hours for noise-generating, dust-generating and volatile products application fume-generating work.
   a. Protect building to be re-roofed, adjacent buildings, walkways, site improvements, exterior plantings, and landscaping from damage or soiling from re-roofing operations.
   b. Maintain access to existing walkways, corridors, and other adjacent occupied or used facilities.
   c. Owner assumes no responsibility for condition of areas to be re-roofed.

1) Conditions existing at time of inspection for bidding will be maintained by Owner as far as practical.

PART 2 - PRODUCTS

2.01 AUXILIARY REROOFING MATERIALS

A. General: Auxiliary re-roofing preparation materials recommended by roofing system manufacturer for intended use and compatible with components of existing and new membrane roofing system.

PART 3 - EXECUTION

3.01 PREPARATION

A. Protect existing membrane roofing system that is indicated not to be re-roofed.

1. Limit traffic and material storage to areas of existing roofing membrane that have been protected.

2. Maintain temporary protection and leave in place until replacement roofing has been completed.
   a. Coordinate with Owner to shut down air intake equipment in the vicinity of the Work. Cover air intake louvers before proceeding with re-roofing work that could affect indoor air quality or activate smoke detectors in the ductwork.
   b. During removal operations, have sufficient and suitable materials on-site to facilitate rapid installation of temporary protection in the event of unexpected rain. Re-roofing of
all areas must be carefully coordinated with removal of existing lightweight insulating concrete fill, dust removal and installation of Cold Fluid Applied Protected Membrane Roofing. See provisions in related specification sections.

c. Maintain roof drains in functioning condition to ensure roof drainage at end of each workday. Prevent debris from entering or blocking roof drains and conductors. Use roof-drain plugs specifically designed for this purpose. Remove roof-drain plugs at end of each workday, when no work is taking place, or when rain is forecast.

d. Verify that rooftop utilities and service piping have been shut off before commencing Work.

3.02 ROOF TEAR-OFF

A. Hazardous Materials Removal and Lead Disturbance Requirements as detailed shall be adhered to, for any hazardous materials or lead disturbance that occurs during roof tear-off.

B. General: Notify Owner each day of extent of roof tear-off proposed.

C. Roof Tear-Off: Remove existing roofing membrane and other membrane roofing system components down to the deck.
   1. Remove fasteners from deck.
   2. Coordinate with Owner’s inspector to schedule times for tests and inspections immediately after membrane removal.

3.03 DECK PREPARATION

A. See additional substrate requirements detailed in Sections 07555 and 07556.

B. Inspect deck after partial tear-off of membrane roofing system.

C. Where smooth deck surface is required by roofing membrane manufacturer for roofing membrane installation, the Contractor shall schedule the manufacturer’s representative to inspect the substrate. Installation of roofing board or membrane may not proceed until removal of lightweight insulating concrete fill and installation of Cold Fluid Applied Protected Membrane Roofing is approved with written acceptance of the substrate condition.

3.04 EXISTING BASE FLASHINGS

A. Remove existing base flashings around parapets, curbs, walls, and penetrations.
   1. Clean substrates of contaminants such as asphalt, sheet materials, dirt, and debris.

3.05 DISPOSAL

A. Collect and place demolished materials in containers. Promptly dispose of demolished materials. Do not allow demolished materials to accumulate on-site.
   1. Storage or sale of demolished items or materials on-site will not be permitted.
      a. Transport demolished materials off Owner’s property and legally dispose of them.
SECTION 07 62 00

FLASHINGS AND SHEET METAL WORK

PART 1 - GENERAL

SUMMARY

A. Section includes flashings and sheet metal items shown or required to make the building weathertight and not specified in other Sections.

B. Related requirements:
   1. Division 07 for re-roofing preparation, for new roofing, and for movement joint assembly at roof.
   2. Division 09 for finish painting flashings and sheet metal work.
   3. Division 23 for mechanical sheet metal work, and flashings and collars for mechanical and electrical work, except as specified herein for roof drains.

ADMINISTRATIVE REQUIREMENTS

C. Pre-installation meeting:
   1. Prior to start of installation, arrange a pre-installation meeting between the Contractor, the installer, and the Architect to review areas where flashings will be installed, as well as other conditions that would affect the quality of this work, the Drawings and Specifications.
   2. If more than one trade will be responsible for the successful performance of the work of this Section, these trades shall attend the meeting.
   3. Review all typical and atypical details to verify the fabrication and installation methods that the Contractor will follow, as well as corrective actions that are required.
   4. Special conditions not specifically referenced or addressed by the Project Drawings, manufacturer's typical details, or the Shop Drawings, shall also be identified, reviewed and discussed.
   5. Take photographs and notes of unresolved conditions, if any, along with sketches of the same unresolved conditions so that a determination can be made of actions to be taken to assure an installation that will be visually acceptable to the Architect, and watertight.
   6. Record meeting minutes and distribute copy to all concerned, and the Architect, within 7 days after the meeting.

SUBMITTALS

D. Product Data: Manufacturer product specifications, installation instructions and general recommendations for installation of prefabricated assemblies.

E. Shop drawings:
   1. Show typical and atypical details, material weight, methods of joining and attachment, and relationship with adjacent materials and supports of all sheet metal assemblies.
   2. Detail interface with adjacent materials. For interface between flashings with different profiles and conditions difficult to illustrate in 2-dimension, furnish isometric drawings.

QUALITY ASSURANCE

FLASHINGS AND SHEET METAL WORK
07 62 00 - 1
F. Design criteria and performance requirements: Fabricate and install the work of this Section to withstand wind loads, structural movement, thermally induced movement, and exposure to weather without failing, rattling, leaking, excessive oil-canning, and fastener disengagement.

1. Thermal movements:
   a. Provide sheet metal flashing and trim that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, hole elongation, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects.
   b. Provide clips that resist rotation and avoid shear stress as a result of sheet metal and trim thermal movements.
   c. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
   d. Temperature change (range) of 120 degrees F ambient; 180 degrees F, material surfaces.

2. Water infiltration: Provide sheet metalwork and flashings that do not allow water infiltration to building interior, and to damage materials, such as insulation, in exterior walls.

HANDLING

G. Do not store sheet metal flashing and trim materials in contact with other materials that might cause staining, denting, or other surface damage. Store sheet metal flashing and trim materials away from uncured cementitious materials.

H. Protect strippable protective covering on sheet metal flashing and trim from exposure to sunlight and high humidity, except to the extent necessary for the period of sheet metal flashing and trim installation.

PART 2 - PRODUCTS

MATERIALS

A. Sheet steel: Commercial quality carbon steel sheets complying with ASTM A 653, lock-forming grade, galvanized with a G90 zinc coating, 24-gage (0.025 inch) minimum unless otherwise indicated.

B. Sheet lead for roof drains: 4 lb./square-foot, ASTM B 29 desilverized pig lead.

C. Nails:

1. For attaching sheet steel to wood: Large flat head "stronghold" type roofing nails with barbed point, formed of hot-dip galvanized steel of sufficient length to penetrate a minimum of one-inch into the wood nailer.

2. For attaching sheet steel to concrete: 1-1/4-inch by 8d hot-dip galvanized hardened steel nails with lead washers.

D. Screws: Hot dip galvanized self-tapping screws, self-locking rivets and bolts, and other suitable fasteners designed to withstand design loads.

E. Fasteners for flashing and trim: Blind fasteners or self-drilling screws, gasketed with hex washer head.

F. Cleats:
1. Provide cleats for sheet metal 18 inches and over in width. Space cleats evenly not over 12 inches o.c.
2. Make cleats not less than 2 inches wide by 3 inches long, and of the same material and thickness as the sheet metal being installed.

G. Solder and flux:
2. Lead: ASTM B 32, Grade Sn50, 50 percent tin and 50 percent lead.
3. Copper: ASTM B 32, Grade Sn50, 50 percent tin and 50 percent lead.
4. Lead-coated copper: ASTM B 32, Grade Sn60, 60 percent tin and 40 percent lead.
5. Stainless steel: ASTM B 32, Grade Sn60, with an acid flux of type recommended by stainless-steel sheet manufacturer.

H. Sealing tape:
1. Pressure-sensitive, 100 percent solids, polyisobutylene compound sealing tape with release-paper backing.
2. Provide permanently elastic, nonsag, non-toxic, non-staining tape.

I. Expansion-joint sealant: For hooked-type expansion joints, which must be free to move, provide non-setting, non-hardening, non-migrating, heavy-bodied polyisobutylene sealant.

J. Bituminous coating:
1. Cold-applied asphalt mastic, SSPC-Paint 12, compounded for 15-mil dry film thickness per coat.
2. Provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.

K. Insect screens: 14 by 18 mesh, 0.063-inch diameter aluminum wire crimped screen material.

L. Slip sheet: Building paper, minimum 5 lb./100 square feet, rosin-sized.


FLEXIBLE FLASHING

N. Flexible flashing, general: Flexible flashing materials shall be installed under, or interface with sheet metal, or used in high temperature environments (temperatures in excess of 225 degrees F.), shall be rated by the flexible flashing manufacturer as "high temperature resistant", and be suitable for their intended use and application. Flexible flashing materials shall be protected from UV exposure and shall not be allowed to remain uncovered in excess of the material manufacturer's published exposure limits.

2. For use on exterior walls, where neither metal flashing or control joists, air and water barrier, or high-temperature flashings occur:
   a. VYCOR V40 by WR Grace & Co.
   b. Window and Door Flashing by Carlisle Coatings & Waterproofing.
   c. Fast Flash by Protecto Wrap Co.
d. Sealight Air-Shield by WR Meadows, Inc.
e. Seam Seal Tape by SafSeal Innovations.
f. TW Moisture Wrap by Tamko Waterproofing.

3. For use under copings and other sheet metal assemblies: Self-adhering (peel and stick) flexible high-temperature resistant, waterproofing flashings by one of the following, and shall include primers, sealants and mastics, liquid membrane and accessories required for complete systems.
   b. PW 100/40 HT by Protecto Wrap Co.
   c. WIP 300HT by Carlisle Coatings & Waterproofing.

4. For use for underlayment under metal wall panel assemblies: Self-adhering (peel and stick) flexible high-temperature resistant, waterproofing flashings by one of the following, and shall include primers, sealants and mastics, liquid membrane and accessories required for complete systems
   a. Manufactured by W.R. Grace Ultra, or approved equal.

PREFABRICATED ASSEMBLIES

O. Counterflushing assemblies: Formed of 24-gage galvanized sheet steel, of the profiles shown on the Drawings, complete with factory-formed internal and external corners, and end closures by one of the following.
   1. Basis of design is for Fry Reglet Corp. Type ST (stucco), CO (concrete), SM (surface mounted).
   2. CF Cheney Flashing Co.
   4. MM Systems Corp.

P. Strainer units for conductor heads: Removable beehive design fabricated from 0.062-inch diameter galvanized steel wire or wire mesh with openings not more than 1/2-inch.

Q. Prefabricated expansion gutter joints: "Expansion Joint" by Wilco, or "T-Pren Expansion Joint" by Matthew Hebden.

R. Sheet metal curbs:
   1. Of the sizes and profiles indicated, by Thybar Corp., Pate Co. or Custom Curb, Inc., with an 18-gage galvanized steel shell and base plate fully welded, factory installed insulation, and continuous wood nailer.
   2. Reinforce curb as required to safely support the equipment thereon.

FABRICATION

S. General:
   2. Form sheet metal on bending brake with straight, sharp edges. Shape, trim, and hand seam sheet metal on bench; keep job site forming to a minimum.
3. Comply with metal producers' recommendations for tinning, soldering, and cleaning flux from metal.
4. Fabricate with joints and corners accurately machined, filed and fitted, and rigidly framed together and connected.

T. Fabricate in as long length as possible to minimize field joints.
U. Prefabricate intersections, including counterflashings, with mitered, riveted joints. Make corners and intersections with legs a minimum of 24-inch long extending in each direction.
V. Tinning and soldering:
   1. Tin edges on both sides of sheet steel to be soldered.
   2. Perform soldering slowly, thoroughly heating seams and completely sweating solder through full width of seams.

W. Exposed edges: Neatly double back sheet metal 1/2-inch to stiffen edges and to provide a finished appearance.
X. Provisions for attachment to structure: Furnish supports, hangers, bracing, anchors and other devices shown, specified or necessary for reinforcement and proper attachment of flashings and sheet metal to building.

**FINISHING**

Y. Exposed surfaces:
   1. Preparation: Remove fabrication burrs, oil, grease and other deleterious materials before priming. Prepare galvanized surfaces for paint bond.
   2. Primer: Spray primer evenly over the surfaces in compliance with the paint manufacturer's instructions to provide a uniform dry film a minimum of one mil thick. Oven dry.
   3. Finish coat:
      a. Spray finish paint evenly over the prime coat in compliance with the paint manufacturer's printed instructions to produce a uniform dry film a minimum of 2 mils thick. Oven dry.
      b. The finish coat shall be smooth and even, free of runs, sags, orange peel, holidays and other imperfections.
      c. Color: to match Centria paint coor "Valspar coating #9989, Platinum.
      d. Touchup: Touchup damaged finish on prefinished items when the results are satisfactory to the Architect, otherwise return the damaged component to the shop for refinishing.

**PART 3 - EXECUTION**

**EXAMINATION**

A. Examine conditions and measurements affecting the work of this Section at site.
B. Correct detrimental conditions before proceeding with installation.

**GENERAL REQUIREMENTS**

C. In addition to the assemblies listed above, provide required sheet metal flashings, counterflashings, transitional and interface flashings required to achieve a properly weatherproofed, flashed and counterflashed building envelope, including sheet metal.
flashings in the angles formed where exterior waterproofed decks abut walls, and as well at curbs, platforms, ventilators, pipes, roof hatches, and other vertical and horizontal surfaces, where indicated and necessary to make the Work weatherproof.

D. Comply with manufacturer’s installation instructions where applicable, and applicable SMACNA and NRCA details, except as indicated and specified.

E. Install counterflashing assemblies at a constant height above the roof.

1. Anchor counterflashing securely into reglet by friction, or provide lead wedges spaced 2-foot o.c. maximum.
2. Use manufacturer standard splice plates and preformed corners for a weathertight assembly.

F. Coordinate this work with other trades whose work penetrates, intersects and adjoins flashings and sheet metal work, to permit the correct sequencing and the watertightness of the assemblies.

PART 4 - INSTALLATION

G. General:

1. Install sheet metal work in accordance with the approved Shop Drawings.
2. Fasten coping on inside wall with hex head screws and bonded sealing washers through oversized holes in the back of the coping. Except as specified, lap and solder corners and angles; lapping and sealant method is not an acceptable substitute for coping corners; provide for thermal movement no more than 10 feet from corner.
3. Slope copings and sills with a minimum slope of 10 percent to drain away form walls and building interior. Slope gutters 1/4-inch per foot to drain.
4. Solder joints of window flashings (pans) and saddles.
5. Attach work securely to supporting construction, plumb, level, with tight, flush joints allowing for thermal movements.
6. Install work with lines, arises, and angles sharp and true.
7. Fold exposed edges neatly to form a 1/2-inch hem on the concealed side; hem all exposed edges, unless otherwise indicated.
8. Assemble work so that face of metal in contact has hairline joints, except where required for expansion or fitting. Provide back-up plates at joints.
9. Conceal fastenings and reinforcement where they would be visible by the public and the building occupants.
10. Vulcanize joints of the roof expansion joint covers and lap the sheet metal portion, after sealing for water tightness.
11. Finish work shall be straight, smooth and continuous, without dimples, dents and other damage.

H. Soldering:

1. Protect underlying waterproof membrane (flexible flashing) when soldering sheet metal.
2. Except as specified, solder all joints not intended for expansion and contraction.
3. Clean material and tin prior to soldering.
4. Solder slowly. Heat the seams thoroughly, and completely fill with solder.
5. Make exposed soldering on finish surfaces neatly, full flowing and smooth.
6. Wash acid flux with a soda solution after soldering and remove soldering flux on exposed surfaces.
I. Nailing:

1. Confine nailing of sheet metal generally to sheet metal having a maximum width of 18-inches. Nailing of flashings shall be confined to one edge only.
2. Space nails evenly not over 12 inches o.c., and approximately 2 inches from the edge.
3. Face nailing is not permitted. Do not nail sheet metal assemblies on horizontal surfaces.
4. Where sheet metal is applied to surfaces other than wood, furnish detailed Shop Drawings showing locations of required sleepers and nailing strips specified in Division 06.

J. Cleats: Secure one end of the cleat with 2 nails and the cleat folded back over the nail heads. Lock the other end into the seam. Pre-tin cleats for soldered seams.

K. Bolts, rivets, and screws:

1. Install bolts, rivets, and screws where required. Space equally and symmetrically.
2. Provide compatible washers to protect surface of sheet metal and to provide a watertight connection.

L. Dissimilar material protection:

1. Protect sheet metal in contact with dissimilar metals, concrete, masonry and plaster with a heavy coating of bituminous paint, approved separation tape, or building felt or paper.
2. Set sheet metal assemblies supported by pressure-treated wood on building paper or felt attached to the wood nailer, except set copings on flexible flashing specified. Lap on vertical surfaces at least 2 inches.

M. Seams - general: Make seams straight, uniform in width and height, with no solder showing on the face.

1. Flat-lock seams: Finish not less than 3/4-inch wide made in the direction of water flow.
2. Lap seams: Finish soldered seams not less than one-inch wide. Overlap seams not soldered at least 3-inches.
3. Loose-lock expansion seams: No less than 3 inches wide, designed to provide minimum one-inch movement within the joint. Fill joint completely with sealant applied at not less than 1/8 inch thick bed.
4. Standing seams: Not less than one-inch high, double locked without solder.

N. Expansion and contraction:

1. Provide for thermal and building movement without over-stressing the material, breaking connections or producing wrinkles and distortion in finished surfaces. Make sheet metal installations weathertight at all locations.
2. Provide expansion and contraction joints at not more than 40-foot intervals, except that where the distance between the last expansion joint and the end of the continuous run is more than half the required interval spacing, provide an additional joint. Where expansion and contraction joints are exposed to view, their location is subject to the Architect’s approval.
3. Exposed surfaces shall be free from visible wave, warp, and buckle.
O. Miscellaneous:

1. Flexible flashing: Install under all parapet caps. Lap joints 2-inches. Carry flexible flashing down wall as far as the edge of the coping; overlap wall weather barrier at least 2-inches.
2. Curbs and vents: Install curbs and vents level and square with tight, waterproof joints; attach securely to deck.
3. Insect screens: 14 by 18 mesh, 0.063-inch diameter aluminum wire crimped screen material.

P. Completed work: Completed flashings and sheet metal work shall be watertight, free of tool marks, dents, scratches and other damages, with joints and corners accurately machined, filed and fitted, and rigidly framed together and connected.

Q. Coatings:

1. Prime coat: Universal baked primer.
2. Finish coat: Acrylic baking enamel of the color and gloss selected by the Architect.

R. Clean the damaged area, sand smooth, reclean and prime and paint to match and be invisible from adjacent surfaces, as approved by the Architect. Replace assemblies damaged beyond satisfactory field repair, as determined by the Architect, with satisfactory items.

S. Patching existing sheet metal:

T. Provide new sheet metal work of the same profiles and dimensions as the existing work.

U. Lap existing sheet metal, seal to make watertight and provide positive mechanical attachment between new and existing work.

V. Extruded aluminum copings:

W. Custom extrusions formed to the profiles and dimensions indicated in the longest possible length.

X. Make curved sections of uniform profile without causing grain separation.

Y. Miter and weld corners with adjacent joints a minimum of 2 feet from the corner. Make all joints with concealed splice plates.

Z. Fabricate so that when assembled the fasteners will be concealed from public spaces.

**SCHEDULE**

Fabricate sheet metal items in thickness or weight needed to comply with performance requirements but not less than that listed below for each application and metal.

1. Exposed trim and fascia: Galvanized steel, 0.0276 inch thick (24 gauge).
2. Base Flashing: Galvanized steel, 0.0276-inch thick (26 gauge).
3. Counterflashing: Galvanized steel, 0.0217-inch thick (26 gauge).
4. Flashing Receivers: Galvanized steel, 0.0217-inch thick (26 gauge).
5. Drip Edges: Galvanized, 0.0217-inch thick (26 gauge).
6. Equipment Support Flashing: Galvanized steel, 0.0276-inch thick (24 gauge).
7. Roof Penetration Flashing: Galvanized steel, 0.0276-inch thick (24 gauge).

**END OF SECTION**
SECTION 07 84 00

PENETRATION FIRESTOP SYSTEMS AND SEALANTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:

1. Protection of penetrations through fire-resistive construction, including both empty openings and the annular space of openings containing cables, pipes, ducts, conduits, and other penetrating items.
2. Penetrations through smoke barriers and construction enclosing compartmentalized areas involving both empty openings and openings containing penetrating items.
3. Joint sealants used in fire-resistive construction.

B. Related requirements:

1. Divisions 07 and 09 for sprayed fireproofing and for all other sealants.
2. Division 08 for firesafing insulation.

1.2 ADMINISTRATIVE REQUIREMENTS

A. Pre-installation meeting:

1. Prior to start of installation, arrange a pre-installation meeting between the manufacturer or manufacturers authorized representatives of the firestopping materials, the Contractor, the installer, and the Architect to review conditions of surfaces to be firestopped, as well as other conditions that would affect the quality of this work, the Drawings and Specifications, and the firestopping manufacturer’s data.
2. If more than one trade will be responsible for the successful performance of the work of this Section, these trades shall attend the meeting.
3. Review all typical and atypical details to verify the method(s) of installation that the Contractor will follow, as well as corrective actions that are required.
4. Identify, review and discuss special conditions not specifically referenced or addressed by the Project Drawings, manufacturer’s typical details, or the Shop Drawings.
5. Take photographs and notes of unresolved conditions, if any, along with sketches of the same unresolved conditions so that a determination can be made of actions to be taken to assure an installation that will be acceptable to the material manufacturers and Authorities Having Jurisdiction.
6. Record meeting minutes and distribute copy to all concerned, and the Architect, within 7 days after the meeting.

1.3 DEFINITIONS

A. Fire-resistive construction: Construction designed and tested to resist, for a prescribed period of time, the passage of fire specifically at occupancy separations, area separations, shafts, exit enclosures, smoke barriers, corridor construction and other construction assemblies as prescribed by Code.
B. F-rating: Time period the firestop system limits the passage of fire through the penetration when tested as prescribed by Code.

C. T-rating: Time period the firestop system, including the penetrating item, limits the maximum temperature rise to 325 degrees F above its initial temperature through the penetration on the non-fire side, when tested as prescribed by Code.

1.4 SUBMITTALS

A. Data: Manufacturer Product Data and installation instructions for materials and prefabricated devices.

B. Shop Drawings: Large scale Shop Drawings indicating materials, installation methods, and interfaces with adjoining construction for each penetration firestop system.

1. Include qualified testing and inspecting agency's penetration firestop design designation evidencing compliance with requirements for each condition indicated.

2. Include qualified testing and inspecting agency's applicable illustrations showing each penetration firestop configuration at every construction assembly penetrated for each type of penetrating item.

3. Where Project conditions require modification of qualified testing and inspecting agency's tested assembly to suit a particular penetration firestop condition, obtain acceptance of authorities having jurisdiction (AHJ) for the modification prior to submitting Shop Drawings.

C. Test reports: Certified laboratory test report demonstrating the material or combination of materials proposed for use meets the requirements specified in ASTM E 814, are so classified in UL Building Materials Directory and are approved by the authorities having jurisdiction.

D. Certificates:

1. Product certificates signed by firestopping product manufacturers certifying their products comply with specified requirements.

2. Manufacturer's certificates stating that the installer has been trained by the manufacturer in installation of the proposed materials.

1.5 QUALITY ASSURANCE

A. Uniformity: Obtain firestopping materials and components from a single manufacturer for each kind of penetration and construction condition indicated. When not possible, provide materials acceptable or recommended by the primary firestopping manufacturer for the condition of use.

B. Compatibility: Provide firestop systems compatible with one another and with the assemblies into which they are installed under conditions of application and service as demonstrated by their manufacturer and based on testing and field experience.

C. Installer qualifications: Firm and individuals authorized and trained by the firestopping material manufacturer with a minimum of 3 consecutive years experience in the installation of specified products and firestop systems on projects similar in material, design, complexity and extent to this Project, and whose work has resulted in applications with a record of successful in-service performance.

D. Regulatory requirements: Materials proposed for use shall be approved by the AHJ for their intended use.

1.6 HANDLING
A. Store materials in a manner to prevent deterioration or damage.
B. Do not install damaged and contaminated materials.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. General: Provide penetration firestop systems manufactured and installed to resist the spread of flame and the passage of smoke and other gases in compliance with CBC and the following:

1. F-rated penetration firestop systems: Provide penetration firestop systems with an F rating, determined in compliance with ASTM E 814 or UL 1479, equaling or exceeding the fire-resistance rating of the fire-resistive wall construction penetrated, but not less than one hour with a minimum positive pressure of 0.01 inch of water (CBC section 712).

2. T-rated penetration firestop systems: Provide penetration firestop systems with a T rating, in addition to an F rating determined in compliance with ASTM E 814, where systems protect items penetrating fire-resistive floor construction that will be exposed to contact with adjacent materials in occupied floor areas. T-rated assemblies are required where the following conditions exist.
   a. Where firestop systems protect floor penetrations located outside of wall cavities.
   b. Where firestop systems protect floor penetrations located outside fire-resistant shaft enclosures.
   c. Where firestop systems protect penetrations located in fire-resistive construction containing doors required to have a temperature-rise rating.
   d. Where firestop systems protect penetrating items larger than a 4-inch diameter nominal pipe or 16 square inches in overall cross-sectional area.

3. Fire-resistive joint sealants: Provide joint sealants with a fire-resistance rating, determined in compliance with ASTM E 119, equaling or exceeding the fire-resistance rating of the construction penetrated, but not less than one hour.

B. Firestopping exposed to view, traffic, moisture, or physical damage: Provide products that will not deteriorate when exposed to these conditions.

1. For plumbing and wet-pipe sprinkler system piping penetrations provide moisture-resistant penetration firestop systems.

2. For floor penetrations with annular spaces exceeding 4 inches or more in any dimension, and for penetrations exposed to possible loading and traffic: Provide penetration firestop system capable of supporting the floor load involved without damage to the firestop system.

3. For penetrations with insulated piping: Provide penetration firestop systems not requiring removal of piping insulation.

C. Firestopping exposed to view: Provide products with a flame-spread rating of than 25 or less and a smoke-developed value of 450 or less, as determined in compliance with ASTM E 84.
2.2 MANUFACTURERS

A. Provide materials from one or a combination of the following, as selected by the manufacturer, depending on the condition of use:

1. Grace Construction Products.
2. 3M Fire Protection Products.
3. Hilti Construction Chemicals, Inc.
4. Specified Technologies, Inc.
5. Tremco Inc.

2.3 MATERIALS

A. Ceramic-fiber and mastic coating: Ceramic fibers in bulk form formulated for use with mastic coating, and ceramic fiber manufacturer's mastic coating.

B. Ceramic-fiber sealant: Single-component formulation of ceramic fibers and inorganic binders.

C. Endothermic, latex compound sealant: Single-component, endothermic, latex formulation.

D. Intumescent, latex sealant: Single-component, intumescent, latex formulation.

E. Intumescent putty: Non-hardening, dielectric, water-resistant putty containing no solvents, inorganic fibers, or silicone compounds.

F. Intumescent wrap strips: Single-component, elastomeric sheet with aluminum foil on one side.

G. Job-mixed vinyl compound: Prepackaged vinyl-based powder product for mixing with water at the Project site to produce a paintable compound, passing ASTM E 136, with flame-spread and smoke-developed ratings of zero per ASTM E 84.

H. Mortar: Prepackaged dry mix composed of a blend of inorganic binders, fillers, and lightweight aggregate formulated for mixing with water at the Project site to form a non-shrinking, homogenous mortar.

I. Pillows/bags: Re-usable, heat-expanding pillows/bags composed of glass-fiber cloth cases filled with a combination of mineral-fiber, water-insoluble expansion agents and fire-retardant additives.

J. Silicone foam: 2-component, silicone-based liquid elastomer that, when mixed, expands and cures in place to produce a flexible, non-shrinking foam.

K. Silicone sealant: Moisture-curing, single-component, silicone-based, neutral-curing elastomeric sealant.

L. Solvent-release-curing intumescent sealant: Solvent release curing, single-component, synthetic polymer based sealant.

M. Color: Where firestopping/firesafing material is exposed to view, provide material color selected by the Architect from the manufacturer's palette, unless the material will be field painted.

2.4 ACCESSORIES

A. Provide accessories as required to install fill materials and complying with the system description above.

1. General: As specified by the firestopping manufacturer and approved by the qualified testing and inspecting agency for the designated fire-resistive assembly.

2. Permanent forming/damming/backing materials:
a. Semi-refractory fiber (mineral wool) insulation.
b. Ceramic fiber.
c. Sealants used in combination with other forming/damming materials to prevent leakage of fill materials in liquid state.
d. Fire-rated form board.
e. Joint fillers for joint sealants.

3. Temporary forming materials:
   a. Substrate primers.
   b. Collars.
   c. Steel sleeves.

2.5 MIXING

A. For products that require field mixing prior to application, comply with firestopping manufacturer's directions.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions under which penetration firestop systems will be installed.
B. Verify surfaces to be in contact with firestopping materials are clean of dirt, grease, oil, loose materials, rust, and other substances that may affect proper fitting or the required fire resistance.
C. Correct detrimental conditions before proceeding with installation.

3.2 INSTALLATION

A. General: Install materials in conformance with their manufacturer's instructions and to comply with UL Fire Resistance Directory.
B. Surface cleaning: Clean openings and joints immediately prior to installing firestopping in accordance with the recommendations of firestopping manufacturer and the following:
   1. Remove foreign materials from surfaces of opening and joint substrates and from penetrating items that could interfere with adhesion of firestopping materials.
   2. Clean opening and joint substrates and penetrating items to produce clean, sound surfaces capable of developing optimum bond with firestopping. Remove loose particles remaining from cleaning operation.
   3. Remove laitance and form release agents from concrete.
C. Priming: Prime substrates where recommended by the firestopping manufacturer using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.
D. Masking tape:
   1. Use masking tape to prevent firestopping from contacting adjoining surfaces that will remain exposed and that would otherwise be permanently stained or damaged by
such contact or by cleaning methods used to remove smears from firestopping materials.
2. Remove tape as soon as it is possible to do so without disturbing firestopping’s seal with substrates.

3.3 PENETRATION FIRESTOP SYSTEMS

A. Forming/damming materials and accessories:
   1. Install as required to support fill materials during their application to produce the cross-sectional shapes and depths required to achieve fire ratings of firestop systems.
   2. After installing fill materials, remove combustible forming materials and other accessories not indicated as permanent components of firestop systems.

B. Install fill materials for penetration firestop systems to produce the following results:
   1. Completely fill voids and cavities formed by openings, forming materials, accessories, and penetrating items.
   2. Apply materials so they contact and adhere to substrates formed by openings and penetrating items.
   3. For fill materials that will remain exposed after completing Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

3.4 FIRE-RESISTIVE JOINT SEALANTS

A. Install joint fillers to provide support of sealants during application, produce the cross sectional shapes and depths of installed sealants for optimum sealant movement capability, and develop fire-resistance rating required.
B. Install sealants so they will directly contact and fully wet joint substrates. Completely fill recesses provided for each joint configuration, and provide uniform, cross-sectional shapes and depths relative to joint width. Install sealants at the same time joint fillers are installed.
C. Tool non-sag sealants immediately after sealant application and before skinning or curing begins; form smooth, uniform beads. Eliminate air pockets to ensure contact and adhesion of sealants with sides of joint.
   1. Remove excess sealant from surfaces adjacent to joint.
   2. Do not use tainting agents that will discolor sealants or adjacent surfaces, or that are not approved by the sealant manufacturer.

3.5 FIELD QUALITY CONTROL

A. Examine penetration firestop systems to ensure proper installation prior to concealing or enclosing firesafed and firestopped areas.
B. Repair damaged areas and restore the integrity of the assembly.
C. Keep areas of work accessible until inspection and approval by applicable authorities having jurisdiction.

3.6 CLEANING

A. Cleanup spills of liquid components.
B. Cut and trim excess materials neatly, flush with adjacent surfaces.
SECTION 07 92 00

JOINT SEALANTS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS
   A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SECTION INCLUDES
   A. Sealants and joint backing.
   B. Precompressed foam sealers.
   C. Hollow gaskets.

1.03 PERFORMANCE REQUIREMENTS
   A. Provide elastomeric joint sealants that establish and maintain watertight and airtight continuous joint seals without staining or deteriorating joint substrates.

1.04 REFERENCES

1.05 SUBMITTALS
   A. See Section 01 33 00 – Submittals for submittal procedures.
   B. Product Data: For each joint-sealant product indicated. Include manufacturer’s installation instruction.
   C. Samples: Submit two samples, illustrating sealant colors for selection.
   D. Qualification Data: For Installer.
   E. Warranties: Special warranties specified in this Section.

1.06 QUALITY ASSURANCE
   A. Installer Qualifications: Manufacturer’s authorized Installer who is approved or licensed for installation of sealants required for this Project, with minimum three years experience.
B. Source Limitations: Obtain each type of joint sealant through one source from a single manufacturer.

C. Pre-installation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Management and Coordination."

D. Maintain one copy of each reference document covering installation requirements on site.

1.07 PROJECT CONDITIONS

A. Do not proceed with installation of joint sealants under the following conditions:
   1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer or are below 40 deg F (5 deg C).
   2. When joint substrates are wet.
   3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
   4. Contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

1.08 WARRANTY

A. See Section 01 77 10 –Closeout Procedures for additional warranty requirements.

B. Special Installer's Warranty: Installer’s standard form in which Installer agrees to repair or replace elastomeric joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.
   1. Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Products: Subject to compliance with requirements, provide one of the products listed in other Part 2 articles.

2.02 MATERIALS, GENERAL

A. Compatibility: Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by sealant manufacturer, based on testing and field experience.

2.03 JOINT SEALANTS

A. Type SJ-1 - General Purpose Exterior Sealant: Polyurethane; ASTM C 920, Grade NS, Class 25, Uses M, G, and A, single component.
   3. Applications: Use for:
      a. Control, expansion, and soft joints in masonry.
      b. Joints between concrete and other materials.
      c. Joints between metal frames and other materials.
      d. Other exterior joints for which no other sealant is indicated.

C. Type SJ-2 - Exterior Expansion Joint Sealer: Pre-compressed foam sealer; urethane with water-repellent;
   2. Size as required to provide weathertight seal when installed.
3. Provide product recommended by manufacturer for traffic-bearing use.
5. Applications: Use for:
   a. Exterior wall expansion joints.

D. Type SJ-3 - Exterior Metal Lap Joint Sealant: Butyl or polyisobutylene, nondrying, nonskinning, noncuring.
   1. Product: Butyl Sealant manufactured by Tremco.
   2. Applications: Use for:
      a. Concealed sealant bead in sheet metal work.
      b. Concealed sealant bead in siding overlaps.

E. Type SJ-4 - General Purpose Interior Sealant: Acrylic emulsion latex; ASTM C 834, Type OP, Grade NF single component, paintable.
   3. Applications: Use for:
      a. Interior wall and ceiling control joints.
      b. Joints between door and window frames and wall surfaces.
      c. Other interior joints for which no other type of sealant is indicated.

F. Type SJ-5 - Bathtub/Tile Sealant: Clear silicone; ASTM C 920, Uses I, M and A; single component, mildew resistant.
   1. Product: Tremsil 200 with fungicide manufactured by Tremco.
   2. Applications: Use for:
      b. Joints between countertops and wall surfaces.

G. Type SJ-6 - Acoustical Sealant: Synthetic rubber sealant; ASTM D 217, Grade NS, Class 12-1/2, Uses M and A; single component, solvent release curing, non-skimming.
   1. Acoustical sealant shall be non-skimming, non-hardening, flexible sealant specifically designed for sealing gypsum wallboard. Sealant shall be capable to spanning ½ inch wide by 3/8 inch deep gaps. Synthetic rubber based products shall comply with ASTM D217 and acrylic latex based products shall comply with ASTM C834.
   3. Applications: Use for concealed locations only:
      a. Sealant bead between top stud runner and structure and between bottom stud track and floor.

H. Type SJ-7 - Interior Floor Joint Sealant: Polyurethane, self-leveling; ASTM C 920, Grade P, Class 25, Uses T, M and A; single component.
   1. Approved by manufacturer for wide joints up to 1-1/2 inches.
   4. Applications: Use for:
      a. Expansion joints in floors.

I. Type SJ-8 - Silicone Sealant: ASTM C 920, Grade NS, Class 25, Uses NT, A, G, M, O; single component, solvent curing, non-sagging, non-staining, fungus resistant, non-bleeding.
   4. Service Temperature Range: -65 to 180 degrees F.
   5. Shore A Hardness Range: 15 to 35.
   6. Applications: Use for:
      a. Glass.
2.04 ACCESSORIES

A. Primer: Non-staining type, recommended by sealant manufacturer to suit application.
B. Joint Cleaner: Non-corrosive and non-staining type, recommended by sealant manufacturer; compatible with joint forming materials.
C. Joint Backing: Round foam rod compatible with sealant; ASTM D 1667, closed cell PVC; oversized 30 to 50 percent larger than joint width.
D. Bond Breaker: Pressure sensitive tape recommended by sealant manufacturer to suit application.
E. Masking Tape: Non-staining, non-absorbent material compatible with joint sealants and surfaces adjacent to joints.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint-sealant performance.
B. Proceed with installation only after unsatisfactory conditions have been corrected.
C. Verify that joint backing and release tapes are compatible with sealant.

3.02 PREPARATION

A. Perform preparation in accordance with manufacturer's instruction and ASTM 1193.
B. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions and the following requirements:
   1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.
   2. Clean porous joint substrate surfaces by brushing, grinding, blast cleaning, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining after cleaning operations above by vacuuming or blowing out joints with oil-free compressed air. Porous joint substrates include the following:
      a. Concrete.
      b. Masonry.
C. Clean nonporous surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants. Protect elements surrounding the work of this section from damage or disfigurement.
D. Joint Priming: Prime joint substrates based on preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.
E. Masking Tape: Use masking tape where required to prevent contact of sealant with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning.
methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

3.03 INSTALLATION OF JOINT SEALANTS

A. General: Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.

B. Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.

C. Perform aoustical sealant application work in accordance with ASTM C 919.

D. Install sealants using proven techniques that comply with the following and at the same time backings are installed:
   1. Place sealants so they directly contact and fully wet joint substrates.
   2. Completely fill recesses in each joint configuration.
   3. Install sealant free of air pockets, foreign embedded matter, ridges, and sags.
   4. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.
   5. Tool joints concave.

E. Tooling of Non-sag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.
   1. Remove excess sealant from surfaces adjacent to joints.
   2. Provide concave joint configuration per Figure 5A in ASTM C 1193, unless otherwise indicated.
   3. Provide flush joint configuration where indicated per Figure 5B in ASTM C 1193.
   4. Provide recessed joint configuration of recess depth and at locations indicated per Figure 5C in ASTM C 1193.

D. Install bond breaker where joint backing is not used.

E. Apply sealant within recommended application temperature ranges. Consult manufacturer when sealant cannot be applied within these temperature ranges.

F. Pre-compressed Foam Sealant: Do not stretch; avoid joints except at corners, ends, and intersections; install with face 1/8 to 1/4 inch below adjoining surface.

G. Compression Gaskets: Avoid joints except at ends, corners, and intersections; seal all joints with adhesive; install with face 1/8 to 1/4 inch below adjoining surface.

3.04 FIELD QUALITY CONTROL

A. Field-Adhesion Testing: Field test joint-sealant adhesion to joint substrates as follows:
   1. Inspect joints for complete fill, for absence of voids, and for joint configuration complying with specified requirements. Record results in a field-adhesion-test log.

B. Evaluation of Field Test Results: Sealants not evidencing adhesive failure from testing or noncompliance with other indicated requirements will be considered satisfactory. Remove sealants that fail to adhere to joint substrates during testing or to comply with other requirements. Retest failed applications until test results prove sealants comply with indicated requirements.
3.05 CLEANING
   A. Clean off excess sealant or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

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

3.06 JOINT SEALANT SCHEDULE
   A. Exterior Joints for Which No Other Sealant Type is Indicated: Type SJ-1; colors as selected.
   B. Control and Expansion Joints in Paving: Type SJ-2.
   C. Control, Expansion, and Soft Joints in Masonry, and Between Masonry and Adjacent Work: Type SJ-1.
   D. Lap Joints in Exterior Sheet Metal Work: Type SJ-3.
   E. Joints between Exterior Metal Frames and Adjacent Work (except masonry): Type SJ-1.
   F. Under Exterior Door Thresholds: Type SJ-1.
   G. Interior Joints for Which No Other Sealant is Indicated: Type SJ-4; colors as selected.
   H. Control and Expansion Joints in Interior Concrete Slabs and Floors: Type SJ-7.
   I. Joints between Plumbing Fixtures and Walls and Floors, and Between Countertops and Walls: Type SJ-5.
   J. In STC-Rated Walls, Between Metal Stud Track/Runner and Adjacent Construction: Type SJ-6.
   K. Glass to aluminum joints: Type SJ-8; color as selected from manufacturer's standard colors.

END OF SECTION
SECTION 08 13 00

STEEL DOORS AND FRAMES

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes
   1. Provision of fire-rated and non-fire rated flush steel doors for interior locations.
   2. Provision of steel frames for interior doors and windows.

B. Products Installed but not Furnished Under this Section
   1. Section 08 71 00 - Door Hardware: Furnishing of finish hardware.

C. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

D. Related Sections
   1. Section 08 14 16 - Flush Wood Doors: Provision of flush wood doors.
   3. Section 09 22 00 - Metal Support Assemblies: Provision of metal framing.
   4. Section 09 90 00 - Painting and Coating: For field painting primed doors and frames.

1.02 REFERENCES

A. ANSI - American National Standards Institute
   1. ANSI/UL 10B Fire Tests of Door Assemblies
   2. ANSI/NFPA 80 Standards for Fire Doors and Fire Windows
   3. ANSI/NFPA252 Fire Tests of Door Assemblies
   4. ANSI A250.3 - Test Procedure and Acceptance Criteria for Factory Applied Finish Painted Steel Surfaces for Steel Doors and Frames
   5. ANSI A250.4 - Test Procedure and Acceptance Criteria for Physical Endurance for Steel Doors and Hardware Reinforcing
   6. ANSI A250.6 (SDI 107) - Hardware on Standard Steel Doors (Reinforcement-Application)
   7. ANSI A250.7 - Nomenclature for Steel Doors and Steel Door Frames
   8. ANSI A250.8 (SDI-100) - Recommended Specifications for Steel Doors & Frames
   9. ANSI A250.10 - Test Procedure and Acceptance Criteria for Prime Painted Steel Surfaces for Steel Doors and Frames
   10. ANSI/DHI A115 Specifications for Hardware Preparations in Standard Steel Doors and Frames

B. ASTM - American Society for Testing and Materials

C. DHI - Door and Hardware Institute
   1. RL - Recommended Locations for Builder's Hardware on Standard Steel Doors and Frames.

D. Fire Protection
   1. UL 10B Fire Tests of Door Assemblies (Neutral test pressure)
   2. UL 10C Standard for Safety for Positive Pressure Fire Tests of Door Assemblies
   3. NFPA 252 Fire Tests of Door Assemblies (Neutral test pressure)
   4. UBC 7-2-1997 Positive Pressure Fire Tests of Door Assemblies
   5. NFPA 80 Standard for Fire Doors and Fire Windows

E. SDI - Steel Door Institute
   1. SDI 105 - Recommended Erection Instructions for Steel Frames
   2. SDI 106 - Recommended Standard Door Type Nomenclature
   3. SDI 108 - Recommended Selection and Usage Guide for Standard Steel Doors
   4. SDI 109 - Hardware for Standard Steel Doors & Frames
   5. SDI 110 - Standard Steel Doors & Frames for Modular Masonry Construction
   6. SDI 111 - Recommended Standard Details for Steel Doors and Frames
   7. SDI 112 - Zinc-Coated (Galvanized/Galvannealed) Standard Steel Doors & Frames
   8. SDI 122 - Installation and Troubleshooting Guide for Standard Steel Doors and Frames
   9. SDI 124 - Maintenance of Standard Steel Doors and Frames

F. UL - Underwriters Laboratories, Inc.

1.03 SUBMITTALS

A. Product Data: Submit product data for each type of door and frame specified, including details of construction, materials, dimensions, hardware preparation, core, label compliance, sound ratings, profiles and finishes, and manufacturer's installation instructions.

B. Shop Drawings: Submit shop drawings showing fabrication and installation of standard steel doors and frames referenced to the Architect's door mark and hardware group. Include details of each frame type, elevations of door design types, conditions at openings, details of construction, location and installation requirements of door and frame hardware and reinforcements, and details of joints and connections. Show anchorage and accessory items.
   1. Provide schedule of doors and frames using same reference numbers for details and openings as those on the Contract Drawings.
   2. Indicate coordinate of glazing frames and stops with glass and glazing requirements.

1.04 QUALITY ASSURANCE

A. Conform to requirements of ANSI A250.8-1998 (SDI-100), ANSI A151.1, and other specifications herein named. Test reports shall be submitted upon request.

B. Acoustical qualities: Doors shall have a minimum sound transmission classification of 28 as tested under ASTM designation E490 and ASTM designation E413.
C. Insulation properties: Doors shall have a U factor .363 (R factor of 2.85) for honeycomb core, U factor for polystyrene core of .263 (R factor of 3.8), U factor for polyurethane core of 0.09 (R factor of 11.1).

D. Underwriters’ Laboratories and Warnock Hersey, labeled fire doors and frames:
   1. All labeled fire doors and frames shall be of a type which has been investigated and tested in accordance with either UL-10(b), ASTM E-152, NFPA 252, ANSI A2.2, or UL-10(c), UBC 7-2-1997.
   2. Underwriters’ Laboratories labeled doors and frames shall be manufactured under the UL factory inspection program and in strict compliance to UL procedures, and shall provide the degree of fire protection, heat transmission and panic loading capability indicated by the opening class.
   3. Warnock Hersey labeled doors and frames shall be manufactured to meet the specific requirements of that labeling agency’s current procedure for the tested hourly rating designated and shall be subject to inspection by representatives of the labeling agency.
   4. A physical label or approved marking shall be affixed to the fire door or fire door frame, at an authorized facility as evidence of compliance with procedures of the labeling agency.

1.05 REGULATORY REQUIREMENTS
   A. Provide fire rated door assemblies that comply with NFPA 80, are identical to door and frame assemblies whose fire resistance characteristics have been determined in accordance with ASTM E152 and which are labeled and listed by UL or Intertek Testing Agency.
   B. Oversized Fire Rated Door Assemblies: For units exceeding sizes of tested assemblies, provide manufacturer’s certification that doors conform to standard construction requirements of tested and labeled doors for rated door assemblies except for size.

1.06 DELIVERY, STORAGE, AND HANDLING
   A. Acceptance at Site
      1. Deliver doors and frames cardboard-wrapped or crated to provide protection during transit and job storage.
      2. Inspect doors and frames upon delivery for damage. Minor damages may be repaired provided refinished items are equal in all respects to new work and acceptable to the Architect; otherwise, remove and replace damaged items as directed.
   B. Storage and Protection: Store doors and frames at building site under cover. Doors shall be stored in an upright position. Place units on minimum 4 inches high wood blocking. Avoid use of non-vented plastic or canvas shelters which could create humidity chamber. If cardboard wrapper on door becomes wet, remove carton immediately. Provide 1/4-inch spaces between stacked doors to promote air circulation.

PART 2 - PRODUCTS

2.01 MANUFACTURERS
   A. Acceptable Manufacturers: Steelcraft Manufacturing Co., Curries, Republic Builders Products or equal.

2.02 MATERIALS
A. Hot-Rolled Steel Sheets and Strip: Commercial quality carbon steel, pickled and oiled, complying with ASTM A569 and ASTM A568.

B. Cold-Rolled Steel Sheets: Commercial quality carbon steel, complying with ASTM A366 and ASTM A568.

C. Galvanized Steel Sheets: Zinc-coated carbon steel sheets of commercial quality, complying with ASTM A526, or drawing quality, ASTM A642, hot dipped galvanized in accordance with ASTM A525 with A60 or G60 coating designation, mil phosphatized.

D. Supports and Anchors: Fabricate of not less than 18 gauge sheet steel; galvanized where used with galvanized frames.

E. Inserts, Bolts, and Fasteners: Manufacturer's standard units. Where items are to be built in at exterior walls, hot-dip galvanize in compliance with ASTM A153, Class C or D as applicable.

F. Shop Applied Paint: Apply after fabrication.
   1. Primer: Rust-inhibitive enamel or paint, either air-drying or baking, suitable as a base for specified finish paints complying with ANSI A250.10 "Test Procedure and Acceptance Criteria for Prime Painted Steel Surfaces for Steel Doors and Frames".

G. Finish: As specified in Section 09900 and refer to Door Schedule Sheet 8.01.

2.03 DOORS

A. Provide metal doors of SDI grades and models specified below or as indicated on the Drawings or schedules:
   1. Interior Doors: Provide doors complying with requirements indicated below by referencing ANSI 250.8 for level and model and ANSI A250.4 for physical endurance level:
      a. Level 1 and Physical Performance Level C, (Standard Duty), Model1 (Full Flush).
      b. Level 2 and Physical Performance Level B (Heavy Duty), Model 1 (Full Flush).
      c. Interior doors shall be 18 gauge commercial quality carbon steel.
   2. Exterior Doors (as occurs): Provide doors complying with requirements indicated below by referencing ANSI A250.8 for level and model and ANSI A250.4 for physical-endurance level:
      a. Level 3 and Physical Performance Level A (Extra Heavy Duty), Model 1 (Full Flush).
   3. Door Louvers (as occurs): Provide sightproof stationary louvers for interior doors where indicated, constructed of inverted V-shaped or Y-shaped blades formed of 24 gauge cold-rolled steel set into minimum 20 gauge steel frame.

B. Construction of Doors:
   1. Laminated core doors
   2. L-Series Doors shall be full-flush or full-flush seamless construction, fabricated from commercial quality carbon steel or hot-dipped galvanized steel (see Section 2.02) 18 gauge for 1-3/4" doors. Doors shall be reinforced, sound deadened and insulated with impregnated Kraft honeycomb core completely filling the inside of the doors and laminated to inside faces of both panels using contact adhesive applied to both panels and honeycomb core.
   3. Door shall have continuous vertical mechanical interlocking joints at lock and hinge edges with visible edge seams or with edge seam filled and ground smooth. The internal portion of the seam shall be sealed with epoxy. An intermittent fastening along the seam is not permitted. Doors shall have beveled (1/8" in 2") hinge and lock edges. Top and bottom steel reinforcement channels shall be galvanized 14 gauge and projection welded to both panels.
   4. Hinge reinforcements shall be 7 gauge for 1-3/4" doors. Lock reinforcements shall be...
16 gage and closer reinforcements 14 gage- box minimum 6" high and 20' long. Hinge and lock reinforcements shall be projection welded to the edge of the door. Galvannealed doors shall have galvannealed hardware reinforcements. Adequate reinforcements shall be provided for other hardware as required.

5. Glass trim for doors with cutouts shall be 24 gage steel conforming to ASTM designation A 924 hot dipped galvannealed steel with a zinc coating of 0.06 ounces per square foot. The trim shall be installed into the door as a four sided welded assembly. The trim shall fit into a formed area of the door face, shall not extend beyond the door face and shall interlock into the recessed area. The corners of the assembly shall be mitered, reinforced and welded. The trim shall be the same on both sides of the door. Exposed fasteners shall not be permitted. Label and non-label doors shall use the same trim.

6. Doors indicating divided glass lites shall be made using a door with a cutout and trim for one piece of glass. The small lites shall be created by an extruded aluminum grille work mechanically fastened to the glass lite trim on both sides of the door. The grille work sections shall be beveled on the exposed side and shall have a flange on the unexposed side to which glazing tape can be applied. The grille work shall be installed into both sets of glass trim prior to installing into the door. One glass trim and muntin assembly shall be installed into the door prior to glazing. After glazing the other glass trim and muntin assembly shall be installed into the door.

7. All exterior out swing doors shall have the tops closed to eliminate moisture penetration. Door tops shall have no holes or openings. Top caps are permitted.

8. Fire Resistive: Labeled door core material shall conform to requirements of labeling authority.

2.04 FRAMES

A. Provide metal frames for doors and windows of types and styles as indicated on the Drawings and schedules. Conceal fastenings, unless otherwise indicated.

1. Interior: Fabricate fully welded frames of minimum 16 gauge commercial quality carbon steel.

2. Exterior: Fabricate fully welded frames of minimum 16 gauge hot dipped galvannealed steel.

B. Construction Frames:

1. Flush Frames:
   a. F-Series flush frames shall be formed from 16 commercial quality carbon steel or galvannealed steel (see Section 2.01).
   b. F-Series frames shall have 2" faces, FN-Series frames shall have 1" faces. F16 gauge frames shall be set-up and back welded with full penetration through to the face, ground down and smoothed. Miter corners shall have reinforcements with four concealed integral tabs for secure and easy interlocking of jambs to head.
   c. Frames for 1-3/4" doors shall have 7 gauge universal steel hinge reinforcements prepared for 4-1/2" x 4-1/2" standard or heavy weight template hinges. Strike reinforcements shall be 16 gauge and prepared for an ANSI-A115.1-2 strike.
   d. Steel plaster guards shall be provided for all mortised cutouts. All hinge and strike reinforcements shall be projection welded to the door frame. Reinforcements for surface applied door closers shall be 14 gauge steel.
   e. Galvannealed frames shall have galvannealed hardware reinforcements. Adequate reinforcements shall be provided for other hardware when required. F-Series frames shall be furnished with a minimum of six wall anchors and two adjustable base anchors of manufacturer's standard design. FN-Series frames shall be furnished with a minimum of six wall anchors and two fixed base anchors.
      1) Steel plaster guards shall be provided for all mortised cutouts.
2) All hinge and strike reinforcements shall be projection welded to the door frame.
3) Reinforcements for surface closer shall be 14 gauge steel. Adequate reinforcements shall be provided for other hardware when specified.
4) Galvannealed frames shall have galvannealed hardware reinforcements.

2. Drywall Frames
   a. DW and K-Series drywall frames shall be formed from 18 or 16 gauge commercial quality carbon steel or galvannealed steel. DW and K-Series frames shall be formed with double return backbends to prevent cutting into the drywall surface. Frames shall be knocked down, designed to be securely installed in the rough opening after wallboard is applied. Mitered corners shall be reinforced with a wedge lock corner clip to provide a firm interlock of jambs to head.
   b. Frames for 1-3/4” doors shall have 7 gauge steel hinge reinforcements and preparation for 4-1/2" x 4-1/2" standard weight template hinges. Strike jamb shall have 16 gauge strike reinforcement and preparation for ANSI A115.1-2 strike. Strike jamb shall have 14 gage reinforcement and preparation for ANSI A115.3 strike.
   c. Each jamb shall have an adjustable compression anchor located 4” from the top of the door opening to hold the frame in rigid alignment. DW-Series frames shall have a welded-in base anchor attaching plate in each jamb for field installation of loose base anchors. K-Series frames shall have a dimpled hole in each face, near the bottom of each jamb for screw anchoring the base of frame to the wall construction.

3. Construction of Architectural Stick Components
   a. Architectural stick frame assemblies shall be made of standard frame components, manufactured from 16 gauge or 14 gauge commercial quality carbon steel or galvannealed steel. Where sticks are used at door openings and frame assemblies, they shall be prepared for hardware as specified. Frame assemblies shall be fabricated from three basic components:
      1) Open sections (perimeter members), closed sections (intermediate members), and sill sections.
      2) Open sections shall be identical in configuration to Steelcraft standard frames.
      3) Closed sections shall have identical jamb depths, face dimensions and stops as open sections. Closed sections shall be factory assembled and shall have full length internal reinforcement of 16 gage steel, factory spot-welded to both soffits at 8” on center.
      4) Sill sections shall be fabricated from galvannealed steel and shall be either flush with both faces of adjacent vertical members or recessed from one face of the adjacent vertical members.
   b. Individual components shall be cut to length and notched to assure square joints and corners. All joints and corners of the frame assembly shall be welded and ground smooth at the face of the sections. Frame assemblies shall be shipped to job site completely welded. Field joints shall be permitted only when the size of the total assembly exceeds shipping limitations. When frame assemblies are subjected to windloads, vertical members shall be free of field splices.
   c. When specified, steel panels shall be furnished 3/8" or 1-3/4" thick as required. 3/8" panels shall be made of 18 gauge cold-rolled steel faces with a corrugated fiberboard filler. 1-3/4" panels shall be made of 20 gauge cold-rolled steel faces with a honeycomb core. Cores shall be laminated to inside faces of both panels. Stick components and panels shall be furnished as specified in Section 2.02. Steel channel glazing beads shall be provided with assemblies for all areas in which glass or panels are to be installed and shall be pierced and dimpled for
oval head sheet metal screws.

d. All necessary anchors for jambs, heads and sills of assemblies shall be provided. When verification of field dimensions is necessary, they shall be made by the contractor. Frame fabrication shall not begin until these dimensions have been submitted.

C. Hardware:
   1. As specified in Section 08710.
   2. Door Silencers: Except on weatherstripped and smoke gasketed frames, drill stops to receive 3 silencers on strike jambs of single door frames and 2 silencers on heads of double door frames.

D. Glass and Glazing: As specified in Sections 08 80 00.
   1. At interior sound-rated windows, provide laminated glass as specified in Section 08 80 00.
   2. Vision Lites shall be as indicated on the drawings; moldings shall be manufacturer’s standard.

E. PROTECTION COATINGS
   1. The inside of all frames shall be fully grouted or, when an anti-freeze agent is used, shall be coated with a fibered asphalt coating prior to grouting. Coating shall be field applied by the contractor to a minimum 1/16” thickness.

2.04 FABRICATION

A. Frames shall be supplied
   1. Knocked-down for field assembly for interior doors only with Architect’s prior approval.
   2. Set up and welded with faces welded and ground smooth. Miters of frames shall be back welded. Weld shall penetrate the outside face. Faces shall be dressed smooth and prime painted. Filler materials are not permitted.

B. Fabricate steel door and frame units to be rigid, neat in appearance and free from defects, warp or buckle. Wherever practicable, fit and assemble units in manufacturer’s plant. Clearly identify work that cannot be permanently factory-assembled before shipment, to assure proper assembly at Project site. Comply with SDI 100 requirements.
   1. Internal Construction: Manufacturer’s standard vertical steel stiffeners or unitized steel grid with internal sound deadener on inside of face sheets in accordance with SDI standards.
   2. Clearances: Not more than 1/8-inch at jambs and heads except between non-fire rated pairs of doors not more than 1/4-inch. Not more than 3/4-inch at bottom.

C. Fabricate exposed faces of doors and panels, including stiles and rails of nonflush units, from only cold-rolled steel.

D. Tolerances: Comply with SDI 117.

E. Fabricate frames, concealed stiffeners, reinforcement, edge channels, louvers and moldings from either cold-rolled or hot-rolled steel.

F. Fabricate exterior doors, panels and frames from galvanized sheet steel in accordance with SDI 112. Close top and bottom edges of exterior doors as integral part of door construction or by addition of minimum 14 gauge inverted steel channels.

G. Exposed Fasteners: Unless otherwise indicated, provide countersunk flat or oval heads for exposed screws and bolts.

H. Hardware Preparation: Prepare doors and frames to receive mortised and concealed hardware in accordance with final Door Hardware Schedule and templates provided by
hardware supplier. Comply with applicable requirements of ANSI A115 Series Specifications for door and frame preparation for hardware.

1. For concealed overhead door closers, provide space, cutouts, reinforcing and provisions for fastening in top rail of doors or head of frames, as applicable.

I. Reinforce doors and frames to receive surface applied hardware. Drilling and tapping for surface applied hardware may be done at Project site.

J. Locate hardware as indicated on final shop drawings or, if not indicated, in accordance with DHI RL.

K. Shop Painting: Clean, treat and paint exposed surfaces of steel door and frame units, including galvanized surfaces.
   1. Clean steel surfaces of mill scale, rust, oil, grease, dirt and other foreign materials before application of paint.
   2. Apply shop coat of prime paint of even consistency to provide a uniformly finished surface ready to receive finish paint.

L. Glazing Stops: Minimum 20 gauge steel.
   1. Provide non-removable stops on outside of exterior doors and on secure side of interior doors for glass, louvers and other panels in doors.
   2. Provide screw applied removable glazing beads on inside of glass, louvers, and other panels in doors.

2.05 FINISHES

A. Finish Painting: As specified in Section 09 90 00 and as noted on Door Schedule

B. All doors, frames and frame components shall be cleaned, phosphatized and finished as standard with one coat of rust inhibiting prime paint in accordance with the ANSI A250.10 "Test Procedure and Acceptance Criteria for Prime Painted Steel Surfaces for Steel Doors and Frames".

C. Factory finish painted doors and frames shall be cleaned, phosphatized and finished with rust inhibiting paint capable of passing a 200-hour salt spray and 480-hour humidity test in accordance with ASTM designation B117 and ASTM designation D1735. Finish paint shall be in accordance with ANSI/SDI A250.3, "Test Procedure and Acceptance Criteria for Factory Applied Finish Painted Steel Surfaces for Steel Doors and Frames".

PART 3 - EXECUTION

3.01 INSTALLATION

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

B. Placing Frames: Comply with provisions of SDI 105, unless otherwise indicated.
   1. Except for frames located at existing concrete, masonry or drywall installations, place frames prior to construction of enclosing walls and ceilings. Set frames accurately in position, plumbed, aligned and braced securely until permanent anchors are set. After wall construction is completed, remove temporary braces and spreaders leaving surfaces smooth and undamaged.
   2. Install fire rated frames in accordance with NFPA Standard No. 80.
   3. In metal stud partitions, install at least 3 wall anchors per jamb at hinge and strike levels. In closed steel stud partitions, attach wall anchors to studs with screws.

C. Door Installation: Fit hollow metal doors accurately in frames, within clearances specified in SDI 100.
1. Install fire rated doors with clearances as specified in NFPA Standard No. 80.

D. Sound-Rated Assemblies
1. Install in accordance with manufacturer's instructions and under manufacturer's supervision.
2. Seal the shim space around frames airtight and in a manner consistent with the STC rating as indicated on the Drawings.
3. Sound-rated assemblies may be selected for in situ verification testing of the acoustical performance in accordance with ASTM E336. Contractor shall remedy all defects.

E. Fire-Rated Assemblies
1. Label doors and frames shall be installed per NFPA-80 and/or as noted in item number 3.01A.

3.02 ERECTION TOLERANCES
A. Clearances Between Door and Frame: As specified in ANSI A250.8.
B. Maximum Diagonal Distortion: 1/16 in measured with straight edge, corner to corner.

3.03 ADJUST AND CLEAN
A. Prime Coat Touch-Up: Immediately after erection, sand smooth any rusted or damaged areas of prime coat and apply touch-up of compatible air-drying primer.
B. Final Adjustments: Check and readjust operating hardware items, leaving steel doors and frames undamaged and in complete and proper operating condition.
1. Adjust for smooth and balanced door movement.
2. Adjust sound control doors so that seals are fully engaged when door is closed.
3. Test sound control doors for force to close, latch, and unlatch in accordance with ASTM E 1408; adjust as required to comply.

END OF SECTION
SECTION 08 14 16

FLUSH WOOD DOORS

PART 1 - GENERAL

1.01 SUMMARY
A. Section Includes: Provision of fire rated and non-fire rated flush solid core doors with wood veneer faces.
B. Products Installed but not Furnished Under this Section
   1. Section 08 71 00 - Door Hardware: Furnishing of finish hardware.
C. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
D. Related Sections
   1. Section 08 13 00 - Steel Doors and Frames: Provision of steel door frames.
   2. Section 08 80 00 - Glazing: Provision of glass and glazing.
   3. Section 09 90 00 - Painting and Coating: For field painting primed doors.

1.02 REFERENCES
A. ASTM - American Society for Testing and Materials
   3. E413 - Classification for Rating Sound Insulation.
B. AWI - American Woodwork Institute
C. DHI - Door and Hardware Institute
   2. WDHS-3 - Recommended Hardware Locations for Wood Flush Doors.
D. NFPA - National Fire Protection Association
   1. 80 - Fire Doors and Windows.
E. WDMA - Window and Door Manufacturers Association
F. UBCS - Uniform Building Code Standard
   1. 7-2 - Fire Tests of Door Assemblies.
G. UL - Underwriters Laboratory, Inc.

1.03 SUBMITTALS
A. Product Data: Submit product data for each type of door, including details of core and edge construction, trim for openings and louvers, factory-finishing specifications and veneer species, type and characteristics.
B. Shop Drawings: Submit shop drawings indicating location and size of each door referenced to the Architect's door mark and hardware group, elevation of each kind of door, details of construction, location and extent of hardware blocking, fire ratings, requirements for factory finishing, cut-outs for glazing and other pertinent data.
   1. For factory-machined doors, indicate dimensions and locations of cutouts for locksets and other cutouts adjacent to light and louver openings.
   2. Samples for verification in the form and size indicated below (as indicated on drawings):
      a. Louvers consisting of blade and frame, 6 inches long for each material and finish specified.
      b. Frames for light openings, 6 inches long for each material, type, and finish required.

C. Test Reports for Sound Rated Doors: Submit independent laboratory acoustical test report indicating STC rating measured in accordance with ASTM E90 and ASTM E413.
   1. STC Rating: 42.

D. Specimen Warranty.

E. Samples: Submit two samples of door veneer, 8 x 12 inch in size, illustrating wood grain, stain color and sheen.

F. Manufacturer's installation instructions. Indicate special installation instructions.

G. Warranty, executed in Owner's name -- Contra Costa Community College District, Los Medanos College.

1.04 QUALITY ASSURANCE

A. Regulatory Requirements
   1. Fire Rated Wood Doors: Provide wood doors that comply with NFPA 80; are identical in materials and construction to units tested in door and frame assemblies per ASTM E152; and are labeled and listed by UL, Warnock Hersey or another testing and inspection agency acceptable to authorities having jurisdiction.
   2. Temperature Rise Rating: At stairwell enclosures, provide doors that have a temperature rise rating of 450 degrees Fahrenheit maximum in 30 minutes of fire exposure specified in UBCS 7-2.

B. Quality Standard
   1. WDMA Quality Standard: I.S.1-A.

C. Sound Rated Doors: Doors with an STC rating shall bear manufacturer's label designating sound retardant construction.

1.05 DELIVERY, STORAGE AND HANDLING

A. Packing and Shipping: Identify each door with individual opening numbers as designated on shop drawings, using temporary, removable or concealed markings. Use the Architect's door numbering system.

B. Storage and Protection: Protect doors during transit, storage, and handling to prevent damage, soiling, and deterioration. Comply with requirements of referenced standard and manufacturer's instructions.

1.06 PROJECT CONDITIONS

A. Environmental Requirements: Do not deliver or install doors until building is enclosed, wet work is complete, and HVAC system is operating and will maintain temperature and relative humidity at occupancy levels during the remainder of the construction period.
B. Coordinate the work with door opening construction, door frame and door hardware installation.

1.07 WARRANTY

A. General Warranty: Door manufacturer’s warranty specified in this Article shall not deprive the District of other rights the District may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by the Contractor under requirements of the Contract Documents.

B. Door Manufacturer’s Warranty: Submit written agreement on door manufacturer’s standard form signed by manufacturer, Installer, and Contractor, agreeing to repair or replace defective doors that have warped (bow, cup, or twist) more than 1/4-inch in a 42 inch by 84 inch section or that show telegraphing of core construction in face veneers exceeding 0.01-inch in a 3 inch span, or do not conform to tolerance limitations of referenced quality standards.

1. Warranty shall also include installation and finishing that may be required due to repair or replacement of defective doors where defect was not apparent prior to hanging.

2. Warranty shall be in effect during the following period of time after date of Substantial Completion, Beneficial Occupancy or Notice of Completion, whichever is earlier.


PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Acceptable Manufacturers: Algoma Hardwoods, Inc.; Eggers Industries, Architectural Door Division; Marshfield Door Systems (formerly Weyerhaeuser Co.), or equal.

2.02 MATERIALS

A. Interior Solid Core Doors for Transparent Finish

   1. Faces: Quarter figured as selected by Architect.
   2. Grade: Premium with Grade AA faces.
   3. Construction: 5 plies.
   5. Core: Particleboard core.
   7. Assembly of Veneer Leaves on Door Faces: Center balance.
   8. Bonding: Stiles and rails bonded to core, then entire unit abrasive planed before veneering.

B. Interior Fire Rated Solid Core Doors

   1. Faces and Grade: Provide faces and grade to match non-fire rated doors in same area of building, unless otherwise indicated.
   2. Construction: Manufacturer’s standard core construction as required to provide fire-resistance rating indicated.
   3. Blocking: Provide composite blocking designed to maintain fire resistance of door but with improved screw-holding capability of same thickness as core and with minimum dimensions as follows:

      a. 5 inch top rail blocking.
      b. 5 inch bottom rail blocking.
      c. 5 inch by 18 inch lock blocks.
      d. 5 inch midrail blocking.
4. Edge Construction: Provide manufacturer’s standard laminated edge construction for improved screw-holding capability and split resistance as compared to edges composed of a single layer of treated lumber.
5. Pairs: Furnish formed steel edges and astragals for pairs of fire rated doors, unless otherwise indicated.
6. Testing: Tested to ratings indicated on drawings in accordance with International Building Code ("positive pressure"); UL or WH (ITS) labeled without any visible seals when door is open.
7. Facing Adhesive: Type II — water-resistant.

C. Interior Sound Rated Solid Core Doors
1. Faces and Grade: Provide faces and grade to match non-sound rated doors in same area of building, unless otherwise indicated.
2. Construction: Manufacturer’s standard core construction as required to provide sound rating indicated.
3. Where latch jamb gaskets protrude more than 1/2-inch, prepare door for latch hardware with additional backset.
4. Provide 16 gauge CRS 1-piece welded door frames with integral stops. Size door frame with gaskets to have a minimum 36 inches horizontal clearance and 84 inches vertical clearance, unless otherwise indicated.
5. Sound Retardant Doors: Minimum STC of 50, calculated in accordance with ASTM E 413, tested in accordance with ASTM E 1408. Equivalent to Type PC construction with core as required to achieve rating specified.
6. Facing Adhesive: Type II — water-resistant.

D. Metal Louver (as occurs): Size, type, and profile shown and fabricated from galvanized steel, 0.0396-inch thick; hot dip, zinc coated and factory primed for paint finish.

E. Acoustical Door Gaskets: Provide the following at 1-3/4 inch thick, STC 45 sound rated doors for items listed below. Coordinate with hardware group as indicated on Door Schedule Sheet 8.01.
1. Bulb at Head and Jamb Stop
2. Head and Jambs
3. Automatic Door Bottom
4. Threshold
5. Astragals

F. Gypsum Plaster: USG, "Structolite", or equal.

G. Hardware: As specified in Section 08 71 00.

H. Glass: As specified in Sections 08 80 00.

I. Glazing Stops: Wood, of same species as door facing, butted corners; prepared for countersink style tamper proof screws.

2.03 FABRICATION

A. Fabri cate flush wood doors to comply with the following requirements:
1. Factory machine doors for hardware that is not surface applied. Locate hardware to comply with DHI WDHS-3. Comply with final hardware schedules, door frame shop drawings, DHI A115-W series standards, and hardware templates.
   a. Coordinate measurements of hardware mortises in metal frames to verify dimensions and alignment before proceeding with factory machining.

B. Openings: Factory cut and trim openings through doors to comply with applicable requirements of referenced standards for kinds of doors required.
1. Light Openings: Trim openings with moldings of material and profile indicated.
2. Louvers: Factory install louvers in prepared openings.
2.04 FACTORY FINISHING
A. Doors for Transparent Finish: Shop seal faces and edges of doors for transparent finish with stain, other required pretreatments and first coat of finish as specified in Section 09900.

2.05 FINISHES
A. Transparent Finish: As specified in Section 09 90 00. Premium quality, satin sheen.

PART 3 - EXECUTION

3.01 EXAMINATION
A. Examine installed door frames prior to hanging door:
   1. Verify that frames comply with indicated requirements for type, size, location, and swing characteristics and have been installed with plumb jambs and level heads.
   2. Reject doors with defects.
B. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.02 INSTALLATION
A. Door Hardware: See Section 08 71 00.
B. Manufacturer's Instructions: Install wood doors to comply with manufacturer's instructions and referenced quality standard and as indicated.
   1. Install fire rated doors in corresponding fire rated frames according to requirements of NFPA 80.
C. Job-Fit Doors: Align and fit doors in frames with uniform clearances and bevels as indicated below; do not trim stiles and rails in excess of limits set by manufacturer or permitted with fire rated doors. Seal cut surfaces after fitting.
   1. Fitting Clearances for Non-Fire Rated Doors: Provide 1/8-inch at jambs and heads; 1/16-inch per leaf at meeting stiles for pairs of doors, and 1/8-inch from bottom of door to top of decorative floor finish or covering. Where threshold is shown or scheduled, provide 1/4-inch clearance from bottom of door to top of threshold.
   2. Fitting Clearances for Fire Rated Doors: Comply with NFPA 80.
   3. Bevel non-fire rated doors 1/8-inch in 2 inches at lock and hinge edges.
   4. Bevel fire rated doors 1/8-inch in 2 inches on lock edge; trim stiles and rails only to extent permitted by labeling agency.
D. Installation of Sound Rated Doors
   1. Install all sound rated door and gasket assemblies in accordance with manufacturer's instructions.
   2. Fill metal door frames at openings with gypsum plaster.
   3. Install all doors, frames, and gasket assemblies plumb and square to provide a continuous seal. Damaged or discontinuous gaskets shall be replaced at no cost to the District.
   4. Coordinate all gaskets at sound rated doors with other hardware to provide a continuous perimeter seal. Provide shim to mount automatic closers as required to clear gaskets.
   5. Install the threshold's horizontal surface 1/4-inch above the finish surface on the swing-side of the doors.
   6. Apply and adjust all gaskets to form an airtight seal with latching and closure forces in compliance with accessible code requirements and the American Disabilities Act.
3.03 INSTALLATION TOLERANCES
   A. Conform to specified quality standard for fit and clearance tolerances.
   B. Conform to specified quality standard for maximum diagonal distortion.
   C. Maximum Vertical Distortion (Bow): 1/8 inch measured with straight edge or taut string, top to bottom, over an imaginary 36 by 84 inches surface area.
   D. Maximum Width Distortion (Cup): 1/8 inch measured with straight edge or taut string, edge to edge, over an imaginary 36 by 84 inches surface area.

3.04 ADJUSTING AND PROTECTION
   A. Operation: Rehang or replace doors that do not swing or operate freely.
   B. Finished Doors: Refinish or replace doors damaged during installation.
   C. Protect doors as recommended by door manufacturer to ensure that wood doors will be without damage or deterioration at the time of Substantial Completion.

END OF SECTION
SECTION 08 31 16
ACCESS DOORS AND PANELS

PART 1 - GENERAL

1.01 SECTION INCLUDES
A. Access door and frame units, fire-rated, in wall locations.

1.02 RELATED REQUIREMENTS

1.03 REFERENCE STANDARDS

1.04 SUBMITTALS
A. See Section 01 33 00 – Submittal Procedures.
B. Product Data: Provide sizes, types, finishes, hardware, schedule locations, and details of adjoining work.
C. Shop Drawings: Indicate exact position of all access door units.
D. Manufacturer’s Installation Instructions: Indicate installation requirements.

1.05 REGULATORY REQUIREMENTS
A. Conform to applicable code for fire rated access doors.
   1. Provide access doors of fire rating equivalent to the fire rated assembly in which they are to be installed.
B. Provide products listed and labeled by UL or ITS (Warnock Hersey) as suitable for the purpose specified and indicated.

1.06 PROJECT CONDITIONS
A. Coordinate the work with other work requiring access doors.
PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Access Doors:

2. Acceptable manufacturers:
   c. JL Industries, www.jlindustries.com
3. Substitutions: See Section 01 60 00 – Product Requirements.

2.02 ACCESS DOOR AND PANELS

A. All Units: Factory fabricated, fully assembled units with corner joints welded, filled, and ground flush; square and without rack or warp; coordinate requirements with assemblies units are to be installed in.

B. Units in Fire Rated Assemblies: Fire rating equivalent to the fire rated assembly in which they are to be installed.

2.03 ACCESS DOORS UNITS – WALLS AND CEILINGS

A. Door and Frame Units: Formed steel.

1. Frames and flanges: 0.058 inch steel.
2. Door panels: 0.070 inch single thickness steel sheet.
3. Size: Size as called out on drawings or if not called out, then size to allow access to equipment in wall/ceiling cavities but not less than 12 x 12 inches in walls and 20 x 20 inch in ceilings.
4. Hardware:
   a. Hinge, Fire-Rated Units: 175 degree steel hinges with non-removable pin.
   b. Hinge: 175 degree stainless steel piano hinge with removable pin.
   c. Lock: Cylinder lock with latch, two keys for each unit.
5. Prime coat with alkyd primer typical.
6. Finish: No. 4 stainless steel finish in toilet rooms and at exterior installations.

B. Non-Fire Rated Door and frame Units in Walls:

1. In Gypsum Board on Steel Studs:
   a. Model RDWP0D manufactured by Karp Associates
2. In Metal Soffits on steel frames.

C. Fire Rated Door and Frame Units in Walls:

1. In Gypsum board on Steel Studs:
   a. 1 hour fire rating.
   b. Model KRP-150 FR manufactured by Karp Associates when less than 24 inches in either direction.
c. Custom fire-rated unit similar to Model RDW manufactured by Karp Associates when greater than 15 inches in either direction.

2.04 FABRICATION
   A. Weld, fill, and grind joints to ensure flush and square unit.

PART 3 – EXECUTION

3.01 INSTALLATION
   A. Install units in accordance with manufacturer’s instructions.
   B. Install frames plumb and level in openings. Secure rigidly in place.
   C. Position units to provide convenient access to the concealed work requiring access.

END OF SECTION
SECTION 08 71 00
DOOR HARDWARE

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Furnish door hardware in accordance with hardware group as indicated.
   2. Furnish templates and hardware list of hardware as required.
   3. Furnish cylinder for entrance doors, colling doors, electrical panels and fire alarm panels.

B. General provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

C. Related Sections:
   1. Section 08 11 00 – Steel Doors and Frames: Installation of finish hardware accordance with standards of this Section.
   2. Section 08 41 00 – Glazed Aluminum Curtainwalls: Installation of weather seals for entrances in accordance with standards of this Section.

1.02 REFERENCES

A. ADA - Americans with Disabilities Act


C. DHI - Door and Hardware Institute.
   1. RL – Recommended Locations for Builders Hardware for Standard Steel Doors and Frames.

   1. NFPA 80 - Fire Doors and Windows

E. NWWDA – National Wood Window and Door Association
   1. I.S.1.7 – Hardware Location for Wood Flush Doors.

F. UL - Underwriters Laboratories, Inc.

1.03 SUBMITTALS

A. Product Data: Submit manufacturer’s product data for each item of door hardware installation instructions, maintenance of operating parts and finish, and other information necessary to show compliance with requirements.
   1. Final hardware schedule, incorporating the Architect’s door numbering system coordinated with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.

B. Samples: Submit samples of each type of exposed hardware unit in finish indicated and tagged with full description of coordination with schedule. Submit samples prior to submission of final hardware schedule.
1. Samples will be returned to the supplier. Units that are acceptable and remain undamaged through submittal, review, and field comparison process may, after final check of operation, be incorporated in the Work, within limitation of keying coordination requirements.

C. Templates for doors, frames, and other work specified to be factory prepared for the installation of door hardware. Check shop drawings of other work to confirm that adequate provisions are made for locating and installing door hardware to comply with indicated requirements.

1.04 QUALITY ASSURANCE

A. Regulatory Requirements:
1. Fire Rated Openings: Provide door hardware for fire rated openings that complies with NFPA 890 and requirements of authorities having jurisdiction. Provide only items of door hardware that are listed and are identical to products tested by UL or Intertek Testing Services.

1.05 DELIVERY, STORAGE AND HANDLING

A. Packing and Shipping
1. Individually package each unit of finish hardware, complete with proper fastenings and appurtenances, clearly marked on the outside to indicate contents and specific location on the Work.
2. Packaging of door hardware is responsibility of supplier. As material is received by hardware supplier from various manufacturers, sort and repackage in containers clearly marked with appropriate hardware set number to match set numbers of approved hardware schedule. Two or more identical sets may be packed in the same container.
   a. Inventory door hardware jointly with representatives of hardware supplier and hardware installer until each is satisfied that count is correct.

B. Acceptance at Site: Deliver individually packaged door hardware items promptly to place of installation (Sop or Project site).

C. Storage and protection: Provide secure lock-up for door hardware delivered to the Project, but not yet installed. Control handling and installation of hardware items that are not immediately replaceable so that completion of the Work will not be delayed by hardware loses both before and after installation.

1.06 MAINTENANCE

A. Maintenance Tools and Instructions: With delivery of keys, furnish a complete set of specialized tools and maintenance instructions as needed for the District’s continued adjustment, maintenance, and removal and replacement of door hardware.

PART 2 - PRODUCTS

2.01 GENERAL

A. Fasteners
1. Furnish necessary screws, bolts, and other fasteners of suitable size and type to anchor the hardware in position for long life under hard use.
2. Where necessary, furnish fasteners with toggle bolts, expansion shields, sex bolts, and other anchors approved by the architect, according to the material to which the hardware is to be applied and according to the recommendations of the hardware manufacturer.

3. Provide fasteners which harmonize with the hardware as to finish and material.

B. Where butts are required to swing 180 degrees, furnish butts of sufficient throw to clear the trim.

C. Furnish silencers for door frames at the rate of 3 for each single door and 2 for each door or pair of doors; except weather-stripped doors and doors with light seals, smoke seals or sound seals.

2.02 KEYING

A. Factory key, masterkey, and grand-masterkey locks and cylinders as directed by the District. Corbin Russwin N-23 Keyway is Campus Standard.

B. Furnish 3 keys for each lock, 12 masterkeys for each set, and 3 grand-masterkeys.

C. Construction Keying
   1. Furnish a construction masterkey system with 5 keys for locks and cylinders. No more than 6 for any group. The rest in blanks.
   2. Use only the construction keys during construction.
   3. Upon Substantial Completion of the work, as that Date is established by the Architect, Campus Facilities personnel will void constriction key system.

D. Identification and Delivery
   1. Factory stamp permanent keys, “DO NOT DUPLICATE”.
   2. Send direct to the District by direct delivery the IC cores and keys specified. Order hardware-less cores for faster delivery.

2.03 HINGES

A. General
   1. provide hinges having minimum of 5 knuckles.
   2. provide ball-bearing hinges having concealed bearings and interior self-lubricating bushings.
   3. Provide ball bearing hinges on doors with closers.
   4. Provide fire-resistance doors with steel hinges.
   5. Provide interior doors with non-rising hinges.
   7. Provide template hinges conforming to ANSI A156.7.
   8. Size: In accordance with the following table unless specifically noted otherwise:
      a. Butt Height
         1) Doors 1-3/8 Inches Thick: 3-1/2 inches.
         2) Doors 1-3/4 Inches Thick and Up to 41 inches wide: 4-1/2 inches.
         3) Doors 1-3/4 Inches and from 41 inches to 48 inches wide: 4-1/2 inches extra heavy.
         4) Doors 2 Inches Thick of Over 48 Inches Wide: 5 inches extra heavy.
      b. But Widths: Sufficient to clear trim projection when door swings 180 degrees.
      c. Number Per Door Leaf Unless Otherwise Noted:
         1) Door to 60 inches high: 2 hinges.
         2) Door to 90 inches high: 3 hinges.

DOOR HARDWARE
08 71 00-3
3) door to 120 inches high: 4 hinges.

B. Material
2. Interior: Steel, ball-bearing.
3. Manufacturer: Ives (IVE), Hager Hinge, Stanley or McKinney.

2.04 LOCKSETS, LATCHSETS AND HANDLESETS

A. General
1. Cylinders
   a. Minimum 6 pin interchangeable core cylinders with steel cylindrical cases, and all interior parts shall be non-ferrous. Do not supply plastic, die-cast or aluminum mechanisms.
   b. Provide in keyway as specified. Corbin Russwin N-23 keyway is Campus Standard.
   c. Furnish with plugs of extruded brass bar material full round without flattened areas.
2. Locksets: Provide lockset types specified from the same manufacturer and capable of receiving cylinders complying with requirements specified in “Cylinders” paragraph above.
3. Heavy Duty Cylindrical Locksets
   a. Product: Corbin-Russwin (C-R), "CL3100 Series" of "NZD" design.
4. Backset: 3-3/4 inches, unless otherwise noted.
5. Strikes
   a. Type: Standard type with extended lips where required to protect trim from marring by latch bolt. Verify cutout types provided in metal frames. Locks shall have stainless steel, 3/4-inch throw.
   b. Material: Same as lock trim.
6. Quantity: Provide 1 lockset assembly for each door opening in accordance with the Schedule, unless other noted. Install lockset on active leaf or pair of doors. Pairs of doors scheduled to receive roller latches shall have one for each leaf.
7. Provide matching door handle on left leaf where needed.

2.05 CLOSERS

A. General
1. Provide closers having maximum effort to operate in accordance with CBC Sections 11B-404.2.8.1 & 1008.1 and ADA as follows:
   a. Exterior Hinges Doors: 5 pounds.
   b. Interior Hinges Doors: 5 pounds.
   c. Fire Doors: The Authority having jurisdiction may increase the maximum effort to operate fire doors to achieve positive latching, but not to exceed 15 pounds.
2. Adjust closers in accordance with manufacturer’s directions for size of door.
3. Provide closers having:
   a. Full rack and pinion with steel spring and non-gumming, non-freezing hydraulic fluid.
   b. Provide complete set of separate controls for regulating sweep speed, latch speed, and backcheck. Sizes as recommended by reviewed manufacturer.
   c. Per 11B-404.2.8.1, door shall take at least 5 seconds to move from an open position of 90 degrees to a position of 12 degrees from the latch jamb.

B. Door Surface Applied Modern Closers:
1. Provide closers with molded plastic covers capable of receiving finishes as specified in Article titled “Finishes” in this Section.
2. Provide drop plates at doors having narrow frames.
3. Product: LCN (LCN), or Norton.

C. Quantity: Provide each leaf in pairs of doors schedule to receive closers.

D. Overhead and Floor Concealed Closers:
   1. Provide concealed closes with fully-adjustable spring power, non-gumming, non-freezing hydraulic fluid and delayed action closing, where specified.
   2. Furnish pivots sets from same manufacturer as concealed closers.
   3. Provide spindle height to suit installation requirements.
   4. Product: Rixson (RIX), Division of Assa-Abloy.

2.06 EXIT DEVICES

A. Exit devices: Von Duprin (VON) as scheduled with push-through pad design, no exposed touch bar fasteners, no exposed cavities when operated.
   1. Provide certificate by independent testing laboratory that device has completed over 1,000,000 cycles and can still meet ANSI/BHMA A156.3 - 2007 standards.
   2. Compression spring engineering.
   3. Non-handed basic device design with center case interchangeable with all functions.
   4. All devices shall have quiet return fluid dampeners.
   5. All latchbolts shall be deadlocking with ¾” throw and have a self-lubricating coating to reduce friction and wear.
   6. Device push bar must release when a force of 32 pounds, or less, of pressure is applied when a force of 250 pounds is applied to the door.
   7. Device shall bear UL label for fire and or panic as may be required.
   8. All surface strikes shall be roller type and utilize a plate underneath to prevent movement.
   9. Panic Hardware shall comply with CBC 1008.1.9.2 and 11B.404.2.7 and shall be mounted between 34" and 44" above the finished floor surface. The unlatching force shall not exceed 15 lbs, applied in the direction of travel. Panic hardware shall comply with CBC Section 1008.1.10.1

2.07 STOPS AND HOLDERS

A. General
   1. Unless otherwise noted in Hardware Sets, provide wall type with appropriate fasteners. Where wall type cannot be used, provide floor type. If neither can be used, provide overhead type.
   2. Do not install floor stops more than four (4) inches from the face of the wall or partition (11B-307).
   3. Overhead stops shall be made of stainless steel and non-plastic mechanisms and finished metal end caps. Field-changeable hold-open, friction and stop-only functions.
   4. Manufacturer: Ives (IVE), Trimco, or Builders Brass.

2.08 AUTO BOLTS

A. General
   1. Automatic Flush Bolts shall be of the low operating force design. Utilize the top bolt only model for interior doors where applicable and as permitted by testing procedures.
   2. Manual flush bolts only permitted on storage or mechanical openings as scheduled.
   3. Provide dust proof strikes at openings using bottom bolts.
   4. Manufacturer: Ives (IVE), Trimco or Builders Brass.
2.09 DOOR PROTECTION PLATES

A. General
   1. Kick Plates
      a. Width and Anchorage: Provide plates 2 inches narrower than single doors or 1
         inch narrower than pair of doors. Ensure anchorage to bottom rail
      b. Height: Minimum 10 inches.
      c. Thickness: Stainless steel, 0.050-inches thick, with beveled edges 3 sides.
      d. Quantity: Provide kick plates on push side of doors unless scheduled differently.
   2. Manufacturer: Ives (IVE), Trimco or Builders Brass.

2.10 THRESHOLDS

A. General
   1. Provide thresholds that comply with the disability requirements of the ADA.
   2. Set thresholds solidly to floor.
   3. Provide thresholds notched at frame stops and entire with of frame.
   4. Material: Extruded aluminum, unless otherwise noted.
   5. Manufacturer: National Guard Products (NGP), or Pemko.
   6. Thresholds shall comply with CBC Section 11B-404.2.5.
   7. See threshold details for model numbers.

2.11 WEATHER-STRIPPING / SEAL

A. General
   1. Fire and Smoke
   2. Manufacturer: National Guard Products (NGP), or Pemko.
      a. Material: Self-adhesive silicon seal, rated for fire and smoke in accordance with
         ASTM E283, sound rated in accordance with ASTM E90.
      b. Extent: Seal sets shall consist of gasketing that is continuous at head and jambs.
   3. Sound and Thermal Seals
      a. Material: Aluminum unless otherwise noted, with adjustable extruded EPDM
         closed cell sponge neoprene and fire labeled in accordance with ASTM E152, UL
         10C and CBC.
      b. Extent: Sound seal sets shall consist of gasketing that is continuous at head and
         jambs.

2.12 MISCELLANEOUS

A. Miscellaneous items include, dust proof strikes, coordinators, and exit alarms and alarm contact
   switches, power supplies.
   1. Manufacturer: See Schedule.

2.13 KEY CONTROL SYSTEM

A. General
   1. Provide system including envelopes, labels, tags with self-locking key clips, receipt forms,
      three-way visible card index, temporary markers, permanent markers, and standard metal
      cabinet, as recommended by system manufacturer, with capacity for 150 percent of the
      number of locks require for the Project.
   2. Provide complete cross index system set up key control manufacturer and place keys on
      markers and hooks in the cabinet as determined by the final key schedule.
   3. Provide hinged-panel type cabinet for wall mounting.

DOOR HARDWARE
08 71 00-6
4. Provide "simplex" type push button lock on cabinet. Furnish Telkee (TEL) "AWC450S-SMTC" or equal.

2.14 SILENCERS

A. General
   1. Material: Pneumatic rubber, installed in metal frame stops.
   2. Quantity: Furnish 3 for single doors and 2 for each door for pairs of doors.
   3. Manufacturer: Ives (IVE), Trimco or equal.

2.15 FINISH

A. Generally to be satin stainless US32D (BHMA 630) unless otherwise noted.

B. Door closers shall be powder-coated to match other hardware, unless otherwise noted.

C. Aluminum items to be finished anodized aluminum US28 (628), except thresholds which can be furnished as standard mill finish.

2.16 KEY BOX

A. Contact jurisdictional fire department and obtain order forms necessary to order Knox Company, 3200 Series Knox Box, recessed mount with hinged door.
   1. Box and lock to be UL listed.
   2. Color: Aluminum.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine doors and door frames for damage or defects and examine hardware for compatibility with receiving conditions and suitability to intended use.

B. Verify that required wall backing has been installed.

C. Do not install hardware until unsuitable conditions have been corrected or inadequate or defective items have been replaced.

3.02 PREPARATION

A. Coordinate with work requiring hardware or work to which harder attaches.

B. Provide necessary copies of schedules or templates in ample time to avoid fabrication and construction delays.

C. Provide key control system installer with 1 reviewed copy of hardware schedule and keying instructions.

3.03 INSTALLATION
A. Mount hardware units at heights indicated in DHI RL and NWWDA I.S.1.7, except as specifically indicated or required to comply with governing regulations and except as otherwise directed by the Architect. Mount floor stops maximum 4” from wall.

B. Install each hardware item in compliance with the manufacturer's instructions and recommendations. Where cutting and fitting is required to install hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstalling or application of surface protection with finishing work specified in Section 09900. Do not install surface mounted items until finishes have been completed on the substrates involved.

C. Set units level, plumb, and true to line and location. Adjust and reinforce the attachment substrate as necessary for proper installation and operation.

D. Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors in accordance with industry standard.

E. Set thresholds for exterior doors in full bed of butyl-rubber or polyisobutylene mastic sealant complying with requirements specified in Section 07900.

F. Weather-stripping and Seals:
   1. Comply with manufacturer’s instructions and recommendations to the extent installation requirements are not otherwise indicated.
   2. Provide door shoe or other bottom door seal / weatherstripping at all exterior and stairwell doors.

3.04 ADJUSTING, CLEANING AND DEMONSTRATING

A. Adjust and check each operating item of hardware and each door, to ensure proper operation or function of every unit. Replace units which cannot be adjusted to operate freely and smoothly as intended for the application made. Doors must be adjusted to ADA requirements at punch list completion.

B. Clean adjacent surface soiled by hardware installation.

C. Instruct the District’s Personnel in proper adjustment and maintenance of hardware finishes.

Manufacturers Abbreviations (Mfr.)

*C-R = Corbin-Russwin
GLY = Glynn-Johnson Corporation
IVE = Ives
*LCN = LCN
ZER = Zero International

* Items indicated with asterisk are Campus Standard – NO SUBSTITUTIONS.

SPEXTRA: 241506
GROUP NO. 01

<table>
<thead>
<tr>
<th>Quantity</th>
<th>Description</th>
<th>Model/Part No. Description</th>
<th>Price</th>
<th>Vendor</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>HW HINGE</td>
<td>5BB1HW 4.5 X 4.5</td>
<td>652</td>
<td>IVE</td>
</tr>
<tr>
<td>1</td>
<td>ELECTRIC HW HINGE</td>
<td>5BB1HW 4.5 X 4.5 TW8</td>
<td>652</td>
<td>IVE</td>
</tr>
<tr>
<td>1</td>
<td>AUTO FLUSH BOLT</td>
<td>FB31P</td>
<td>630</td>
<td>IVE</td>
</tr>
<tr>
<td>1</td>
<td>DUST PROOF STRIKE</td>
<td>DP1</td>
<td>626</td>
<td>IVE</td>
</tr>
<tr>
<td>1</td>
<td>FAIL SECURE LOCK</td>
<td>CL33905 NZD M17 CT6 3-3/4&quot; BS</td>
<td>626</td>
<td>C-R</td>
</tr>
<tr>
<td>1</td>
<td>STD IC CORE</td>
<td>8000-6</td>
<td>626</td>
<td>C-R</td>
</tr>
<tr>
<td>1</td>
<td>COORDINATOR</td>
<td>COR X FL</td>
<td>628</td>
<td>IVE</td>
</tr>
<tr>
<td>2</td>
<td>SURFACE CLOSER</td>
<td>4011</td>
<td>689</td>
<td>LCN</td>
</tr>
<tr>
<td>2</td>
<td>FLOOR STOP</td>
<td>FS439</td>
<td>682</td>
<td>IVE</td>
</tr>
<tr>
<td>1</td>
<td>GASKETING</td>
<td>1885-BK</td>
<td>682</td>
<td>S-BK ZER</td>
</tr>
<tr>
<td>1</td>
<td>ASTRAGAL</td>
<td>BY HM DOOR MFR</td>
<td>P</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>THRESHOLD</td>
<td>PER DETAIL</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

READER, POWER SUPPLY AND WIRING BY ACCESS CONTROL VENDOR

GROUP NO. 02

<table>
<thead>
<tr>
<th>Quantity</th>
<th>Description</th>
<th>Model/Part No. Description</th>
<th>Price</th>
<th>Vendor</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>HINGE</td>
<td>5BB1 4.5 X 4.5</td>
<td>652</td>
<td>IVE</td>
</tr>
<tr>
<td>1</td>
<td>CLASSROOM LOCK</td>
<td>CL3155 NZD M17 CT6 B334</td>
<td>626</td>
<td>C-R</td>
</tr>
<tr>
<td>1</td>
<td>STD IC CORE</td>
<td>8000-6</td>
<td>626</td>
<td>C-R</td>
</tr>
<tr>
<td>1</td>
<td>FLOOR STOP</td>
<td>FS439</td>
<td>682</td>
<td>IVE</td>
</tr>
<tr>
<td>3</td>
<td>SILENCER</td>
<td>SR64</td>
<td>GRY</td>
<td>IVE</td>
</tr>
</tbody>
</table>

GROUP NO. 03

<table>
<thead>
<tr>
<th>Quantity</th>
<th>Description</th>
<th>Model/Part No. Description</th>
<th>Price</th>
<th>Vendor</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>HINGE</td>
<td>5BB1 4.5 X 4.5</td>
<td>652</td>
<td>IVE</td>
</tr>
<tr>
<td>1</td>
<td>CLASSROOM LOCK</td>
<td>CL3155 NZD M17 CT6 B334</td>
<td>626</td>
<td>C-R</td>
</tr>
<tr>
<td>1</td>
<td>STD IC CORE</td>
<td>8000-6</td>
<td>626</td>
<td>C-R</td>
</tr>
<tr>
<td>1</td>
<td>SURFACE CLOSER</td>
<td>4011 OR 4111</td>
<td>689</td>
<td>LCN</td>
</tr>
<tr>
<td>1</td>
<td>FLOOR STOP</td>
<td>FS439</td>
<td>682</td>
<td>IVE</td>
</tr>
<tr>
<td>1</td>
<td>GASKETING</td>
<td>1885-BK</td>
<td>S-BK ZER</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>DOOR BOTTOM</td>
<td>355A</td>
<td>A ZER</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>THRESHOLD</td>
<td>PER DETAIL</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

END OF SECTION
SECTION 08 80 00

GLAZING

PART 1  GENERAL

1.01  SECTION INCLUDES

A. Glazing
B. Glazing compounds and accessories.

1.02  REFERENCES

K. GANA (SM) - FGMA Sealant Manual; Glass Association of North America; 1990.

1.03  PERFORMANCE REQUIREMENTS

A. Select type and thickness of exterior glass to withstand dead loads and wind loads acting normal to plane of glass at design pressures calculated in accordance with California Building code.
   1. Use the procedure specified in ASTM E 1300 to determine glass type and thickness.
   2. Limit glass deflection to 1/200 or flexure limit of glass, whichever is less, with full recovery of glazing materials.
   3. Thicknesses listed are minimum.

1.04  SUBMITTALS

A. Comply with pertinent provisions of Section 01 33 00 - Submittals.
B. Product Data: Submit manufacturer's product data for each glass product and glazing material required.
C. Samples for verification purposes:
   1. (2) 12-inch-square samples of each type of glass indicated except for clear monolithic glass products
   2. (2) 12-inch-long samples of each color required (except black) for each type of sealant or gasket exposed to view. Install sealant or gasket sample between two strips of material representative in color of the adjoining framing system.
3. (2) 12-inch square samples of privacy window film indicated.

D. Compatibility and adhesion test reports from sealant manufacturer indicating that glazing materials were tested for compatibility and adhesion with glazing sealants. Include sealant manufacturer’s interpretation of test results relative to sealant performance and recommendations for primers and substrate preparation needed for adhesion.

E. Compatibility test report from manufacturer of insulating glass edge sealant indicating that glass edge sealants were tested for compatibility with other glazing materials including sealants, glazing tape, gaskets, setting blocks, and edge blocks.

F. Product test reports for each type of glazing sealant and gasket indicated, evidencing compliance with requirements specified.

G. Maintenance Data: Submit manufacturer’s maintenance data for glass and other glazing materials.

H. Installation Instructions: Provide manufacturer’s instructions for installation of privacy window film.

1.05 QUALITY ASSURANCE

A. Glazing Publications: Comply with published recommendations of glass product manufacturers and organizations below, except where more stringent requirements are indicated. Refer to these publications for glazing terms not otherwise defined in this Section or in referenced standards.


B. Safety Glazing Standard: Where safety glass is indicated or required by authorities having jurisdiction, provide type of products indicated which comply with ANSI Z97.1 and testing requirements of 16 CFR Part 1201 for category II materials.

C. Requirements of Regulatory Agencies:

1. California Building Code (CBC), Title 24, Part 2, Chapter 24. Comply with wind design requirements of Title 24, Part 2, Chapter 16A, Division II.


D. Grading and Labeling: Grade and label each light stating quality and grade of glass and manufacturer’s name and brand designation. Leave labels intact until removal is directed by Architect.

E. Glazier Qualifications: Engage an experienced glazier who has completed glazing similar in material, design, and extent to that indicated for Project with a record of successful in-service performance.

F. Single-Source Responsibility for Glass: Obtain glass from one source for each product indicated below:

1. Primary glass of each (ASTM C 1036) type and class indicated.

2. Heat-treated glass of each (ASTM C 1048) condition indicated.

G. Single-Source Responsibility for Glazing Accessories: Obtain glazing accessories from one source for each product and installation method indicated.

H. Pre-Installation Conference: Conduct conference at Project site to comply with requirements of Division 1 Section, "Project Meetings".

1.06 DELIVERY, STORAGE AND PRODUCT HANDLING

A. Protect glazing materials to comply with manufacturer’s directions and as needed to prevent damage to glass and glazing materials from condensation, temperature changes, direct exposure to sun, or other causes.
1.07 PROJECT CONDITIONS
A. Environmental Conditions: Do not proceed with glazing when ambient and substrate temperature conditions are outside the limits permitted by glazing materials manufacturer or when glazing channel substrates are wet from rain, frost, condensation, or other causes.

1.08 WARRANTY
A. General: Warranties specified in this Article shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and will be in addition to and run concurrent with other warranties made by the Contractor under requirements of the Contract Documents.

PART 2 PRODUCTS

2.01 PRIMARY FLOAT GLASS PRODUCTS
A. Clear Float Glass: ASTM C 1036, Type 1 (transparent glass, flat), Class 1 (clear), quality q3 (glazing select), 1/4 inch thick.

2.02 HEAT-TREATED FLOAT GLASS PRODUCTS
A. Fabrication Process: By vertical (tong-held) or horizontal (roller-hearth) process, at manufacturer's option, except provide horizontal process where indicated as tongless or free of tong marks.
B. Uncoated, Clear, Heat-Treated Float Glass: ASTM C 1048, Condition A (uncoated surfaces), Type 1 (transparent glass, flat), Class 1 (clear), Quality q3 (glazing select), 1/4 inch thick, kind as indicated below.
   1. FT (fully tempered) where indicated and per code.

2.03 EXTERIOR GLAZING
A. Type IG-1
   a. Spandrel Glass
      1) ASTM C1048, Kind FT (Fully tempered, condition B (spandrel glass, one-surface ceramic coated), Type (transparent glass, flat), Class 1 (clear), Quality q3 (glazing select).
         a. Location of Ceramic Coating: Second surface.
         b. Ceramic Coating color: Match PPG "Solarban 60 (3) Atlantica", Viracon "Green 2000, HS VE-10-2M #2 (Veralux by Visteom)" or approved equal.

2.03 GLAZING SEALANTS
A. General: Provide products complying with the following requirements:
   1. Compatibility: Select glazing sealants and tapes of proven compatibility with other materials they will contact, including glass products, seals of insulating glass units, and glazing channel substrates, under conditions of installation and service, as demonstrated by testing and field experience.
   2. Suitability: Comply with sealant and glass manufacturer's recommendations for selecting glazing sealants and tapes that are suitable for applications indicated and conditions existing at time of installation.
   3. Colors: Provide color of exposed joint sealants to comply with the following:
      a. Match colors indicated by reference to manufacturer's standard designations.
      b. Provide selections made by Architect from manufacturer's full range of standard
colors for products of type indicated.

B. Sealant: 1-part silicone rubber glazing sealant complying with ASTM C 920, Type S, Grade NS, Class 25, Uses NT, G and A. Provide acid-curing type recommended by manufacturer where only nonporous bond surfaces are contacted; provide nonacid curing type recommended by manufacturer where one or more porous bond surfaces are contacted.

2.04 MISCELLANEOUS GLAZING MATERIALS

A. Cleaners, Primers and Sealers: Type recommended by sealant or gasket manufacturer.

B. Setting Blocks: Elastomeric material with a Shore A durometer hardness of 85 plus or minus 5 with proven compatibility with sealants used.

C. Spacers: Elastomeric blocks or continuous extrusions with a Shore A durometer hardness required by glass manufacturer to maintain glass lites in place for installation indicated.

D. Edge Blocks: Elastomeric material of hardness needed to limit glass lateral movement (side walking).

2.05 FABRICATION OF GLASS AND OTHER GLAZING PRODUCTS

A. Fabricate glass and other glazing products in sizes required to glass openings indicated for Project, with edge and face clearances, edge and surface conditions, and bite complying with recommendations of product manufacturer and referenced glazing standard as required to comply with system performance requirements.

B. Clean cut or flat grind vertical edges of butt-glazed monolithic lites in a manner that produces square edges with slight kerfs at junctions with indoor and outdoor faces.

2.06 PRIVACY WINDOW FILM

A. Provide privacy window film at interior glazing surfaces of existing windows within project remodel area per dwgs.

B. Acceptable Manufacturers: Provide Decorative Films LLC, “Solyx Blackout Film”, color: SXWF-BO Black Film, or equal.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine glass framing, with glazier present, for compliance with the following:
   1. Manufacturing and installation tolerances, including those for size, squareness, offsets at corners.
   2. Presence and functioning of weep system.
   3. Minimum required face or edge clearances.
   4. Effective sealing between joints of glass-framing members.

B. Do not proceed with glazing until unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Clean the glazing channel, or other framing members to receive glass, immediately before glazing. Remove coatings which are not firmly bonded to the substrate. Remove lacquer from metal surfaces wherever elastomeric sealants are used.

3.03 GLAZING, GENERAL

A. Watertight and airtight installation of each piece of glass is required, except as otherwise
shown. Each installation must withstand normal temperature changes, wind loading, impact loading (for operating sash and doors) without failure of any kind including loss or breakage of glass, failure of sealants or gaskets to remain watertight and air-tight, deterioration of glazing materials and other defects in the work.

B. Protect glass from edge damage during handling and installation as follows:
   1. Use a rolling block in rotating glass units to prevent damage to glass corners. Do not impact glass with metal framing. Use suction cups to shift glass units within openings; do not raise or drift glass with a pry bar. Rotate glass lites with flares or bevels on bottom horizontal edges so edges are located at top of opening, unless otherwise indicated by manufacturer's label.
   2. Remove damaged glass from Project site and legally dispose of off-site. Damaged glass is glass with edge damage or other imperfections that, when installed, weaken glass and impair performance and appearance.

C. Glazing channel dimensions as shown are intended to provide for necessary bite on glass, minimum edge clearance, and adequate sealant thicknesses, with reasonable tolerances. Adjust as required by job conditions at time of installation.

D. Comply with combined recommendations and technical reports by manufacturers of glass and glazing products as used in each glazing channel, and with recommendations of GANA's "Glazing Manual," except where more stringent requirements are indicated.

E. Apply primer or sealer to joint surfaces wherever recommended by sealant manufacturer.

F. Install elastomeric setting blocks in sill rabbets, sized and located to comply with referenced glazing standard, unless otherwise required by glass manufacturer. Set blocks in thin course of compatible sealant suitable for heel bead.

G. Do not exceed edge pressures stipulated by glass manufacturers for installing glass lites.

H. Provide spacers for glass sizes larger than 50 united inches (length plus height) as follows:
   1. Locate spacers inside, outside, and directly opposite each other. Install correct size and spacing to preserve required face clearances, except where gaskets and glazing tapes are used that have demonstrated ability to maintain required face clearances and comply with system performance requirements.
   2. Provide 1/8 inch minimum bite of spacers on glass and use thickness equal to sealant width. With glazing tape, use thickness slightly less than final compressed thickness of tape.

I. Provide edge blocking to comply with requirements of referenced glazing publications, unless otherwise required by glass manufacturer.

J. Set glass lites in each series with uniform pattern, draw, bow, and similar characteristics.

K. Provide safety glass in all hazardous locations as required by code, including the following:
   1. Provide safety glass for all glazed panels adjacent to a door, within the same wall plane as the door whose nearest vertical edge is within 12 inches of the door in a closed position and whose bottom edge is less than 60 inches above the floor or walking surface.
   2. Provide safety glass for glazed panels in excess of 9 square feet of area, where the lowest edge is less than 18 inches above the finished floor level or walking surface within 36 inches of such glazing.

L. Cut and install colored (tinted) and heat absorbing glass as recommended in "Technical Services Report No. 130" by PPG Industries.

M. Install insulating glass units to comply with recommendations by Sealed Insulating Glass Manufacturers Association, except as otherwise specifically indicated or recommended by glass and sealant manufacturers.
3.04 GLAZING

A. Cutting and Fitting Glass: Accurately cut and fit glass to opening size. Provide clearance for expansion. Cut and set glass to keep wave lines horizontal. Ensure sharp, clean cut glass edges.

B. Force sealants into channel to eliminate voids and to ensure complete "wetting" or bond of sealants to glass and channel surfaces.

C. Tool exposed surfaces of glazing liquids and compounds to provide a substantial "wash" away from the glass. Install pressurized tapes and gaskets to protrude slightly out of the channel, so as to eliminate dirt and moisture pockets.

D. Clean and trim excess glazing materials from the glass and stops or frames promptly after installation, and eliminate stains and discolorations.

E. Do not attempt to cut, seam, nip or abrade glass which is tempered, heat strengthened, or coated.

3.05 PRIVACY WINDOW FILM INSTALLATION

A. Preparation: Clean the interior glazing surface to which the film is to be applied, removing all traces of dirt, grime, grease, etc.

B. Cutting: Carefully measure the height and width of the glass surface. Oversize the film up to 3/4" extra material on each side of the film and cut the film to this size. Lay decorative film on a clean flat surface with the release liner up.

C. Wetting of Film: Remove the release liner and spray the exposed adhesive surface thoroughly with the wetting solution (8 drops of very mild detergent into 32 oz. spray bottle). Apply wetting solution to glass surface, to allow proper positioning of the film.

D. Film Placement: Place the wetted film onto the clean glass surface. Wet the outside face of the film. Moving from the center out towards the edges, use plastic card squeegee to remove any air bubbles and wetting solution. Double check that the film is flat and smooth with no remaining air bubbles and water.

E. Finishing: Trim the excess film from the edges of the surface. Cut in one continuous movement, using the ruler and razor knife. Cleaning glass surface to remove excess wetting solution around the edges.

F. Drying: The film may take a few days to dry in order for it to completely adhere to the glass surface.

G. Precautions: The glazing surface to which the film will be applied should be very clean, free of dirt, dust particles and silicone. Make sure there are no dry spots on the film prior to placing it onto the glass.

H. Seaming Films: For windows that are wider than the available width of window films, industry standards allow for seaming. Standard installation for seaming is a butt-join type seam. The films are overlapped and cut through with a sharp blade using a straight edge. The excess films are removed.

I. Maintenance: Normal cleaning with a mild window cleaner. It is not recommended that anything abrasive be used.

3.06 CURE, PROTECTION AND CLEANING

A. Cure glazing sealants and compounds in compliance with manufacturer's instructions and recommendations, to obtain high early bond strength, internal cohesive strength and surface durability.
B. Protect exterior glass from breakage immediately upon installation, by attachment of crossed streamers to framing held away from glass. Do not apply markers of any type to surfaces of glass. Remove nonpermanent labels and clean surfaces.

C. Remove and replace glass which is broken, chipped, cracked, abraded or damaged in other ways during the construction period, including natural causes, accidents and vandalism.

D. Protect glass from contact with contaminating substances resulting from construction operations including weld splatter. If, despite such protection, contaminating substances do come into contact with glass, remove them immediately as recommended by glass manufacturer.

E. Examine glass surfaces adjacent to or below exterior concrete and other masonry surfaces at frequent intervals during construction, but not less than once a month, for build-up of dirt, scum, alkali deposits, or stains, and remove as recommended by glass manufacturer.

END OF SECTION
SECTION 09 21 16

GYPSUM BOARD SHAFTWALL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes vertical gypsum board shaftwall assemblies consisting of gypsum shaftwall boards, U-shaped metal floor and ceiling tracks, specially shaped studs, and gypsum sheathing on finished side or sides.

B. Related requirements: Division 09 for gypsum board systems.

1.2 SUBMITTALS

A. Data: Manufacturer Product Data and installation instructions for shaftwall assemblies, including provisions for fixture and equipment anchorage.

B. Shop drawings: Large scale, dimensioned Shop Drawings showing provisions for fixture and equipment anchorage to systems.

1.3 QUALITY ASSURANCE

A. Fire resistance: Where a fire resistance classification is indicated, provide materials, accessories, and application procedures listed by UL or tested according to ASTM E 119 for the type of construction shown, and approved by Authorities having jurisdiction.

B. Single source responsibility: Obtain shaftwall products from a single manufacturer, or from manufacturers recommended by the prime manufacturer of shaftwall systems.

1.4 HANDLING

A. Store materials inside under cover and keep them dry and protected against weather, condensation, direct sunlight, construction traffic, and other potential causes of damage.

B. Stack panels flat and supported on risers on a flat platform to prevent sagging.

1.5 JOB CONDITIONS

A. As specified in Section 09 29 00.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Structural performance characteristics: Provide shaftwall assemblies designed and tested by manufacturer to withstand the lateral loads specified, within the specified deflection limit.

1. Lateral loading: 5 psf, except where otherwise indicated.

2. Deflection limit: L/240 of partition height except where more restrictive limits are specified or noted on the Drawings.

3. Modify and supplement manufacturer's standard systems to comply with performance requirements.
2.2 MANUFACTURERS

A. As specified in Section 09 29 00.

2.3 METAL FRAMING

A. One of the following systems of the size indicated and gage required to comply with criteria specified.

1. Dale/InCor Series 600.
3. USG J-runners, E and C-H studs.

B. Studs: Manufacturer's standard profile for repetitive members, corner and end members, and fire-resistance-rated assembly indicated.

1. Depth: As indicated.
2. Minimum base-metal thickness: 0.033 inch.

C. Runner tracks: Manufacturer standard J-profile track with manufacturer's standard long-leg length, but at least 2 inches long and matching studs in depth. Minimum Base-Metal Thickness: 0.033 inch.

D. Room-side finish: Gypsum board, unless otherwise indicated.

E. Shaft-side finish: Gypsum shaftliner board, Type X.

F. Deflection compensation: Where studs extend to the underside of floor or roof slabs, secure at top with "Fire Trak Cavity Shadowline" track by Fire Trak Corp. or other Code-compliant assemblies acceptable to the Architect.

2.4 GYPSUM SHAFTLINER BOARD

A. ASTM C 1396, Type X, with moisture-resistant paper facings, maximum lengths available to eliminate or minimize end-to-end butt joints, thickness indicated by one of the manufacturers specified in Section 09 29 00.

B. Gypsum board, accessories, including joint tape, compound, and laminating adhesive: As specified in Section 09 29 00.

2.5 ACOUSTICAL INSULATION & SEALANT

A. As specified in Section 09 80 00.

PART 3 - EXECUTION

3.1 EXAMINATION/PREPARATION

A. Before enclosing cavity walls, thoroughly clean space and floor tracks of debris.

B. Verify conditions and measurements affecting the work of this Section at site.

C. Correct other conditions detrimental to the proper and timely completion of this work before proceeding with installation.

3.2 INSTALLATION
A. Comply with shaftwall components manufacturer's installation instructions and with applicable provisions of ASTM C 754 and C 840.

B. Anchor and attach materials to comply with indicated fire-rating, performance requirements, and governing regulations.

C. Install supplementary framing in gypsum board shaft wall assemblies around openings and as required for blocking, bracing, and support of gravity and pullout loads of fixtures, equipment, services, heavy trim, furnishings, wall-mounted door stops, and similar items that cannot be supported directly by shaft wall assembly framing.

1. Where handrails directly attach to gypsum board shaft wall assemblies, provide galvanized steel reinforcing strip with 0.033-inch minimum thickness of base metal (uncoated), accurately positioned and secured behind at least one layer of face panel.

D. Isolate shaftwall systems from transfer of structural loading, both horizontally and vertically. Provide slip or cushioned type joints to attain lateral support and avoid axial loading.

E. Seal perimeter of each section of work where it abuts other work.

1. Install a bead of acoustical sealant to prevent dislocation by air pressure differential as specified in Section 09 80 00.
2. Seal joints and penetrations in compliance with manufacturer's instructions.

F. Trim:

1. Where room side of system will be finished, install trim accessories in compliance with shaftwall manufacturer's instructions.
2. Apply trim where edge of gypsum board would otherwise be exposed or semi-exposed, including terminations, openings, external corners, expansion and control joints and similar edges.

G. Finish exposed gypsum board surfaces as specified in Section 09 29 00.

3.3 PROTECTION

A. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.

B. Remove and replace panels that are wet, moisture damaged, or mold damaged.

1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, and irregular shape.
2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

END OF SECTION
SECTION 09120
CEILING & SOFFIT SUSPENSION SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY
A. Section includes ceiling and soffit suspension systems for horizontal gypsum board systems.
B. Related requirements:
   1. Division 08 for access panes and their frames.
   2. Division 09 for suspension system for acoustical ceiling panels.

1.2 REFERENCES
A. Comply with the following:
   1. DSA IR-25-2.
   2. DSA IR 25-3.

1.3 SUBMITTALS
A. Shop Drawings:
   1. Dimensioned Shop Drawings of all ceiling and soffit suspension and framing system at 1:48 scale for plans and 1:24 for details.
   2. Show plan layout.
   3. Detail attachment to overhead construction.
   4. Identify and dimension adjacent materials and supports.
B. Data: Manufacturer’s Product Data, specifications and installation instructions for each type of suspension system, including provisions for fixture and equipment anchorage.

1.4 HANDLING
A. Store materials undercover, off the ground or floor, in a dry, ventilated space.

PART 2 - PRODUCTS

2.1 PERFORMANCE CRITERIA
A. Ceiling suspensions systems shall safely support dead loads (ceiling, work of other trades supported by the ceilings such as annunciators, fire alarm and their accessories) with a maximum deflection of finished ceilings of L/240.
B. Ceiling suspensions systems shall be designed and constructed to safely resist seismic loads and movements without failure of their components, except minor damage (cracks) to the ceiling finish.

2.2 MATERIALS

A. Metal channels: ASTM C 645, galvanized in compliance with ASTM A 924, G60 coating designation.

1. Framing, furring and stiffening:

<table>
<thead>
<tr>
<th>Size</th>
<th>Type</th>
<th>Pounds per 1,000 linear feet</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/4-inch with 7/16-inch flanges</td>
<td>Cold-rolled</td>
<td>300</td>
</tr>
<tr>
<td>One-inch</td>
<td>Hot-rolled</td>
<td>410</td>
</tr>
<tr>
<td>1-1/2-inch with 7/16-inch flanges</td>
<td>Hot-rolled</td>
<td>475</td>
</tr>
<tr>
<td>2-inches</td>
<td>Cold-rolled</td>
<td>590</td>
</tr>
</tbody>
</table>

2. Furring channels: Minimum 16 mills thick (26-gage) galvanized steel with knurled faces, hat-shaped or Zee section as required.

B. Hanger wire: Galvanized, soft, mild annealed steel, 0.145-inch diameter (8 BW gage) unless otherwise indicated.

C. Diagonal bracing wire: Galvanized, soft, mild annealed steel, 0.109-inch (12 BW gage) unless otherwise indicated.

D. Tie-wire: 0.0598-inch (16-gage), galvanized, single-strand annealed steel or 0.0478-inch (18-gage), galvanized, double-strand annealed steel.

E. Fasteners and attachments:

1. Screws: ASTM C 1002, 3/8-inch head diameter, cadmium-plated pan head screws; length and gage required by Code, or recommended by recommended by manufacturer for uses and materials involved.

2. Furring channel clips: Manufacturer standard clips for attaching gypsum board furring channels to runner channels.

3. Welding electrodes: ASTM A 233, as recommended by AWS for the conditions of use and the metals to be welded.


PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions and measurements affecting the work of this Section at site.
B. Correct detrimental conditions before proceeding with installation.

3.2 CEILING SUSPENSION FRAMING
A. Space main runners as indicated so that hanger wires do not support more than 12 square feet of ceiling.
B. Hang suspended framing independent of walls, columns, pipes, ducts, and conduits, and their insulation.
C. Do not attach wires to, or bend around, interfering material such as ductwork, pipes and conduits. Provide trapeze, or equivalent devices substantiated by detailed Shop Drawings and calculations, where obstructions interfere with direct suspension.
D. Space runner channels not more than 6 inches from parallel walls or beams.
   1. Align runner channels accurately relative to indicated ceiling height and saddletie with hanger wires.
   2. Lap channels 12 inches at splices and tie at each end of lap.
E. For gypsum board soffits and ceilings, install 7/8-inch hat channels perpendicular to carrying channels, spaced 16 inches o.c. and within 6 inches of walls.
   1. Provide one inch clearance between furring channels and abutting walls and partitions.
   2. Attach to carrying channels with furring channel clips or wire-tie with triple wrap and triple twist.
   3. At splices, nest furring channels with a minimum 8 inches overlap and wire-tie each end.
F. Install 4-way, 45-degree diagonal bracing wires in a 12-foot grid maximum.
G. Stiffener:
   1. For gypsum board ceiling/soffits, install uplift stiffener for each 144 square feet of ceiling, consisting of a vertical metal stud occurring at the junction of the carrier and furring channel. Wire-tie to carrier or screw to channel and secure to overhead structure.
H. At control joints, provide discontinuous lap in main runners occurring over joints.
   1. Do not bridge joints with cross furring where joints run perpendicular to furring.
   2. Where joints run parallel to furring, provide furring to support each side of joint.
I. Provide recesses and openings where indicated for lighting fixtures, registers, access panels and other items to be installed in ceilings. Provide additional furring channels where required by opening condition.

END OF SECTION
SECTION 09 23 00

GYPSUM BOARD

PART 1 GENERAL

1.01 SECTION INCLUDES

A. This section includes the following:
   1. Gypsum board attached to metal framing.
   2. Gypsum shaftwall board used in rated ceiling construction as indicated on Drawings.
   3. Gypsum board finishing (joint taping, joint compound and primer).

1.02 RELATED SECTIONS

A. Section 07 92 00 – Joint Sealants.
B. Section 09 22 00 – Metal Support Assemblies

1.03 REFERENCES

F. ASTM E 413 - Classification for Rating Sound Insulation; 2010.
G. GA-214 - Recommended Levels of Gypsum Board Finish; Gypsum Association; 2010.

1.04 SYSTEM DESCRIPTION

A. Acoustic Attenuation for Interior Partitions Indicated as Acoustic: STC of 45-49 calculated in accordance with ASTM E 413, based on tests conducted in accordance with ASTM E 90.
B. Shaft Wall: Configure and install components as required to achieve the following performance levels:
   1. Air Pressure Within Shaft: Intermittent loads of 5 lbf/sq ft with maximum mid-span deflection of L/240.
   2. Acoustic Attenuation: STC of 45-49 calculated in accordance with ASTM E 413, based on tests conducted in accordance with ASTM E 90.

1.05 SUBMITTALS
A. Comply with pertinent provisions of Section 01 33 00.
B. Product Data: Submit manufacturer's product data for each product specified.

1.06 QUALITY ASSURANCE
A. Perform in accordance with ASTM C 840. Comply with requirements of GA-600 for fire-rated assemblies.
B. Fire-Resistance Ratings: Comply with fire-resistance ratings as shown and as required by governing authorities and codes. Provide materials, accessories and application procedures which have been listed by UL or tested according to ASTM E 119 for the type of construction shown.
C. Installer Qualifications: Company specializing in performing gypsum board application and finishing, with minimum three years of documented experience.

1.07 DELIVERY AND STORAGE
A. Deliver materials in original packages, containers or bundles, bearing name of manufacturer and brand.
B. Store materials inside under cover and keep them dry and protected against damage from weather, direct sunlight, surface contamination, corrosion, construction traffic, and other causes. Neatly stack gypsum panels flat to prevent sagging.

1.08 PROJECT CONDITIONS
A. Environmental Conditions, General: Establish and maintain environmental conditions for applying and finishing gypsum board to comply with ASTM C 840 requirements or gypsum board manufacturer's recommendations, whichever are more stringent.
B. Room Temperatures: For non-adhesive attachment of gypsum board to framing, maintain not less than 40 deg F. For adhesive attachment and finishing of gypsum board, maintain not less than 50 deg F for 48 hours before application and continuously after until dry. Do not exceed 95 deg F when using temporary heat sources.
C. Ventilation: Ventilate building spaces as required to dry joint treatment materials. Avoid drafts during hot, dry weather to prevent finishing materials from drying too rapidly.

PART 2 PRODUCTS

2.01 GYPSUM BOARD PRODUCTS
A. Provide Gypsum Wallboard, ASTM C 36, in assemblies as indicated in Section 09 22 00, and as follows:
   1. Regular Type: For use at vertical surface and ceiling, unless otherwise indicated.
      a. Width: 48 inches.
      b. Thickness: 5/8 inch except where otherwise indicated.
      c. Edges: Tapered.
   2. Fire Resistant Type: complying with Type X requirements; UL or WH rated.
      a. At Assemblies indicated with fire-rating: Use type required by indicted tested assembly; if no tested assembly is indicated use Type X.
      b. Edges: Tapered.
B. Gypsum Shaftwall or Coreboard: ASTM 1396/C1396M; Type X core; sizes to minimize joints in place; 1-inch thick; square, tongue and groove or double beveled edges, ends square cut.

2.02 TRIM ACCESSORIES
A. Accessories for Interior Installation: Corner bead, edge trim, and control joints complying with ASTM C 1047 and requirements indicated below:
   1. Material: Steel sheet zinc coated by hot-dip process or rolled zinc.
   2. Shapes indicated below by reference to Fig. 1 designations in ASTM C 1047:
      a. Corner bead on outside corners, unless otherwise indicated.
      b. LC-bead with both face and back flanges; face flange formed to receive joint compound. Use LC-beads for edge trim, unless otherwise indicated.
      c. L-bead with face flange only; face flange formed to receive joint compound. Use L-bead where indicated.

2.03 JOINT TREATMENT MATERIALS

A. General: Provide joint treatment materials complying with ASTM C 475 and the recommendations of both the manufacturers of sheet products and of joint treatment materials for each application indicated.

B. Joint Tape for Gypsum Board: 2-inch wide, coated glass fiber tape by joints and corner, except as otherwise indicated.

C. Setting-Type Joint Compounds for Gypsum Board: Factory-packaged, job-mixed, chemical-hardening powder products formulated for uses indicated.
   1. Where setting-type joint compounds are indicated as a taping compound only or for taping and filling only, use formulation that is compatible with other joint compounds applied over it.
   2. For prefilling gypsum board joints, use formulation recommended by gypsum board manufacturer.
   3. For filling joints and treating fasteners of water-resistant gypsum backing board behind base for ceramic tile, use formulation recommendation by gypsum board manufacturer.
   4. For topping compound, use sandable formulation.

D. High Build Drywall Surfacers: Vinyl acrylic latex-based coating for spray application, designed to take the place of skim coating and separate paint primer in achieving Level 5 finish.

2.04 SEALANTS

A. Acoustical Sealants
   2. Acoustical Sealant for Concealed Joints: Manufacturer's standard nondrying, non-hardening, non-skinning, non-staining, gunnable, synthetic-rubber sealant recommended for sealing interior concealed joints to reduce transmission of airborne sound.
   3. Products: Subject to compliance with requirements, provide one of the following, or approved equal:
      b. Acoustical Sealant for Concealed Joints: BA-98; Pecora Corp.; Tremco Acoustical Sealant; Tremco, Inc.

B. Expanding Foam Sealant: Class 1 fire retardant polycell expanding foam by Macklanburg Duncan.

C. Cementitious sealant: Spray-applied (40 pcf) Monokote Z-146.

D. Sheet caulking for junction boxes: "Lowery's Electrical Box Sealer" or Tremco sheet caulking.

E. Sheet caulking for junction boxes at fire-rated assemblies: "Firestop Putty Pads" by Hevi-
duty/Nelson; Specified Technologies, Inc.; or HILTI CP-617.

2.05 MISCELLANEOUS MATERIALS

A. General: Provide auxiliary materials for gypsum drywall work of the type and grade recommended by the manufacturer of the gypsum board.

B. Gypsum Board Nails: ASTM C 514.

C. Steel Drill Screws: ASTM C 1002, for the following applications:
   1. Fastening gypsum board to wood members where indicated.

D. Acoustical Insulation: As specified in Section 07210.

PART 3 EXECUTION

3.01 INSTALLATION OF GYPSUM BOARD

A. Gypsum Board Application and Finishing Standards: Install and finish gypsum panels to comply with ASTM C 840 and GA-216.

B. Gypsum Board Installation: Apply first to ceilings, then to walls horizontally. Use board of maximum practical lengths. Stagger end joints. Cut or saw all openings. Do not score and punch. Apply metal edge to all exposed edges and outside corners.
   1. Single-Layer Non-Rated: Install gypsum board in most economical direction, with ends and edges occurring over firm bearing.
   2. Double-Layer Non-Rated: Use gypsum board for first layer, placed parallel to framing or furring members, with ends and edges occurring over firm bearing. Use glass mat faced gypsum board at exterior walls and at other locations as indicated. Place second layer perpendicular to framing or furring members. Offset joints of second layer from joints of first layer.
   3. Fire-Rated Construction: Install gypsum board in strict compliance with requirements of assembly listing.
   4. Shaft Wall Liner: Cut panels to accurate dimension and install sequentially between special friction studs.
      a. Seal perimeter of shaft wall and penetrations with acoustical sealant.

C. Where sound-insulated wallboard work is indicated, seal the work at perimeters, control and expansion joints, openings and penetrations with a continuous bead of acoustical sealant including a bead at both faces of partitions. Comply with manufacturer's recommendations for location of beads, and close off sound-flanking paths around or through the work, including sealing of partitions above acoustical ceilings.

D. Installation on Metal Framing: Use screws for attachment of all gypsum board except face layer of non-rated double-layer assemblies, which may be installed by means of adhesive lamination if permitted under testing agency testing. Space fasteners in accordance with Title 24, Part 2, Table 25A-G for single ply and Table 25A-H for two-ply application.

E. Acoustical Tile Base: Where gypsum panels form the base for adhesively applied acoustical tile, install gypsum wallboard panels with tapered edges taped and finished to produce a flat surface.

3.02 PENETRATIONS (through Sound-Rated Construction).

A. Cut-outs are to be regular and not fracture core or tear covering of gypsum board and meet the following requirements.

B. Minimize penetrations of insulated wall and ceiling constructions. Penetrate only where necessary and fully seal airtight at the perimeter using acoustical sealant.
C. Where ducts and piping greater than 3-inches diameter penetrate insulated wall or ceiling construction, provide a clearance of 1-inch to 1/4-inch at the perimeter of the penetration.

D. Where conduit piping 3-inches diameter and less (including mechanical, hydraulic, plumbing, etc.) pass through insulated wall or ceiling construction, provide a clearance of 1/4-inch to 1/8-inch between the conduit or piping and the structure, unless otherwise shown.

E. After the ductwork, conduit or piping has been installed, repair the gypsum board perimeter clearance to the specified tolerance as required. Where the clearance exceeds 3/4-inch, provide a sheet metal sleeve within the partition packed with saffing insulation batts and caulk both sides airtight with an acoustical sealant. Where the perimeter clearance exceeds 3/8-inch, use a flexible backing rod to caulk against.

F. Where penetration clearances are 3/8-inch or less, caulk airtight with acoustical sealant at gypsum board.

G. All gypsum board penetrations (including those resulting from wiring, cables, and electrical junction boxes) are to be sealed airtight with acoustical sealant.

H. The back and sides of junction boxes in sound-rated construction must be sealed airtight with sheet caulking. Caulk perimeter face at gypsum board with acoustical sealant.

I. Recessed panel boards, equipment, boxes, etc. with penetration area greater than 25 sq. in. at sound-rated partitions are to be fully enclosed and sealed with 5/8-inch thick gypsum board or 2 psf sheet lead.

J. Seal multiple conduit penetrations airtight with expanding fire foam sealant.

K. Seal other sound-rated conditions with spray-applied (40 pcf) cementitious sealant equal to Monokote Z-146.

3.03 INSTALLATION OF TRIM ACCESSORIES

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

B. Control Joints: Place control joints consistent with lines of building spaces and as indicated.

C. Corner Beads: Install at external corners, using longest practical lengths.

D. Edge Trim: Install where edge of gypsum panels would otherwise be exposed. Provide edge trim type with face flange formed to receive joint compound.
   1. Install LC-bead where gypsum panels are tightly abutted to other construction and back flange can be attached to framing or supporting substrate.
   2. Install L-bead where edge trim can only be installed after gypsum panels are installed.

3.04 FINISHING OF GYPSUM BOARD

A. General: Treat gypsum board joints, interior angles, flanges of cornerbead, edge trim, control joints, penetrations, fasteners heads, surface defects, and elsewhere as required to prepare gypsum board surfaces for decoration.


C. The finished drywall shall present a smooth, unblemished, homogenous appearance with inconspicuous joining between boards and no visible fasteners. There shall be no areas of raised fibers on the face paper due to over sanding. Visible nail pops, scam lines and cracks within the first year will be corrected as required by the guarantee.

D. Tape, fill, and sand exposed joints, edges, and corners to produce smooth surface ready to receive finishes. Prefill open joints, rounded or beveled edges, and damaged areas using
setting-type joint compound.

1. Feather coats of joint compound so that camber is maximum 1/32 inch.

E. Apply joint tape over gypsum board joints, except those with trim accessories having flanges not requiring tape.

F. Use the following joint compound combination as applicable to the finish levels specified:


G. Finish gypsum board in scheduled areas in accordance with levels defined in ASTM C 840 and as scheduled below:

1. Above Finished Ceilings Concealed From View: Level 1.
2. Utility Areas and Areas Behind Cabinetry: Level 2.
3. Walls and Ceilings to Receive Flat or Eggshell Paint Finish: Level 4.

H. Where Level 5 finish is indicated, spray apply high build drywall surfacer over entire surface after joints have been properly treated; achieve a flat and tool mark-free finish.

I. Where Level 3 gypsum board finish is indicated, embed tape in joint compound and apply first, fill (second), and finish (third) coats of joint compound over joints, angles, fastener heads, and accessories; and apply a thin, uniform skim coat of joint compound over entire surface. For skim coat, use joint compound specified for third coat, or a product specially formulated for this purpose and acceptable to gypsum board manufacturer. Touch up and sand between coats and after last coat as needed to produce a surface free of visual defects, tool marks, and ridges and ready for decoration.

J. Where Level 1 gypsum board finish is indicated, embed tape in joint compound.

3.06 FINISH LEVEL SCHEDULE (PER GA-214)

A. Level 1

1. Ceiling plenum Areas, concealed areas, janitor closets and where indicated.
2. General:
   a. All joints and interior angles shall have tape embedded in joint compound. Surface shall be free of excess joint compound. Tool marks and ridges are acceptable.

B. Level 2

1. Areas behind fixed cabinetry.

C. Level 3

1. Utility spaces including electrical rooms and mechanical rooms.
2. Storage rooms, not including room

D. Level 4

1. Individual offices
2. Walls and ceilings scheduled to receive flat or eggshell paint finish.
3. General:
   a. All joints and interior angles shall have tape embedded in joint compound and 3 separate coats of joint compound applied over all joints, angles, fastener heads and accessories. All joint compound shall be smooth and free of tool marks and ridges.
   b. Gloss, semi-gloss and enamel paints are not recommended over this level of finish.

D. Level 5

1. Gypsum Board Ceilings
2. Walls and ceiling scheduled to receive semi-glass, gloss, enamel or non-textured flat paint.
3. All areas not noted above
4. General:
   a. All joints and interior angles shall have tape embedded in joint compound and 3 separate coats of joint compound applied over all joints, angles, fastener heads and accessories. A thin skim coat of joint compound or a material manufactured especially for this purpose, shall be applied to entire surface. Surface shall be smooth and free of tool marks and ridges.

3.07 CLEANING AND PROTECTION
   A. Promptly remove any residual joint compound from adjacent surfaces.
   B. Provide final protection and maintain conditions, in a manner acceptable to Installer, that ensure gypsum board assemblies are without damage or deterioration at the time of completion.

END OF SECTION
SECTION 09 24 00

LATH & PORTLAND CEMENT PLASTER

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:

1. Metal lath and lathing accessories.
2. Weather barrier.

B. Related requirements:

1. Division 07 for flexible flashings bridging plaster control joints
2. Division 09 Gypsum sheathing

1.2 DEFINITION

A. "Control joints" in this Section is defined as all joints installed to control contraction during initial curing period of the plaster, and thermal movement in plaster so as to minimize cracking, but excluding seismic joints. “Control Joints” are synonymous with "Stress Relief Joints" in ASTM C 1063.

1.3 SUBMITTALS

A. Product Data: Submit manufacturer data for plaster system, lath, fasteners and accessories.
B. Samples: 2-foot square preliminary sample panels showing proposed textures and colors.
C. Shop Drawings: Show walls elevations with windows and other openings and penetrations in plaster walls.

1. Indicate the proposed locations and types of metal lathing accessories (screeds, control joints, etc.) in plaster surfaces.
2. Details of control joints. Show their attachment to the supports.
3. Schedule of proposed control joints and metal trim items keyed to the elevations specified above.

1.4 QUALITY ASSURANCE

A. Mockup:

1. Provide at the Project site, where directed by the Architect, a mockup representative of the plaster textures and colors proposed for the Project.
2. Make mockup a minimum of 8 feet square, mount on studs, plywood sheathing, weather barrier, studs, with a typical opening centered in the panel, complete with flashing and trim. Provide finished corners at each end.
   a. Layer the mockup to show all materials and proposed construction.
b. Incorporate all flashings (behind control joints, at opening head, and at least one penetration.)

3. Provide a vertical and horizontal control joint at mid-height.
4. Finish mockup to match the approved preliminary sample panel available for the Contractor's review in the Architect's office.
5. Demonstrate patching that will be required for a typical scaffolding tie on one side of the panel.
6. Repeat mockup(s) until Architect's approval is obtained.
7. Protect approved mockup, which will be used as a standard for the Project, until its removal is authorized.
8. After the mockup is approved, start application of the plaster on the building where directed by the Architect. Obtain Architect's approval of a panel full height on the building before proceeding further.

1.5 HANDLING

A. Deliver materials in original packages, containers and bundles bearing name of manufacturer and brand name.
B. Store aggregates on clean platforms and cover with plastic sheeting to exclude dirt and other foreign materials that would adversely affect the plaster.
C. Keep metal lath and accessories dry and off the ground.

1.6 JOB CONDITIONS

A. Protect adjacent surfaces from damage as a result of plastering operations.
B. Protect plaster against extreme climatic conditions, including uneven and excessive evaporation from hot dry air.
C. Do not leave weather barrier exposed to the elements longer than recommended by its manufacturer.

PART 2 - PRODUCTS

2.1 LATH AND ACCESSORIES

A. Lath: Expanded diamond mesh lath weighing 3.4 lb./square yard made from zinc-coated (galvanized) steel sheet to produce lath complying with ASTM C 847 by one of the following manufacturers (On soffits use zinc-coated (galvanized) flat rib lath with rib depth of not more than 1/8 inch, weighing 3.4 lb/square yard.)

1. Amico West.
2. Cemco.
3. Clark/Western.
4. Fry Reglet.
5. Stockton.
6. Or approved equal.

B. Metal trim members: Minimum 26-gage hot-dip galvanized steel, supplied in longest obtainable single lengths to minimize joints, by Clark Western, Amico, Cemco, Stockton Products, or approved equal.
1. Control Joints
   a. Prefabricated folded pair of nonperforated screeds screeds in M-shaped configuration, with expanded or perforated flanges, of zinc alloy, minimum 0.0207-inch thick. review locations with Architect prior to installation.
   b. 2 piece Control screed: aluminum, extruded alloy 6063 T5, with clear anodized finish, as manufactured by Fry Reglet, "2-Piece Plaster Control Screed", or equal.
   c. Type CJ-1: Concealed type as required to reduce cracking (vertical joints).
   d. Type CJ-2: Prefabricated folded pair of non-perforated screeds in "M" shaped configuration (horizontal joints).

2. Casing bead expansion flange: Clark Western No. 66.
3. Corner reinforcement: Stockton Products Co. Corneraid, or Clark Western “Stucco-Lok”.
4. Reveal Joints: As manufactured by Fry Reglet, "FDM-625-75", or approved equal.
5. Base screed: Manufacture's standard profile designed for use at sill plate line to form plaster stop and prevent plaster form contacting damp earth, fabricated from light gray rigid vinyl as manufactured by Fry Reglet, "Foundation weep screed FWS-875", or equal.
6. Drip Screed: Vented aluminum, extruded alloy 6060 T5, with clear anodized finish, as manufactured by Fry Reglet, "Stucco Drip Screed DS-875-V-875", or equal.
7. Transition Pieces: Aluminum, as indicated and as manufactured by Fry Reglet, or equal.
8. Door and window flashing: Stockton Products WTP.

C. Tie-wire: 18-gage galvanized, annealed steel wire for accessories-to-lath.
D. Fasteners: "Fastenseal" self-sealing screws conforming to ASTM F 1667, with a 0.125-inch diameter shank, a 7/16-inch diameter head, length to satisfy Code but not less than required to penetrate stud a minimum of 3 full threads, with an HDPE spacer containing butyl rubber, by Fasten Seal (www.fastenseal.com) – no known equal.
E. Pipe and electrical box flashing: Quickflash assemblies by Quickflash Products – no known equal.
F. Sealant: Silicone sealant as specified in Section 07 92 00.

2.2 WEATHER BARRIER

A. One of the following, complying with FS UU-B-790, Type I, Grade D (vapor permeable), Style 2, except with a water resistance of 60 minutes.

   1. Fortifiber Corp. "Super Jumbo Tex."
   2. Firstline Corp. "Kraftex Stucco Paper."
   3. Or approved equal.

2.3 PLASTERING MATERIALS

A. Portland cement: ASTM C 150, Type I or II. Use only one brand throughout this work.
B. Hydrated lime: ASTM C 206, Type S.
C. Sand: ASTM C 897, graded as follows, except for finish coat.

| PART 3 - PERCENTAGE RETAINED ON EACH SIEVE |

LATH & PORTLAND CEMENT PLASTER
09 24 00 - 3
<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>PART 4 - MAXIMUM</th>
<th>Minimum</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. 4</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>No. 8</td>
<td>10</td>
<td>0</td>
</tr>
<tr>
<td>No. 16</td>
<td>40</td>
<td>10</td>
</tr>
<tr>
<td>PART 5 - NO. 30</td>
<td>65</td>
<td>30</td>
</tr>
<tr>
<td>No. 50</td>
<td>90</td>
<td>70</td>
</tr>
<tr>
<td>No. 100</td>
<td>100</td>
<td>90</td>
</tr>
<tr>
<td>No. 200</td>
<td>100</td>
<td>97</td>
</tr>
</tbody>
</table>

B. Water: Potable, fresh from domestic source.
C. Integrally-colored finish coat:

1. Pre-mixed vapor permeable 100 percent acrylic polymer with marble aggregate, medium texture elastomeric finish, of the colors to match existing plaster. All materials for the Project shall have identical or consecutive batch numbers. Deliver products to job site premixed in the water at specified ratios, ASTM C 932.
2. Acceptable finish coat manufacturers:
   a. La Habra.
   b. El Rey Stucco.
   c. Highland Stucco & Lime Products.
   d. Merlex.
   e. Parex.
   f. Or approved equal.

### 5.2 PLASTER MIXES

A. Scratch coat (by volume): One part Portland cement, maximum one part dry hydrated lime, maximum 4 parts loose sand aggregate of the total volume of cement/lime.
B. Brown coat (by volume): Same as specified for scratch coat except that sand may be increased to 4-1/2 parts of the total volume of cement/lime.

### 5.3 MIXING

A. Mix ingredients thoroughly, measuring as accurately as possible. Add to the mixer from calibrated containers. Do not use materials that are caked, lumpy, dirty or contaminated by foreign materials.
B. If calibrated container supply interferes with progress of Work, shovels may be used provided they are measured to determine the accuracy of the volume of aggregate they carry, in accordance with manufacturer's instructions.
C. Manufactured elastomeric acrylic coat shall be formulated at the factory. Follow manufacturer's instructions for mixing and application.
PART 6 - EXECUTION

6.1 EXAMINATION/PREPARATION

A. Examine conditions and measurements affecting the work of this Section at site, including the following:
   1. Ensure that air/water barrier is intact and integral, and isolates the building interiors from air and water infiltration.
   2. Ensure that adjacent finish work is well protected with waterproof covers securely taped in place.

B. Before enclosing stud walls, thoroughly clean spaces of debris.
C. Correct detrimental conditions before proceeding with installation.

6.2 GENERAL

A. The applicable provisions of ASTM C 1063 and ASTM C 926 govern the work of this Section, except as specified herein.

6.3 WEATHER BARRIER

A. Install over substrates and framing members with a minimum of fasteners.
B. Lap shingle fashion 2 inches at horizontal joints and 6 inches at vertical joints. No weather barrier is required on soffits. Stagger vertical joints.
C. Interrupt weather barrier behind control joints and install flexible flashing continuously for the length of the joint lapping the paper weather barrier 2 inches. Drape the flexible flashing in the joint where space allows. Ensure water tightness of the joint.
D. Interface weather barrier with flashing materials at windows, doors, electrical boxes, pipes, and other penetrations to properly discharge water to the exterior face of the wall (refer to Section 07 62 00). Correct absence of flashing prior to installing weather barrier.
E. Seal unused holes from fasteners in weather barrier with silicone sealant specified in Section 07 92 00.

6.4 LATHING

A. Comply with ASTM C 1063, except as specified below, and where Code requirements are more stringent.
B. Apply lath taut with long dimension at right angle to supports.
C. Apply first course at bottom and work up.
   1. Stagger vertical joints. Lap end joints one inch minimum and horizontal joints 1/2 inch minimum.
   2. Wire-tie intermediate horizontal joints at 9 inches o.c. maximum.
D. Attach lath to supports, thru weather barrier membrane where applicable, at 6 inches o.c.
E. Cut lath at control joints and lap over flange of control joints. Make sure that framing members are provided behind joints to securely attach the lath on each side of the joint.
F. Hold lath 1/4 inch clear of electrical boxes, columns, and similar items projecting through the plaster.
6.5 ACCESSORIES

A. Wire-tie at no more than 6 inches o.c. to lath, or joists/rafters where no sheathing occurs.
B. Use single length wherever length of run does not exceed longest standard stock length available.
C. Miter or cope at corners with hairline joints, and seal with sealant specified in Section 07 92 00. Seal butt splices in the same manner.
D. Set accessories level, plumb and true to line with a tolerance of not more than 1/8 inch in 5 feet. Shim as required and align joints with concealed splice or tie plates.
E. Install corner reinforcement at external corners.
F. At plaster terminations, provide casing bead at the following locations:
   1. Where plaster termination abuts other finishes, isolate casing bead from contact with adjacent finishes with 1/4 inch thick tape sealant specified in Section 07 92 00.
   2. Where plaster termination is not covered by another finish or applied trim, provide cased opening by installing casing bead around perimeter of opening as detailed.

G. Control joints:
   1. Install vertical control joints first, continuous from top to bottom of wall; install horizontal control joints second and split where they meet the vertical control joints.
   2. Install joints plumb, level, evenly spaced where so indicated, and in one piece at the spacing indicated.
   3. Splices and intersections in control joints must have pre-welded splices set in sealant.

H. Accessories that butt each other need to be lapped, sealed, soldered or welded, and/or covered with flexible flashing.

6.6 PLASTERING

A. General:
   1. Comply with ASTM C 926, except as specified below, and where Code requirements are more stringent.
   2. Keep control joints clear of plaster.

B. Plaster types:
   1. General: Total thickness of base coat must meet code requirements for fire-rated construction as applicable.
   2. Three-coat work on metal lath on weather barrier and sheathing. Minimum thickness one inch.
   3. Three-coat work on metal lath on open framing (soffits). Minimum thickness 7/8 inch.
   4. Two-coat work (base- and brown coat) behind brick veneer.

C. Sequencing: Provide sufficient manpower and equipment to ensure a continuous operation free of cold joints, scaffold lines, texture variations, and other objectionable conditions.
D. Application: Plaster surfaces in one operation once the application of any coat has begun. Stop plaster at control joints, edges or corners only. Plaster in one operation, full height and width between control joints.
1. **Scratch coat:** Apply with sufficient material and pressure to form good full keys, and to cover well.
   a. Make minimum thickness of scratch coat 3/8 inch when measured from backing to crest of scored plaster.
   b. Scratch before plaster hardens to provide sufficient mechanical key for brown coat. Moist cure continuously for a minimum of 48 hours, including weekends and holidays.

2. **Brown coat:**
   a. Apply the brown coat approximately 3/8-inch thick in 2 coats. Bring to a true, even surface by rodding and floating and leave slightly rough to receive the finish coat.
   b. Begin floating only after hydration of the cement has commenced and sufficient moisture has evaporated, so that surface sheen has disappeared, but before plaster has become too rigid to be moved under the float.
   c. Moist-cure continuously for a minimum of 48 hours, including weekends and holidays.

3. **Finish coat:**
   a. Comply with finish coat manufacturer’s instructions for mixing and applying acrylic finish coat.
   b. Apply finish coat continuously in one operation to entire surface maintaining a “wet” edge so that completed finish is free of scaffold lines and imperfections due to application methods.
   c. Completed finish textures and colors shall be consistent with the approved mockups.

E. **Allowable tolerance:** Maximum deviation from true planes of finish plaster shall not exceed 1/8 inch in 5 feet when measured with a straightedge placed at any point on plaster surfaces.

F. **Do not use materials** that are caked, lumpy, dirty, or contaminated by foreign materials.

G. **Plaster flush with metal frames and other built-in metal items or accessories that act as plaster grounds.**

H. **Where permanent grounds are too far apart to serve as guides for rodning,** provide supplemental plaster screeds as required.

1. Establish true surfaces with rods before setting the screeds.
2. Keep grounds clean and free of plaster.
3. Finish plaster in a true plane, plumb, or level as applicable, flush with grounds.

6.7 **FIELD QUALITY CONTROL**

A. The specified moist-curing periods are minimum requirements. Be responsible for determining the most effective procedure for curing and time lapse between application of coats, based on climatic and job conditions.

B. Completed plaster shall match approved mockups, be within the tolerances specified, be uniform in thickness, texture and color when applicable, free of cracks, blisters, pits, checks and other defects.

C. Repair, or remove and replace, as determined by the Architect, lath/plaster that does not meet these requirements, with materials satisfactory to the Architect.

6.8 **REPAIRING/CLEANING**
A. Cut, patch, repair, and point-up defective plaster.
   1. Repair cracks and indented surfaces by moistening plaster and filling with new material, troweled and tamped to match adjoining surfaces.
   2. Point-up finished plaster surfaces around items that are built into or penetrate plaster.

B. Promptly remove plaster spatter and droppings from adjacent surfaces. Repair surfaces that are stained, marred, or otherwise damaged during plastering.

C. Protect plaster against damage and stain until acceptance or occupancy of the building by the Owner.

6.9 ADJUSTING

A. Patching: Cut, patch, repair, and point-up plaster as necessary to accommodate other work; point-up around items that are built into or penetrate plaster surfaces.

B. Imperfections: Repair or replace work to eliminate cracks, dents, blisters, buckles, crazing, check cracking, dry outs, efflorescence, sweat outs, excessive pinholes, and similar imperfections and where bond to substrate has failed.

END OF SECTION
SECTION 09 51 13

ACOUSTICAL PANEL CEILINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:

1. Lay-in acoustical ceiling panels and their metal suspension systems.
2. Glue-on acoustical ceiling tiles.
3. Accessories and installation materials.

B. Related requirements:

1. Other Section of Division 09 for metal suspension systems for gypsum board ceilings.
2. Divisions 21 and 26 for mechanical and electrical work in acoustical ceilings.

1.2 SUBMITTALS

A. Product data:

1. Manufacturer Product Data, specifications and installation instructions for ceiling materials, and suspension system.
2. Include satisfactory test data certifying that the acoustical units comply with Code requirements.
3. Evidence that acoustical units and adhesive comply with Code for flammability, combustibility and toxicity.

B. Shop Drawings:

1. Show ceiling layouts, seismic bracing (lateral and vertical), method of suspension where interference such as ducts and pipes exists, with light fixtures, grilles, sprinkler heads, speakers accurately located, and typical details of constructions and installation.
2. Where pipes, ducts and conduits prevent direct suspension, and trapezes have to be used, justify the suspension system with structural calculations.
3. Reproduction of the Contract Drawings as Shop Drawings is not acceptable; take necessary measurements at the job site.

C. Samples:

1. Full size acoustical units showing the full range of color and texture to be expected in the completed work.
2. 12-inch Samples of each linear components of the suspension system and Samples of connectors.

D. Warranty: Proposed warranty form.
E. Closeout: Manufacturer recommendations for cleaning and refinishing ceiling materials, including precautions against materials and methods that may be detrimental to finishes and acoustical performances.
1.3 QUALITY ASSURANCE

A. Sample panel:

1. Install a 10-foot square sample panel of each type of acoustical ceiling for the Architect's approval before proceeding with this work.
2. Locate where directed by the Architect in the building.
3. Do not proceed with remainder of this work until Architect's approval is obtained.
4. The finished work shall match approved sample panel and, if properly identified for future reference, may remain a part of the finished work, when approved by the Architect.

1.4 HANDLING

A. Delivery: Deliver UL labeled cartons of acoustical units bearing label classification of acoustical and flammability characteristics.
B. Storage:

1. Store acoustical panel cartons open at each end to stabilize moisture content and temperature, in fully enclosed space(s), in well-ventilated area protected from weather, moisture, soiling, extreme temperatures and humidity.
2. Before installing acoustical tiles, permit them to reach room temperature and a stabilized moisture content.

C. Handling: To avoid chipping edges or otherwise staining or damaging units.

1.5 JOB CONDITIONS

A. Do not install acoustical ceilings until the space to receive them is enclosed and weathertight, until work above ceilings is completed, and until ambient conditions of temperature and humidity will be continuously maintained at values near those indicated for final occupancy.
B. Illuminate work areas during installation to provide the same or greater level of illumination required to properly perform the work and as will occur in the room or space after the building is in operation.
C. Do not use ceiling panels in extreme or continuous high humidity, or areas exposed directly to weather or water.
D. Allow time for dimensional changes in ceiling panels stored at temperature/humidity conditions well outside of those recommended for service; with increases in temperature/humidity, these products expand (up to 1/64-inch/foot at 85-degree F and 90 percent RH) and may not fit into a fixed grid.

1.6 MAINTENANCE

A. At Project completion, furnish 10 percent box of each type of acoustical units matching those installed, packaged with protective covering for storage, and identified with appropriate labels.
1.7 SPECIAL WARRANTY

A. Manufacturer agrees to repair or replace acoustical panels that fail within the warranty period. Failures include, but are not limited to: Acoustical panels: Sagging and warping.

1. Grid system: Rusting and manufacturer's defects.

B. Warranty period: 2 years from Substantial Completion.

C. The warranty shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and will be in addition to and run concurrent with other warranties made by the Contractor under the requirements of the Contract Documents.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS:

A. Design ceiling components to ensure that light fixtures and installed accessories will not induce concentrated loads.

B. Where components may induce rotation of ceiling system components, provide stabilizing reinforcement.

C. Design ceiling components to limit deflection of completed ceilings to L/360.

2.2 MATERIALS

A. Suspended Acoustical ceiling - AC-1

1. Moisture resistant wet formed mineral fiber with factory applied vinyl latex paint, mildew resistant, and with the following properties.
   a. Size: 24 x 48 inches.
   b. Thickness: 3/4 inches.
   c. Light Reflectance: Minimum LR 0.84, determined as specified in ASTM E 1264.
   d. NRC Range: 0.65 - 0.70, determined as specified in ASTM E 1264.
   e. Edge: SLT
   f. Surface Burning Characteristics: Class A in accordance with ASTM E84, with flame spread 25 or under.
   g. Insulation value: Average R factor at 75 degrees Fahernheit of 2.78.
   h. Color White
   i. Product: USG interiors, "Eclipse ClimaPlus face cuts, Illusion two/24 panels", or approved equal. To match existing
   j. Suspension System: Exposed grid, Heavy-duty.

B. Metal Grid: Chicago Metallic Corporation Series 1200 or Donn DX System USG Interiors heavy-duty steel suspended grid system, roll-formed from 0.020 cold-rolled, pre-painted steel.


C. Suspended Acoustical ceiling - AC-2

1. Provide panels with factory applied washable, embossed, vinyl-laminated face, sealed back and edges, and with the following properties.
D. Metal Grid: USG Interiors, "Donn CE Suspension Systems", or approved equal. Heavy-duty steel suspended grid system, roll-formed from 0.020 cold-rolled, pre-painted steel.

E. Hanger wires: Galvanized carbon steel, ASTM A 641 soft-temper, prestretched, yield-stress load of at least 3 times design load, 12-gage minimum.

F. Accessories:
   1. Devices for attachment to overhead construction, secondary members, splines, splicers, connection slips, wall connectors and all other accessories required for a complete installation.
   2. Hold down clips: KeepClip by American Retention Components, Armstrong World Industries Retention Clip #414, Donn Brand Panel Retention Clip #730600 by USG, or equal.
   3. Field assembled compression post (strut):
      a. Cold-or hot-rolled angles, steel studs, EMT or rigid conduit, or black iron.
      b. Cold-rolled steel section with maximum L/R ratio of 200.
   4. Engineered compression struts: As an alternate to compression struts indicated above, manufactured compression struts may be provided when installed in compliance with their manufacturer's instructions.
      a. Description: Pre-engineered telescoping seismic compression posts made from heavy-wall galvanized tubing.
      b. Products: "Donn Brand Compression Post VAS" by USG Interiors, Inc., or equal by Armstrong World Industries.

G. Trim:
   1. As required by construction, and compatible with design and appearance of ceiling.
   2. Provide perimeter trim not less than 2 inches wide at tile support point.
   3. Perimeter trim and trim in ceiling penetrations shall permit lateral adjustment of at least 1/2-inch to accommodate irregularities in vertical surfaces interrupting ceiling.
H. Screws: Eye bolts with lag thread, overall size 1/4 inch by 3/4 inch, 9/16 inch inside diameter eye and 2-inch threaded portion, long enough to penetrate wood supports 1-1/2 inch minimum.

I. Tile adhesive: Type recommended by tile manufacturer bearing label for Class 0-25 flame spread.

J. Finishes:

1. Concealed ferrous metal surfaces: Galvanized, cadmium-plated or coated with a factory-applied rust-inhibitive paint.
2. Exposed metal surfaces: Prime and apply a satin baked-on enamel finish matching the color of the acoustical units, as approved by the Architect.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions and measurements affecting the work of this Section at site.

B. Correct detrimental conditions before proceeding with installation.

3.2 INSTALLATION

A. General:

1. Install materials in compliance with the approved Shop Drawings, the Specifications, and the ceiling panel and suspension system manufacturers' instructions. In case of conflict, the most stringent provisions apply.
2. Comply with ASTM C 636 and E 580, governing regulations and industry standards applicable to this work.
3. Install materials so that the sound insulation of adjacent construction materials and assemblies is not compromised by locally reducing their surface mass, or creating unsealed penetrations.
4. Plan layout to balance border widths at opposite edges of each ceiling area.
5. Avoid use of less than half-width acoustical units wherever possible.
6. Comply with reflected ceiling plans shown on the Contract Drawings.

3.3 SUSPENDED GRILLAGE INSTALLATION

A. Anchor hanger wires to overhead construction as indicated on the Drawings.

B. Attach hanger wires at not more than 4 feet o.c. along each member supported directly from hanger, with a hanger not more than 8 inches from wall and end of each member.

C. Hang ceiling system independent of walls, columns, pipes, ducts, and conduits, and their insulation; maintain minimum distance from end of grid to wall of 3/4-inch.

D. Screw eye screw into roof joists penetrating 1W, minimum. Loop hanger wire through eye screw and secure with triple twist. Secure bracing wires with 4 twists. Both conditions, all twists shall be made within a distance of 1W. Hanger or bracing wire anchors to the structure should be installed in such a manner that the direction of the wire aligns as closely as possible with the direction of the forces acting on the wire. NOTE: Wire turns made by machine where both strands have been deformed or bent in wrapping can waive the 1W requirement, but the number of turns should be maintained, and be as tight as possible.

E. To avoid splitting of wood joists, pre-drill pilot holes for eye screws 70% of the diameter of the eye screw root in bottom edges of roof joist, 1/2" edge distance, minimum.
F. Do not attach wires to, or bend around, interfering material such as ductwork, pipes and conduits. Provide trapeze or equivalent devices where obstructions interfere with direct suspension.

G. Connection device from vertical wire to the structure above must sustain, without failure, a minimum of 100 lb. load.

H. Assemble and install metal grillage so that it is rigid, square, and free of lateral movement, level within the tolerances specified, with hairline, flush joints at abutting members, and with all members accurately aligned. Grid connection to perimeter must be attached on 2 adjacent walls.

I. Tie perimeter Tee ends together.

J. Provide seismic bracing as indicated, (splay wires or rigid bracing) within 2 inches of intersection and splayed 90-degree apart at 45-degree angle.

K. Install perimeter and edge trim level with flush, hairline joints:
   1. Screw-attach trim to studs at not over 16 inches o.c. and not more than 3 inches from ends, leveling with ceiling suspension system to a tolerance of 1/8-inch in 12 feet. Miter corners accurately and connect securely.
   2. Do not use exposed fasteners, including pop rivets, on moldings and trim.

L. Tolerance of completed grillage shall be limited to 1/8-inch for entire ceiling in each area.

3.4 ACOUSTICAL UNITS

A. Match tile for color and pattern by using tile from cartons in the same sequence as manufactured.

B. Scribe and cut acoustical units for accurate fit at borders and around work which penetrates ceilings. Install with flush, tight joints.

C. For square-edged units, install units with edges fully hidden from view by flanges of suspension system runners and moldings or reveal-edged units on suspension system runners, install units with bottom of reveal in firm contact with top surface of runner flanges.

D. For reveal-edged units on suspension system members with box-shaped flanges, install units with reveal surfaces in firm contact with suspension system surfaces and panel faces flush with bottom face of runners.

E. Paint cut edges of panel remaining exposed after installation; match color of exposed panel surfaces using coating recommended for this purpose by acoustical panel manufacturer.

F. Duplicate Tegular edges at partial panels with straight, square cuts.

3.5 EGGCRATE PANELS

A. Install full size modules only. No intermediate supports allowed; butt short side to hairline contact so that pattern is uninterrupted. Support on continuous angles attached to the walls. Paint trim to match eggcrate panels.

3.6 HOLD DOWN CLIPS

A. Install hold-down clips at third point on each 2-foot by 4-foot panel on each cross Tee, minimum of 2 per panel per side; and one clip for each 2-foot by 2-foot panel, minimum 2 clips per panel on each cross Tee.

B. Where required to comply with fire-rated ceiling construction requirements. Provide additional clips at (1) all acoustical units within 6-foot of exterior doors to prevent panel uplift or flutter from air movement, (2) other locations designated on the Drawings.
3.7 ADHESIVE INSTALLATION

A. Bond tiles to substrate using amount of adhesive and procedure recommended by the tile manufacturer.

1. Prime ceiling according to CISCA's "Ceiling Systems Handbook."
2. Remove loose dust from backs of tiles.
3. Install splines in joints between tiles; maintain level of bottom surface of tiles to a tolerance of 1/8 inch in 12 feet and not exceeding 1/4 inch cumulatively.
4. Align tiles parallel to walls; alternate tile direction.
5. Maintain tight butt joints, aligned in both directions and coordinated with ceiling fixtures.

3.8 CLEANING

A. Clean soiled acoustical units and suspension systems in compliance with their manufacturer's instructions.

3.9 FIELD QUALITY CONTROL

A. Replace units that are damaged or cannot be cleaned, to the Architect's satisfaction.

END OF SECTION
SECTION 09 65 00
RESILIENT FLOORING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:
   1. Sheet Vinyl.
   2. Rubber base.
   3. Accessories, and installation and finishing materials.

B. Related requirements:
   1. Division 03 for self-leveling cementitious underlayment.

1.2 ADMINISTRATIVE REQUIREMENTS

A. Pre-installation meeting: Prior to start of installation, survey floors with the concrete finisher to verify acceptability of concrete substrate to receive flooring. Refer to Part 3 for corrective work.

1.3 SUBMITTALS

A. Product Data: Manufacturer installation instructions and test reports for the specified materials.
B. Samples: Resilient flooring manufacturer's standard size Samples of each type of resilient flooring and secondary materials.
C. Shop Drawings:
   1. Submit for each type of resilient flooring.
   2. Include material layouts, edges, columns, doorways, enclosing partitions, built-in furniture, cabinets, and cutouts.
   3. Show details of special patterns.
D. Tests: Moisture and pH tests results.
E. Closeout:
   1. Furnish the Owner 2 copies of resilient flooring manufacturer recommended maintenance products, and recommended maintenance methods and procedures.
   2. Include precautions against cleaning materials and methods detrimental to finishes and their performance.

1.4 QUALITY ASSURANCE

A. Installer: Firm competent in installation of resilient flooring, with a minimum of 3 project installations and 5 years of successful experience installing flooring of the kind and scope specified.
B. Regulatory requirements: Materials shall have the following flammability ratings, according to NFPA 253:

1. Smoke density: 450 or less.
2. Critical radiant flux: Class I – minimum 0.45 watts per square centimeter.

C. Coefficient of friction less than 0.6 for level surfaces and 0.8 for sloped surfaces per ASTM D2047.

1.5 HANDLING

A. Store materials in accordance with manufacturer instructions, indoors above 70 degrees F for at least 24 hours before use.

1.6 JOB CONDITIONS

A. Illuminate work areas during installation to provide the same or greater level of illumination required to properly perform the work and as will occur in the room or space after the building is in operation.
B. Maintain temperature in spaces to receive resilient flooring between 70 and 90 degrees F for not less than 24 hours before and 48 hours after installation.
C. Maintain minimum temperature of 55 degrees F after resilient flooring has been installed, except as specified above.

1.7 MAINTENANCE

A. Furnish the Owner in cartons 2 percent of the quantity of each type of resilient flooring installed on the Project.
B. Coordinate selection of floor polish with the Owner's maintenance service.

1.8 SPECIAL WARRANTY

A. Manufacturer shall warrant materials and workmanship for 2 years from Substantial Completion, and agrees to make repairs and replacements due to faulty materials and workmanship during the warranty period at no cost to the Owner.

PART 2 - PRODUCTS

2.1 MATERIALS

A. General: Provide materials uniform in thickness and size, edges cut accurately and square and of uniform colors with variations in variegated patterns kept to a minimum

2.2 SHEET VINYL

A. Sheet Vinyl: ASTM F1303, with backing.
1. Type (Binder Content): Type I, minimum binder content of 90 percent.
2. Wear Layer thickness: Min. Grade 1 thickness according to ASTM F1303 for Type indicated.
3. Wearing Surface: Smooth
4. Coefficient of Friction: Minimum 0.6 in accordance with ASTM D2047.
5. Interlayer Material: Foamed plastic.
8. Color and Pattern: Match Armstrong's #87715, Sage Green, to match existing.

2.3 RUBBER BASE

A. Product complying with FS-W40, type I.
B. Style: Coved with resilient flooring with FS SS-W-40, Type I.
C. Min. nominal thickness: 1/8- inch.
D. Length: Coils in length standard with manufacture but not less than 100 feet.
E. Interior and exterior corners and ends: Premolded.
F. Color and Pattern: Match Allstate's Color #46, Dark Gray.
G. Match existing 4 inches high

2.4 ACCESSORIES, AND INSTALLATION AND FINISHING MATERIALS

A. Edging and reducer strip: Tapered hard rubber edging strip made specifically for termination of resilient tile flooring, by Johnsonite, Mercer Products Co., or approved equal of the color selected by the Architect.

1. Provide materials of uniform thickness and to match thickness of abutting flooring material.

B. Self-leveling, cementitious underlayment: As specified in Section 03 54 16.
C. Adhesives: Water-resistant type recommended by manufacturer to suit resilient floor types and substrate conditions indicated.

1. Adhesives shall comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
   a. VCT and Asphalt Tile Adhesives: Not more than 50 g/L.
   b. Rubber Floor Adhesives: Not more than 60 g/L.

2. Adhesives 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."

D. Floor finish: Commercially available product acceptable to flooring manufacturer which, when cured, shall have a coefficient of friction of 0.6 or greater when tested in accordance with ASTM D 2047.

PART 3 - EXECUTION

3.1 EXAMINATION/PREPARATION
A. Prepare substrates according to adhesive manufacturer's instructions and the following to ensure adhesion of floor coverings.
B. Concrete: Prepare according to ASTM F 710.
   1. Verify that substrate is dry and free of curing compounds, sealers, and hardeners.
   2. Remove substrate coatings and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by manufacturer. Do not use solvents.
   3. Perform alkalinity and adhesion tests recommended by manufacturer. Proceed with installation only after substrates passes testing.
   4. Moisture testing: Perform tests recommended by manufacturer and as follows. Proceed with installation only after substrates pass testing.
      a. Perform anhydrous calcium chloride test, ASTM F 1869, or equivalent test recommended by the flooring manufacturer. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of 3 lb of water/1000 square foot in 24 hours.
      b. Perform relative humidity test using in situ probes, ASTM F 2170. Proceed with installation only after substrates have a maximum 75 percent relative humidity level measurement.
   5. Check pH level and correct until it is within range recommended by the adhesive manufacturer.
   6. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound and remove bumps and ridges to produce a uniform and smooth substrate.
   7. Level surfaces to be covered with flooring by grinding bumps and filling-in depressions to a tolerance an overall values of flatness, F(F) 35; and levelness, F(L) 25; with minimum local values of flatness, F(F) 24; and levelness, F(L) 17. Use fill material compatible with both substrates.
C. Sweep and vacuum clean substrates to be covered with flooring before installation.
D. Move resilient flooring and installation materials into spaces where they will be installed at least 48 hours in advance of installation. Do not install resilient flooring until materials are the same temperature as space where they will be installed.
E. Correct other detrimental conditions before proceeding with installation.

3.2 ADHESIVES

A. Mix and apply adhesives in compliance with their manufacturer's instructions.
B. Apply adhesive uniformly over backing surfaces, but only on areas that can be covered by flooring material within the recommended working time of the adhesive.
C. Remove adhesive that dries or films over. Do not soil adjacent surfaces with adhesive, and promptly remove spillage without damaging those surfaces.

3.3 SHEET VINYL

A. Lay sheets in single lengths from wall to wall, square to room axis, matching pattern at seams.
B. Scribe, cut and fit sheet vinyl to butt neatly and tightly to vertical surfaces and permanent fixtures, including cabinets, pipes, outlets, edgings, door frames and thresholds.

C. Adhere sheet vinyl to flooring substrates to comply with floor covering manufacturer's written instruction, including those for trowel notching, adhesive mixing and adhesive open and working times.

D. Heat Welded Seams: Rout joints and heat weld with welding bead, permanently fusing sections into a seamless flooring covering. Prepare, weld and finish seams according to manufacturer's written instructions and ASTM F1516 to produce surfaces flush with adjoining floor covering surfaces.

E. Hand roll sheet vinyl in both directions from center out to embed floor covering in adhesive and eliminate trapped air. At walls, door casings and other locations where access by roller is impractical, press floor coverings firmly in place with flat-bladed instrument.

3.4 BASE

A. At masonry surfaces, fill voids along top edges of base, using base manufacturer's recommended adhesive filler material.

B. Match edges at seams or double cut adjoining lengths. Install with hairline, flush butt joints.

C. Locate end of runs not less than 36 inches from a corner, except where impossible due to length of wall.

D. Do not use pieces less than 6 feet long, except where impossible due to length of wall.

E. Do not use preformed corner pieces.

   1. Form inside corners on job from straight pieces of maximum lengths possible by cutting an inverted V-shaped notch in toe of wall base at the point where corner is formed. Shave back of base where necessary to produce snug fit to substrate.

   2. Form outside corners on job from straight pieces of maximum lengths possible by shaving back of base at point where bending will occur. Remove a strip perpendicular to length of base and only deep enough to produce a snug fit without bends whitening or removal of more than half the thickness of base.

   3. Form without producing discoloration (whitening) at bends.

F. Scribe base accurately to abutting materials.

3.5 ACCESSORIES

A. Install reducer and edging strips at termination of floor tile where tile is not covered by another material. Glue securely to clean, dry subfloor.

B. Install in one piece between door jambs, and in longest possible length elsewhere with no piece less than 6 feet long.

C. Butt tightly to resilient tiles, where applicable, and scribe accurately to doorframe and other abutting surfaces.

D. Install slip-resistant strips on the upper approach and the lower tread of each flight of interior stair. Install on clean, dry steel surfaces in compliance with their manufacturer's instructions, in straight lines, within 1-1/2 of the stair nosing.

3.6 FINISHING/CLEANING/PROTECTING
A. Protect flooring against mars, marks, indentations, and other damage immediately after installation and polishing.
B. Use protection methods recommended by flooring manufacturer.
C. Do not move heavy and sharp objects directly over resilient flooring. Place hardboard panels over flooring and under objects being moved. Slide or roll objects over panels without moving panels.
D. Cover traffic paths with undyed, untreated building paper taped securely in place. Remove at final cleaning.
E. Apply protective polish to floor surfaces that are free from soil, visible adhesive and surface blemishes.
F. Clean resilient floors not more than 4 days before dates scheduled for inspections intended to establish Substantial Completion in each area of the Project.

1. If required to restore polish finish, and if recommended by flooring manufacturer, strip protective floor polish applied after completing installation before cleaning.
2. After cleaning, reapply polish to floor to restore floor finish according to flooring manufacturer instructions. Coordinate with Owner's maintenance program.

G. Remove and replace materials that are damaged or cannot be cleaned.

END OF SECTION
SECTION 09 68 13

CARPET TILE

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Carpet tile, fully adhered.

1.02 REFERENCE STANDARDS


B. CRI (CIS) - Carpet Installation Standard; Carpet and Rug Institute; 2009.

C. CRI (GLA) - Green Label Testing Program - Approved Adhesive Products; Carpet and Rug Institute; Current Edition.

1.03 SUBMITTALS

A. See Section 01 33 00 - Submittal Procedures.

B. Shop Drawings: Indicate layout of joints and pattern layout as specified.

C. Product Data: Provide data on specified products, describing physical and performance characteristics; sizes, patterns, colors available, and method of installation.

D. Samples: Submit two carpet tiles illustrating color and pattern design for each carpet color selected.

E. Submit two, 12 inch long samples of edge strip.

F. Manufacturer's Installation Instructions: Indicate special procedures.

G. Maintenance Data: Include maintenance procedures, recommended maintenance materials, and suggested schedule for cleaning.

H. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. See Section 01 60 00 - Product Requirements and Substitutions, for additional provisions.
   2. Extra Carpet Tiles: Quantity equal to 5 percent of total installed of each color and pattern installed.

1.04 QUALITY ASSURANCE

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

B. Installer Qualifications: Company specializing in installing carpet with minimum three years experience.

1.05 FIELD CONDITIONS

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

PART 2 PRODUCTS
2.01 MANUFACTURERS
   A. InterfaceFlor, Campus standard.
   B. Substitutions: Not permitted.

2.02 MATERIALS
   A. Carpet Tile: Tufted, manufactured in one color dye lot.
      1. Product: Interface, "50 CM Carpet Tile"
      2. General Requirements:
         b. Product Construction: Tufted Cut & Loop.
         c. Soil/Stain Protection: Protect®.
         d. Antimicrobial Treatment: (AATCC 138 Washed) (AATCC 174 Parts 2&3) Intersept®.
         e. Yarn System: Post-Consumer Content Type 6,6 Nylon.
         f. Yarn Manufacturer: Universal.
         g. Dye Method: 100% Solution Dye.
         h. Post-Industrial Recycling Content: 32% - 35%.
         i. Post-Consumer Recycling Content: 30%.
         j. Total Recycled Content: 62% - 65%.
      3. Product Specifications:
         a. Tile Size: 50 cm by 50 cm nominal.
         b. Tufted Yarn Weight: 24 oz/sq yd.
         c. Pile Thickness: 0.163 inches.
         d. Pile Height: 0.21 inches.
         e. Pile Density: 5301.
         g. Machine Gauge: 5/64 inch.
         h. Layout Pattern: Quarter-Turn
      4. Performance Requirements:
         a. Indoor Air Quality: Green Label Plus Certified #GLP0820.
         b. Sustainable Carpet Assessment Standard: NSF-140 Platinum.
         d. Smoke Density: (ASTM E - 662).
         e. Lightfastness: (AATCC 16 - E).
         f. Static: (AATCC - 134) < 3 KV.
         g. Standard Backing: GlasBac® Tile.
      5. Color: Match Interface's 1672902500, Chenille Wrap 1750 "Repetitions". to match existing.

2.03 ACCESSORIES
   A. Sub-Floor Filler: White premix latex; type recommended by flooring material manufacturer.
   B. Edge/Transition Strips: Rubber, color to match rubber base
   C. Edge Strips: Rubber, color as selected.
   D. Adhesives: Acceptable to carpet tile manufacturer, compatible with materials being adhered; maximum VOC of 50 g/L; CRI Green Label certified; in lieu of labeled product, independent test report showing compliance is acceptable.
      1. Product: Grid-Set Green Glue 2000 manufactured by InterfaceFlor or approved equal.
PART 3 EXECUTION

3.01 EXAMINATION
A. Verify that sub-floor surfaces are smooth and flat within tolerances specified for that type of work and are ready to receive carpet tile.
B. Verify that sub-floor surfaces are dust-free and free of substances that could impair bonding of adhesive materials to sub-floor surfaces.
C. Verify that concrete sub-floor surfaces are dry enough and ready for flooring installation by use of an Anhydrous Calcium Chloride test for moisture emission rate and alkalinity in accordance with ASTM F 1896; obtain instructions if test results are not within limits recommended by carpet tile manufacturer and adhesive materials manufacturer. Do not proceed with installation if emissions exceed manufacturer's limitations.
D. Verify that required floor-mounted utilities are in correct location.
E. Remediation:
   1. In the event that moisture and pH conditions are outside specified limit, install MoistureGard 2.0 barrier sheet if recommended by manufacturer over substrate prior to installation of carpet tile. Install system in accordance with manufacturer's written installation instructions.

3.02 PREPARATION
A. Remove sub-floor ridges and bumps. Fill minor or local low spots, cracks, joints, holes, and other defects with sub-floor filler.
B. Apply, trowel, and float filler to achieve smooth, flat, hard surface. Prohibit traffic until filler is cured.
C. Vacuum clean substrate.

3.03 INSTALLATION
A. Starting installation constitutes acceptance of sub-floor conditions.
B. Install carpet tile in accordance with manufacturer's instructions and CRI Carpet Installation Standard.
C. Blend carpet from different cartons to ensure minimal variation in color match.
D. Cut carpet tile clean. Fit carpet tight to intersection with vertical surfaces without gaps.
E. Lay carpet tile in square pattern, with pile direction parallel to next unit, set parallel to building lines.
F. Locate change of color or pattern between rooms under door centerline.
G. Fully adhere carpet tile to substrate.
H. Trim carpet tile neatly at walls and around interruptions.
I. Complete installation of edge strips, concealing exposed edges.
3.04 CLEANING

A. Remove excess adhesive without damage, from floor, base, and wall surfaces.

B. Clean and vacuum carpet surfaces.

END OF SECTION
PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:
   1. Acoustic insulation.
   3. Acoustic pads, tape and gaskets.

B. Related requirements: Division 07, 22 and 23 for thermal insulation, including pipe and duct insulation.

1.2 DEFINITIONS

A. This Section includes requirements that apply to all rooms and spaces where partitions are indicated to be filled with acoustical insulation and where acoustical insulation is indicated over suspended ceilings.

1.3 SUBMITTALS

A. Manufacturer Product Data for materials specified.

1.4 HANDLING

A. Store materials under cover, protected from moisture and off the ground or floor.

B. Remove insulation that becomes wet or damp immediately from the job site.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Acoustic sealant and pads shall prevent transmission of airborne sound through cracks in the construction.

2.2 MANUFACTURERS/PRODUCTS

A. Batt insulation:

   1. Low-density glass fiber insulation: Use for packing and filling small joints and openings behind sealants.
   2. Long-strand glass fiber insulation of one to 2 pcf density, without covering, thickness as required.

   a. 700 Series Insulation by Owens-Corning Fiberglas.
   b. Microlite by Johns Manville.
   c. Toughgard Fiber Glass Duct Liner Insulation by CertainTeed.
B. High-density ceramic or mineral fiber safing:

1. For packing and filling large and/or critical openings, usually behind a sealant or putty.
2. Long-strand ceramic or mineral fiber insulation of minimum 6 pcf density, without covering, thickness as required. Mineral (glass and rock wool) fiber, flame spread and smoke developed in conformance with IBC requirements and other authorities having jurisdiction. Non combustible having a minimum density of 1.1 pcf and minimum Noise Reduction Coefficient of 1.10 at 1/3 Octave Center Frequency (Hz).
   a. “QuietZone Acoustical Batt” by Owens Corning.
   b. “Roxul AFB - Acoustical Fire Batt” by Roxul Inc.
   c. "Fibrex Sound Attenuation Batt (SAFB) Insulation" by Fibrex Insulations Inc.
   d. "Thermafiber" by U.S. Gypsum.

3. Thickness; 2-1/2 inches, except as otherwise indicated.

C. Insulation in stud cavity:

1. Formaldehyde-free, unfaced fiber glass blankets, “Sound-Shield” by Johns Manville, "Greenguard" by Knauf, or equal complying with ASTM C 665, Type 1, unfaced.
2. Unless other indicated, provide insulation of same thickness as the stud depth. Select batt widths to match stud spacing and to be self supporting between the studs.

D. Accessories:

1. Impaling pins and clips: Cemco 1500 Series, Tactoo Insul-Hangers Series T by AGM Industries, Inc. or equal by Eckel Industries, Inc., of appropriate length required for insulation thickness used.
2. Adhesive for impaling pins: Made, or approved by the clip manufacturer. Do not use "peel and press" hangers with self-adhesive back.
3. Caps: Spun aluminum caps fitting pin size used.

2.3 ACOUSTIC SEALANTS & TAPE

A. Bulk sealant for closing small openings and joints up to a maximum of one-inch wide. Sealant backed with glass fiber packing, compressible joint filler or resilient backer rod. Do not use acetoxy silicone sealant where it might contact copper pipes.

1. Products:
   d. WW Henry Co.: Henry 313.
   e. Pabco Gypsum: QuietSeal Pro.

B. Fire-barrier (acoustical) putty:

1. For closing large openings and joints typically over one inch wide. Applied full depth or backed with a dense safing, as detailed.
2. Non-shrinking, highly-adhesive, minimum 40-pcf density fire-barrier putty.
3. **Products:**
   b. Chargar Corp.: Nelson FSP Firestop Intumescent Putty.
   c. Unifrax: Fiberfrax Fyre Putty.
   d. Hilti: CP 617 and CP 617L, intumescent moldable firestop putty for electrical outlet boxes.
   e. Pabco Gypsum: QuietPutty pads.

C. **Foamed-in-place silicone sealant:**
   1. For closing electrical ducts and cable trays where they penetrate constructions. Apply full depth of construction between permanent or temporary dams.
   2. Fire-resistant, minimum 17-pcf density, foamed-in-place silicone sealant.

D. **Fire-resistive acoustic foam tape:** “Norseal V740FR” compressible, closed cell polyvinyl chloride foam tape with pressure sensitive adhesive by Saint Gobain, or equal.
   1. Provide one-inch wide by not less than 1/4-inch thick, self-extinguishing, 6 pcf density UL-listed acoustical foam tape.
   2. Furnish tape in rolls with protective release liner on non-adhesive face.

2.4 **ACOUSTIC PADS**

A. Use: For sealing the backs and sides of standard electrical back boxes. Select size to completely cover the box and overlap wall facing material at least one-inch.
   1. Fire-rated assemblies:
      a. WR Grace & Co.: Flamesafe FSP 1077 Putty Pads.
      b. Specified Technologies Inc.: Putty Pads.
      c. Hilti CP617 Putty Pads by Hilti.
      d. 3M: Fire Barrier Moldable Putty Pads by RectorSeal.
      e. International Protective Coatings: Putty Pads.

2. Elsewhere:
   b. Harry A. Lowry & Associates: Lowry’s Outlet Box Pads.
   c. L.H. Dottie Co.: Sound Pad #68.
   d. Pabco Gypsum: QuietPutty pads.

B. **Self-adhesive sponge neoprene pads:**
   1. For providing a compressible filler and acoustical seal in the gaps of slip joints. Set in place with 10 to 15 percent compression. Airtight splices work in length-wise direction.
   2. Closed-cell sponge or foam neoprene of 8- to 12-pcf density, self-adhesive on one side, thicknesses and widths as required.
   3. Products:
      a. American Saint-Gobain: Type V760 Norseal Foam Sealants.
      b. DS Brown Co.
C. Felt-lined metal sleeves:

1. For sealing around pipe, hanger rod or other round element penetrating a construction. Inside sleeve diameter to equal outside diameter of penetrating element. Exposed end of sleeve closed with acoustical sealant.

2. Products:
   a. Eleen: Pipe Isolator.
   c. Stoneman Engineering: Trisolator.

D. Self-adhesive bubble gaskets:

1. To seal around the edge of an operating access panels. Typically set on jamb or head frame or stop to act as a compression seal.

2. Nominal 1/4-inch by 1/2-inch compressible bulb of silicone rubber or polyprene with self-adhesive on one side.

3. Products:
   b. Pemko: S88D or S88W Siliconseal.
   c. Reese Enterprises: 797 or 797W.

PART 3 - EXECUTION

3.1 EXAMINATION/PREPARATION

A. Examine conditions and measurements affecting the work of this Section at site.
B. Before installing insulation in stud walls, thoroughly clean space of debris.
C. Correct detrimental conditions before proceeding with installation.

3.2 ACOUSTIC PADS

A. Install acoustic pads behind all recessed boxes in walls that have acoustical insulation in their stud cavities.
B. Clean the contact area of loose and foreign materials in accordance with the pad manufacturer's instructions.
C. Verify that all unused knockouts are plugged before installing the pad.
D. Center the pad and cover the back and sides of all electrical, telephone and CATV boxes in sound-insulated walls with the acoustical pad.
E. Mold around conduits and cables entering the box.
F. Mold pads tightly to the boxes and to the adjacent surfaces.

3.3 BATT INSULATION

A. Cut for a firm fit in irregular spaces, butt edges into firm contact with each other and adjoining surfaces.
B. Hand pack around pipes, ducts, conduits, electrical boxes, etc., as required to thoroughly fill voids and spaces between framing members and to form a continuous acoustical barrier.
C. Comply with the National Electrical Code (NEC) for installation in proximity to light fixtures. Do not install insulation closer than recommended by NEC.
D. Where in-wall electrical conduit is parallel to the wall, slit the insulation halfway to bury the conduit in it. Where the conduit is perpendicular to the wall (penetration), do not oversize the penetration; tape the conduit to prevent sound leakage.

3.4 ACOUSTIC SEALANT

A. Comply with ASTM C 919 and the following.
B. Clean space to be caked of debris, dust and powdered materials which would prevent the sealant from adhering properly.
C. Seal openings between gypsum board and the perimeter of items penetrating gypsum board, such as electrical boxes, continuously using sealant specified.
D. Seal openings between the gypsum board and floors and ceilings along sound-insulated walls continuously, and along those intersecting walls for a minimum distance of 3 feet from insulated walls. When multiple layers occur, seal the perimeter of each layer continuously.
E. Seal gypsum board edges in contact with door frames continuously.

3.5 FIELD QUALITY CONTROL

A. Prior to closing-in of insulated assemblies, or prior to Substantial Completion for insulation that will remain exposed in the building, refit, reinstall and/or replace wet, damaged and displaced insulation.

END OF SECTION
SECTION 09 90 00

PAINTING AND COATING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Surface preparation, painting and finishing of exposed interior and exterior items and surfaces.

B. General provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

C. Related Sections
   1. Section 08 13 00 - Steel Doors and Frames: Shop priming steel doors and frames.
   2. Section 08 14 16 - Flush Wood Doors: Shop priming wood doors.
   3. Section 09 23 00 – Gypsum Board.

1.02 SYSTEM DESCRIPTION

A. Performance Requirements
   1. Paint exposed surfaces whether or not colors are designated in the schedules, except where a surface or material is specifically indicated not to be painted or is to remain natural.
   2. Painting is not required on pre-finished items, finished metal surfaces, concealed surfaces, operating parts and labels.
   3. Do not paint over UL, FM or other code required labels or equipment name, identification, performance rating or nomenclature plates.

1.03 SUBMITTALS

A. See Section 01 33 00 – Submittals for submittal procedures.

B. Product Data: Submit manufacturer's product data for each paint system specified, including primers.

C. Samples
   1. Following the selection of colors and glosses by the Architect, submit samples for the Architect's review.
      a. Provide 3 samples of each color and each gloss for each material on which the finish is specified to be applied.
      b. Make samples approximately 8 inches by 10 inches in size. Clearly label with color designation as listed on Finish Schedule.
      c. If so directed by the Architect, provide field mock-ups during progress of the Work in the form of actual application of the materials on actual surfaces to be painted for approval by the Architect. Areas shall be 10 feet by 10 feet.
   2. Do not commence finish painting until samples are approved.

1.04 QUALITY ASSURANCE

A. Provide primers and undercoat paint produced by the same manufacturer as finish coats.
1. Review other Sections of these Specifications as required, verifying the prime coats to be used and assuring compatibility of the total coating system for the various substrates.
2. Provide barrier coats over non-compatible primers, or remove the primer and re-prime as required.
3. Notify the Architect in writing of anticipated problems in using the specified coating systems over prime coatings supplied under other Sections.

1.05 MAINTENANCE

A. Upon completion of the work of this Section, deliver to the District an extra stock equaling 1 gallon of each color, type and gloss of paint used in the Work; tightly sealing each container, and clearly labeling with contents and location where used.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Acceptable Manufacturers: ICI Dulux, Dunn-Edwards, Benjamin Moore, Pratt & Lambert, Tnemec, Rustoleum, Sherwin-Williams, Kelly Moore or equal.

2.02 PAINT MATERIALS

A. Paint Materials General: Provide block fillers, primers, finish coat materials and related materials that are compatible with one another and the substrates.
B. Material Quality: Provide manufacturer's best quality trade sale paint material of the various coating types specified.
C. Colors: (per dwgs)

PART 3 - EXECUTION

3.01 PREPARATION

A. General: Mix and prepare paint materials in strict accordance with the manufacturers’ recommendations as approved by the Architect.
B. Surface Preparation
   1. General
      a. Perform preparation and cleaning procedures in strict accordance with the paint manufacturers’ recommendations as approved by the Architect.
      b. Remove removable items which are in place and are not scheduled to receive paint finish; or provide surface applied protection prior to surface preparation and painting operations.
      c. Following completion of painting in each space or area, reinstall the removed items by using workmen who are skilled in the necessary trades.
   2. Schedule the cleaning and painting so that dust and other contaminants from the cleaning process will not fall onto wet newly painted surfaces.
C. Preparation of Wood Surfaces
   1. Clean wood surfaces until free from dirt, oil, and other foreign substance.
   2. Smooth finished wood surfaces exposed to view, using the proper sandpaper. Where so required, use varying degrees of coarseness in sandpaper to produce a uniformly smooth and unmarred wood surface.

PAINTING AND COATING
09 90 00-2
3. Unless specifically approved by the Architect, do not proceed with painting of wood surfaces until the moisture content of the wood is 12 percent or less as measured by a moisture meter approved by the Architect.

D. Preparation of Metal Surfaces
1. Thoroughly clean surfaces until free from dirt, oil and grease.
2. On galvanized surfaces, use solvent for the initial cleaning, and then treat the surface thoroughly with the phosphoric acid etch. Remove etching solution completely before proceeding.
3. Allow to dry thoroughly before application of paint.

3.02 PAINT APPLICATION

A. General
1. Touch-up shop-applied prime coats which have been damaged, and touch-up bare areas prior to start of finish coats application.
2. Slightly vary the color of succeeding coats.
3. Sand and dust between coats to remove defects visible to the unaided eye from a distance of 5 feet.
4. On removable panels and hinged panels, paint the back sides to match the exposed sides.

B. Concrete and Unit Masonry Surfaces to be Painted: Remove dirt, loose mortar, scale, salt or alkali powder, and other foreign matter. Remove oil and grease with a solution of trisodium phosphate; rinse well and allow to dry. Remove stains caused by weathering of corroding metals with a solution of sodium metasilicate after thoroughly wetting with water. Allow to dry.

C. Gypsum Board Surfaces to be Painted: Fill minor defects with filler compound. Spot prime defects after repair.

D. Shop-Primed Steel Surfaces to be Finish Painted: Sand and scrape to remove loose primer and rust. Feather edges to make touch-up patches inconspicuous. Clean surfaces with solvent. Prime bare steel surfaces. Re-prime entire shop-primed item.

E. Metal Doors to be Painted: Prime metal door top and bottom edge surfaces.

F. Drying: Allow sufficient drying time between coats, modifying the period as recommended by the material manufacturer to suite adverse weather conditions.

G. Brush Applications
1. Brush out and work the brush coats onto the surface in an even film.
2. Cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness and other surface imperfections will not be acceptable.

H. Spray Application
1. Confine spray application to metal framework and similar surfaces where hand brush work would be inferior.
2. Where spray application is used, apply each coat to provide the hiding equivalent of brush coats.
3. Do not double back with spray equipment to build up film thickness of 2 coats in 1 pass.

I. Miscellaneous Surfaces and Procedures
1. Exposed mechanical items:
   a. Finish electric panels, access doors, conduits, pipes, ducts, grilles, registers, vents and items of similar nature to match the adjacent wall and ceiling surfaces, or as directed.
   b. Paint visible duct surfaces behind vents, registers, and grilles flat black.
c. Wash metal with solvent, prime and apply 2 coats of alkyd enamel.

2. Exposed pipe and duct insulation:
   a. Apply 1 coat of latex paint on insulation which has been sized or primed under other Sections; apply 2 coats on such surfaces when unprepared.
   b. Match color of adjacent surfaces.
   c. Remove band before painting, and replace after painting.

3. Paint interior surfaces of air ducts and convectors and baseboard heating cabinets that are visible through grilles and louvers with one coat of flat black paint to visible surfaces.

4. Paint dampers exposed behind louvers, grilles, and convectors and baseboard cabinets to match face panels.

5. Hardware:
   a. Paint prime coated hardware to match adjacent surfaces;
   b. Paint metal portions of head seals, jamb seals, and astragal seals to match the color of the door frame unless otherwise directed by the Architect.

6. Wet areas:
   a. For oil base paints, use 1 percent phenolic or 4 percent tetrachlorophenol.
   b. For water emulsion and glue size surfaces, use 4 percent sodium tetrachlorophenate.

7. Interior: Use “stipple” finish where enamel is specified.

8. Exposed Vents: Apply 2 coats of heat resistant paint approved by the Architect.

3.03 EXTERIOR PAINT SCHEDULE

A. Exterior Ferrous Metal and Galvanized Metal: Provide the following finish systems over exterior ferrous metal. Primer is not required on shop-primed items. Reprime all areas where primer has been scratched, scraped or removed.

   a. Ferrous and Galvanized Metal Primer
      1) Self-priming polyamide epoxy applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 3.0 to 5.0 mils.
      2) Product: Tnemec, “Series 66 Hi-Build Epoxoline”, or equal.
   b. First and Second Coats
      1) Semi-gloss, aliphatic acrylic polyurethane applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 2.0 to 5.0 mils per coat.
      2) Product: Tnemec, “Series 75 Endura-Shield”, or equal.
   c. Top Coat
      1) Clear, high gloss, aliphatic acrylic polyurethane applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 1.0 to 2.0 mils.

3.04 INTERIOR PAINT SCHEDULE

A. Gypsum Board
1. Eggshell Finish: 2 finish coats over a primer at offices, studios, Classroom Corridor and at areas to matching existing.
   a. Primer
      1) Latex based, interior primer applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 1.2 mils.
      2) Product: ICI Dulux - 1080 Dulux Ultra, or equal.
   b. First and Second Coats
1) Low luster eggshell, acrylic-latex based, interior enamel applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 2.8 mils.

2) Product: ICI Dulux - 1403 Dulux Ultra, or equal.

2. Semi-gloss Acrylic Enamel Finish: 2 finish coats over a primer at store rooms
   a. Primer
      1) Latex based, interior primer applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 1.2 mils.
      2) Product: ICI Dulux - 1080 Dulux Ultra, or equal.
   b. First and Second Coats
      1) Semi-gloss, acrylic latex, interior enamel applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 2.6 mils.
      2) Product: ICI Dulux - 1407 Dulux Ultra, or equal.

B. Wood Designated to Receive Transparent Finish
   1. Clear Satin Finish: Provide number of coats and apply to wood in accordance with the manufacturer's instructions as follows:
      a. Stain Coat: Sherwin-Williams, "Wiping Stain S64 Series", or equal.
      b. Filler Coat: Sherwin-Williams, "Sheer-Wood Natural Filler D70T1", or equal.
      d. Finish Coat: Sherwin-Williams, "Water White Conversion Varnish V84F82,MRE (34-38 units of Gloss)", reduced up to 3% with "Xylene, Catalyst V66V25", catalyzed with "Sheer-Kenver Catalyst V66V21" at 3%, or equal.

C. Ferrous Metal
   1. Semi-gloss, Acrylic Enamel Finish: 1 finish coat over enamel undercoat and a primer. Primer is not required on shop-primed items.
      a. Primer
         1) Quick drying, rust-inhibitive epoxy metal primer, as recommended by the manufacturer for this substrate, applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 1.5 mils.
         2) Product: ICI Dulux - 4160 Ultra-Hide, or equal.
      b. Undercoat
         1) Acrylic, interior enamel undercoat or semigloss, acrylic latex, interior enamel, as recommended by the manufacturer for this substrate, applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 1.3 mils.
         2) Product: ICI Dulux - 1120 Ultra-Hide, or equal.
      c. Finish Coat
         1) Semi-gloss, acrylic latex, interior enamel applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 1.3 mils.
         2) Product: ICI Dulux - 1407 Dulux Ultra, or equal.

D. Galvanized Metal
   1. Semi-gloss, Acrylic Enamel Finish: 2 finish coats over a primer.
      a. Primer
         1) Galvanized metal primer applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 1.2 mils.
         2) Product: ICI Dulux - 4020 Devflex, or equal.
      b. First and Second Coats
1) Semi-gloss, acrylic latex interior enamel applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 2.6 mils.
2) Product: ICI Dulux - 1407 Dulux Ultra, or equal.

3.06 FINISHING MECHANICAL AND ELECTRICAL EQUIPMENT

A. Paint shop-primed equipment, where indicated.
B. Remove unfinished louvers, grilles, covers, and access panels on mechanical and electrical components and paint separately.
C. Reinstall electrical cover plates, hardware, light fixture trim, escutcheons, and fittings removed prior to finishing.
D. Paint exposed Mechanical ductwork and equipment, and electrical conduits prior to installation of new light fixtures.

3.07 SURFACES TO BE FINISHED

A. Do Not Paint or Finish the Following Items:
   1. Items fully factory-finished unless specifically noted.
   2. Fire rating labels, equipment serial number and capacity labels.
   3. Stainless steel items.
B. Paint both sides and edges of plywood backboards for electrical and telecommunications equipment before installing equipment.

3.08 CLEANING

A. Collect waste material which may constitute a fire hazard, place in closed metal containers, and remove daily from site.

END OF SECTION
SECTION 10 11 00

VISUAL DISPLAY BOARDS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Markerboards and Tackboards.

1.02 REFERENCE STANDARDS


1.03 SUBMITTALS

A. See Section 01 33 00 - Submittals, for submittal procedures.
B. Product Data: Provide manufacturer's data on markerboard, tackboard, trim, and accessories.
C. Shop Drawings: Indicate wall elevations, dimensions, joint locations, special anchor details.
D. Samples: Submit color charts for selection of color and texture of markerboard, tackboard, and trim.
E. Manufacturer's printed installation instructions.
F. Maintenance Data: Include data on regular cleaning, stain removal.

1.04 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum ten years documented experience.

1.05 WARRANTY

A. See Section 01 77 00 - Contract Closeout Procedures for additional warranty requirements.
B. Provide five year warranty for markerboard to include warranty against discoloration due to cleaning, crazing or cracking, and staining.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Visual Display Boards:
   1. Basis of Design: Model 1300 Series LCS-II by Claridge Products or approved equal.
   4. Substitutions: See Section 01625 - Product Options and Substitutions.

2.02 VISUAL DISPLAY BOARDS

A. Markerboards: Porcelain enamel on steel, laminated to core.
2. Metal Face Sheet Thickness: 0.024 inch (24 gage).
3. Enameling grade steel shall be coated with a three coat process as follows:
   a. Bottom Ground Coat - 1.5 to 2.2 mils.
   b. Top Ground Coat - 2.0 - 2.8 mils.
   c. Top Cover (Color) Coat - 3.0 to 4.0 mils.
4. Core: Density Fiberboard (MDF, 7/16 inch thick, laminated to face sheet.
5. Backing: Aluminum sheet, laminated to core.
6. Size: As indicated on drawings.
7. Frame: Extruded aluminum, with concealed fasteners.
10. Accessories: Provide chalk tray and map rail.
11. Basis of Design: Model 1300 Series LCS-II.

B. Tackboards: Fine-grained, homogeneous natural cork.
   1. Basis of Design: Model 900A.
   3. Backing: Hardboard, 1/4 inch thick, laminated to tack surface.
   4. Surface Burning Characteristics: Flame spread index of 25, maximum, and smoke developed index of 450, maximum, when tested in accordance with ASTM E84.
   5. Size: As indicated on drawings.
   6. Frame: Same type and finish as for markerboard.
   7. Frame Profile: Type "CO" with snap-on aluminum trim #273B and surface applied continuous ground #77; and clips #277W.

2.03 MATERIALS
   A. Porcelain Enamed Steel Sheet: ASTM A424, Type I, Commercial Steel, with fired-on vitreous finish.
   B. Hardboard for Chalk Surface: AHA A135.4, Tempered type.
   C. Particleboard: ANSI A208.1; wood chips, set with waterproof resin binder, sanded faces.
   D. Aluminum Sheet Backing: 0.015 inch thick.
   E. Adhesives: Type used by manufacturer.

2.04 ACCESSORIES
   A. Map Rail: Extruded aluminum, manufacturer's standard profile, with cork insert and runners for accessories; 1 inch wide overall, full width of frame.
   B. Temporary Protective Cover: Sheet polyethylene, 8 mil thick.
   C. Chalk Tray: Aluminum, manufacturer's standard profile one piece full length of chalkboard, molded ends; concealed fasteners, same finish as frame.
   D. Mounting Brackets: Concealed.

PART 3 EXECUTION

3.01 EXAMINATION
   A. Verify that field measurements are as indicated.
B. Verify that internal wall blocking is ready to receive work and positioning dimensions are as indicated on shop drawings.

3.02 INSTALLATION
A. Install boards in accordance with manufacturer's instructions.
B. Secure units level and plumb.
C. Carefully cut holes in boards for thermostats, wall switches, and fire alarms.

3.03 CLEANING
A. Clean board surfaces in accordance with manufacturer's instructions.
B. Cover with protective cover, taped to frame.
C. Remove temporary protective cover at date of Substantial Completion.

END OF SECTION
SECTION 10 14 00
IDENTIFICATION DEVICES

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Room sign.
C. Code Compliance Signs: Signs shall be inspected per CBC 1117B.5.1.(4.2)

1.02 REFERENCE STANDARDS
C. CBC - California Building Code, 2010, latest edition with amendments. Signage shall comply with sections 1114B, 1115B.5, 1117B.5 and 1011.3 and 1022.8. All accessibility signage shall comply with the requirements in CBC Chapter 10 and 11B.

1.03 DEFINITIONS
A. Braille Symbols: California Contracted Grade 2 Braille shall be used wherever Braille symbols are specifically required in other portions of these standards. Dots shall be 1/10-inch on centers in each cell with 3/10-inch space between cells. Dots shall be raised a minimum of 1/40-inch above the background.

1.04 SUBMITTALS
A. See Section 01 33 00 - Submittals, for submittal procedures.
B. Product Data: Manufacturer's printed product literature for each type of sign, indicating sign styles, font, Braille data, foreground and background colors, locations, overall dimensions of each sign.
C. Signage Schedule: Provide information sufficient to completely define each sign for fabrication, including room number, room name, other text to be applied, sign and letter sizes, fonts, and colors.
1. When room numbers to appear on signs differ from those on the drawings, include the drawing room number on schedule.
2. When content of signs is indicated to be determined later, request such information from Owner through Architect at least 2 months prior to start of fabrication; upon request, submit preliminary schedule.
3. Submit for approval by Owner through Architect prior to fabrication.
D. Samples: Submit two samples of each type of sign, of size similar to that required for project, illustrating sign style, font, Braille and method of attachment.
E. Selection Samples: Where colors are not specified, submit two sets of color selection charts or chips.
F. Verification Samples: Submit samples showing colors specified.
G. Manufacturer's Installation Instructions: Include installation templates and attachment devices.
1.05 QUALITY ASSURANCE
   A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in
      this section with minimum three years of documented experience.
   B. Source Limitations: Obtain each size type color pattern and variety of regulatory sign used for
      the Project through one source from the same manufacturer.
   C. Comply with applicable provisions in ADA-ABA Accessibility Guidelines, CBC Chapter 11B,
      Section 1117B.5.

1.06 DELIVERY, STORAGE, AND HANDLING
   A. Package signs as required to prevent damage before installation.
   B. Package room and door signs in sequential order of installation, labeled by floor or building.

PART 2 PRODUCTS

2.01 MANUFACTURERS
   A. Flat Signs:
      2. InPro Corporation; Aspen produced in one piece photopolymer media:
      5. Substitutions: See Section 01 60 00 - Product Requirements and Substitutions
   B. Dimensional Letter Signs:
      1. Aluminum Cast letters by Metal Arts; www.metalarts.net
      2. Aluminum Cast letters by Signletters.com; www.signletters.com
      3. Substitutions: See Section 01 60 00 - Product Requirements and Substitutions

2.02 SIGNAGE REQUIREMENTS
   A. Code compliance signs include: International Symbol of Accessibility signs (ISA) at building
      entrances; Assistive Listening System signs (ALS), California Restroom symbols on doors and
      restroom identification sign on walls; Stair and Elevator Identification signs; details as shown on
      Drawings.
   B. Code Compliance Signs include the following signs:
      1. Restroom Doors.
      2. Egress Stairway Doors.
      3. Exit Passageway Doors.
      4. Exit Discharge Doors.
      5. Occupancy Signage.
      6. Room Identification Signage.
      7. Tactile exit and exit route signage.

2.03 SIGNAGE APPLICATIONS
   A. Accessibility Compliance: In addition to CBC, signs are required to comply with ADAAG and
      ANSI/ICC A 117.1 and applicable building codes, unless otherwise indicated; in the event of
      conflicting requirements, comply with the most comprehensive and specific requirements.
   B. All Signage Types: Unless otherwise indicated:
      1. Character Font: Helvetica, Arial, or other sans serif font.
      2. Character Case: Upper case only.
3. Background Color: Contrast between character, symbols and their background must be 70% minimum and have a non-glare finish. CBC Section 1117B.5.2.

C. Room Identification and Tactile Exit Route Signs: Provide a sign for every doorway, not including corridors, lobbies, and similar open areas.
1. Sign Type: Flat signs with engraved panel media as specified.
2. Provide "tactile" signage, with letters raised minimum 1/32 inch and Contracted California Grade II Braille.
3. Braille shall be rounded or contracted domed top.
4. Character Height: As indicated on drawings.
5. Sign Height: As indicated on drawings.
6. Office Doors: Identify with room numbers to be determined later, not the numbers shown on the drawings.
7. Conference and Meeting Rooms: Identify with room numbers to be determined later, not the numbers shown on the drawings.
8. Service Rooms: Identify with the room names and numbers shown on the drawings.
9. Rest Rooms: Identify with pictograms, the names "MEN" and "WOMEN", and Contracted California Grade II Braille.
10. Inserts: Provide 3 interchangeable inserts where indicated on sign type. Black coatings on white background. Size and thickness as indicated on drawings.

2.04 MATERIALS

A. Cast plastic sheet: Cast (not extruded or continuous cast) methacrylate acrylic sheet with a minimum flexural strength of 16,000 psi, complying with ASTM D 790, as follows.
1. Transparent sheet: Colorless sheet with light transmittance of 92 percent, ASTM D 1003, in matte finish, unless otherwise indicated.
2. Translucent sheet: White or colored translucent sheet of density required to produce uniform brightness and free of blistering, fading and other imperfections.
3. Opaque sheet: Colored opaque acrylic sheet in colors and finishes indicated.

B. Colored coatings for acrylic sheet: Non-fading coatings, including inks and paints for copy and background colors, recommended by acrylic manufacturers for optimum adherence to acrylic surface where applicable.

C. Adhesive: Transparent silicone glue by Dow Corning or GE. Use in conjunction with 2-sided Polyfoam tape or Isotac contact adhesive by 3M, in minimum thickness available.
1. Completely cover the plate with adhesive.

D. Fasteners: Concealed fasteners unless otherwise indicated. Fabricate from metals that are non-corrosive to sign materials and mounting surface.

2.05 ACRYLIC SIGNS

A. Surface and subsurface silkscreened acrylic signs:
1. Silkscreen copy shall be photo-produced using fine mesh screens, 280 mesh or finer, and screening inks.
2. Surface of printed material shall be uniform in color and finish and free of pinholes or other blemishes.
3. Signs shall be consistent in color, value and coverage, and shall maintain proper opacity, or translucency as applicable, and shall be free of blistering, fading and other imperfections.
4. Sign color registration shall be crisp, sharp and free of imperfections.
5. Pictogram color shall match character color.

2.06 TYPICAL SIGNAGE
A. Flat Signs: Signage media without frame.
   1. Edges: Square.
   2. Corners: Radiused.
   3. Wall Mounting of One-Sided Signs: double-sided tape adhesive and silicone glue per 2.04 C.
   4. Signs shall have letters and graphics silk-screened on reverse side of acrylic surface.

B. Color and Font: Unless otherwise indicated:
   1. Character Font: Helvetica, Arial, or other sans serif font.
   2. Character Case: Upper case only.
   3. Background Color: White, per campus standard color
   4. Character Color: Black, per campus standard colors.

2.07 TACTILE SIGNAGE MEDIA

A. Engraved Panels: Laminated colored acrylic; engraved through face to expose core as background color:
   1. Total Thickness: 1/4 inch.

B. Pictogram: See paragraph 2.05 for typical signage specifications.

2.08 ACCESSORIES

A. Concealed Screws: Stainless steel, galvanized steel, chrome plated, or other non-corroding metal.
   2. Interior: Bright finish.

B. Fasteners: Concealed fasteners unless otherwise indicated. Fabricate from metals that are non-corrosive to sign materials and mounting surface.

C. Where flat signs are mounted on glass walls:
   1. Provide an additional blank plate with same background color.
   2. Mount this plate on the inside of glass in alignment with sign plate.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that substrate surfaces are ready to receive work.

3.02 INSTALLATION

A. Signage mounting: Glue and mechanically attach signs to substrates.

B. Install in accordance with approved shop drawings, manufacturer’s instructions.

C. Install neatly, with horizontal edges level.

D. Locate signs where indicated:
   1. Room and Door Signs: Locate on wall at latch side of door as indicated on drawings.
   2. If no location is indicated obtain Owner’s instructions.

E. Protect from damage until Substantial Completion; repair or replace damage items.

END OF SECTION
SECTION 10 44 00

FIRE EXTINGUISHERS, CABINETS AND ACCESSORIES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Fire extinguishers.
B. Fire extinguisher cabinets, fire-rated and non-fire-rated.
C. Accessories.

1.02 REFERENCE STANDARDS


1.03 SUBMITTALS

A. See Section 01 33 00 - Submittals, for submittal procedures.
B. Shop Drawings: Indicate cabinet physical dimensions.
C. Product Data:
   1. Provide extinguisher operational features, color and finish, rated capacity and physical dimensions.
   2. Cabinet: Physical and rough-in dimensions, fire-rating if required, color and materials.
D. Manufacturer's Installation Instructions: Indicate special criteria and wall opening coordination requirements.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Fire Extinguisher Cabinets and Accessories:
   4. Substitutions: See Section 01 60 00 - Product Requirements and Substitutions.

2.02 FIRE EXTINGUISHERS

A. Fire Extinguishers - General: Comply with product requirements of NFPA 10 and applicable codes, whichever is more stringent.
   1. Provide extinguishers labeled by Underwriters Laboratories Inc. for the purpose specified and indicated, with current certification tags attached.
B. Dry Chemical Type Fire Extinguishers: Stainless steel tank, with pressure gage.
   1. Class: A:B:C.
   2. Size: 10 pound, 4A:80B:C.
   3. Finish: Baked polyester powder coat, red color.

2.03 FIRE EXTINGUISHER CABINETS

A. Metal: Formed primed steel sheet; 0.036 inch thick base metal.
B. Box construction: cold-rolled steel with baked enamel finish
   1. Where cabinet occurs in fire-rated wall, provide the following:
   2. Fire-rated cabinet with Larsen’s Flame-shield Option, or equal, certified by Warnock Hersey for one hour combustible and non-combustible wall systems to meet the requirements of UBC Standard 7-5 (ASTM E814-83). All fire-rated cabinets to have trims with reinforced corners and factory supplied anchoring devices.

C. Door Glazing: Glass, clear, 1/8 inch thick float tempered safety glass. Set in resilient channel gasket glazing.

D. Cabinet Mounting Hardware: Appropriate to cabinet. Pre-drill for anchors.

E. Weld, fill, and grind components smooth.

F. Provide Break-away lock for emergency access to fire extinguisher.

G. Finish of Cabinet Exterior Trim and Door: Steel with standard white baked acrylic enamel finish.

H. Finish of Cabinet Interior: White enamel.

I. Cabinet Configuration, Type 1: Semi-recessed type, model #SS 2712-RL.
   1. Sized to accommodate accessories.
   2. Where rated cabinet is required: model #FS SS 2712-RL.
   3. Exterior nominal dimensions of 12 inch wide x 27 inch high x 8 inch deep.
   4. Trim: Returned to wall surface, with 3-1/2 inch projection, 1-3/8 inch wide face.

J. Cabinet Configuration Type 2: Recessed type, model #SS 2712-R.
   1. Sized to accommodate accessories.
   2. Where rated cabinet is required: model #FS SS 2712-R.
   3. Exterior nominal dimensions of 9 inch wide x 24 inch high x 5-3/4 inch deep.

2.04 ACCESSORIES
   A. Extinguisher Brackets: Formed steel, chrome-plated.

PART 3 EXECUTION

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

3.02 INSTALLATION
   A. Install in accordance with manufacturer's instructions.
   B. Install cabinets plumb and level in wall openings at locations shown on drawings.
   C. Secure rigidly in place.
   D. Where cabinets occur in fire-rated wall assemblies, install type X gypsum board behind cabinet as shown in drawings to meet building inspector’s approval.
   E. Where cabinets occur in sound-rated wall assemblies, see Drawings for details.
   F. Place extinguishers in cabinets at time of Certificate of Occupancy.
   G. Extinguishers must have current certification tags attached
   H. Place extinguishers and accessories in cabinets at time of Substantial Completion.
SECTION 11 52 13

PROJECTION SCREENS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes manually-operated front projection screens and motorized, complete with accessories and installation materials.

1.2 SUBMITTALS

A. Data: Manufacturer Product Data for the screens.
B. Sample: 12-inch square screen sample when requested by the Architect.
C. Shop drawings: Show layout and type of projection screens. Include the following.
   1. Location of screen centerline relative to ends of screen case.
   2. Location of seams in viewing surfaces.
   3. Drop length.
   5. Anchorage details.
   6. Details of interface of exposed surfaces with adjacent finishes.
   7. Frame details.
   8. Accessories.

D. Closeout: Operating, troubleshooting and maintenance instructions.

1.3 HANDLING

A. Do not deliver projection screens until building is enclosed and other construction within spaces where screens will be installed is substantially complete and ready for screen installation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Da-Lite Screen Company.
B. Draper Inc. (basis of design.)
C. Or approved equal.

2.2 PROJECTION SCREENS

A. Assembly: Standard spring-roller-operated units, consisting of case, screen, mounting accessories, and other components necessary for a complete installation.
B. Materials:
   1. "Luma" spring roller classroom projection screens with 6-inch wall brackets.
   2. Viewing surfaces: Matte white fiberglass.
a. Mildew-Resistance Rating: 0 or 1 when tested according to ASTM G 21.
c. Flame-Spread Index: Not greater than 75 when tested according to ASTM E 84.
d. Construction: Provide screens in sizes indicated without seams.

3. Wall-mounting case: 22-gage steel, color to be selected by the Architect from manufacturer’s standard palette.

4. Endcaps: 16-gage plated, with integral roller brackets, concealing roller ends with matching universal mounting brackets.

5. Screen Mounting: Top edge securely anchored to a 3-inch diameter, rigid steel roller; bottom edge formed into a pocket holding a tubular metal slat, with ends of slat protected by plastic caps, and with a saddle and pull attached to slat by screws.

6. Pull rods: Provide for each screen.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions and measurements affecting the work of this Section at site.
B. Correct detrimental conditions before proceeding with installation.

3.2 INSTALLATION

A. Install screens at locations indicated, in compliance with their manufacturer’s instructions.
B. Set assemblies plumb, and level and attach securely to adjacent construction and supports.

3.3 FIELD QUALITY CONTROL

A. Test, adjust screens for proper operation.
B. Demonstrate screen operation to the Owner’s designated personnel and go over the operating, troubleshooting and maintenance instructions at that time.

END OF SECTION
SECTION 11 53 00
LABORATORY SERVICE FITTINGS AND FIXTURES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Laboratory service fittings, valves, and related components.
B. Laboratory emergency plumbing fixtures.
C. Laboratory sink units.

1.2 RELATED SECTIONS

A. General and Supplementary Conditions and Division 1.
B. Division 15 – Mechanical.
C. Section 15410 – Laboratory Plumbing.
D. Division 16 – Electrical.

1.3 REFERENCES

A. Comply with requirements of general and supplementary conditions and Division 1 as part of this specification.
B. Conform to the recommended practices for laboratory service fittings and fixtures published by the Scientific Equipment and Furniture Association, SEFA 7-1996: Laboratory and Hospital Fixtures.

1.4 DESCRIPTION

A. Work includes but is not necessarily limited to furnishing to the project site for installation by Division 15, all laboratory fixtures, fittings, and emergency plumbing fixtures described herein and shown on the Laboratory Furnishings Drawings.

1.5 SUBMITTALS

A. Materials List/Product Data: Submit complete materials list, including catalogue data, of all materials, equipment, and products for Work in this Section.
B. Shop Drawings: Submit complete shop fabrication and installation drawings, including plans, elevations, sections, details and schedules. Show relationship to adjoining materials and construction. Shop Drawings shall be in the form of reproducibles or photocopies, not to exceed 11" x 17" in size. Blueline prints are not acceptable.
C. Samples: Submit two (2) samples of each type of specified finish and color range available.
D. Operations/Maintenance Manuals: Submit under provisions of Division One complete operating and maintenance manuals that describe proper operating procedures, maintenance and replacement schedules, components parts list, and nearest local factory representative for components and repairs.

1.6 PRODUCT HANDLING

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

1.7 QUALITY ASSURANCE

A. Contractor for Work specified in this Section shall have an established organization and production facility with five years documented experience specializing in the manufacture of the type of equipment specified, with an experienced Engineering Department. Each shall have demonstrated ability to produce the specified equipment of the required quality and quantity for complete installation in a project of this type and size within the required time limits.

B. Work in this Section requires close coordination with Work in electrical and mechanical Sections. Coordinate all Work to assure an orderly progress in the Project, without removal of previously installed Work, and so as to prevent damage to finishes and products.

C. Review conditions of installation, procedures and coordination with related Work.

D. Carefully inspect the installed Work specified in other Sections and verify that all such Work is complete and ready for the installation of this Work to properly commence.

E. Verify that all Work may be installed in complete accordance with the original design, reviewed submittals and manufacturer’s recommendations.

PART 2 - PRODUCTS

2.1 GENERAL

A. All service fittings and emergency plumbing fixtures shall be specifically designed for laboratory use.

B. Service fittings shall be furnished and delivered to point of use for installation as specified in other Sections of the Specifications.

C. All service fittings shall be factory pre-assembled including the assembly of valves to turrets, mounting shanks to turrets, etc., and individually factory tested.

D. All laboratory service fittings shall be the product on one service fitting manufacturer to assure ease of replacement and maintenance.

E. All service valves, fittings, and accessories shall be of cast brass with a minimum copper content of 85%, except for items which are to be brass forging or bar stock.

F. Provide fittings as shown in laboratory fitting details for all laboratory equipment at locations shown on the Laboratory Furnishings drawings. See Service Fitting Schedule.

G. Assembly components and operating parts such as valve stems, renewable units, packing nuts, outlet nozzles and straight serrated hose ends shall be made from solid brass stock.

H. Replaceable seats, needle cones, valve disc screws and other accessories shall be Monel or stainless steel alloys especially selected for use intended.

I. Fittings shall be factory tested and shall be supplied with nipples, lock nuts, shanks, etc.

J. Serrated tip fittings shall have 3/8 inch. IPS thread with the hose end being tapered. Diameter of orifice in serrated tip shall be 1/8 inch, except where otherwise specified.

K. Turrets shall be brass drop forging of design indicated in details shown elsewhere in the Section and shall be one or two-way, as required, with 3/8 inch IPS female inlet thread for connections. Units shall be furnished with brass shanks, brass locknuts, and washers.

L. Fittings located on the same plane shall have their handles project the same distance from the plane of reference to present a uniform related appearance, regardless of valve type construction.

M. Flanges shall be brass forging of approved design with 3/8 inch IPS female inlet and outlet.

N. All goosenecks shall provide full thread for attachment of anti-splash outlet fittings, serrated tips, and filter pumps.
O. Hot water/cold water gooseneck mixers and wall-mounted cold water goosenecks shall swivel. Swivel point shall be at turret or at valve level if wall-mounted. Swing joints shall have heavy Teflon type packings; “0” rings will not be permitted. Cold water goosenecks at cup sinks shall be rigid.

P. All fittings shall have plastic colored service index buttons as specified in this Section.

Q. Provide vacuum breakers at handheld drench hoses. See details on Laboratory Furnishings drawings.

R. Provide durable 1” x 3” sign “CAUTION: NONPOTABLE WATER, DO NOT DRINK” at each bench mounted industrial water fitting. See details on Laboratory Furnishings drawings.

S. All exposed traps and pipework beneath emergency eyewash fittings and ADA sinks shall be provided with protection for the wheelchair user.

2.2 LABORATORY SERVICE FITTINGS

A. Manufacturers:

1. Products, which comply with this specification section as judged and approved by the Architect, may be provided by the following manufacturers. All products specified in this section shall be provided by a single manufacturer.

   a. Water Saver Faucet Co., 701 West Erie Street, Chicago, IL 60610
      Tel: (312) 666-5500.
   b. Far Laboratory Faucets Ltd., 399 South Edgeware Road, Unit 3, St. Thomas, Ontario, Canada N5P 4B8 Tel: (519) 637-0411.
   c. T&S Brass and Bronze Works, Inc., 2 Saddleback Cove, P.O. Box 1088, Travelers Rest, SC 29690 Tel: (800) 476-4103.
   d. Broen Lab, 4401 S. Kansas Avenue, St. Francis WI 53235 Tel: (414) 744-1000.
   e. Delta Faucet Company (USA), 55 E. 111th Street, PO Box 40980, Indianapolis, IN 46280 Tel: (317) 817-1812
   f. Approved equal.

B. Pattern: All service fittings shall have tapered body profiles.

C. Pattern: All service fittings shall have cylindrical profiles.

D. Finish: Polished chrome, with clear, acid-resistant coating.

E. Water Valves:

1. Water valves shall include a renewable unit containing all the working parts which are subject to wear, including stainless steel or monel seat, monel screw and heavy duty seat disk and Teflon packing, and an integral adjustable volume.

2. Unit shall be capable of being readily converted from compression to self-closing, and vice versa, without disturbing faucet body proper and shall also be capable of being readily converted from water construction to needle valve or steam valve construction having outside packing gland without disturbing faucet body.

3. Unit shall be sealed in valve body with special composition gasket. Metal-to-metal or ground joint type of sealing is not acceptable.

4. Water fixtures shall be fully assembled and factory tested at 80 psi water pressure.

F. Needle Valves: All needle valve assemblies shall be fully assembled and factory tested at 225 psi air pressure. Gas, air, vacuum and steam needle valve fittings shall have stainless steel replaceable floating cone that is precision ground and self-centering which shall seat against a stainless steel or monel renewable valve seat. Action of valve shall be slow compression for fine control under pressure up to 150 psi and shall have subject-to-wear parts easily replaceable. Provide pressure regulators designed for use with the appropriate service at locations indicated on the Laboratory Furnishings drawings.

G. Laboratory Ball Valves: All ball valves shall be suitable for laboratory gas, air and vacuum and be supplied fully assembled and factory tested at 125 psi air pressure. Ball valves shall be of quarter-turn (closed to fully open) design, be fitted with lever handle requiring less than
5 lbf force to operate, and shall have subject-to-wear parts easily replaceable. Ball valves shall be AGA/CMA certified for gas service.

H. High Purity Water Valves: High purity water valves shall be chromium plated cast brass with polypropylene liner. Valve stem and bonnet shall be brass. See fitting schedule on Laboratory Furnishings Drawings.

I. Service Fitting Color Index:

<table>
<thead>
<tr>
<th>Service Name</th>
<th>Disc Color</th>
<th>Letters</th>
<th>Letter Color</th>
</tr>
</thead>
<tbody>
<tr>
<td>Industrial Cold Water</td>
<td>Dark Green</td>
<td>ICW</td>
<td>White</td>
</tr>
<tr>
<td>Industrial Hot Water</td>
<td>Red</td>
<td>IHW</td>
<td>White</td>
</tr>
<tr>
<td>Cold Water</td>
<td>Dark Green</td>
<td>CW</td>
<td>White</td>
</tr>
<tr>
<td>Hot Water</td>
<td>Red</td>
<td>HW</td>
<td>White</td>
</tr>
<tr>
<td>High Purity Water</td>
<td>White</td>
<td>DI</td>
<td>Black</td>
</tr>
</tbody>
</table>

J. Hose Station:
1. Manufacturers:
   a. Products, which comply with this specification section as judged and approved by the Architect, may be provided by the following manufacturers. All products specified in this section shall be provided by a single manufacturer.
   c. Approved equal.
2. Recessed mixing wall unit.
3. Hose rack.
4. Control valves.
5. Hose: 30 feet.

2.3 LABORATORY EMERGENCY PLUMBING FIXTURES

A. Manufacturers:
1. Products, which comply with this specification section as judged and approved by the Architect, may be provided by the following manufacturers. All products specified in this section shall be provided by a single manufacturer.
   a. Water Saver Faucet Co., 701 West Erie Street, Chicago, IL 60610 Tel: (312) 666-5500.
   b. Haws Drinking Faucet Co., 1435 Fourth Street, PO Box 1999, Berkeley, CA 94701 Tel: (510) 525-5801.
   c. Broen Lab, 4401 S. Kansas Avenue, St. Francis, WI 53235 Tel: (414) 744-1000.
   d. Approved equal.

B. All emergency plumbing fixtures shall comply with requirements of ANSI Standard Z358.1-1998.

C. All emergency plumbing fixtures shall be accessible to the disabled in compliance with the requirements of the federal Americans with Disabilities Act (ADA), ADA Accessibility Guidelines (ADAAG), and state accessibility regulations.

D. Safety station: Barrier free safety station with swing-down eye/face wash and shower actuation valve in stainless steel cabinet for recess mounting. Water Saver Model No. SSBF2150, or equivalent.

E. Handheld single head eye wash: Deck mounted drench hose unit with single spray outlet head angled at 45° and squeeze valve with locking clip. Water Saver Model No. EW1020, or equivalent.

LABORATORY SERVICE FITTINGS AND FIXTURES
F. Alarm horn: Provide and install a wall-mounted alarm horn at every emergency shower location to sound when the safety shower is activated. Provide additional contacts for wiring to a remote monitoring system. Guardian Equipment AP280-625, or equivalent.

G. Alarm horn: Provide and install a wall-mounted horn at emergency showers located in corridors to sound when the safety shower is activated. Provide additional contacts for wiring to a remote monitoring system. Guardian Equipment AP280-625, or equivalent.

2.4 FINISHES

A. Chrome finish with clear, acid-resistant coating:
   1. All laboratory service fittings (except fittings inside fume hoods) and emergency plumbing fixtures.
   2. Chrome finish: All exposed surfaces shall be polished and buffed, then electroplated with one layer of nickel and one layer of chrome. Each layer of plating shall completely cover all visible areas. Total plating thickness shall be not less than 0.4 mil. Finish:
      a. Polished.
   3. Clear epoxy coating: Following plating, clear epoxy coating shall be applied to all exposed surfaces and then baked to permit curing. Surfaces shall have a minimum coating thickness of 2 mils.

B. Colored coating:
   1. All laboratory service fittings and emergency plumbing fixtures.
   2. Fume hood service fittings.
   3. Preparation: Surfaces to be coated shall be polished or sandblasted to produce a uniform fine-grained surface and immersed in a phosphoric acid cleaning solution to remove thoroughly all oil, grease and other foreign substances.
   4. Epoxy finish: Following cleaning, coating material shall be electrostatically applied to all exposed surfaces. After application, coating shall be fully baked to permit curing. Coating material shall be free-flowing epoxy powder with particle size of 1.4 to 2.8 mils. Surfaces shall have a minimum finished coating thickness of 2 mils.
   5. Color:
      a. White (except fittings inside fume hoods).

C. Performance requirements for coated finishes:
   1. Chemical resistance:
      a. Fume Test: Suspend coated samples in a container at least 6 cu. Ft. capacity, approximately 12 inches above open beakers, each containing 100 mL of 70% nitric acid, 94% sulfuric acid and 35% hydrochloric acid, respectively. After exposure to these fumes for 150 hours, the finish on the samples shall show no discoloration, disintegration or other effects.
      b. Direct Application Test: Subject coated samples to the direct action of the following reagents and solvents at a temperature of 25°C dropping from a burette at the rate of 60 drops per minute for ten minutes. Finish on samples shall not rupture, though slight discoloration or temporary softening is permissible.

<table>
<thead>
<tr>
<th>Reagent</th>
<th>Concentration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acetic Acid</td>
<td>98%</td>
</tr>
<tr>
<td>Acetone</td>
<td></td>
</tr>
<tr>
<td>Ammonium Hydroxide</td>
<td>28%</td>
</tr>
<tr>
<td>Amyl Acetate</td>
<td></td>
</tr>
<tr>
<td>Amyl Alcohol</td>
<td></td>
</tr>
</tbody>
</table>

LABORATORY SERVICE FITTINGS AND FIXTURES
11 53 00 - 5
<table>
<thead>
<tr>
<th>Reagent</th>
<th>Concentration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benzene</td>
<td></td>
</tr>
<tr>
<td>Butyl Alcohol</td>
<td></td>
</tr>
<tr>
<td>Calcium Hypochlorite</td>
<td></td>
</tr>
<tr>
<td>Carbon Disulfide</td>
<td></td>
</tr>
<tr>
<td>Carbon Tetrachloride</td>
<td></td>
</tr>
<tr>
<td>Chloroform</td>
<td></td>
</tr>
<tr>
<td>Chromic Trioxide Acid</td>
<td></td>
</tr>
<tr>
<td>Cresol</td>
<td></td>
</tr>
<tr>
<td>Crude Oil</td>
<td></td>
</tr>
<tr>
<td>Dioxane</td>
<td></td>
</tr>
<tr>
<td>Distilled Water</td>
<td></td>
</tr>
<tr>
<td>Ether</td>
<td></td>
</tr>
<tr>
<td>Ethyl Acetate</td>
<td></td>
</tr>
<tr>
<td>Ethyl Alcohol</td>
<td></td>
</tr>
<tr>
<td>Ethyl Ester</td>
<td></td>
</tr>
<tr>
<td>Formaldehyde</td>
<td>37%</td>
</tr>
<tr>
<td>Formic Acid</td>
<td>90%</td>
</tr>
<tr>
<td>Gasoline</td>
<td></td>
</tr>
<tr>
<td>Glacial Acetic Acid</td>
<td>99.5%</td>
</tr>
<tr>
<td>Glycerine</td>
<td></td>
</tr>
<tr>
<td>Hydrochloric Acid</td>
<td>38%</td>
</tr>
<tr>
<td>Hydrofluoric Acid</td>
<td>48%</td>
</tr>
<tr>
<td>Hydrogen Peroxide</td>
<td>5%</td>
</tr>
<tr>
<td>Isopropyl Alcohol</td>
<td></td>
</tr>
<tr>
<td>Lactic Acid</td>
<td>10%</td>
</tr>
<tr>
<td>Kerosene</td>
<td></td>
</tr>
<tr>
<td>Methanol</td>
<td></td>
</tr>
<tr>
<td>Methyl Alcohol</td>
<td></td>
</tr>
<tr>
<td>Methyl Ethyl Ketone</td>
<td></td>
</tr>
<tr>
<td>Methylene Chloride</td>
<td></td>
</tr>
<tr>
<td>Mineral Oil</td>
<td></td>
</tr>
<tr>
<td>Monochlor Benzene</td>
<td></td>
</tr>
<tr>
<td>N-Hexane</td>
<td></td>
</tr>
<tr>
<td>Naphthalene</td>
<td></td>
</tr>
</tbody>
</table>
Nitric Acid 70%
Perchloric Acid 70%
Phenol
Phosphoric Acid 75%
Sea Water
Silver Nitrate 30%
Sodium Bichromate saturated
Sodium Carbonate 10%
Sodium Chloride 20%
Sodium Hydroxide 50%
Sodium Hypochlorite
Sodium Sulfide
Sulfuric Acid 87%
Toluene
Trichlorethylene
Turpentine
Urea
Xylene
Zinc Chloride saturated

2. Mar and abrasion resistance: Coating material shall have a pencil hardness of 2H – 4H with adhesion substantial enough to withstand both direct and reverse impacts of 160 inch-pounds. Coating shall have excellent mar resistance and be capable of withstanding scuffing, marring and other ordinary ear.

3. Repairability: Scratches and other localized surface damage shall be field-repairable.

2.5 LABORATORY SINKS

A. Cup Sink: Provide cup sinks at fume hoods as described in Section 11061.
B. Cup Sink: Epoxy, color to match work surface, raised lip pattern, sizes per drawings, as manufactured by Laboratory Tops, Inc., Epoxyn, Durcon, or equal.
C. Cup Sink: Epoxy, color to match work surface, to be set flush with work surface, sizes per drawings, as manufactured by Laboratory Tops, Inc., Epoxyn, Durcon, or equal.
D. Provide strainer, outlet and tailpiece for all cup sinks.
E. Laboratory Sink: Epoxy, for drop-in installation by Division 11 in epoxy benchtops, color-matched, as manufactured by Laboratory Tops, Inc., Epoxyn, Durcon, or equal. See Section 11602 molded epoxy resin work surfaces for requirements. Provide epoxy resin sink outlet with strainer, stopper and open-end overflow, and install in sink with silicone bead.
   1. All exposed edges shall be radiused not less than 1/4".
   2. Drain grooves in top: Sink shall be set 1/8" below the lowest drain groove level.
   3. Tops without drain grooves: Sink shall be set 1/8" below the level of the adjacent surface.
F. Laboratory Sink: Plastic, for installation by Division 11 in epoxy benchtops, as manufactured by Scientific Plastics Company, Inc., or equal. Designed of seamless molded one-piece
monolithic construction of virgin polyolefin resins with molded top flange for drop-in, flush with benchtop installation. Specifically designed for use with corrosive materials such as hydrofluoric acid, silica etching acids and all acids and corrosives commonly used in laboratories. Provide an integrally molded threaded tailpiece, an outlet, strainer and stand pipe open end overflow and stopper.

G. Laboratory Sink: Stainless steel: See Section 11602, Stainless Steel Fabrications.
H. Provide stainless steel strainer, outlet, standpipe overflow and stopper for all sinks unless otherwise specified.
I. Provide tailpieces compatible with waste piping system for all sinks unless otherwise specified. See Division 15 for piping requirements.

PART 3 - EXECUTION

3.1 SITE CONDITIONS

A. Inspection:
   1. Prior to delivery of fitting specified in this Section, carefully inspect the installed Work specified in other Sections and verify that all such Work is complete to the point where this installation may properly commence.
   2. Verify that all Work has been installed in complete accordance with the original design, approved submittals, and the manufacturer’s recommendations.

B. Discrepancy:
   1. In the event of discrepancy, immediately notify the Architect.

3.2 PACKING AND DELIVERY

A. Deliver all fittings and fixtures to job site in recommended packaging, with each fitting individually packaged, marked, and scheduled for point of use.
B. Inventory fittings, at job site, verify that type and quantity are correct, and re-package until installed.
C. Store in clean, dry location.

3.3 INSTALLATION

A. Set internal volume control on cup sink water fittings so water does not splash out of sink.

END OF SECTION
SECTION 11 53 13

FUME HOODS AND OTHER AIR CONTAINMENT UNITS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Chemical fume hoods.

1.2 RELATED SECTIONS

A. General and Supplementary Conditions and Division 1.
B. Section 11602 – Laboratory Casework and Other Furnishings.
C. Section 11 53 13 – Laboratory Fittings and Fixtures.
D. Division 16 – Electrical.

1.3 REFERENCES

A. Chemical fume hoods:
   2. Conform to the recommended practices for laboratory fume hoods published by the
      Scientific Equipment and Furniture Association (SEFA) 1.2 1996.
B. Underwriters Laboratories.

1.4 DESCRIPTION

A. Provide equipment complete with accessories as described herein and shown on Laboratory
   Furnishings drawings.
B. Chemical fume hoods:
   1. Fume hoods with accessories shall be pre-piped and pre-wired. Pre-pipe service fittings
      to single point connection at 6 inches above top of hood or as otherwise shown. See
      Section 11604 and details on Laboratory Furnishings drawings for service fittings. P-
      trap, waste piping and tailpiece extensions for cupsinks shall be furnished and installed
      by Division 15. Refer to Division 15 for piping and installation requirements. Pre-wire all
      electrical devices to junction box at top of hood. Refer to Division 16 for wiring
      requirements.
   2. Provide variable voltage autotransformers (variacs) at fume hoods as shown on the
      Laboratory Furnishings drawings. Each variable autotransformer shall have 20 amp,
      120 volt input with output adjustable from 0 to 120 VAC. Engrave “VARIABLE
      VOLTAGE 0-120 VAC” on the flush plates of receptacles fed from autotransformers.
C. Work of this Section requires close coordination with Work of Divisions 15 and 16 as well as
   installation of Owner furnished components and Work specified in other Sections. Sequence
   all Work to ensure an orderly progress in the project without removal of previously installed
   Work and so as to prevent damage to finishes and products.

1.5 SUBMITTALS

A. Submit under provisions of Division One and specified herein.
B. Materials List Product Data: Submit complete materials list, including catalog data of all
   materials, equipment, and products for Work specified in this Section.
C. Shop Drawings: Submit complete shop fabrication and installation drawings, including plans,
   elevations, sections, details and schedules. Show relationship to adjoining
materials and construction. Shop Drawings shall be in the form of reproducibles or photocopies, not to exceed 11" x 17" in size. Blueline prints are not acceptable.

D. Submit detailed anchorage and attachment drawings and calculations provided by a licensed Structural Engineer complying with the Uniform Building Code Earthquake Regulations and the California Administrative Code, Title 24 Seismic Restraint requirements.

E. Samples: Submit two (2) samples of each type of specified finish and color range available.

F. Certification: Submit certification by an independent testing company stating that equipment is installed per applicable and referenced codes and standards, adjusted and balanced for design operations, and is complete and ready for intended function.

G. "As Manufactured" (AM) Fume Hood Testing in Manufacturing Facility: Provide certification that each type and size of fume hood has achieved an AM performance rating equal or better than 0.05 ppm with 4.0 Lpm tracer gas release rate when tested in accordance with ASHRAE 110-1995.

H. Fume Hood Sound Level Certification: Provide certification of fume hood compliance with design criteria for maximum allowable noise within laboratories.
   1. For hoods operating with a face velocity of 100 feet per minute, maximum allowable decibel level of 65 dBA measured 36 inches away from, and perpendicular to, face of fume hood.
   2. For hoods operating with a face velocity of 125 feet per minute, maximum allowable decibel level of 70 dBA measured 36 inches away from, and perpendicular to, face of fume hood.

I. Operations/Maintenance Manuals: Submit under provisions of Division One. Submit for Owner's use, complete operating and maintenance manuals that describe proper operating procedures, maintenance and replacement schedules, component parts list, and closest factory representative for components and service.

1.6 QUALIFICATIONS

A. Contractor for Work in this Section shall have a minimum eight years documented experience, and an established organization and production facilities including all tools, equipment and special machinery necessary for specializing in the fabrication and installation of the type of equipment specified, with skilled personnel, factory trained workmen and an experienced engineering department. Each shall have the demonstrated knowledge, ability and the proven capability to produce the specified equipment of the required quality and the proven capacity to complete an installation of this size and type within the required time limits.

PART 2 - PRODUCTS

2.1 CHEMICAL FUME HOODS

A. Manufacturers:
   1. Products, which comply with this specification section as judged and approved by the Architect, may be provided by the following manufacturers. All products specified in this section shall be provided by a single manufacturer.
      a. Fisher Hamilton, L.L.C., 1316 18th Street, Two Rivers, WI 54241 Tel: (920) 793-1121.
      b. Jamestown Metal Products, Inc., 178 Blackstone Avenue, Jamestown, NY 14701 Tel: (716) 665-5313.
      c. BCM Fume Hoods, PO Box 4089, Muskegon, MI 49444 Tel: (231) 733-1206.
      d. Labconco Corporation, 8811 Prospect Avenue, Kansas City, MO 64132 Tel: (800) 821-5525.
e. Air Master Systems Corp., 6480 Norton Center Drive, Muskegon, MI 49441 Tel: (231) 798-1111.
f. NuAire, Inc., 2100 Fernbrook Lane, Plymouth, MN 55447 Tel: (800) 328-3352.
g. Approved equal.

B. Bench Mounted Chemical Fume Hoods:
1. Style: General purpose.
2. Style: Flush bottom airfoil. Lower front work surface shall be designed to contain spills.
3. Type: Restricted bypass type, cabinet mounted, designed for 100 fpm face velocity through the sash opening in any position. Equip each hood with a variable air volume control system provided under Division 15. Contractor shall require hood manufacturer to coordinate with VAV control system manufacturer and provide appropriate openings and penetrations for all required control accessories. Prepare all openings and penetrations required at the fume hood manufacturer’s facility prior to painting.
7. Service Fittings: As shown on Laboratory Furnishings drawings and specified in Section 11604, installed and complete with all gaskets, grommets and sleeves.
8. Cup Sink: Epoxy resin per sink schedule with raised rim complete with strainer and outlet tailpiece.
9. Alarm: Continuously operating, field calibratable and programmable, airflow monitoring device mounted at front of fume hood shall provide audible and visual alarm and fpm readout. Provide for remote alarm connections. Fisher Hamilton 54L0480, or equal. Provide receptacle for alarm.
10. Baffle Adjustment: Baffles shall be remotely adjustable. The adjustment control shall be operable from outside the hood without exposing the user to the hood interior environment and, for ADA compliant hoods, shall be within the reach of a wheel chair bound operator.
11. Sash Design: Vertical rising 7/32 inch thick laminated safety glass, frameless full view design, with formed full width flush pull. Counter balance system to utilize stainless steel cable, single weight, and be designed to permit one finger operation at any point along full width.
12. Interior Access Panels: Service fitting access panels shall be held in place by flexible PVC gasketing. Exposed hardware, Velcro and clips not acceptable.
13. Hood Finish: Painted metal as specified elsewhere in this Section. Color to be selected by Architect.
14. Sash Stop: To allow manual override with automatic reset for an 18 inch sash opening.
15. Ceiling Closure Panels: Provide paneled enclosure from top of hood to the ceiling. Enclosure shall include simple to operate means of access to hood lighting fixture. Finish to match superstructure exterior.
16. Trim: provide and install matching steel trim to finish any openings around and between hoods. Finish to match superstructure exterior.
17. Exhaust Collar: Provide contoured 316 stainless steel exhaust collar, including transition piece if necessary, to receive circular exhaust duct connection by Division 15.
18. Electrical Outlets: Flush mounting, 120 V duplex type, as shown on drawings. With brushed stainless steel cover plates and devices to match color of electrical devices in building.
19. Interior Hood Lighting: Lighting within hood shall be provided by a protected fluorescent lighting fixture with two lamps (32W T8, electronic ballast, rapid start) operated by an exterior switch with stainless steel cover plate. Provide safety glass panel cemented and sealed to the hood roof. Provide access to lamp from above hood enclosure.
20. Exterior Color: As selected by Architect from manufacturer's full color line and complying with finish requirements.

2.2 FINISH REQUIREMENTS

A. Preparation:
1. After the units have been completely welded together and before finishing, they shall be given a pre-paint treatment to provide excellent adhesion of the finish to the metal and to aid in the prevention of corrosion. Physical and chemical cleaning of the metal shall be accomplished by washing with an alkaline cleaner, followed by a spray treatment with a heated cleaner/phosphate solution and pretreated with iron phosphate spray followed by a neutral final seal prior to application of final finish. The strength of each solution shall be monitored by filtration to insure consistent quality.
2. All treated parts shall be immediately dried in heated ovens and gradually cooled before application of the finish. Treated metal parts shall be clean and properly prepared to provide optimum adhesion of finish and resistance to corrosion.

B. Application: Electrostatically apply powder coat of selected color and bake in controlled high temperature oven to assure a smooth, hard satin finish. Surfaces shall have a chemical resistant, high grade laboratory furniture quality finish of the following thicknesses:
1. All surfaces, exterior or interior, exposed to view, shall receive sufficient powder coat to achieve an average 1.5 mil film thickness with a minimum 1.2 mil film thickness and shall have smooth satin luster.
2. Backs of cabinets and other surfaces not exposed to view shall have sufficient powder coat to achieve an average 1.0 mil film thickness.
3. Concealed interior parts shall receive corrosion-resistant treatment.

C. Chemical Resistance Finish Performance Requirements:
1. Test Procedure: Apply 10 drops (approximately 0.5 cubic centimeters) of each reagent identified to the surface of the finished test panels laid flat and level on a horizontal surface. Ambient temperature: 68°F to 72°F. After one hour flush away chemicals with cold water and wash surface with detergent and warm water at 150°F and with alcohol to remove surface stains. Examine surface under 100 foot-candles of illumination.
2. Evaluation Ratings: Change in surface finish and function shall be described by the following ratings:
   a. Excellent: No change to slight detectable change in color gloss.
   b. Good: Clearly discernible change in color or gloss. Finish remains intact and protective with no significant impairment to function or life.
   c. Failure: Obvious and significant deterioration, visible blistering, bare spots, or roughness of surface.
3. Performance requirements:
   Test results for powder coat finish shall equal or exceed the following:

<table>
<thead>
<tr>
<th>Reagent</th>
<th>% by weight</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acetic Acid</td>
<td>93%</td>
<td>Excellent</td>
</tr>
<tr>
<td>Formic Acid</td>
<td>33%</td>
<td>Good</td>
</tr>
<tr>
<td>Hydrochloric Acid</td>
<td>37%</td>
<td>Good</td>
</tr>
<tr>
<td>Nitric Acid</td>
<td>25%</td>
<td>Good</td>
</tr>
<tr>
<td>Nitric Acid</td>
<td>60%</td>
<td>Good</td>
</tr>
<tr>
<td>Phosphoric Acid</td>
<td>75%</td>
<td>Excellent</td>
</tr>
<tr>
<td>Sulfuric Acid</td>
<td>28%</td>
<td>Excellent</td>
</tr>
<tr>
<td>Sulfuric Acid</td>
<td>85%</td>
<td>Good</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Reagent</th>
<th>% by weight</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ammonium Hydroxide</td>
<td>28%</td>
<td>Excellent</td>
</tr>
</tbody>
</table>

FUME HOODS AND OTHER AIR CONTAINMENT UNITS
11 53 13 - 4
Sodium Hydroxide 10% Excellent
Sodium Hydroxide 25% Excellent
Acetone Excellent
Carbon Tetrachloride Excellent
Ethyl Acetate Excellent
Ethyl Alcohol Excellent
Ethyl Ether Excellent
Formaldehyde 37% Excellent
Hydrogen Peroxide 5% Excellent
Methyl Ethyl Ketone Excellent
Phenol 85% Good
Xylene Excellent

Note: Maximum concentration is to be understood unless a lower concentration is shown in the table.

4. Physical Tests:
   a. Abrasion – Finish shall have high abrasion resistance with maximum weight loss of 5.5 mg. per 100 cycle as tested on a Taber Abrasion Tester No. E40101 with 1000 gm wheel pressure and Calibrase No. CS10 wheel.
   b. Hardness – Finish shall have surface hardness equivalent to 4H or 5H pencil lead.
   c. Humidity – Finish shall withstand 1000 hours exposure in saturated atmosphere at 100°F.
   d. Moisture – Finish shall withstand the following procedures with no visible effect:
      1) Boiling water flowing over 45° inclined surface for 5 minutes.
      2) 100 hours continuous contact with water-soaked cellulose sponge, maintained in a wet condition throughout test.
   e. Adhesion – Finish shall withstand the following test procedure with at least 95 squares maintaining their finish. Using a razor blade, score the finish surface of the test panel through to the substrate with a pattern of 100 squares, each 1/16" x 1/16". Brush away loose particles with a soft brush.
   f. Salt spray – Finish shall withstand 200 hours exposure to salt spray test.

2.3 FUME HOOD LINER TEST: POLYRESIN

A. Test No. 1 – Spills and Splashes:
   1. Suspend a 42 inches x 12 inches panel (42 inch dimension horizontal) in a position to expose the surface to be tested in a vertical plane. Divide the panel vertically into ¾ inch spaces.
   2. Using an eyedropper, apply five drops of each reagent as listed.
   3. Liquid reagents shall be applied at the top of the panel and permitted to flow down full panel height. (CAUTION! Flush away any reagent drops.)

B. Test No. 2 – Fumes and Gases:
   1. Prepare a panel 24 inches x 12 inches by dividing panel into 2 inch squares. Using 100 ml beakers, place 25 ml (approximately ½ inch of reagent) into each beaker. Place beakers in position so that test panel may be placed over beaker tops in the proper sequence. Place panel over beakers. Note: Beaker pouring lip permits atmospheric oxygen to enter and participate in the reaction of the reagent fumes.
   2. After a 24 hour time period has elapsed, remove panel, flush off with water, clean with naphtha and detergent, rinse and wipe dry. Evaluate.

C. Evaluating Ratings:
1. No Effect – No detectable change in surface material.
2. Excellent – Slight detectable change in color or gloss, but no change to the function of life or the surface material.
3. Good – Clearly discernible change in color or gloss, but no significant impairment of surface function or life.
4. Fair – Objectionable change in appearance due to surface discoloration or etch, possibly resulting in deterioration of function over an extended period of time.
5. Failure – Pitting, cratering or erosion of surface material. Obvious and significant deterioration.

D. Performance:
Test results shall equal or exceed the following:

<table>
<thead>
<tr>
<th>Reagent</th>
<th>% by wt.</th>
<th>Spills</th>
<th>Fumes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydrochloric Acid</td>
<td>48%</td>
<td>Excellent</td>
<td>Excellent</td>
</tr>
<tr>
<td>Sulfuric Acid</td>
<td>33%</td>
<td>Excellent</td>
<td>No Effect</td>
</tr>
<tr>
<td>Sulfuric Acid</td>
<td>77%</td>
<td>Excellent</td>
<td>No Effect</td>
</tr>
<tr>
<td>Sulfuric Acid</td>
<td>93%</td>
<td>Excellent</td>
<td>No Effect</td>
</tr>
<tr>
<td>Formic Acid</td>
<td>88%</td>
<td>No Effect</td>
<td>No Effect</td>
</tr>
<tr>
<td>Nitric Acid</td>
<td>20%</td>
<td>No Effect</td>
<td>No Effect</td>
</tr>
<tr>
<td>Nitric Acid</td>
<td>30%</td>
<td>No Effect</td>
<td>No Effect</td>
</tr>
<tr>
<td>Nitric Acid</td>
<td>70%</td>
<td>No Effect</td>
<td>No Effect</td>
</tr>
<tr>
<td>Hydrofluoric Acid</td>
<td>37%</td>
<td>No Effect</td>
<td>No Effect</td>
</tr>
<tr>
<td>Phosphoric Acid</td>
<td>85%</td>
<td>Excellent</td>
<td>No Effect</td>
</tr>
<tr>
<td>Chromic Acid, saturated</td>
<td></td>
<td>Fair</td>
<td>No Effect</td>
</tr>
<tr>
<td>Acetic Acid, glacial</td>
<td></td>
<td>No Effect</td>
<td>No Effect</td>
</tr>
<tr>
<td>Sulfuric Acid / Nitric Acid Equal Parts</td>
<td>77% / 70%</td>
<td>No Effect</td>
<td>Excellent</td>
</tr>
<tr>
<td>Ammonium Hydroxide</td>
<td>28%</td>
<td>No Effect</td>
<td>No Effect</td>
</tr>
<tr>
<td>Sodium Hydroxide</td>
<td>10%</td>
<td>Excellent</td>
<td>No Effect</td>
</tr>
<tr>
<td>Sodium Hydroxide</td>
<td>20%</td>
<td>Excellent</td>
<td>No Effect</td>
</tr>
<tr>
<td>Sodium Hydroxide</td>
<td>40%</td>
<td>Excellent</td>
<td>No Effect</td>
</tr>
<tr>
<td>Sodium Hydroxide Flake</td>
<td></td>
<td>No Effect</td>
<td>No Effect</td>
</tr>
<tr>
<td>Sodium Sulfide, saturated</td>
<td></td>
<td>Good</td>
<td>Excellent</td>
</tr>
<tr>
<td>Zinc Chloride</td>
<td></td>
<td>No Effect</td>
<td>No Effect</td>
</tr>
<tr>
<td>Tincture of Iodine</td>
<td></td>
<td>No Effect</td>
<td>Good</td>
</tr>
<tr>
<td>Silver Nitrate</td>
<td>10%</td>
<td>Excellent</td>
<td>No Effect</td>
</tr>
<tr>
<td>Methyl Alcohol</td>
<td></td>
<td>No Effect</td>
<td>No Effect</td>
</tr>
<tr>
<td>Ethyl Alcohol</td>
<td></td>
<td>No Effect</td>
<td>No Effect</td>
</tr>
<tr>
<td>Butyl Alcohol</td>
<td></td>
<td>No Effect</td>
<td>No Effect</td>
</tr>
<tr>
<td>Benzene</td>
<td></td>
<td>No Effect</td>
<td>No Effect</td>
</tr>
<tr>
<td>Xylene</td>
<td></td>
<td>No Effect</td>
<td>No Effect</td>
</tr>
<tr>
<td>Gasoline</td>
<td></td>
<td>No Effect</td>
<td>No Effect</td>
</tr>
<tr>
<td>Dichloro Acetic Acid</td>
<td>93%</td>
<td>No Effect</td>
<td>No Effect</td>
</tr>
<tr>
<td>Di Methyl Formamide</td>
<td></td>
<td>No Effect</td>
<td>No Effect</td>
</tr>
<tr>
<td>Ethyl Acetate</td>
<td></td>
<td>No Effect</td>
<td>No Effect</td>
</tr>
<tr>
<td>Amyl Acetate</td>
<td></td>
<td>No Effect</td>
<td>No Effect</td>
</tr>
<tr>
<td>Acetone</td>
<td></td>
<td>No Effect</td>
<td>No Effect</td>
</tr>
<tr>
<td>Chloroform</td>
<td></td>
<td>No Effect</td>
<td>No Effect</td>
</tr>
<tr>
<td>Phenol</td>
<td>85%</td>
<td>No Effect</td>
<td>Excellent</td>
</tr>
<tr>
<td>Cresol</td>
<td></td>
<td>No Effect</td>
<td>No Effect</td>
</tr>
<tr>
<td>Formaldehyde</td>
<td>37%</td>
<td>No Effect</td>
<td>No Effect</td>
</tr>
</tbody>
</table>

Reagent % by wt. Spills Fumes
--- --- --- ---
Trichloroethylene No Effect No Effect

FUME HOODS AND OTHER AIR CONTAINMENT UNITS
11 53 13 - 6
Ethyl Ether | No Effect | No Effect
Furfural | Good | No Effect
Monochlorobenzene | No Effect | No Effect
Dioxane | No Effect | No Effect
Methyl Ethyl Ketone | No Effect | No Effect
Acid Dichromate | Excellent | Excellent
Hydrogen Peroxide | 30% | No Effect | No Effect
Naphthalene | No Effect | No Effect
Methylene Chloride | No Effect | No Effect
Carbon Tetrachloride | No Effect | No Effect
Toluene | No Effect | No Effect

Note: Maximum concentration is to be understood unless a lower concentration is shown in the table.

3.1 SITE CONDITIONS

A. Prior to installation of the Work of this Section, carefully inspect the installed Work specified in other sections and verify that all such Work is complete to the point where this installation may properly commence.

B. Verify that all Work has been installed in complete accordance with the original design, received submittals, and the manufacturer's recommendations.

C. In the event of discrepancy, immediately notify the Architect. Do not proceed with installation in areas of discrepancy until all such discrepancies have been fully resolved.

3.2 INSTALLATION

A. Work in this Section requires close coordination with Work specified in Division 15 and Division 16, as well as installation by Owner of Owner furnished components. Coordinate all Work to ensure an orderly process in the Project, without removal of previously installed Work, and so as to prevent damage to finishes and products.

B. Coordinate location and alignment of fume hoods and cabinets for proper connection of all piping and duct work.

C. Install all equipment in accordance with applicable codes and regulations, accepted Shop Drawings, and as necessary for a complete operating system.

D. Install all hood fittings specified in Section 11604, pre-piped to a single point of connection 6 inches above the top of hood for connection by Division 15.

3.3 FIELD TESTING

A. Chemical Fume Hoods:
   2. Fume hood field tests shall be performed by a qualified independent testing company on each hood to determine face velocity and air flow patterns.
   3. Fume hoods shall achieve an AI performance rating equal or better than 0.10 ppm with 4.0 Lpm tracer gas release rate when tested in accordance with ASHRAE 110-1995.
   4. Balancing of the system is in the scope of work in Division 15.

3.4 CLEANING AND PROTECTION
A. Repair or remove and replace defective work as approved by the Architect upon completion of installation.
B. Adjust all moving or operating part to function within their design parameters.
C. Clean equipment, touch up as required.
D. Protect all units before, during and after installation. Damaged materials due to improper protection shall be cause for rejection.

END OF SECTION
SECTION 12490

ROLLER SHADES

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Sunscreen roller shades, manual operation.
B. Room darkening and sunscreen double roller shades, manual operation.

1.02 RELATED SECTIONS

A. Section 06114 - Wood Blocking and Curbing: Wood blocking and grounds for mounting roller shades and accessories.
B. Section 09260 - Gypsum Board Assemblies: Coordination with gypsum board assemblies for installation of shade pockets, closures and related accessories.
C. Section 09510 - Acoustical Ceilings: Coordination with acoustical ceiling systems for installation of shade pockets, closures and related accessories.
D. Division 16 - Electrical: Electric service for motor controls.

1.03 REFERENCES

B. NFPA 70 - National Electrical Code.
C. NFPA 701 - Fire Tests for Flame-Resistant Textiles and Films.

1.04 SUBMITTALS

A. Submit under provisions of Section 01330 Submittal Procedures.
B. Product Data: Manufacturer's data sheets on each product to be used, including:
   1. Preparation instructions and recommendations.
   2. Styles, material descriptions, dimensions of individual components, profiles, features, finishes and operating instructions.
   3. Storage and handling requirements and recommendations.
   4. Mounting details and installation methods.
   5. Typical wiring diagrams including integration of motor controllers with building management system, audiovisual and lighting control systems as applicable.
C. Shop Drawings: Plans, elevations, sections, product details, installation details, operational clearances, wiring diagrams and relationship to adjacent work.
D. Window Treatment Schedule: For all roller shades. Use same room designations as indicated on the Drawings and include opening sizes and key to typical mounting details.
E. Verification Samples: For each finish product specified, one complete set of shade components, unassembled, demonstrating compliance with specified requirements. Shadecloth sample and aluminum finish sample as selected. Mark face of material to indicate interior faces.
F. Maintenance Data: Methods for maintaining roller shades, precautions regarding cleaning materials and methods, instructions for operating hardware and controls.
1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications: Obtain roller shades through one source from a single manufacturer with a minimum of twenty years experience in manufacturing products comparable to those specified in this section.

B. Installer Qualifications: Installer trained and certified by the manufacturer with a minimum of ten years experience in installing products comparable to those specified in this section.

C. Fire-Test-Response Characteristics: Passes NFPA 701 small and large-scale vertical burn. Materials tested shall be identical to products proposed for use.

D. Electrical Components: NFPA Article 100 listed and labeled by either UL or ETL or other testing agency acceptable to authorities having jurisdiction, marked for intended use, and tested as a system. Individual testing of components will not be acceptable in lieu of system testing.

E. Anti-Microbial Characteristics: ‘No Growth’ per ASTM G 21 results for fungi ATCC9642, ATCC 9644, ATCC9645.

F. Mock-Up: Provide a mock-up (manual shades only) of one roller shade assembly for evaluation of mounting, appearance and accessories.
   1. Locate mock-up in window designated by Architect.
   2. Do not proceed with remaining work until, mock-up is accepted by Architect.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver shades in factory-labeled packages, marked with manufacturer and product name, fire-test-response characteristics, and location of installation using same room designations indicated on Drawings and in the Window Treatment Schedule.

1.07 PROJECT CONDITIONS

A. Environmental Limitations: Install roller shades after finish work including painting is complete and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.

1.08 WARRANTY

A. Roller Shade Hardware and Chain Warranty: Manufacturer's standard non-depreciating twenty-five year limited warranty.

B. Standard Shadecloth: Manufacturer's standard twenty-five year warranty.

C. ThermalVeil Shadecloth: Manufacturer's standard ten year warranty.

D. Roller Shade Motors and Motor Control Systems: Manufacturer's standard non-depreciating five year warranty.

E. Roller Shade Installation: One year from date of Substantial Completion, not including scaffolding, lifts or other means to reach inaccessible areas.

PART 2 - PRODUCTS

2.01 SYSTEM DESCRIPTION

A. Provide top-down operation of roller shades as indicated on drawings.
2.02 MANUFACTURERS


B. Acceptable Manufacturers:

2.03 ROLLER SHADE TYPES

A. Manually Operated Shades:
   1. Mounting as indicated in Drawings:
      a. Surface Mounted with Fascia.
      b. Concealed perimeter pocket for suspended gyp board ceiling conditions.
      c. Concealed perimeter pocket for acoustic lay-in ceiling.
   2. Configuration: Single solar shadecloth, at rooms SC103a, and SC104

B. Manually Operated Shades:
   Mounting: Recess mounted with ceiling pocket and fascia.
   Configuration: Double solar and blackout shadecloth.
   Solar Shadecloths:
      a. Fabric: ThermoVeil 1300, 5 percent open, 2 by 2 dense basket-weave pattern.
      b. Fabric: Selected from manufacturer's standard fabrics.
      c. Color: Selected from manufacturer's standard colors.
   Blackout Shadecloths:
      d. Fabric: ThermoVeil Equinox 0100, blackout shadecloth with opaque acrylic backing.
      e. Color: Selected from manufacturer's standard colors.

2.04 SHADE CLOTH

A. Visually Transparent Solar Shadecloth: MechOShade Systems, Inc., ThermoVeil series, single thickness non-raveling 0.030-inch (0.762 mm) thick vinyl fabric, woven from 0.018-inch (0.457 mm) diameter extruded vinyl yarn comprising of 21 percent polyester and 79 percent reinforced vinyl.
   1. Solar Shadecloth:
      a. Fabric: ThermoVeil Series 1300, basket-weave pattern at 5 percent open.
      b. Color: #1316 Eggshell.

B. Room Darkening Shadecloth: MechOShade Systems, Inc., ThermoVeil 0700 series, blackout material, washable and colorfast laminated and embossed vinyl coated fabric, 0.012 inches thick (0.30 mm) blackout material and weighing 0.81 lbs. per square yard, with a minimum of 62 threads per square inch.
   1. Blackout Shadecloth:
      a. ThermoVeil Equinox 0100.
      b. Fabric: Series 1500 (3% open).
      c. Color: #1520 Shadow Grey.

2.05 SHADE BAND

A. Shade Bands: Construction of shade band includes the fabric, hem weight, hem-pocket, shade roller tube, and attachment of shade band to the roller tube. Sewn hems and open hem pockets
are not acceptable.

1. Hem Pockets and Hem Weights: Fabric hem pocket with RF-welded seams (including welded ends) and concealed hem weights. Hem weights shall be of appropriate size and weight for shade band. Hem weight shall be continuous inside a sealed hem pocket. Hem pocket construction and hem weights shall be similar, for all shades within one room.

2. Shade Band and Shade Roller Attachment:
   a. Use extruded aluminum shade roller tube of a diameter and wall thickness required to support shade fabric without excessive deflection. Roller tubes less than 1.55 inch (39.37 mm) in diameter for manual shades, and less than 2.55 inches (64.77 mm) for motorized shades are not acceptable.
   b. Provide for positive mechanical engagement with drive / brake mechanism.
   c. Provide for positive mechanical attachment of shade band to roller tube; shade band shall be made removable / replaceable with a "snap-on snap-off" spline mounting, without having to remove shade roller from shade brackets.
   d. Mounting spline shall not require use of adhesives, adhesive tapes, staples, and/or rivets.
   e. Any method of attaching shade band to roller tube that requires the use of adhesive, adhesive tapes, staples, and/or rivets are not acceptable.
2.06 SHADE FABRICATION

A. Fabricate units to completely fill existing openings from head to sill and jamb-to-jamb, unless specifically indicated otherwise.

B. Fabricate shadecloth to hang flat without buckling or distortion. Fabricate with heat-sealed trimmed edges to hang straight without curling or raveling. Fabricate unguided shadecloth to roll true and straight without shifting sideways more than 1/8 inch (3.18 mm) in either direction per 8 feet (2438 mm) of shade height due to warp distortion or weave design. Fabricate hem as follows:

C. Provide battens in standard shades as required to assure proper tracking and uniform rolling of the shadecloths. Contractor shall be responsible for assuring the width-to-height (W:H) ratios shall not exceed manufacturer's standards or, in absence of such standards, shall be responsible for establishing appropriate standards to assure proper tracking and rolling of the shadecloth within specified standards. Battens shall be roll-formed stainless steel or tempered steel, as required.

D. For railroaded shadecloths, provide seams in railroaded multi-width shadecloths as required to meet size requirements and in accordance with seam alignment as acceptable to Architect. Seams shall be properly located. Furnish battens in place of plain seams when the width, height, or weight of the shade exceeds manufacturer's standards. In absence of such standards, assure proper use of seams or battens as required to, and assure the proper tracking of the railroaded multi-width shadecloths.

E. Provide battens for railroaded shades when width-to-height (W:H) ratios meet or exceed manufacturer's standards. In absence of manufacturer's standards, be responsible for proper use and placement of battens to assure proper tracking and roll of shadecloths.

F. Room darkening shadecloths, when used in side channels, shall have horizontally mounted, roll-formed stainless steel or tempered-steel battens not more than 3 feet (115 mm) on center extending fully into the side channels. Battens shall be concealed in a integrally-colored fabric to match the inside and outside colors of the shadecloth, in accordance with manufacturer's published standards for spacing and requirements.
   1. Battens shall be roll formed of stainless steel or tempered steel and concave to match the contour of the roller tube.
   2. Batten pockets shall be self-colored fabric front and back RF welded into the shadecloth. A self-color opaque liner shall be provided front and back to eliminate any see through of the batten pocket that shall not exceed 1-1/2 inches (38.1 mm) high and be totally opaque. A see-through moire effect, which occurs with visible layers of transparent fabrics, shall not be acceptable.

2.07 COMPONENTS

A. Access and Material Requirements:
   1. Provide shade hardware allowing for the removal of shade roller tube from brackets without removing hardware from opening and without requiring end or center supports to be removed.
   2. Provide shade hardware that allows for removal and re-mounting of the shade bands without having to remove the shade tube, drive or operating support brackets.
   3. Use only Delrin engineered plastics by DuPont for all plastic components of shade hardware. Styrene based plastics, and/or polyester, or reinforced polyester will not be acceptable.
B. Manual Operated Chain Drive Hardware and Brackets:

1. Provide for universal, regular and offset drive capacity, allowing drive chain to fall at front, rear or non-offset for all shade drive end brackets. Universal offset shall be adjustable for future change.
2. Provide hardware capable for installation of a removable fascia, for both regular and/or reverse roll, which shall be installed without exposed fastening devices of any kind.
3. Provide shade hardware system that allows for removable regular and/or reverse roll fascias to be mounted continuously across two or more shade bands without requiring exposed fasteners of any kind.
4. Provide shade hardware system that allows for operation of multiple shade bands (multi-banded shades) by a single chain operator, subject to manufacturer's design criteria. Connectors shall be offset to assure alignment from the first to the last shade band.
5. Provide shade hardware system that allows multi-banded manually operated shades to be capable of smooth operation when the axis is offset a maximum of 6 degrees on each side of the plane perpendicular to the radial line of the curve, for a 12 degrees total offset.
6. Provide positive mechanical engagement of drive mechanism to shade roller tube. Friction fit connectors for drive mechanism connection to shade roller tube are not acceptable.
7. Provide shade hardware constructed of minimum 1/8-inch (3.18 mm) thick plated steel or heavier as required to support 150 percent of the full weight of each shade.

Drive Bracket / Brake Assembly:

a. MechoShade Drive Bracket model M5 shall be fully integrated with all MechoShade accessories, including, but not limited to: SnapLoc fascia, room darkening side / sill channels, center supports and connectors for multi-banded shades.

b. M5 drive sprocket and brake assembly shall rotate and be supported on a welded 3/8 inch (9.525 mm) steel pin.

c. The brake shall be an over-running clutch design which disengages to 90 percent during the raising and lowering of a shade. The brake shall withstand a pull force of 50 lbs. (22 kg) in the stopped position.

d. The braking mechanism shall be applied to an oil-impregnated hub on to which the brake system is mounted. The oil impregnated hub design includes an articulated brake assembly, which assures a smooth, non-jerky operation in raising and lowering the shades. The assembly shall be permanently lubricated. Products that require externally applied lubrication and or not permanently lubricated are not acceptable.

e. The entire M5 assembly shall be fully mounted on the steel support bracket, and fully independent of the shade tube assembly, which may be removed and reinstalled without effecting the roller shade limit adjustments.

f. Drive Chain: #10 qualified stainless steel chain rated to 90 lb. (41 kg) minimum breaking strength. Nickel plate chain shall not be accepted.

1.2 ACCESSORIES

A. Roller Shade Pocket: For recessed mounting in acoustical tile, or drywall ceilings as indicated on the Drawings.

B. Provide either extruded aluminum and or formed steel shade pocket, sized to accommodate roller shades, with exposed extruded aluminum.
closure mount, tile support and removable closure panel to provide access to shades.

C. Provide "Vented Pocket" such that there will be a minimum of four 1 inch (25.4 mm) diameter holes per foot allowing the solar gain to flow above the ceiling line.

D. Pocket Accessories: As indicated on the Drawings.

E. Fascia: Continuous removable extruded aluminum fascia that attaches to shade mounting brackets without the use of adhesives, magnetic strips, or exposed fasteners.
   1. Fascia shall be able to be installed across two or more shade bands in one piece.
   2. Fascia shall fully conceal brackets, shade roller and fabric on the tube.
   3. Provide bracket / fascia end caps where mounting conditions expose outside of roller shade brackets.
   4. Notching of Fascia for manual chain shall not be acceptable.

F. Room Darkening Channels: Side Channels, MechoShade: Extruded aluminum with polybond edge seals and SnapLoc-mounting brackets and with concealed fastening. Exposed fastening is not acceptable. Units 1-15/16 inches (49.2 mm) wide by 1-3/16 inches (30.1 mm) deep, two-band center channels, 2-5/8 inches (66.6 mm) wide by 1-3/16 inches (30.1 mm) deep. The 2-5/8-inch (66.6 mm) double-center channels may be installed at center-support positions of multi-band-shade ElectroShades. MechoShade side channels 2-5/8 inch (66.6 mm) may be used as center supports for ElectroShades; shadebands up to 8 high. For shadebands over 8 feet (2438 mm), provide ElectroShade side channels.

G. Sill Channels: Extruded aluminum with polybond edge seals and SnapLoc-mounting brackets and with concealed fastening. Exposed fastening is not acceptable.
   1. Channel Color: Selected from manufacturer's standard colors.

PART 3 - EXECUTION

3.01 EXAMINATION
   A. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

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

3.03 INSTALLATION
   A. Install roller shades level, plumb, square, and true according to manufacturer's written instructions, and located so shade band is not closer than 2 inches (50 mm) to interior face of glass. Allow proper clearances for window operation hardware.
   B. Turn-Key Single-Source Responsibility for Motorized Interior Roller Shades: To control the responsibility for performance of motorized roller shade systems, assign the design, engineering, and installation of motorized roller shade systems, motors, controls, and low voltage electrical control wiring specified in this Section to a single manufacturer and their authorized installer/dealer. The Architect will not produce a set of electrical drawings for the
installation of control wiring for the motors, or motor controllers of the motorized roller shades. Power wiring (line voltage), shall be provided by the roller shade installer/dealer, in accordance with the requirements provided by the manufacturer. Coordinate the following with the roller shade installer/dealer:

1. Contractor shall provide power panels and circuits of sufficient size to accommodate roller shade manufacturer's requirements, as indicated on the mechanical and electrical drawings.
2. Contractor shall coordinate with requirements of roller shade installer/dealer, before inaccessible areas are constructed.
3. Roller shade installer/dealer shall run line voltage as dedicated home runs (of sufficient quantity, in sufficient capacity as required) terminating in junction boxes in locations designated by roller shade dealer.
4. Roller shade installer/dealer shall provide and run all line voltage (from the terminating points) to the motor controllers, wire all roller shade motors to the motor controllers, and provide and run low voltage control wiring from motor controllers to switch/ control locations designated by the Architect. All above-ceiling and concealed wiring shall be plenum-rated, or installed in conduit, as required by the electrical code having jurisdiction.
5. Contractor shall provide conduit with pull wire in all areas, which might not be accessible to roller shade contractor due to building design, equipment location or schedule.

C. Adjust and balance roller shades to operate smoothly, easily, safely, and free from binding or malfunction throughout entire operational range.

D. Clean roller shade surfaces after installation, according to manufacturer's written instructions.

E. Engage Installer to train Owner's maintenance personnel to adjust, operate and maintain roller shade systems.

3.04 PROTECTION

A. Protect installed products until completion of project.

B. Touch-up, repair or replace damaged products before Substantial Completion.

END OF SECTION
SECTION 12 35 53
LABORATORY CASEWORK

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes the following in life science rooms and preparation rooms.
   1. Fixed modular casework furniture with finished interiors.
   2. Countertops.
   3. Fixtures.
   4. Sinks and plumbing accessories.
   5. Electrical fixtures and accessories.
   6. Utility-space closure panels between base cabinets and at exposed ends of utility spaces.
   7. Utility-space framing at backs of base cabinets and between backs of base cabinets.
   8. Miscellaneous accessories and materials required for complete installations.

B. Related requirements:
   1. Division 06 for framing, reinforcements of walls, floors and ceilings, wood blocking for supporting and anchoring laboratory casework.
   2. Division 09 for the following:
      a. Reinforcements in metal-framed gypsum board partitions for anchoring laboratory casework.
      b. Resilient base applied to wood laboratory casework.
   3. Divisions 22 and 26 Sections for the following:
      a. Installing and connecting service lines and fittings, and connecting service utilities at indicated points.
      b. Connecting drain lines, traps, piping, wire, and conduit within the equipment and through, under, or along the backs of working surfaces as required and indicated on the drawings.
      c. Installing sink and service fixtures, and final connection of all services.
      d. Connecting vents and plumbing fixtures or piping to meet local codes.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated.
B. Shop Drawings:
   1. Submit plans, elevations, sections, details, and attachments to other work, showing cabinets, fixtures, moldings, countertops and other pertinent items.
   2. Show overall dimensions and call specific attention to dimensions and conditions which vary from those shown on the Drawings.
   3. Indicate locations of blocking and reinforcements required for installing laboratory casework.
   4. Indicate locations and types of service fittings, together with associated service supply connection required.
   5. Include details of utility spaces showing supports for conduits and piping.
   6. Include details of exposed conduits, if required, for service fittings.
7. Indicate locations of and clearances from adjacent walls, doors, windows, other building components, and other laboratory equipment.
8. Include coordinated dimensions for laboratory equipment specified in other Sections.

C. Preliminary samples:
   1. Submit the following:
      a. For each type of finish, including countertop material in manufacturer's standard sizes.
      b. One each of all mechanical service fixtures, locks, door pulls, hinges, and interior hardware.
      c. Color samples, in duplicate, for countertop material, wood, metal, finished as specified, on 4-inch by 8-inch stock of same material as specified for each element.

D. Verification samples: Unless otherwise directed, build the following sample units in an undisturbed condition at time of Substantial Completion, which may become part of the completed Work. Notify Architect of their exact locations. If not incorporated into the Work, retain acceptable Sample units at Project site and remove when directed by Architect.
   1. One full-size, finished base cabinet complete with hardware, doors, and drawers, but without countertop.
   2. One full-size, finished wall cabinet complete with hardware, doors, and adjustable shelves.
   3. Include at least one hinged and one sliding door, one of each service fitting specified, complete with accessories and specified finish, and one of each type of sink and accessory item specified.

E. Qualification data: For testing agency.
F. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, indicating compliance of laboratory casework finishes and countertops with requirements specified for chemical and physical resistance.

1.3 QUALITY ASSURANCE
A. Manufacturer Qualifications: Firm with not less than 5 years' experience in the actual production of specified products.
B. Installer Qualifications: Firm with 5 years' experience in installation or application of systems similar in complexity to those required for this Project.
C. Testing Agency Qualifications: An independent agency qualified for testing indicated, as documented according to ASTM E 548.
D. Source Limitations: Obtain laboratory casework, including countertops, sinks, service fittings, and accessories, through one source from a single manufacturer.
E. Product Standard: Comply with SEFA 8, "Laboratory Furniture-Casework, Shelving and Tables--Recommended Practices."
F. Flammable Liquid Storage: Where cabinets are indicated for flammable liquid storage, provide units that are listed and labeled as complying with requirements of NFPA 30 by UL or another testing and inspecting agency acceptable to authorities having jurisdiction.
G. 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.

1.4 HANDLING
A. Protect finished surfaces during handling and installation with protective covering of polyethylene film or other suitable material.

B. Provide additional protection as needed to assure that the work of this Section remains undamaged during installation, and the time between completion of installation and actual acceptance of the Work.

C. Environmental Limitations: Do not deliver or install casework until building is enclosed, wet work and utility roughing-in are complete, and HVAC system is operating and maintaining the required temperature and relative humidity at occupancy levels during the remainder of the construction period.

1.5 PROJECT CONDITIONS

A. For delivery and installation of laboratory casework and equipment, building conditions shall comply with WI Standard 1700-G-3 and 1700-G-4 and be as follows:
   1. Flooring required to be placed under casework and equipment installed.
   2. Blocking (wall grounds) installed within partitions to allow for immediate installation upon delivery.
   3. Relative humidity not less than 40 percent, nor more than 60 percent.
   4. Temperatures not less than 65 degrees F and not greater than 80 degrees F in areas of casework and equipment installation.
   5. Overhead mechanical, electrical and plumbing rough-in work is complete.
   6. Wet operations complete prior to delivery.
   7. Ceiling grids (with or without ceiling tiles), overhead soffits, ductwork and lighting installed.
   8. Painting complete.

1.6 SPECIAL WARRANTY

A. Casework Manufacturer Warranty: 3 years from date of Substantial Completion, as follows:
   1. Defects in materials and workmanship.
   2. Deterioration of material and surface performance below minimum SEFA 8 standards as certified by independent third party testing laboratory.

B. Manufacturer agrees repair or replace defective casework at no cost to the Owner.

1.7 EXTRA MATERIALS

A. Furnish complete touchup kit for each type and color of wood laboratory casework provided. Include scratch fillers, stains, finishes, and other materials necessary to perform permanent repairs to damaged laboratory casework finish.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Campbell Rhea, Mohon International, Inc. (basis of design.)
B. Kewaunee Scientific Corporation, Laboratory Division.
C. Or approved equal.

2.2 CASEWORK

A. Construction type frameless, lipped overlay upper and lower wood laboratory casework with radiused edges.
2.3 MATERIALS

A. Lumber:
   1. For exterior construction use "A" grade Appalachian Red oak, especially selected for color and grain and free of splits, checks or other defects. Lumber shall be air dried for 12 months, kiln-dried to approximately 4-1/2 percent moisture content and tempered to approximately 7 percent before fabrication.
   2. Lumber used for interior construction shall be Oak, or other suitable hardwoods, but not selected for color or grain.

B. Oak plywood:
   1. 3/4-inch, minimum 7-ply, crossband, solid core, plain sliced red Oak, grade A-2.
   2. 1/2-inch Oak plywood shall be minimum 5-ply construction, plain sliced Red Oak, grade A-2.
   3. 1/4-inch Oak plywood shall be the same as 1/2-inch plywood, except 3-ply.

C. Hardwood plywood: Other hardwood plywood shall be solid core, sound grade 2-2, thicknesses as indicated.

D. Fir plywood: 3/4-inch Fir plywood shall be minimum 5-ply, cross-banded solid core construction, grade A-B.

E. Tempered hardboard: Steam-exploaded wood fibers, highly compressed into dense, hard, homogeneous sheets, using natural resins and other added binders with the following physical properties:
   2. Modulus of rupture 6300 to 9800 lbs./sq.in.
   3. Tensile strength-4000 to 4500 lbs./sq.in.
   4. 24-hour water absorption by weight- 105 maximum.

F. Glass: 7/32 inch thick laminated safety glass.

G. Locks: Comply with District standards, and provide the following at all locations:

H. Latching Handles: 4-1/4 inches long, streamlined, chrome-plated finish, and shall operate with a 1/4 turn to left or right. Furnish a 3-point latch plate for positive engagement at top, bottom, and middle of doors. Two 5/16-inch diameter aluminum rods extending full height of case latch behind adjustable, plastic strikes at top and bottom of case, with the latch plate at the center of the door engaging the side of case, or latches behind adjacent door on double-door cases. Provide nylon guides for the aluminum rods shall be provided at top and bottom of door.

I. Locking handles: Same As "Latching Handles" except locking mechanism and keys are provided.

J. Aluminum pull: (Style AL-1): Extruded aluminum, of trim modern design, surface mounted, 4-1/2 inches long, and attached with 2 screws 4 inches on centers.

K. Metal drawer slides: Heavy-duty, side-mounted type, 75-lb capacity, zinc-plated steel, equipped with heavy-duty, ball-bearing nylon wheels, to provide smooth, effortless operation. Slides shall have automatic positive stops to prevent accidental removal of drawers, yet permit quick removal without use of tools.

L. Hinges for lipped doors: Heavy-duty steel, satin-chrome-plated, 5-knuckle, semi-concealed type with off-set wings, material thickness shall be 0.083 inch. Hinges shall be attached with 6 screws.
M. Magnetic catches: Aluminum or zinc-plated metal, with aluminum 10-lb. pull, attached with screws.

N. Friction catches: Positive action type, zinc or cadmium-plated steel with spring-cushioned, polyethylene roller engaging a metal strike plate.

O. Sliding door track: Aluminum, overhead type, with adjustable, nylon roller hangers. Each door shall be secured at bottom by 2 hard plastic guides attached to the back side of the door and shall operate in aluminum channels recessed into the bottom of the case.

P. Metal shelf clips for adjustable shelves: Nickel-plated metal with non-slip plastic coating.

Q. Leg shoes:
   1. Black, open bottom, cove type, molded from chemically-inert vinyl material.
   2. Black, closed bottom, square design, molded from chemically inert vinyl or rubber, with 1/8-inch thick wall and bottom.

2.4 MECHANICAL SERVICE FIXTURES

A. Water faucets: Refer Division 22 and the Drawings.

B. Fixtures for water and other required services shall be heavy duty construction, triple chrome-plated, especially designed for laboratory use.

2.5 ELECTRICAL SERVICE FIXTURES

A. Electrical boxes, where mounted flush in rails, shall be cadmium-plated steel. Include polished, cast aluminum pedestal type boxes, with nipple and lock nuts. Equip boxes with stainless steel cover plates, and include 3-wire grounded type, 15A, 125V receptacles.

2.6 PLASTIC TRAPS AND FITTINGS

A. Chemical-resistant, flame-retardant, polypropylene material with schedule 40 wall thickness, with mechanical connections. Traps shall be 2 inches, unless otherwise indicated or required. At prep rooms sinks with point use acid waste neutralization units.

2.7 SINK OUTLETS AND TAIL PIECES

A. Epoxy resins specially compounded and cured to give optimum physical and chemical resistant properties, 1-1/2 inches, unless otherwise indicated or required. Include tailpieces for connecting mechanically to "Duriron" traps or piping only.

2.8 SINKS

A. Non-glaring, black epoxy resin units molded of specifically modified epoxy resins in solid, one-piece construction, providing optimum physical and chemical resistant properties. Fabricate with coved inside corners and with bottom dished to outlet.

   1. Provide at all epoxy sinks slot at faucet for vandal-resistant pin.

2.9 COUNTERTOPS

A. Factory molded of modified epoxy-resin formulation with smooth, nonspecular finish.

   1. Physical Properties:

      a. Flexural Strength: Not less than 10,000 psi.
      b. Modulus of Elasticity: Not less than 2,000,000 psi.
      c. Hardness (Rockwell M): Not less than 100.
      d. Water Absorption (24 Hours): Not more than 0.02 percent.
e. Heat Distortion Point: Not less than 260 deg F.

2. Chemical Resistance: Epoxy-resin material has the following ratings when tested with indicated reagents according to NEMA LD 3, Test Procedure 3.4.5:

a. No Effect: Acetic acid (98 percent), acetone, ammonium hydroxide (28 percent), benzene, carbon tetrachloride, dimethyl formamide, ethyl acetate, ethyl alcohol, ethyl ether, methyl alcohol, nitric acid (70 percent), phenol, sulfuric acid (60 percent), and toluene.

b. Slight Effect: Chromic acid (60 percent) and sodium hydroxide (50 percent).

3. Color: As scheduled by Architect from manufacturer's full range.

4. Countertop Fabrication: Fabricate with factory cutouts for sinks and with butt joints assembled with epoxy adhesive and prefitted, concealed metal splines.

a. Countertop Configuration: Flat, 3/4 inch thick, with rounded edges and corners, and with drip groove and integral coved backsplash.

b. Provide integral sinks in epoxy countertops, bonded to countertops with invisible joint line.

B. Fabricate tops to widths indicated, in one piece molded surface with integrally molded back curb, 4 inches high, unless otherwise indicated or required.

C. Countertops shall be as wide as indicated.

2.10 CABINETS

A. General: Cabinets and cases shall be in flush overlap construction providing dust resistant interiors with an overlap on all 4 sides of drawer fronts and swinging doors completely covering the cabinet opening. Fabricate cabinets shall rigidly with structural joints mortised and tenoned, and glued and fastened for optimum strength. All cabinets shall be integral units, each completely enclosed without the use of common partitions.

B. Lipped drawers (Style S-1):

1. Drawer sides: 1/2-inch solid hardwood, dovetailed into 1/2-inch hardwood back and into 3/4-inch solid Oak front.

2. Drawer fronts: Lipped on all 4 edges, overlapping opening 1/4 inch all around.

3. Drawer bottoms: 1/4-inch tempered hardboard, let in all 4 sides and securely glued.


C. Hinged doors:

1. Equip doors 48 inches high or less with 2 hinges.

2. Equip doors over 48 inches high with 3 hinges and a 3-point latching (or locking) handle.

3. All doors shall overlap opening 114 inches all around and be secured with friction roller catches.

D. Lipped wood and glass doors: (Style S-1):

1. Fabricate with 3/8-inch thick, radiused lip, machined on all 4 edges.

2. Wood doors 48 inches high or less shall be 13/16 inch thick, 7-ply construction with a solid core, solid Oak framing all 4 edges, and Red oak veneer on both sides.

3. Wood doors over 48 inches high shall be same, except 1-1/16 inch thick with honeycomb core.

4. Glazed doors shall have frames of solid Oak, 1-1/16 inch thick by 3 inches wide, with all joints mortised and tenoned, glued and screwed.

5. Provide center astragal strip for left door of all double doors.
E. Glass sliding doors: Fabricate from 7/32 inch safety glass with polished edges, supported from bottom by an aluminum shoe with nylon rollers, operating on an aluminum bottom track. Provide aluminum or plastic guide track at top. Doors shall be provided with round, recessed, nickel-plated finger pulls and ratchet type locks.

F. Wall cases:

1. Top panel, bottom panel, and adjustable shelves of cases with exposed interiors shall be 3/4 inch thick Oak plywood and end panels shall be same material when exterior or interior is exposed.
2. Top panel, bottom panel, and adjustable shelves of cases with unexposed interiors shall be 3/4 inch thick Fir plywood.
3. End panels shall be the same material when exterior and interior of case is unexposed.
4. Backs of cases with exposed interiors shall be 1/4 thick Oak plywood.
5. Backs of cases with unexposed interiors shall be 1/4 inch thick tempered hardboard.
6. Top of front rail and bottom front rail shall be 2-1/4 inch by 3/4 inch thick solid Oak.
7. Top and bottom hanger rails on back of cases shall be 4 inches by 3/4 inch thick plywood.
8. End panels and adjustable shelves shall be edge-banded with solid Oak on front exposed edge.
9. Cases with sliding doors shall have a 1/4-inch thick solid Oak mold running full height of case opening on front interior edge of each end panel, providing dust strip for the sliding doors.
10. Top and bottom panels shall be tenoned and let into routed end panels.
11. Back of case shall be recessed and let into routed end panels and further secured at each side with glue blocks.
12. Adjustable shelves shall be supported on heavy-duty metal shelf clips fitting into holes drilled into cabinet ends 32 mm on centers.
13. Case doors shall be as required and described under "DOORS". All joints shall be glued and screwed, utilizing the best quality in cabinet making practices.

G. Upper cases:

1. Top panel, bottom panel, and adjustable shelves of cases with exposed interiors shall be 3/4 inch thick Oak plywood, and end panels shall be same material when exterior or interior is exposed.
2. Top panel, bottom panel, and adjustable shelves of cases with unexposed interiors shall be 3/4 inch thick Fir plywood, and end panels shall be same material when exterior and interior case is unexposed.
3. Backs of cases with unexposed interiors shall be 1/4 inch thick tempered hardboard.
4. Top front rail and bottom front rail shall be 2-1/4 by 3/4 inch thick solid Oak.
5. End panels and adjustable shelves shall be edge banded with solid Oak on front exposed edge.
6. Cases with sliding doors shall have 1/4-inch thick solid Oak mold, running full height of case opening and front interior edge of each end panel, providing a dust strip for the sliding doors.
7. Top and bottom panels shall be tenoned and let into routed end panels.
8. Back of case shall be recessed and let into routed end panels. Provide plywood cross-bracing 4 inches by 3/4 inch thick on back side of case at top and bottom; back shall be further secured at each side with glue blocks.
9. Adjustable shelves shall be supported on heavy-duty metal shelf clips fitting into holes drilled into end panels 32-mm on centers.
10. All joints shall be glued and screwed, utilizing the best in cabinet making practices.

H. Tall cases:
1. Top panel, bottom panel, fixed shelf, and adjustable shelves of cases with exposed interiors shall be 3/4 inch thick Oak plywood. End panels shall be same material when exterior or interior is exposed.
2. Top panel, bottom panel, fixed shelf, and adjustable shelves of cases with unexposed interiors shall be 3/4 inch thick Fir plywood, and end panels shall be same material when exterior and interior of case is unexposed.
3. Backs of cases with exposed interiors shall be 1/4 inch thick Oak plywood.
4. Top front rails shall be 2-1/4 by 3/4 inch thick solid Oak.
5. Plywood cross-brace 4 inches by 3/4 inch thick shall be provided at the top of each case on the back side. Provide additional cross rails as required on back side of all cases that do not have a fixed center shelf or other fixed, horizontal dividers.
6. Recessed backs shall be further secured at each side with glue blocks.
7. Provide a totally enclosed toe space 2-1/4 inches by 4 inches high shall Toe rail shall be 4 inches high and shall be securely screwed to end panels and bottom panel.
8. End panels, bottom panel, divider panels, fixed shelf, and adjustable shelves shall be edge-banded with solid Oak on front exposed edge.
9. Cases with sliding doors shall have a 1/4-inch thick solid Oak mold running full height of case opening on front interior edge of each end panel, providing a dust strip for the sliding doors.
10. Top and bottom panels and fixed center shelf shall be tenoned and let into routed end panels.
11. Adjustable shelves shall be supported on heavy-duty metal shelf clips, fitting into holes drilled into end panels 32-mm on centers.
12. Case doors shall be as required and described under "DOORS".
13. All joints shall be glued and screwed, utilizing the best in cabinet making practices.

I. Base cabinets:
1. Fabricate with a full horizontal top frame with mortised and tenoned joints, intermediate front and rear horizontal parting rails as required, 3/4 thick plywood end panels, 3/4 inch thick plywood bottom, 1/4 tempered hardboard back, and 3/4 inch thick plywood vertical dividers and partitions as required.
2. Horizontal top frame front members shall be one inch thick solid Oak
3. Intermediate horizontal front parting rails shall be 3/4 inch thick solid Oak.
4. Other frame members and rails may be other suitable hardwoods.
5. End panels, bottom, vertical dividers and partitions shall be edge-band with solid Oak.
6. Exposed end panels (and backs when exposed) shall be 3/4 inch Oak plywood.
7. Unexposed end panels, bottom, vertical dividers and partitions shall be Fir plywood.
8. Horizontal top frame, intermediate parting rails and 3/4- inch plywood bottom shall be tenoned and let into routed end-panels, except where they shall be removable for access plumbing.
9. Recessed backs shall be further secured at each side with glue blocks. A totally enclosed toe space 2-1/4 inch by 4 inches high shall be provided. Toe rail shall be 4 inches high and securely screwed to end panels and to bottom panel. Drawer separators shall be 1/4 inch tempered hardboard, let into routed intermediate rails and end panels. Provide separators between locked drawers.
10. Adjustable shelves shall be 3/4 inch thick Fir plywood with solid Oak edge-banding on exposed edge and supported on heavy-duty metal shelf clips fitting into holes drilled into cabinet ends 32-mm on centers.
11. Drawers shall be supported on heavy-duty side-mounted metal slides. Cabinet doors shall be as described under "DOORS". All joints shall be glued and screwed, utilizing the best in cabinet making practices.
2.11 TABLES

A. Open frame tables:
1. All exposed rails shall be 3/4 inch thick solid Oak.
2. Rails with drawers or compartments shall be 5-1/2 inches high.
3. Plain rails shall be 4-1/8 inches high.
4. A minimum of 2 cross braces shall be used on all tables, whether plain with compartments, or with drawers.
5. Cross-braces shall be mortised and tenoned into rails, glued and stapled.
6. All openings for drawers and compartments shall be routed out of a solid one piece rail.
7. Compartment bottoms shall be 1/4 inch Oak plywood, let into grooved cross braces and front rail, glued and stapled.
8. Legs shall be solid Oak of 3- or 4-ply construction, 2-1/2 inches square and furnished with black vinyl, closed bottom, leg shoes.
9. Table rails shall be grooved at each corner to receive a heavy steel corner brace fastened to the rails with screws. Each leg shall be held securely against rails by a 5/16 inch threaded hanger bolt, one end of which has been machine-screwed into the leg to a depth of at least 2 inches.
10. Leg stretchers, 2-inch square construction of solid Oak, shall be provided where indicated or required.
11. Rails shall be grooved to accept “Z” clips for attaching top.
12. Two duplex receptacles in rail.

B. Mobile Tables:
1. Tables shall have a rigid understructure consisting of a center rail, running the length of the table; 2 end rails across the width of the table; and legs with Oak feet.
2. Center rail and end rails shall be 4-1/2 inches wide by 1-1/16 inch thick solid Oak, notched to interlock with each other and securely fastened to the table top and to the pedestal legs.
3. Include 4 heavy duty 3-inch casters (2 rigid and 2 swivel types) with locks as indicated on the Drawings.
4. Two duplex receptacles in rail.

2.12 FINISHES

A. Wood finishes for cases and cabinets:
1. All exposed exterior cabinet surfaces, including interiors of glazed door cases and open cases shall be smoothly sanded, removing scratch marks, burrs and loose fibers.
2. Prior to the first application of materials in the finishing process, use compressed air to remove all dust.
3. To secure a desired color, a toner on NGR stain shall be first applied. Next, apply a catalyzed resin sealer which provides a coat with good water, chemical and solvent resistance.
4. A catalyzed top coat of clear conversion varnish shall be applied to provide acid resistance, toughness, durability, and very good color stability. The resultant smooth finish shall have a high-gloss luster.
5. Unexposed surfaces of drawers and unexposed interior of cupboards and cases shall receive one stain coat and a double pass coat of catalyzed resin sealer only.
6. All other unexposed surfaces shall receive a double pass coat of catalyzed resin sealer only.

2.13 EQUIPMENT AND ACCESSORIES
A. Laboratory water faucets and gas turrets shall be manufactured by Chicago Faucets.
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 its intended use.

PART 3 - EXECUTION

3.1 EXAMINATION
A. Examine conditions and measurements affecting the work of this Section at site.
B. Correct detrimental conditions before proceeding with installation.

3.2 PREPARATION AND COORDINATION
A. Coordinate as required with other trades to assure proper and adequate provisions in the work of those trades for interface with the work of this Section.
B. Make necessary measurements in the field to assure proper fit of shop fabricated items.
C. Prior to start of installation verify that the work of other trades is sufficiently complete to properly permit this installation to proceed.

3.3 INSTALLATION
A. Install the work of this Section at the locations shown on the Drawings, and in accordance with the approved Shop Drawings.
B. Scribe units to wall, floor, and other surfaces as appropriate, with not more than 1/32 inch clear between the cabinet or fixture and the abutting permanent surface, and with no change of clearance in excess of 0.01 inch in any 4 inches.
C. Provide all necessary fillers and scribe cabinets to wall.
D. Set each unit square, level, plumb, and aligned within the tolerance of one in 1000 vertically and horizontally, and within 1/4 inch of the designated location for free-standing work.
E. Securely anchor cabinets to the building construction and to adjoining units.
F. Accurately fit and securely anchor countertops and splash backs on groups of base cabinets.
G. Coordinate the time of installation with availability of other trades to make required utility connections.
H. Provide access panels as needed for connection and maintenance of utilities.

3.4 FIELD QUALITY CONTROL
A. Test each plumbing and electrical item through at least 5 operating cycles, and adjust as needed to achieve optimum operation.
B. Upon completion of installation, thoroughly clean each item by use of only such cleaning materials as are recommended by the manufacturer of the item being cleared.
C. Touch-up scratches and abrasions to be completely invisible to the unaided eye from a distance of 5 feet.

3.5 ACCEPTANCE
A. Prior to final inspection by the Architect, adjust all hardware so that doors and drawers operate smoothly and quietly, locks and catches function as intended. Thoroughly clean exteriors and interiors of cabinets. Shelves shall bear evenly on all 4 points or supports. Adjust sliding doors to operate smoothly without sticking or binding. Repair or replace, to the satisfaction of the Architect and at no expense to the Owner, any items showing evidence of incomplete or faulty
fabrication and installation, inadequate protection, mishandling or misuse. Replace all doors with noticeable warp or twist.

END OF SECTION
SECTION 21 00 50

BASIC FIRE SPRINKLER MATERIALS AND METHODS

PART 1 - GENERAL

1.01 SECTION INCLUDES
A. Access doors.

1.02 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
B. This Section is part of each Division 21 Section.

1.03 ADDITIONAL REQUIREMENTS
A. Furnish and install incidental work not shown or specified necessary to provide a complete and workable system.
B. Make temporary connections required to maintain services during the course of the Contract without additional cost to Owner. Notify Owner seven days in advance before interrupting services.

1.04 REFERENCED STANDARDS
A. Where material or equipment is specified to conform to referenced standards, it shall be assumed that the most recent edition of the standard in effect at time of bid shall be used.
   1. ANSI - American National Standards Institute
   2. ASTM - American Society for Testing and Materials
   3. CCR - California Code of Regulations
      a. Title 8 - Division of Industrial Safety, Subchapter 7; General Industry Safety Orders, Articles 31 through 36
   4. NCPWB - National Certified Pipe Welding Bureau
   5. CEC - California Electrical Code
   6. NEMA - National Electrical Manufacturers' Association
   7. NFPA - National Fire Protection Association, as amended by the CBC.
   8. OSHA - Occupational Safety and Health Act
   9. UL - Underwriters' Laboratories, Inc.

1.05 DRAWINGS
A. Examine Contract Documents prior to bidding of Work and report discrepancies in writing to Architect.
B. Contractor shall visit Project site and examine existing conditions in order to become familiar with Project scope. Verify dimensions shown on Drawings at Project site. Bring discrepancies to the attention of Architect. Failure to examine Project site shall not constitute basis for claims for additional work because of lack of knowledge or location of hidden conditions that affect Project scope.
C. Drawings showing location of equipment and materials are diagrammatic and job conditions will not always permit installation in location shown. The fire protection Drawings show general arrangement of equipment and materials, etc., and shall be followed as closely as existing conditions, actual building construction, and work of other trades permit.

1. Architectural and structural Drawings are part of the Work. These Drawings furnish Contractor with information relating to design and construction of the Project. Architectural Drawings take precedence over fire protection Drawings.

2. Because of the small scale of fire protection Drawings, not all offsets, fittings, and accessories required are shown. Investigate structural and finish conditions affecting the Work and arrange Work accordingly. Provide offsets, fittings, and accessories required to meet conditions. Inform Architect immediately when job conditions do not permit installation of equipment and materials in locations shown. Obtain Architects’ approval prior to relocation of equipment and materials.

3. Relocate equipment and materials installed without prior approval of Architect. Remove and relocate equipment and materials at Contactors’ expense upon Architects’ direction.

4. Minor changes in locations of equipment, piping, ducts, etc., from locations shown shall be made when directed by the Architect at no additional cost to the Owner providing such change is ordered before such items of work, or work directly connected to same are installed and providing no additional material is required.

D. Execute work mentioned in Specifications and not shown on Drawings, or vice versa, the same as if specifically mentioned or shown in both.

1.06 REQUIREMENTS OF REGULATORY AGENCIES

A. The publications listed below form part of this Specification. Comply with provisions of these publications except as otherwise shown or specified.

2. California Electrical Code, 2013
8. California Code of Regulations, Title 24
10. CAL-OSHA
11. California State Fire Marshal, Title 19 CCR
12. National Fire Protection Association, as amended by the CBC
13. Occupational Safety and Health Administration
14. Other applicable state laws

B. Nothing in Drawings or Specifications shall be construed to permit work not conforming to these codes, or to requirements of authorities having jurisdiction. It is not the intent of Drawings or Specifications to repeat requirements of codes except where necessary for clarity.


D. When Contract Documents differ from governing codes, furnish and install larger size or higher standards called for without extra charge.
E. No material installed as part of the Work shall contain asbestos.

1.07 FEES AND PERMITS
A. Obtain and pay for permits and service required in installation of the Work. Arrange for required inspections and secure approvals from authorities having jurisdiction. Comply with the requirements of Division 01.
B. Arrange for utility connections and pay charges incurred, including excess service charges.

1.08 UTILITY CONNECTIONS
A. Bear the cost of construction related to utility services, from point of connection to utility services shown on Contract Documents. This includes piping, excavation, backfill, meters, boxes, check valves, backflow prevention devices, general service valves, concrete work, and the like, whether or not Work is performed by Contractor, local water/sanitation district, public utility, other governmental agencies or agencies’ assigns.

1.09 FRAMING, CUTTING AND PATCHING
A. Special framing, recesses, chases and backing for Work of this Section, unless otherwise specified, are covered under other Specification Sections.
B. Contractor is responsible for placement of pipe sleeves, hangers, inserts, supports, and location of openings for the Work.
C. Cutting, patching, and repairing of existing construction to permit installation of equipment, and materials is responsibility of Contractor. Repair or replace damage to existing work with skilled mechanics for each trade.
D. Cut existing concrete construction with a concrete saw. Do not utilize pneumatic devices.
E. Core openings through existing construction for passage of new piping and conduits. Cut holes of minimum diameter to suit size of pipe and associated insulation installed. Coordinate with building structure, and obtain Structural Engineer’s approval prior to coring through existing construction.

1.10 SUBMITTALS
A. Provide submittal of materials proposed for use as part of this Project. Product names in Specifications and on Drawings are used as standards of quality. Furnish standard items on specified equipment at no extra cost to the Contract regardless of disposition of submittal data. Other materials or methods shall not be used unless approved in writing by Architect. Architect’s review will be required even though "or equal" or synonymous terms are used. Refer to Division 01 for complete instructions.
1. Partial or incomplete submittals will not be reviewed.
2. Quantities are Contractor’s responsibility and will not be reviewed.
3. Provide materials of same brand or manufacturer for each class of equipment or material.
4. Identify each item by manufacturer, brand, trade name, number, size, rating, or other data necessary to properly identify and review materials and equipment. Words "as specified" are not sufficient identification.
5. Identify each submittal item by reference to items’ Specification Section number and paragraph, by Drawing and detail number, and by unit tag number.
6. Organize submittals in same sequence as in Specification Sections.
7. Show physical arrangement, construction details, finishes, materials used in fabrications, provisions for piping entrance, access requirements for installation and maintenance, physical size, mechanical characteristics, foundation and support details, and weight.
   a. Submit shop drawings, performance curves, and other pertinent data, showing size and capacity of proposed materials.
   b. Specifically indicate, by drawn detail or note, that equipment complies with each specifically stated requirement of Contract Documents.
   c. Drawings shall be drawn to scale and dimensioned (except schematic diagrams). Drawings may be prepared by vendor but must be submitted as instruments of Contractor, thoroughly checked and signed by Contractor before submission to Architect for review.
   d. Catalog cuts and published material may be included with supplemental scaled drawings.

B. Review of submittals will be only for general conformance with design concept and general compliance with information given in Contract Documents. Review will not include quantities, dimensions, weights or gauges, fabrication processes, construction methods, coordination with work of other trades, or construction safety precautions, which are sole responsibility of Contractor. Review of a component of an assembly does not indicate acceptance of an assembly. Deviations from Contract Documents not clearly identified by Contractor are Contractor's responsibility and will not be reviewed by Architect.

C. Within reasonable time after award of contract and in ample time to avoid delay of construction, submit to Architect shop drawings or submittals on all items of equipment and materials provided. Provide submittal in at least seven copies and in complete package.
   1. Shop drawings and submittals shall include Specification Section, Paragraph number, and Contract Drawing unit symbol or detail number for reference. Organize submittals into booklets for each Specification section and submit in loose-leaf binders with index. Deviations from Contract Documents shall be clearly identified and appear at the beginning of submittal package, and shall be referenced to applicable Contract Documents requirements.

D. Provide layouts for fire protection systems, for inclusion in coordinated layout specified in Section 23 80 00. Comply with requirements for layouts specified in Section 23 80 00.

E. Provide coordination drawings for fire protection systems in accordance with the requirements of Specification Section 21 10 00.

F. Furnish to Project Inspector complete installation instructions on material and equipment before starting installation.

G. Product Data for California Green Building Standards Code Compliance: For adhesives and sealants, including primers, documentation of compliance including printed statement of VOC content and chemical components.

1.11 SUBSTITUTIONS
A. Refer to Division 01 for complete instructions. Requirements given below are in addition to or are intended to amplify Division 01 requirements. In case of conflict between requirements given in this Section and those of Division 01, Division 01 requirements shall apply.
B. It is the responsibility of Contractor to assume costs incurred because of additional work and or changes required to incorporate proposed substitute into the Project. Refer to Division 01 for complete instructions.
C. Substitutions will be interpreted to be manufacturers other than those specifically listed in Contract Documents by brand name, model, or catalog number.
D. Only one request for substitution will be considered for each item of equipment or material.

E. Substitution requests shall include the following:
   1. Reason for substitution request.
   2. Complete submittal information as described herein; see “Submittals.”
   3. Coordinated scale layout drawings depicting position of substituted equipment in relation to other work, with required clearances for operation, maintenance and replacement.
   4. List optional features required for substituted equipment to meet functional requirements of the system as indicated in Contract Documents.
   5. Explanation of impact on connected utilities.
   6. Explanation of impact on structural supports.

F. Installation of reviewed substitution is Contractors’ responsibility. Any mechanical, electrical, structural, or other changes required for installation of substituted equipment or material must be made by Contractor without additional cost to Owner. Review by Architect of substituted equipment or material, will not waive these requirements.

G. Contractor may be required to compensate Architect for costs related to substituted equipment or material.

1.12 OPERATION AND MAINTENANCE MANUAL

A. Instruct Owner’s authorized representatives in operation, adjustment, and maintenance of mechanical equipment and systems. Provide three copies of certificate signed by Owner’s representatives confirming that instruction is completed.

B. Furnish three complete sets of Operating and Maintenance Manual bound in hardboard binder, and one compact disc containing complete Operating and Maintenance Manual in searchable PDF format. Provide Table of Contents. Provide index tabs for each piece of equipment in binder and disc. Start compiling data upon approval of submittals.
   1. Sets shall incorporate the following:
      a. Service telephone number, address and contact person for each category of equipment or system.
      b. Complete operating instructions for each item of fire sprinkler system.
         1) Original manual of NFPA-25 for fire sprinkler system.
      c. Copies of guarantees/warrantees for each item of equipment or systems.
      d. Test data as specified.
      e. Typewritten maintenance instructions for each item of equipment listing lubricants to be used, frequency of lubrication, inspections required, adjustment, etc.
      f. Manufacturers’ bulletins with parts numbers, instructions, etc., for each item of equipment.
      g. A complete list or schedule of scheduled valves giving the number of the valve, location and the rooms or area controlled by the valve. Identify each valve with a permanently attached metal tag stamped with number to match schedule. Post list in frame under plastic on wall in mechanical room or where directed by Architect.
      h. Check test and start reports for each piece of fire protection equipment provided as part of the Work.
      i. Commissioning and Preliminary Operation Tests required as part of the Work.

C. Post service telephone numbers and addresses in an appropriate place designated by Architect.
1.13 SITE CONDITIONS

A. Information on Drawings relative to existing conditions is approximate. Deviations from Drawings necessary during progress of construction to conform to actual conditions shall be approved by Architect and shall be made without additional cost to Owner. The Contractor shall be held responsible for damage caused to existing services. Promptly notify Architect if services are found which are not shown on Drawings.

1.14 EXISTING MATERIALS

A. Remove existing equipment, piping, wiring, construction, etc., which interferes with Work of this Contract. Promptly return to service upon completion of work in the area. Replace items damaged by Contractor with new material to match existing.

B. Removed materials which will not be re-installed and which are not claimed by Owner shall become property of Contractor and shall be removed from Project site. Consult Owner before removing any material from Project site. Carefully remove materials claimed by Owner to prevent damage and deliver to Owner-designated storage location.

C. Existing piping and wiring not reused and are concealed in building construction may be abandoned in place and all ends shall be capped or plugged. Remove unused piping and wiring exposed in Equipment Rooms or occupied spaces. Material shall be removed from Project premises. Disconnect power, water, gas, pump or any other active energy source from piping or electrical service prior to abandoning in place.

D. Existing piping and equipment modified or altered as part of this Work shall comply with the most recent applicable code requirements.

1.15 WARRANTY

A. Refer to Division 01 for warranty requirements, including effective date of warranty. Refer to specific items of equipment specified herein for warranty duration if different from that specified in Division 01.

B. Repair or replace defective work, material, or part that appears within warranty period, including damage caused by leaks.

C. On failure to comply with warranty requirements within a reasonable length of time after notification is given, Architect/Owner shall have repairs made at Contractor's expense.

1.16 RECORD DRAWINGS

A. Refer to Division 01, Record Documents, for requirements governing Work specified herein.

B. Upon completion of the Work and as precedent to final payment, deliver to Architect the following:
   1. Originals of drawings showing the Work exactly as installed.
   2. One complete set of reproducible drawings showing the Work exactly as installed.
   3. One compact disc with complete set of drawings in PDF format showing the Work exactly as installed.
   4. Provide Contractor's signature, verifying accuracy of record drawings.

C. Obtain signature of Project Inspector for record drawings.

1.17 DELIVERY AND STORAGE

A. Protect equipment and materials delivered to Project site from weather, humidity and temperature variations, dirt, dust and other contaminants.
1.18 COORDINATION

A. General:
   1. Coordinate Work in this Section with trades covered in other Specification Sections to provide a complete and operable installation of highest quality workmanship.

B. Electrical Coordination:
   1. Refer to the Electrical Drawings and Specifications, Division 26, for service voltage and power feed wiring for equipment specified in this Section. Contractor has full responsibility for the following items of work:
      a. Review the Electrical Drawings and Division 26 Specifications to verify that electrical services provided are adequate and compatible with equipment requirements.
      b. If additional electrical services are required above that indicated on Electrical Drawings and in Division 26, such as more control interlock conductors, larger feeder, or separate 120 volt control power source, include cost to furnish and install additional electrical services as part of bid.
      c. Prior to proceeding with installation of additional electrical work, submit detailed drawings indicating exact scope of additional electrical work.

C. Mechanical Coordination:
   1. Arrange for pipe spaces, chases, slots and openings in building structure during progress of construction, to accommodate mechanical system installation.
   3. Coordinate requirements for access panels and doors for mechanical items requiring access where concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section “Access Doors and Frames.”

PART 2 - PRODUCTS

2.01 GENERAL

A. Materials or equipment of the same type shall be of the same brand wherever possible. All materials shall be new and in first class condition.

B. All sizes, capacities, and efficiency ratings shown are minimum.

C. Refer to Section 21 10 00 for specific system piping materials.

2.02 MATERIALS

A. California Green Building Code Compliance:
   1. Fire protection equipment shall not contain CFCs.
   2. Fire protection equipment shall not contain Halons.

2.03 ACCESS DOORS

A. Where floors, walls, or ceilings must be penetrated for access to fire protection equipment or devices, provide access doors, 14 inch by 14 inch minimum size in usable opening. Where entrance of a serviceman may be required, provide 20 inch by 30 inch minimum usable opening. Locate access doors/panels for non-obstructed and easy reach.
   1. Access doors less than 7'-0" above floors and exposed to public access shall have keyed locks.
B. Access doors shall match those supplied in Division 08, except as noted in this Section.

C. Provide stainless steel access doors for use in toilet rooms, shower rooms, kitchens and other damp areas. Provide steel access doors with prime coat of baked-on paint for other areas.

D. Do not locate access doors in highly visible public areas such as lobbies, waiting areas, and primary entrance areas. Coordinate with Architect when access is required in these areas.

E. Where specific information or details relating to access panels different from the above is shown or given on Drawings or other Divisions of work, that information shall supersede this specification.

F. Manufacturers: Subject to compliance with requirements, available manufacturers offering products which may be incorporated into the Work include Milcor, Karp, Nystrom, or Cesco, equal to the following:
   1. Milcor
      a. Style K (plaster)
      b. Style DW (gypsum board)
      c. Style M (masonry)
      d. Style "Fire Rated" where required

2.04 PIPE IDENTIFICATION

A. Identify each piping system and indicate the direction of flow by means of Seton, Inc., Marking Services Inc., Reef Industries, Inc., or equal, pre-tensioned, coiled semi-rigid plastic pipe labels formed to circumference of pipe, requiring no fasteners or adhesive for attachment to pipe.

B. The legends and flow arrows shall conform to ASME A13.1.

PART 3 - EXECUTION

3.01 MECHANICAL DEMOLITION

A. Refer to Division 01 Sections “Cutting and Patching” and/or “Selective Demolition” for general demolition requirements and procedures.

B. Disconnect, dismantle and remove fire protection systems, equipment, and components indicated to be removed. Coordinate with all other trades.
   1. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
   2. Piping to Be Abandoned in Place: Drain piping and cap or plug piping to remain with same or compatible piping material.
   3. Equipment to Be Removed: Drain down and cap remaining services and remove equipment.
   4. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
   5. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.

C. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.
3.02 ELECTRICAL REQUIREMENTS

A. Provide adequate working space around electrical equipment in compliance with the California Electrical Code. Coordinate the fire protection Work with the electrical Work to comply.

B. Furnish necessary control diagrams and instructions for controls. Before permitting operation of equipment which is furnished, installed, or modified under this Section, Contractor shall review associated electrical work, including overload protection devices, and assume complete responsibility for correctness of electrical connections and protective devices. Motors and control equipment shall conform to the Standards of the National Electrical Manufacturers’ Association. Equipment and connections exposed to weather shall be installed in NEMA IIIIR enclosures with factory wired strip heaters in each starter enclosure and temperature control panel where required to inhibit condensation.

C. All line voltage and low voltage wiring and conduit associated with fire protection system are included in this Section. Wiring and conduit shall comply with Division 26.

3.03 PIPING SYSTEM REQUIREMENTS

A. Drawing plans, schematic and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.

3.04 PRIMING AND PAINTING

A. Perform all priming and painting on the equipment and materials as specified herein.

B. Priming:

1. Exposed ferrous metals, including piping, which are not galvanized or factory-finished shall be primed. Black steel pipe exposed to weather shall be painted one coat of Rust-Oleum #1069 primer for black steel piping or Rust-Oleum #5260, Kelly Moore, or equal, primer for galvanized piping.

2. Metal surfaces of items to be jacketed or insulated except piping shall be given two coats of primer unless furnished with equivalent factory finish. Items to be primed shall be properly cleaned by effective means free of rust, dirt, scale, grease and other deleterious matter and then primed with the highest grade zinc rich primer. After erection or installation, primed surfaces shall be properly cleaned of foreign or deleterious matter that might impair proper bonding of subsequent paint coatings. Abrasion or other damage to shop or field prime coat shall be properly repaired and touched up with same material used for original priming.

3. Where equipment is provided with nameplate data, the nameplate shall be masked off prior to painting. When painting is completed, remove masking material.

C. See Painting Section for detailed requirements.

3.05 INSTALLATION OF PIPING SYSTEMS

A. At time of final connection, and prior to opening valve to allow pressurization of water piping from existing systems, on site or off site, perform a pressure test to indicate static pressure of existing systems. If pressure on fire protection piping is greater than 175 psi, inform Architect immediately. Do not allow piping systems to be pressurized without written consent of the Architect.

B. General:

1. Piping shall be concealed unless shown or otherwise directed. Allow sufficient space for ceiling panel removal.
2. Installation of piping shall be made with appropriate fittings. Bending of piping will not be accepted.
3. Install piping to permit application of insulation where required and to allow valve servicing.
4. Where piping or conduit is left exposed within a room, the piping or conduit shall be run true to vertical, horizontal, or intended planes. Where possible, uniform margins are to be maintained between parallel lines and/or adjacent wall, floor, or ceiling surfaces.
5. Horizontal runs of pipes and/or electrical conduit suspended from ceilings shall provide for maximum headroom clearance. The clearance shall not be less than 6'-6" without written approval from Architect.
6. Close ends of pipe immediately after installation. Leave closure in place until removal is necessary for completion of installation.
7. Each piping system shall be thoroughly flushed and proved clean before connection to equipment.
8. Install exposed polished or enameled connections with special care showing no tool marks or threads at fittings.
9. Install horizontal valves with valve stem above horizontal.
10. Use reducing fittings; bushings shall not be allowed. Use eccentric reducing fittings wherever necessary to provide free drainage of lines and passage of air.
11. Verify final equipment locations for roughing-in.
12. Where piping is installed in walls within one inch of face of stud, provide 16 gauge sheet metal shield plate on face of stud. The shield plate shall extend minimum 1-1/2 inches beyond outside diameter of pipe.

C. Sleeves:
1. Install Adjus-to-Crete, Pipeline Seal and Insulator, or equal, pipe sleeves of sufficient size to allow for free motion of pipe, 24 gauge galvanized steel. The space between pipe and sleeves through floor slabs on ground, through outside walls above or below grade, through roof, and other locations, as directed, shall be caulked with oakum and mastic and made watertight. The space between pipe and sleeve and between sleeve and slab or wall shall be sealed watertight.
2. At Contractor's option, Link-Seal, Metraflex Metraseal, or equal, casing seals may be used in lieu of caulking. Wrap pipes through slabs on grade with 1 inch thick fiberglass insulation to completely isolate pipe from concrete.

D. Floor, Wall, and Ceiling Plates:
1. Fit pipes, with or without insulation, passing through walls, floors, or ceilings, and hanger rods penetrating finished ceilings with chrome-plated or stainless escutcheon plates.

E. Firestopping:
1. Pack annular space between pipe sleeves and pipe through floors and walls with UL listed fire stop, and seal at ends. Pipe penetrations shall be UL listed, Hilti, 3M Pro-Set, or equal.
   a. Install fire caulking behind fire protection services installed within fire rated walls, to maintain continuous rating of wall construction.
2. Provide SpecSeal Systems UL fire rated sleeve/coupling penetrators, or equal, for each pipe penetration or fixture opening passing through floors, walls, partitions or floor/ceiling assemblies. Penetrators shall comply with UL Fire Resistance Directory (Latest Edition), and with Chapter 7, CBC requirements.
3. Sleeve penetrators shall have built in anchor ring for waterproofing and anchoring into concrete pours or use special fit cored hole penetrator for cored holes.
4. Steel piping shall have SpecSeal, or equal, plugs on both sides of penetrator to reduce noise and to provide waterproofing.

5. All above systems to be installed in strict accordance with manufacturer's instructions.

6. Alternate firestopping systems are acceptable if approved as equal. Contractor is responsible for determining suitability of alternate products for their intended use, and shall assume all risks and liabilities in connection with the use of alternate products.

F. Hangers and Supports:

1. General: Support equipment and piping so that it is firmly held in place by approved iron hangers and supports and special hangers as required. Hangers and supports shall be UL listed for fire protection service. Components shall support weight of equipment, pipe, fluid, and pipe insulation based on spacing between supports with minimum factor of safety of five based on ultimate strength of material used. Do not exceed manufacturer's load rating. Pipe attachments or hangers, shall be of same size as pipe or tubing on which used, or nearest size available. Architect shall approve hanger material before installation. Do not support piping with plumbers' tape, wire rope, wood, or other makeshift devices. Where building structural members do not match piping support spacing, provide "trapeze" (bridging) support members attached to building structural members by methods approved by structural Engineer.
   a. Materials, design, and type numbers per Manufacturers' Standardization Society (MSS), Standard Practice (SP)-58.

2. Hanger components shall be provided by one manufacturer. B-Line, Grinnell, Tolco, Afcon, Loos & Co., Uni-Strut, or equal.

3. Hanger and Supports:
   a. Vertical Piping: Tolco Fig. 6, or equal, clamps attached to pipe above each floor to rest on floor. Provide intermediate support for vertical piping greater than 25 feet in length.
   b. Individually Suspended Piping: Tolco Fig. 200 or Fig. 1 Clevis, complete with threaded rod, or equal.
   
<table>
<thead>
<tr>
<th>Pipe Size</th>
<th>Rod Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>4&quot; and Smaller</td>
<td>3/8&quot;</td>
</tr>
<tr>
<td>5&quot; to 6&quot;</td>
<td>5/8&quot;</td>
</tr>
</tbody>
</table>

   c. Trapeze Suspension: Sch-10 or Sch-40 steel pipe trapeze member in accordance with NFPA 13 published load ratings.
   d. Pipe Clamps and Straps: B-Line B2000 or B2400, Tolco, Fig. 200 or Fig. 1, or equal. Where used for seismic support systems, provide B-line B2400, Tolco fig. 69 series retainer pipe straps, or equal.
   e. Steel Connectors: Tolco Fig. 65 beam clamps with Fig. 69 retainer straps, or equal.
   f. Deck Connectors: Afcon Fig. 610 steel ceiling plate, or equal, where approved by structural Engineer.

4. Support to Structure:
   a. Steel Structure: Provide and install additional steel bracing as required to suit structure. Provide through bolts with length to suit requirements of structural components. Burning or welding on structural member may only be done if approved by Architect.

5. Pipe hanger and support spacing: Locate hangers and supports at each change of direction, within one foot of elbow, and spaced per NFPA 13, and per pipe manufacturer's listing, except as noted below.
6. Provide rigid insulation and a 12 inch long, 18 gauge galvanized sheet iron shield between the covering and the hanger whenever hangers are installed on the outside of the pipe covering.

7. Insulate copper piping from ferrous materials and hangers with two layers of 3 inch wide, 10 mil polyvinyl taper wrapped around pipe.

8. Provide a support or hanger close to each change of direction of pipe either horizontal or vertical and as near as possible to concentrated loads.

9. Suspend rods from concrete inserts with removable nuts where suspended from concrete decks. Power actuated inserts will not be allowed.

3.06 UNIONS AND FLANGES

A. Install Watts, Epco, Nibco, or equal, dielectric unions or flanges at points of connection between copper or brass piping or material and steel pipe or material. Bushings or couplings shall not be used.

B. Install unions in piping NPS 2" and smaller and flanges in piping NPS 2-1/2" and larger whether shown or not at each connection to equipment and tanks, and at connections to automatic valves.

C. Locate unions for easy removal of equipment, tanks, or valves.

3.07 ACCESS DOOR

A. Furnish and install access doors wherever required whether shown or not for easy maintenance of fire protection systems. Access doors shall provide for complete removal and replacement of equipment.

3.08 PIPE IDENTIFICATION

A. Provide temporary identification of each pipe installed, at time of installation. Temporary identification shall be removed and replaced with permanent identification as part of the Work.

B. Apply legend and flow arrow at valve locations; at points where piping enters or leaves a wall, partition, cluster of piping or similar obstruction, at each change of direction, and at approximately 20'-0" intervals on pipe runs. Variations or changes in locations and spacing may be made with approval of Architect. There shall be at least one marking in each room. Markings shall be located for maximum visibility from expected personnel approach.

1. Apply legend and flow arrow at approximately 10'-0" intervals in science classrooms and science prep rooms.

C. Wherever two or more pipes run parallel, markings shall be supplied in the same relative location on each.

D. Apply markings after painting and cleaning of piping and insulation is completed.

3.09 TESTS AND ADJUSTMENTS

A. Test installations in accordance with the following requirements and all applicable codes:

1. Project Inspector should witness tests of piping systems.

2. Notify Architect at least seven days in advance of tests.

3. Notify local fire department of time and date of fire systems testing.

4. Piping shall be tested at completion of roughing-in, or at other times as directed by Architect.

5. Furnish necessary materials, test pumps, gases, instruments and labor required for testing.
6. Isolate from system equipment that may be damaged by test pressure.

7. Make connections to existing systems with flanged connection. During testing of new work, provide a slip-in plate to restrict test pressure to new systems only. Remove plate and complete connection to existing system at completion of testing.
   a. Project Inspector shall witness final connection to system.

B. Test Schedule: No loss in pressure or visible leaks shall show after four hours at pressures indicated:

<table>
<thead>
<tr>
<th>System Tested</th>
<th>Test Pressure PSI</th>
<th>Test With</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fire Sprinkler Piping</td>
<td>200</td>
<td>Water</td>
</tr>
</tbody>
</table>

1. Piping connected to fire sprinkler system shall be tested and certified in accordance with NFPA requirements, except where requirements listed in this Section exceed requirements of NFPA.

C. Should material or work fail in any of these tests, it shall be immediately removed and replaced with new material, and portion of work replaced shall again be tested by Contractor at his own expense.

END OF SECTION
SECTION 21 10 00

FIRE SPRINKLER SYSTEM

PART 1 - GENERAL

1.01 SECTION INCLUDES
   A. Sprinkler heads.
   B. Pipe and Fittings.

1.02 RELATED DOCUMENTS
   A. Drawings and general provisions of the Contract, including General and Supplementary
      Conditions and Division 01 Specification Sections, apply to this Section.
   B. Section 21 00 50 Basic Fire Sprinkler Materials and Methods.

1.03 REFERENCES
   A. It is the intent of these Specifications to provide for complete and operating fire protection
      automatic sprinkler system in full compliance with the following standards:
      National Fire Protection Association (NFPA) Standard No. 13, 2010
      National Fire Protection Association (NFPA) Standard No. 13, 2013, as amended by the CBC.
      CBC Chapter 9 (as amended).
   B. The work shall also be in accordance with local or state requirements that apply.

1.04 DESCRIPTION OF WORK
   A. Work of this section includes, but is not necessarily limited to, the following:
      A. An existing fire sprinkler system is in place, consisting of a fire sprinkler riser for each zone with
         the main supply line and zone control valve for each floor, branch lines, and tees to each
         sprinkler head. Extend and modify the existing system as required to properly protect the
         building in accordance with NFPA 13 criteria.
      B. Furnish all coordination, labor, materials, tools, and equipment to install a wet pipe automatic
         fire sprinkler system as described in this Specification Section, and shown on Contract
         Drawings.
   1. The Work includes, but is not limited to the following:
      a. Complete interior wet type automatic fire protection spray type sprinkler distribution
         system, including overhead service and branch mains, lateral supply piping, supports, hangers, seismic bracing, and heads, as indicated on Drawings.
      b. Required tests and inspections.
      c. Protected areas include areas above and below the finished ceilings, canopies, stairways, rooms, areaways, entry, etc, and other areas requiring sprinklers as
         indicated on drawings.
      d. Tags, identification labels and instruction manuals for proper operation and
         maintenance.
1.05 SEQUENCING

A. It is expected that the Project shall progress according to the following sequence of events:
   1. Upon award of bid, Contractor shall begin preparing coordination drawings. See Coordination Article.
   2. Completed coordination drawings shall be submitted to Architect for review. See Submittals Article in this Section and in Section 21 00 50.
   3. Engineer will determine need for Project re-submittal to DSA:
      a. No DSA re-submittal required: Coordination drawings will be returned to Contractor with comments noted and Contractor shall proceed with fabrication and erection of system in accordance with Contract Documents and reviewed submittal.
      b. DSA re-submittal required: Engineer will incorporate changes depicted in coordination drawings into Contract Drawings and hydraulic calculations for re-submittal to DSA. Upon DSA approval of re-submittal, Contractor shall proceed with fabrication and erection of system in accordance with modified Contract Documents.
   4. Contractor shall issue Request for Information (RFI) for each field change required after approval of coordination drawings or approval of DSA re-submittal has been obtained. Contractor shall not proceed with changes prior to RFI response.
   5. Contractor shall inform Architect immediately if deviating from this sequence of events.

B. The coordination process may not be used to redesign an automatic fire sprinkler system by the Contractor. Only those changes required for coordination with the work of other trades will be allowed.

1.06 DRAWINGS

A. Contractor shall thoroughly examine architectural, structural, and other Drawings provided as part of this Contract.

B. Number of sprinkler heads indicated on Contract Drawings shall not be reduced. Provide additional heads required for coordination and to obtain approvals. Coordinate suitable head locations and spacing with Architect.

1.07 QUALITY ASSURANCE

A. Manufacturers: Firms regularly engaged in manufacture of fire protection products, of types, materials, and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Installer: A firm with at least five years of successful installation experience on projects with fire sprinkler piping systems similar to that required for this Project.
   1. A State of California Fire Protection Contractor’s license (C-16) is required.

C. Installation Criteria: Provide complete fire protection systems as indicated and as required by authority having jurisdiction.
   1. When there is conflict between requirements of authority having jurisdiction or requirements of other agencies and these Drawings and Specifications, requirements of authority having jurisdiction and recommendations of standards agencies and shall govern.
   2. Install entire system in accord with applicable codes, standards, and regulations.
   3. The automatic sprinkler system shall conform to requirements of the National Fire Protection Association, Standard No. 13.
4. FM Compliance: Comply with Factory Mutual "Approval Guide."
5. Supply equipment and accessories in accordance with requirements of applicable national, state and local codes.
6. Items of a given type shall be the products of the same manufacturer.
7. Scheduled equipment performance is minimum capacity required.
8. Scheduled electrical capacity shall be considered as maximum available.

1.08 COORDINATION

A. Coordinate Work in this Section with trades covered in other Sections of Specifications to provide a complete and operable installation of highest quality workmanship.

B. Coordinate location of fire protection piping, mains and branches, to avoid interference with work by other trades. Plumbing drainage piping and ductwork shall have right-of-way over fire protection piping. Wherever conflicts exist, fire protection piping shall be offset or rerouted at no additional cost to Owner. Provide locations of piping for use in Coordinated Layout called for in Specification Section 23 80 00.

C. Piping shall be concealed, except where so indicated or where absolutely necessary to be exposed. Exposed piping shall be placed as approved by Architect prior to installation. Heads shall be fully coordinated with architectural reflected ceiling plan and placed in center of ceiling tiles.

D. On-site measurement of pipe will be required. Offsets, pipe, fittings, drains, etc., required to meet job conditions shall be furnished and installed at no extra cost to Owner.

E. Additional heads required by NFPA 13 regulations shall be provided at no extra cost, if required as a result of Contractors’ coordination. Location of heads and mains shall not be changed unless approved by Architect.

F. Coordinate layout and installation of sprinklers with other construction penetrating ceilings, including light fixtures, HVAC equipment, and partition assemblies.

G. The Architect shall decide any differences or disputes concerning coordination, interference or extent of work, and his decision shall be final.

H. Contract Drawings are schematic. Rerouting of pipe and the addition, deletion or relocation of sprinkler heads may be necessary. Contractor shall prepare coordination drawings documenting changes. Contractor shall not proceed with fabrication or installation of fire protection system prior to approval of coordination drawings by Architect.

1. Re-submittal of revised Contract Drawings and calculations to DSA will be required when changes to the system design, made during Project coordination phase, alter parameters used in calculations furnished to DSA for permitting purposes. If re-submittal to DSA is required, mechanical Engineer shall prepare revised Drawings and hydraulic calculations. Contractor shall not proceed with fabrication or installation of fire protection system prior to approval of revised calculations by DSA.

2. Contractor-proposed changes to supports, anchorages, and seismic restraints for fire protection system shall conform to the following.
   a. Calculations performed for use in selection of supports, anchorages, and seismic restraints shall utilize criteria indicated in Structural Contract Documents.
   b. Supports, anchorage and seismic restraints for piping and equipment shall be an OSHPD pre-approved system such as Tolco, Afcon, ISAT, Badger, Mason, or equal. Pipes and equipment shall be seismically restrained in accordance with requirements of current editions of California Building Code and NFPA 13. System shall have current OPA number and shall meet additional requirements of authority having jurisdiction. Provide supporting documentation required by the reviewing
authority and the Architect and Engineer. Provide layout drawings showing piping and restraint locations.

1) Bracing of Piping and Equipment: Specifically state how bracing attachment to structure is accomplished. Provide shop drawings indicating seismic restraints, including details of anchorage to building. In-line equipment must be braced independently of piping, and in conformance with applicable building codes. Provide calculations to show that pre-approval numbers have been correctly applied in accordance with general information notes of pre-approval documentation.

c. In lieu of the above or for non-standard installations not covered in the above pre-approved systems, Contractor shall provide layout drawings showing piping, equipment, and restraint locations, and detailing supports, attachments and restraints. Furnish supporting calculations and legible details sealed by a California registered structural engineer, in accordance with California Building Code, and NFPA 13.

d. Additional Requirements: In addition to the above, conform to State and local requirements.

1.09 SUBMITTALS

A. Samples: Provide one sample of each sprinkler head type.

B. Coordination Drawings: Submit in accordance with Division 01, and as follows:

1. Provide minimum 1/4 inch equals one foot scaled coordination drawings showing plan and pertinent section or elevation views of fire protection piping, equipment, and accessories. Drawings shall be reproducible and work represented shall be fully coordinated with structure, other disciplines, and with finishes. Drawings shall be presented on a single size sheet. Coordination drawings shall have title block, key plan, north arrow and sufficient grid lines to provide cross-reference to DSA approved Drawings.

2. Coordination drawings shall depict changes and additions to fire protection system required for coordination with work of other trades. Changes and additions shall be clouded.

3. Note on coordination drawings piping which will project beyond finished surfaces of normally occupied rooms, exterior of building or other locations which will expose system to view.

4. Coordination drawings shall be provided with note affirming that the fire sprinkler system shown has been coordinated with the HVAC Contractor for inclusion in Coordinated Layout specified in Section 23 80 00. Provide signature of person responsible for information supplied and date of transmission.

C. For proposed changes to supports, anchorage, and seismic restraints shown on DSA approved Contract Drawings, submit details and calculations prepared, sealed, and signed by a California registered structural engineer. Comply with requirements of Coordination Article in this Section.

D. Manufacturer’s data for each item of material or equipment used.

E. Welding operator qualification certificates.

F. Test Reports: As indicated in paragraph “Tests."

1. Sprinkler pressure test.
2. Standpipe pressure test.
3. Alarm system test.
G. Operation and Maintenance Manual:
   1. Operation and Maintenance Manual in accordance with Section 21 00 50. Include an
      original copy of NFPA 25 in Operation and Maintenance manual for fire sprinkler system.
   2. Guarantees in accordance with Division 01.

1.10 APPLICABLE PUBLICATIONS
   A. The following publications form a part of this specification:
      2. ASME - American Society of Mechanical Engineers.
      5. NFPA National Fire Protection Standards, as amended by the CBC.
      6. CFC - California Fire Code.
      7. CPC - California Plumbing Code.
      8. DSA - Division of the State Architect. Interpretive Regulations (IR's).

1.11 SUPERVISION
   A. Keep a competent superintendent on the job that shall coordinate the activities of the crafts and
      maintain the progress of the work to the satisfaction of the Architect.

1.12 REGULATIONS
   A. All work shall be installed in strict conformity with California Building Code (CBC), California
      Plumbing Code (CPC), and California Electric Codes (CEC), Industrial Safety Orders, California
      Mechanical Code (CMC), California Fire Code (CFC), and other laws and regulations of
      authorities having jurisdiction.

1.13 FEES AND PERMITS
   A. Take out permits and pay fees and charges required in connection with this Work.

1.14 TEMPORARY CONNECTIONS
   A. Temporary connections required to maintain services during the course of the Contract shall be
      made without additional cost to Owner. The normal function of the building must not be
      interrupted; notify Owner minimum seven days in advance before interrupting any service.

1.15 EXISTING MATERIALS
   A. Existing equipment, piping, construction, etc., which interferes with work of the Contract shall be
      removed and promptly returned to service. Damaged items shall be replaced with new material
      to match existing.
   B. Removed materials which will not be reused and which are not claimed by the Owner shall
      become the property of the Contractor and shall be removed from the premises. Consult Owner
      before removing any material from premises. Materials claimed by Owner shall be removed
      carefully to prevent damage and delivered on the site where directed.
   C. Existing piping not to be reused and which is concealed in the building construction may be
      capped and abandoned in place but such piping and wiring which is exposed in equipment
      rooms or occupied spaces shall become property of Contractor and shall be removed from the
      premises.
PART 2 - PRODUCTS

2.01 GENERAL

A. The equipment to be furnished under this specification shall be standard product of manufacturer. Where two or more units of the same class of equipment are required, these units shall be products of a single manufacturer; however, component parts of system need not be products of the same manufacturer.

2.02 MATERIALS AND EQUIPMENT

A. Unless otherwise shown on Drawings, specified, or directed by Architect, materials and equipment used in installation of sprinkler systems shall be listed as approved by FM or UL for fire protection systems, and shall be the latest design of the manufacturer.

2.03 SPRINKLER HEADS

A. Provide spray pattern type sprinkler heads, of ordinary degree temperature rating, except that sprinkler heads for installation in vicinity of heating equipment, and in other areas noted on Drawings, shall have temperature ratings required for such locations by NFPA 13.

B. Sprinkler heads shall be upright, pendent or sidewall, as required.

1. Heads in ceilings of occupied spaces with recessed lights shall be chrome plated, semi-recessed pendent type, with white escutcheon.

2. Sprinkler heads in rooms with surface mounted lights shall be chrome plated pendant style, with two-piece white escutcheon.

3. Provide head guards in equipment rooms and storage rooms and all other locations where subject to damage.

4. Upright heads in areas with no ceilings shall be rough bronze finish.

5. Provide quick response type heads in light and ordinary hazard occupancies.

6. Side wall heads may be used (except in extended coverage type) to cover special areas where overhead piping and heads are impractical or considered a visual problem by the Architect or Owner. Side wall heads shall be chrome finish.

7. Outdoor heads, if required shall be dry or freeze resistant.

8. Adjustable drop nipples are not acceptable.

9. Flexible sprinkler connectors are not acceptable.

C. Recessed sprinkler heads shall have chrome finish and adjustable chrome finish escutcheons; exposed pendent heads in finished ceilings shall have chrome finish and white ceiling escutcheons. Concealed (flush) heads shall be all brass, with white cover plate.

1. Provide oversized escutcheons where required to meet the requirements of ASCE 7.

D. Spare Heads: Furnish spare heads equal to one percent of total number of heads installed under Contract, but not less than twelve. Spare head types furnished shall be representative of types and temperature ratings of heads installed, and in proportion to number of each type and temperature rating of heads installed. Furnish not less than two sprinkler head wrenches, with at least one wrench for each type of sprinkler head installed. Place spare heads and wrenches in wall mounted box manufactured for this purpose.

2.04 PIPE AND FITTINGS

A. For Installation Aboveground: 150 PSI, Schedule 40 black steel, ASTM A-135 or A-53 with UL approved ductile or cast iron screwed fittings.
1. Schedule 10 UL approved pipe with UL approved grooved fittings and associated couplings may be used for pipe sizes 2 inches and greater. Threading of piping will not be accepted.

B. Mechanical tees, saddle fittings, bushings and mechanical sprinkler head fittings shall not be used.

2.05 UNION AND FLANGES

A. Size and Type:
   1. Steel 2 inches and smaller: 150 pound screwed black or galvanized malleable iron, match pipe, ground joint, brass to iron seat.
   2. Steel 2-1/2 inches and larger: 150 pound black flange union, flat faced, full gasket.

B. Gaskets: 1/16 inch thick rubber Garlock #122, Johns-Manville, or equal.

C. Flange Bolts: Open hearth bolt steel, square heads, with cold pressed hexagonal nuts, cadmium plated when installed below ground. Provide copper plated steel bolts and nuts or brass bolts and nuts for brass flanges.

2.06 GAUGES

A. Marsh "Quality Gage", U.S. Gage, Danton 800, or equal, U.L. Listed, with bronze bushed movement and front recalibration. Dials shall be white with black numerals, 3-1/2 inch dial face. Normal reading shall be at midscale. Provide a three-way valve on each gauge connection.

2.07 SEISMIC SEPARATION ASSEMBLY

A. Provide seismic separation assembly as defined in NFPA 13 at locations where piping crosses building seismic joints and at locations where required to prevent pipe breakage due to building movement.
   1. At Contractors option, provide Metraflex “Fireloop” UL listed assembly, or equal at each seismic joint location, in lieu of seismic separation assembly.

PART 3 - EXECUTION

3.01 GENERAL

A. Installation of the sprinkler system shall not be started until complete plans and specifications (including water supply information and type of existing sprinkler system, if any) have been approved by DSA.
   1. Piping shall be concealed unless shown or otherwise directed.
   2. Where piping is left exposed within a room, it shall be run true to vertical, horizontal or intended planes. Where possible, uniform margins shall be maintained between parallel lines and/or adjacent wall, floor or ceiling surfaces.
   3. Horizontal runs of pipes and/or electrical conduit suspended from ceilings shall provide for maximum headroom clearance. This clearance shall not be less than 7'-6" without written approval from Architect.
   4. Minor changes in locations of equipment, piping, etc., from locations shown shall be made when directed by Architect at no additional cost to Owner, providing such change is ordered before such items of work, or work directly connected to same, are installed, and providing no additional material is required.
   5. Grade all piping as required by NFPA 13.
6. Close ends of pipe immediately after installation; leave closure in place until removal is necessary for completion of installation.

7. Piping systems shall be thoroughly flushed and proved clean before connection to equipment.

8. Pipe discharge of each drain valve to floor sink or drain.

3.02 HANGERS AND SUPPORTS

A. General: Support piping so that it is firmly held in place by approved iron hangers and supports and by special hangers as required in accordance with NFPA 13. Hangers shall support loads specified in NFPA 13, and, in addition, shall support weight of pipe, fluid and pipe insulation, based on spacing between supports with minimum factor of safety of five based on ultimate strength of material used. Do not exceed manufacturer's load rating. Pipe attachments, or hangers, shall be of same size as pipe or tubing on which used, or nearest larger size available. Materials, design, and type numbers per Manufacturers' Standardization Society (MSS) Standard Practice SP-58, provide branch line restraints where hangers exceed 6 inches long, in accordance with NFPA 13. Install concrete anchors required. Hanger material shall be approved by Architect before installation. Do not support piping by plumbers' tape, wire, rope, wood or other makeshift devices.

B. Suspend rods from angle clips, in accordance with Section 21 00 50.

3.03 SEISMIC REQUIREMENTS

A. Comply with CBC, Volume 2, Chapter 16A and CBC Chapter 9 and NFPA 13.

B. Items of equipment shown or specified to be anchored shall maintain integrity at point of anchor after being subjected to accelerations equivalent to those established herein.

C. Anchors: Piping shall be provided with anchors for protection of piping against damage due to earthquakes, as required by CBC Chapter 16A, NFPA 13, and other sections of this Specification.

3.04 TESTS

A. At various stages and upon completion, the system shall be tested in the presence of the enforcing agency.

B. Upon completion and prior to acceptance of the installation, subject entire new system to tests required by NFPA 13, and furnish Owner with certificates as appropriate.

3.05 IDENTIFICATION

A. Coordinate requirements with the authority having jurisdiction.

B. Provide brass valve tags at each system valve, indicating valve service.

C. Provide signage at each sprinkler valve, with sign indicating specific portion of system controlled by valve.

D. Provide signage at each outdoor alarm device, with sign indicating which authority to call if device is activated.

E. Provide hydraulic data signage permanently attached to risers, indicating location, basis of design, water supply and pressure requirements of system.
3.06 ELECTRICAL WIRING

A. Coordination of wiring systems is part of this work. Contractor shall ensure that the following is completed.
   1. Work provided in other Specification Sections:
      a. Supervised wiring to fire alarm control panel.
      b. Supervised wiring from main water flow indicator to fire alarm panel.
      c. Supervised wiring from sprinkler flow switches to fire alarm panel.
      d. Supervised wiring from valve water flow alarm switches to fire alarm panel.
   2. Work provided in this Specification Section:
      a. Wiring diagrams for devices.
      b. Other wiring not specified to provide an operating system.

3.07 SPRINKLER HEADS

A. Heads shall be placed upright where on exposed piping, unless otherwise noted, and in pendant position on concealed piping, unless noted otherwise, with deflectors parallel to the ceiling or roof slope. Clearance between deflectors and ceilings, electric, or heating equipment, or other obstruction shall be in accordance with the requirements of NFPA 13. Provide sprinkler head guards where heads are subject to mechanical damage, for example, at mechanical rooms, and storage rooms and gymnasiums.

B. Mount box containing spare sprinkler heads and wrenches on wall in location selected by Owner.

C. Do not install pendent sprinkler heads until flushing of piping has been completed.

D. Provide return bend as illustrated in NFPA 13 (NFPA exceptions do not apply) for each sprinkler head installed in finished ceiling.

3.08 PIPING JOINTS AND CONNECTIONS

A. Pipe shall be assembled in accordance with the requirements of NFPA 13.

B. Flange and spigot piece at the base of sprinkler riser shall be secured to the underground elbow at the base of riser with tie-rods which are properly coated, or stainless steel to protect against corrosion. Set-screw type flange adapters and mechanical joint retainer glands are not an acceptable substitute for tie-rods. Provide concrete thrust blocks in accordance with NFPA 24 and CBC.

3.09 DRAINS

A. Auxiliary drains shall be installed on low points in each system.
   1. Five or fewer trapped gallons will not require a drain valve but may be drained through a plugged fitting. Drain valves shall be in accordance with requirements of NFPA 13.

B. Install one inspector’s test drain on sprinkler system. Extend drain to outside in location approved by Architect. Water discharge shall be positioned such that landscaping will not be damaged.

C. Drain valves shall be piped to a safe place of discharge and discharge shall be visible either by open-end drainpipe or sight drain fitting.

D. Provide flushing connections at ends of cross-mains.
3.10 SLEEVES
A. Install AMI Products, Adjus-to-Crete, or equal, pipe sleeves of sufficient size to allow for free motion of pipe, 24 gauge galvanized steel. The space between pipe and sleeves through floor slabs on ground, through outside walls above or below grade, through roof, and other locations as directed shall be caulked with oakum and mastic and made watertight. The space between pipe and sleeve and between sleeve and slab or wall shall be sealed watertight.
B. Holes through existing concrete walls or floors shall be core drilled. The space between pipe and hole through floor slabs on ground, through outside walls above or below grade, through roof and other locations as directed shall be made watertight.
C. At walls below grade: Link-Seal casing seals, or equal, may be used in lieu of caulking. Pipes penetrating walls below grade shall be anchored at wall.

3.11 FLOOR, WALL, AND CEILING PLATES
A. Fit pipes with or without insulation passing through walls, floors, or ceilings, and hanger rods penetrating finished ceilings with chrome plated or stainless steel plates.

3.12 FIRESAFING
A. The annular space between pipe sleeves and pipe passing through all floors and walls shall be packed with incombustible mastic or other suitable material, in accordance with U.L. Fire Resistance Directory.
B. Penetrations in fire rated assemblies shall also be protected in accordance with CBC Chapter 7, Section 712, and UL Fire Resistance Directory.

3.13 UNION AND FLANGES
A. Install unions whether shown or not at each connection to equipment and at one connection to each valve or cock.
B. Locate the unions for easy removal of the equipment or valve.

3.14 CLEANING
A. Upon completion of tests, clean equipment, piping, etc., installed under this Section of the Specification.

3.15 FLUSH
A. Entire system shall be flushed out and cleaned after completion of piping, and prior to installation of sprinkler heads. Flush shall be continued until water runs clear at drain connections.

END OF SECTION
SECTION 22 00 50

BASIC PLUMBING MATERIALS AND METHODS

PART 1 - GENERAL

1.01 SECTION INCLUDES
A. Valves and fittings.
B. Access Doors.
C. Insulation.

1.02 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
B. This Section is a part of each Division 22 Section.

1.03 ADDITIONAL REQUIREMENTS
A. Furnish and install any incidental work not shown or specified which is necessary to provide a complete and workable system.
B. Make all temporary connections required to maintain services during the course of this Contract without additional cost to the Owner. Notify the Owner seven days in advance before disturbing any service.

1.04 REFERENCED STANDARDS
A. Where material or equipment is specified to conform to referenced standards, it shall be assumed that the most recent edition of the standard in effect at the time of bid shall be used.
1. CSA – Canadian Standards Association International
2. ANSI - American National Standards Institute
3. ASTM - American Society for Testing and Materials
4. CCR - California Code of Regulations
   a. Title 8 - Division of Industrial Safety, Subchapter 7; General Industry Safety Orders, Articles 31 through 36
5. NCPWB - National Certified Pipe Welding Bureau
6. CEC - California Electrical Code
7. NEMA - National Electrical Manufacturers' Association
8. NFPA - National Fire Protection Association
9. OSHA - Occupational Safety and Health Act
10. UL - Underwriters' Laboratories, Inc.

1.05 DRAWINGS
A. Examine Contract Documents prior to bidding of work and report discrepancies in writing to Architect.
B. Contractor shall visit Project site and examine existing conditions in order to become familiar with Project scope. Verify dimensions shown on Drawings at Project site. Bring discrepancies to the attention of Architect. Failure to examine Project site shall not constitute basis for claims for additional work because of lack of knowledge or location of hidden conditions that affect Project scope.

C. Drawings showing location of equipment and materials are diagrammatic and job conditions will not always permit installation in location shown. The Plumbing Drawings show general arrangement of equipment and materials, etc., and shall be followed as closely as existing conditions, actual building construction, and work of other trades permit.
   1. Architectural and Structural Drawings shall be considered part of the Work. These Drawings furnish Contractor with information relating to design and construction of the Project. Architectural Drawings take precedence over Plumbing Drawings.
   2. Because of the small scale of Plumbing Drawings, not all offsets, fittings, and accessories required are shown. Investigate structural and finish conditions affecting the Work and arrange Work accordingly. Provide offsets, fittings, and accessories required to meet conditions. Inform Architect immediately when job conditions do not permit installation of equipment and materials in the locations shown. Obtain the Architects approval prior to relocation of equipment and materials.
   3. Relocate equipment and materials installed without prior approval of the Architect. Remove and relocate equipment and materials at Contactors’ expense upon Architects’ direction.
   4. Minor changes in locations of equipment, piping, etc., from locations shown shall be made when directed by the Architect at no additional cost to the Owner providing such change is ordered before such items of work, or work directly connected to same are installed and providing no additional material is required.

D. Execute work mentioned in Specifications and not shown on Drawings, or vice versa, the same as if specifically mentioned or shown in both.

1.06 REQUIREMENTS OF REGULATORY AGENCIES

A. The publications listed below form part of this specification; comply with provisions of these publications except as otherwise shown or specified.
   2. California Electrical Code, 2013
   8. California Code of Regulations, Title 24
   10. CAL-OSHA
   11. California State Fire Marshal, Title 19 CCR
   12. National Fire Protection Association
   13. Occupational Safety and Health Administration
   14. Other applicable state laws
B. Nothing in Drawings or specifications shall be construed to permit work not conforming to these codes, or to requirements of authorities having jurisdiction. It is not the intent of Drawings or specifications to repeat requirements of codes except where necessary for clarity.


D. When Contract Documents differ from governing codes, furnish and install larger size or higher standards called for without extra charge.

E. No material installed as part of this Work shall contain asbestos.

1.07 FEES AND PERMITS

A. Obtain and pay for all permits and service required in installation of this work; arrange for required inspections and secure approvals from authorities having jurisdiction. Comply with requirements of Division 01.

B. Arrange for utility connections and pay charges incurred, including excess service charges.

1.08 UTILITY CONNECTIONS

A. Bear the cost of construction related to utility services, from point of connection to utility services shown on Contract Documents. This includes piping, excavation, backfill, meters, boxes, check valves, backflow prevention devices, general service valves, concrete work, and the like, whether or not Work is performed by Contractor, local water/sanitation district, public utility, other governmental agencies or agencies’ assigns.

1.09 FRAMING, CUTTING AND PATCHING

A. Special framing, recesses, chases and backing for Work of this Section, unless otherwise specified, are covered under other Specification Sections.

B. Contractor is responsible for placement of pipe sleeves, hangers, inserts, supports, and location of openings for the Work.

C. Cutting, patching, and repairing of existing construction to permit installation of equipment, and materials is the responsibility of Contractor. Repair or replace damage to existing work with skilled mechanics for each trade.

D. Cut existing concrete construction with a concrete saw. Do not utilize pneumatic devices.

E. Core openings through existing construction for passage of new piping and conduits. Cut holes of minimum diameter to suit size of pipe and associated insulation installed. Coordinate with building structure, and obtain Structural Engineer’s approval prior to coring through existing construction.

1.10 SUBMITTALS

A. Submittal packages may be submitted via email as PDF electronic files, or as printed packages. PDFs shall be legible at actual size (100 percent). Provide seven copies of printed submittal packages.

B. Provide submittal of materials proposed for use as part of this Project. Product names in Specifications and on Drawings are used as standards of quality. Furnish standard items on specified equipment at no extra cost to the Contract regardless of disposition of submittal data. Other materials or methods shall not be used unless approved in writing by Architect. Architect’s review will be required even though ”or equal” or synonymous terms are used. Refer to Division 01 for complete instructions.

1. Partial or incomplete submittals will not be considered.
2. Quantities are Contractor's responsibility and will not be reviewed.
3. Provide materials of the same brand or manufacturer for each class of equipment or material.
4. Identify each item by manufacturer, brand, trade name, number, size, rating, or other data necessary to properly identify and review materials and equipment. Words "as specified" are not sufficient identification.
5. Identify each submittal item by reference to items' Specification Section number and paragraph, by Drawing and detail number, and by unit tag number.
6. Organize submittals in same sequence as in Specification Sections.
7. Show physical arrangement, construction details, finishes, materials used in fabrications, provisions for piping entrance, access requirements for installation and maintenance, physical size, mechanical characteristics, foundation and support details, and weight.
   a. Submit Shop Drawings, performance curves, and other pertinent data, showing size and capacity of proposed materials.
   b. Specifically indicate, by drawn detail or note, that equipment complies with each specifically stated requirement of Contract Documents.
   c. Drawings shall be drawn to scale and dimensioned (except schematic diagrams). Drawings may be prepared by vendor but must be submitted as instruments of Contractor, thoroughly checked and signed by Contractor before submission to Architect for review.
   d. Catalog cuts and published material may be included with supplemental scaled drawings.

C. Review of submittals will be only for general conformance with design concept and general compliance with information given in Contract Documents. Review will not include quantities, dimensions, weights or gauges, fabrication processes, construction methods, coordination with work of other trades, or construction safety precautions, which are sole responsibility of Contractor. Review of a component of an assembly does not indicate acceptance of an assembly. Deviations from Contract Documents not clearly identified by Contractor are Contractor's responsibility and will not be reviewed by Architect.

D. Within reasonable time after award of contract and in ample time to avoid delay of construction, submit to Architect Shop Drawings or submittals on all items of equipment and materials provided. Provide submittal in at least seven copies and in complete package.
   1. Shop Drawings and submittals shall include Specification Section, Paragraph number, and Drawing unit symbol or detail number for reference. Organize submittals into booklets for each Specification section and submit in loose-leaf binders with index. Deviations from the Contract Documents shall be prominently displayed in the front of the submittal package and referenced to the applicable Contract requirement.

E. Furnish to the Project Inspector complete installation instructions on material and equipment before starting installation.

F. Product Data for California Green Building Standards Code Compliance: For adhesives and sealants, including primers, documentation of compliance including printed statement of VOC content and chemical components.

G. Provide product data for insulation products, including insulation, insulation facings, jackets, adhesives, sealants, and coatings, indicating compliance with requirement that these products contain less than 0.1 percent (by mass) polybrominated diphenyl ethers (PBDEs) in penta, octa, or deca formulations.

H. Pipe, pipe or plumbing fittings, fixtures, solder and flux installed in a system providing water for human consumption shall comply with lead free requirements of the California Health and
Safety Code Section 11 68 75. Provide submittal information for products third-party certified by an approved laboratory as complying with California Health and Safety Code Section 11 68 75.

I. Delegated-Design Submittal: For seismic supports, anchorages, and restraints indicated to comply with performance requirements and design criteria.


2. Supports, anchorage and restraints for piping, ductwork, and equipment shall be an OSHPD pre-approved system such as Tolco, Afcon, ISAT, Badger, Mason, or equal. Pipes, ducts and equipment shall be seismically restrained in accordance with requirements of current edition of California Building Code. System shall have current OPM number and shall meet additional requirements of authority having jurisdiction. Provide supporting documentation required by the reviewing authority and the Architect and Engineer. Provide layout drawings showing piping, ductwork and restraint locations.

   a. Bracing of Piping and Equipment: Specifically state how bracing attachment to structure is accomplished. Provide shop drawings indicating seismic restraints, including details of anchorage to building. In-line equipment must be braced independently of piping, and in conformance with applicable building codes. Provide calculations to show that pre-approval numbers have been correctly applied in accordance with general information notes of pre-approval documentation.

3. In lieu of the above or for non-standard installations not covered in the above pre-approved systems, Contractor shall provide layout drawings showing piping, ductwork, and restraint locations, and detail supports, attachments and restraints, and furnish supporting calculations and legible details sealed by a California registered structural engineer, in accordance with 2013 California Building Code.

4. Additional Requirements: In addition to the above, conform to all state and local requirements.

1.11 SUBSTITUTIONS

A. Refer to Division 01 for complete instructions. Requirements given below are in addition to or are intended to amplify Division 01 requirements. In the case of conflict between requirements given herein and those of Division 01, Division 01 requirements shall apply.

B. It is the responsibility of Contractor to assume costs incurred because of additional work and or changes required to incorporate proposed substitute into the Project. Refer to Division 01 for complete instructions.

C. Substitutions will be interpreted to be all manufacturers other than those specifically listed in the Contract Documents by brand name, model or catalog number.

D. Only one request for substitution will be considered for each item of equipment or material.

E. Substitution requests shall include the following:

   1. Reason for substitution request.
   2. Complete submittal information as described herein; see "Submittals."
   3. Coordinated scale layout drawings depicting position of substituted equipment in relation to other work, with required clearances for operation, maintenance and replacement.
   4. List optional features required for substituted equipment to meet functional requirements of the system as indicated in Contract Documents.
   5. Explanation of impact on connected utilities.
   6. Explanation of impact on structural supports.
F. Installation of reviewed substitution is the Contractors’ responsibility. Any mechanical, electrical, structural, or other changes required for installation of reviewed substituted equipment or material must be made by the Contractor without additional cost to the Owner. Review by the Architect of the substituted equipment or material, including dimensioned Drawings will not waive these requirements.

G. Contractor may be required to compensate the Architect for costs related to substituted equipment or material.

1.12 OPERATION AND MAINTENANCE MANUAL

A. Furnish three complete sets of Operation and Maintenance Manual bound in hardboard binder, and one compact disc containing complete Operation and Maintenance Manual in searchable PDF format. Provide Table of Contents. Provide index tabs for each piece of equipment in binder and disc. Start compiling data upon approval of submittals.

1. Sets shall incorporate the following:
   a. Service telephone number, address and contact person for each category of equipment or system.
   b. Complete operating instructions for each item of plumbing equipment.
   c. Copies of guarantees/warrantees for each item of equipment or systems.
   d. Test data and system balancing reports.
   e. Typewritten maintenance instructions for each item of equipment listing lubricants to be used, frequency of lubrication, inspections required, adjustment, etc.
   f. Manufacturers' bulletins with parts numbers, instructions, etc., for each item of equipment.
   g. Control diagrams and literature.
   h. A complete list or schedule of all scheduled valves giving the number of the valve, location and the rooms or area controlled by the valve. Identify each valve with a permanently attached metal tag stamped with number to match schedule. Post list in frame under plastic on wall in mechanical room or where directed by Architect.
   i. Check test and start reports for each piece of plumbing equipment provided as part of the Work.
   j. Commissioning and Preliminary Operation Tests required as part of the Work.

B. Post service telephone numbers and/or addresses in an appropriate place as designated by the Architect.

1.13 SITE CONDITIONS

A. Information on Drawings relative to existing conditions is approximate. Deviations from Drawings necessary during progress of construction to conform to actual conditions shall be approved by the Architect and shall be made without additional cost to the Owner. The Contractor shall be held responsible for damage caused to existing services. Promptly notify the Architect if services are found which are not shown on Drawings.

1.14 EXISTING MATERIALS

A. Remove existing equipment, piping, wiring, construction, etc., which interferes with Work of this Contract. Promptly return to service upon completion of work in the area. Replace items damaged by Contractor with new material to match existing.

B. Removed materials which will not be re-installed and which are not claimed by Owner shall become property of Contractor and shall be removed from Project site. Consult Owner before
removing any material from Project site. Carefully remove materials claimed by Owner to prevent damage and deliver to Owner-designated storage location.

C. Existing piping and wiring not reused and are concealed in building construction may be abandoned in place and all ends shall be capped or plugged. Remove unused piping and wiring exposed in Equipment Rooms or occupied spaces. Material shall be removed from Project premises. Disconnect power, water, gas, pump or any other active energy source from piping or electrical service prior to abandoning in place.

D. Existing piping, ductwork, and equipment modified or altered as part of this Work shall comply with the most recent applicable code requirements.

1.15 WARRANTY
A. Refer to Division 01 for warranty requirements, including effective date of warranty. Refer to specific items of equipment specified herein for warranty duration if different from that specified in Division 01.

B. Repair or replace defective work, material, or part that appears within the warranty period, including damage caused by leaks.

C. On failure to comply with the above warranty within a reasonable length of time after notification is given, the Architect/Owner shall have the repairs made at the Contractor's expense.

1.16 RECORD DRAWINGS
A. Refer to Division 01, Record Documents, for requirements governing Work specified herein.

B. Upon completion of the work, deliver to Architect the following:
   1. Originals of drawings showing the Work exactly as installed.
   2. One complete set of reproducible drawings showing the Work exactly as installed.
   3. One compact disc with complete set of drawings in PDF format showing the Work exactly as installed.

C. Provide Contractor's signature, verifying accuracy of record drawings.

D. Obtain the signature of the Project Inspector for all record drawings.

1.17 DELIVERY AND STORAGE
A. Protect equipment and piping delivered to Project site from weather, humidity and temperature variations, dirt, dust and other contaminants.

1.18 COORDINATION
A. General:
   1. Coordinate Work in this Section with trades covered in other Specifications Sections to provide a complete, operable and sanitary installation of the highest quality workmanship.

B. Electrical Coordination:
   1. Refer to the Electrical Drawings and Specifications, Division 26, for service voltage and power feed wiring for equipment specified under this section. Contractor has full responsibility for the following items of work:
      a. Review the Electrical Drawings and Division 26 Specifications to verify that electrical services provided are adequate and compatible with equipment requirements.
      b. If additional electrical services are required above that indicated on Electrical Drawings and in Division 26, such as more control interlock conductors, larger
Feeder, or separate 120 volt control power source, include cost to furnish and install additional electrical services as part of the bid.

c. Prior to proceeding with installation of additional electrical work, submit detailed drawings indicating exact scope of additional electrical work.

C. Mechanical Coordination:
1. Arrange for pipe spaces, chases, slots and openings in building structure during progress of construction, to accommodate mechanical system installation.
3. Coordinate requirements for access panels and doors for mechanical items requiring access where concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section “Access Doors and Frames.”

PART 2 - PRODUCTS

2.01 GENERAL

A. Materials or equipment of the same type shall be of the same brand wherever possible. All materials shall be new and in first class condition.

B. All sizes, capacities, and efficiency ratings shown are minimum, except that gas capacity is maximum available.

C. Refer to Sections 22 10 00 and 23 80 00 for specific system piping materials.

2.02 VALVES AND FITTINGS FOR POTABLE WATER SYSTEMS

A. General:
1. Provide valves and fittings conforming to lead-free requirements of California Health and Safety Code Section 11 68 75.
   a. Provide valves listed to NSF/ANSI 61-G or NSF/ANSI 372 for valve materials for potable-water service.
      1) Exception: Main distribution gate valves above 1-1/2 inches located underground outside building are not required to conform lead-free requirements of California Health and Safety Code Section 11 68 75.

B. Gate Valves:
1. Gate valves are no acceptable for use on this project.

C. Ball Valves:
1. 2 inches and smaller: 600 psi CWP, cast bronze or brass body, full port, two piece, threaded ends, and reinforced PTFE seal, conforming to MSS SP-110. Nibco T-685-80-LF, Milwaukee UPBA400, Apollo 77C-LF10, Kitz 868, or equal.

2.03 VALVES AND FITTINGS FOR NON-POTABLE WATER SYSTEMS

A. Gate Valves:
1. Gate valves are not acceptable for use on this project.

B. Ball Valves:
1. 2 inches and smaller: 600 psi CWP, 150 psi SWP, cast bronze body, full port, two piece, threaded ends, and reinforced PTFE seal, conforming to MSS SP-110. Nibco T585-70, Milwaukee BA-400, Stockham T-285, or equal.
2.04 JOINING MATERIALS

A. Refer to Division 22 and 23 piping sections for special joining materials not listed below.

B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
   1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch (3.2-mm) maximum thickness unless thickness or specific material is indicated
      a. Full-Face Type: For flat-face, Class 125, cast iron and cast bronze flanges.
      b. Narrow-Face Type: For raised-face, Class 250, cast iron and steel flanges.
   2. AWWA C111, rubber, flat face, 1/8-inch (3.2mm) thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.
   3. Flange Bolts and Nuts: AWWA C111, carbon steel, unless otherwise indicated.
   4. Plastic, Pipe-Flange Gasket, Bolts and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.

C. Solder Filler Metals: ASTM B 32, 100 percent lead free alloys. Include water-flushable flux according to ASTM B813.

D. Brazing Filler Metals: AWS A5.8, BCup-5 Series, copper-phosphorus unless otherwise indicated. Sil-Fos 15, or equal.

2.05 ACCESS DOORS

A. Where floors, walls, or ceilings must be penetrated for access to mechanical equipment, provide access doors, 14 inch by 14 inch minimum size in usable opening. Where entrance of a serviceman may be required, provide 20 inch by 30 inch minimum usable opening. Locate access doors/panels for non-obstructed and easy reach.
   1. All access doors less than 7'-0" above floors and exposed to public access shall have keyed locks.

B. Access doors shall match those supplied in Division 08 in all respects, except as noted herein.

C. Provide stainless steel access doors for use in toilet rooms, shower rooms, kitchens and other damp areas. Provide steel access doors with prime coat of baked-on paint for all other areas.

D. Do not locate access doors in highly visible public areas such as lobbies, waiting areas, and primary entrance areas. Coordinate with the Architect when access is required in these areas.

E. Where specific information or details relating to access panels different from the above is shown or given on the Drawings or other Divisions of work, then that information shall supersede this specification.

F. Manufacturers: Subject to compliance with requirements, available manufacturers offering products which may be incorporated into the Work include Milcor, Karp, Nystrom, or Cesco, equal to the following:
   1. Milcor
      a. Style K (plaster)
      b. Style DW (gypsum board)
      c. Style M (Masonry)
      d. Style "Fire Rated" where required

2.06 PIPE IDENTIFICATION
A. Identify each piping system and indicate the direction of flow by means of Seton, Inc., Marking Services Inc., Reef Industries, Inc., or equal, pre-tensioned, coiled semi-rigid plastic pipe labels formed to circumference of pipe, requiring no fasteners or adhesive for attachment to pipe.

B. The legends and flow arrows shall conform to ASME A13.1.

2.07 INSULATION WORK

A. General:

1. Insulation products, including insulation, insulation facings, jackets, adhesives, sealants and coatings shall not contain polybrominated diphenyl ethers (PBDEs) in penta, octa, or deca formulations in amounts greater than 0.1 percent (by mass).

2. Adhesives and sealants shall comply with testing and product requirements of South Coast Air Quality Management District, Rule 1168.

3. The term "piping" used herein includes pipe, valves, strainers and fittings.

4. Apply insulating cement to fittings, valves and strainers and trowel smooth to the thickness of adjacent covering. Cover with jacket to match piping. Extend covering on valves up to the bonnet. Leave strainer cleanout plugs accessible.

5. Provide pre-formed PVC valve and fitting covers.

6. Provide Calcium Silicate rigid insulation and sheet metal sleeve, 18 inch minimum length at each pipe hanger. Seal ends of insulation to make vapor tight with jacket.

7. Urethane insulation will not be allowed above ground or on hot water piping.

8. Test insulation, jackets and lap-seal adhesives as a composite product and confirm flame spread of not more than 25 and a smoke developed rating of not more than 50 when tested in accordance with UL723 or ASTM E84.

9. Clean thoroughly, test and have approved, all piping and equipment before installing insulation and/or covering.

10. Repair all damage to existing pipe and equipment insulation whether or not caused during the work of this contract, to match existing adjacent insulation for thickness and finish, but conforming to flame spread and smoke ratings specified above.

B. Insulation of Piping:

1. Insulate domestic hot and tempered water with 1 inch thick 3-1/2# minimum density fiberglass with ASJ-SSL jacket for sizes up to and including 3/4 inches. For larger sizes provide 1-1/2 inch thick 3-1/2# minimum density fiberglass insulation and ASJ-SSL jacket.

2. Exposed insulated piping within the building shall have a Zeston 2000 25/50, Proto Lo-Smoke, or equal, PVC jacket and fitting cover installed over the insulation, applied per manufacturer's instructions. Verify suitability with manufacturer of insulation. Insulation with pre-applied polymer jacket may be substituted at Contractor's option.

PART 3 - EXECUTION

3.01 PLUMBING DEMOLITION

A. Refer to Division 01 Sections "Cutting and Patching" and "Selective Demolition" for general demolition requirements and procedures.

B. Disconnect, dismantle and remove mechanical systems, equipment, and components indicated to be removed. Coordinate with all other trades.

1. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
2. Piping to Be Abandoned in Place: Drain piping and cap or plug piping to remain with same or compatible piping material. Refrigerant system must be evacuated per EPA requirements.
3. Equipment to Be Removed: Drain down and cap remaining services and remove equipment.
4. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
5. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.

C. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

3.02 ELECTRICAL REQUIREMENTS
A. Provide adequate working space around electrical equipment in compliance with the California Electrical Code. Coordinate the Mechanical Work with the Electrical Work to comply.
B. Furnish necessary control diagrams and instructions for the controls. Before permitting operation of any equipment which is furnished, installed, or modified under this Section, review all associated electrical work, including overload protection devices, and assume complete responsibility for the correctness of the electrical connections and protective devices. Motors and control equipment shall conform to the Standards of the National Electrical Manufacturers' Association. All equipment and connections exposed to the weather shall be NEMA IIIIR with factory-wired strip heaters in each starter enclosure and temperature control panel where required to inhibit condensation.
C. All line voltage and low voltage wiring and conduit associated with the Temperature Control System are included in this Section. Wiring and conduit shall comply with Division 26.

3.03 PIPING SYSTEM REQUIREMENTS
A. Drawing plans, schematic and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.

3.04 PRIMING AND PAINTING
A. Perform all priming and painting on the equipment and materials as specified herein.
B. Priming:
1. Exposed ferrous metals, including piping, which are not galvanized or factory-finished shall be primed. Black steel pipe exposed to the weather shall be painted one coat of Rust-Oleum #1069 primer for black steel piping or Rust-Oleum #5260, Kelly Moore, or equal, primer for galvanized piping.
2. Metal surfaces of items to be jacketed or insulated except piping shall be given two coats of primer unless furnished with equivalent factory finish. Items to be primed shall be properly cleaned by effective means free of rust, dirt, scale, grease and other deleterious matter and then primed with the best available grade of zinc rich primer. After erection or installation, all primed surfaces shall be properly cleaned of any foreign or deleterious matter that might impair proper bonding of subsequent paint coatings. Any abrasion or other damage to the shop or field prime coat shall be properly repaired and touched up with the same material used for the original priming.
3. Where equipment is provided with nameplate data, the nameplate should be masked off prior to painting. When painting is completed, remove masking material.

C. See Painting Section for detailed requirements.

3.05 INSTALLATION OF VALVES

A. Install valves as indicated on Drawings and in the following locations:

1. Shut off Valves: Install on inlet of each plumbing equipment item, and on inlet of each plumbing fixture, and elsewhere as indicated.

2. Drain Valves: Install on each plumbing equipment item located to completely drain equipment for service or repair. Install at base of each riser, at base of each rise or drop in piping system, and elsewhere indicated or required to completely drain potable water system.

3. Provide ball or globe valves on inlet and outlet of each water heater or pump.

B. General:

1. Valves shall be full line size unless indicated otherwise on Drawings.

2. Install horizontal valves with valve stem above horizontal, except butterfly valves.

3. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

4. Locate valves for easy access and provide separate support where necessary.

5. Install valves in position to allow full stem movement.

6. Install exposed polished or enameled connections with special care showing no tool marks or exposed threads.

7. Butterfly valves conforming to the paragraph “Butterfly Valves” may be used in lieu of gate or globe valves for locations above grade.

8. Ball valves conforming to the paragraph “Ball Valves” may be used in lieu of gate valves for locations above grade for services 2-1/2 inches and smaller.

9. Valves 2-1/2 inches and smaller (except ball valves) in nonferrous water piping systems may be solder joint type with bronze body and trim.

10. Rigidly fasten hose bibbs, hydrants, fixture stops, compressed air outlets, and similar items to the building construction.

C. Valve Adjustment: Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.06 PIPE JOINTS AND CONNECTIONS

A. General:

1. Cutting: Cut pipe and tubing square, remove rough edges or burrs. Bevel plain ends of steel pipe.

2. Remove scale, slag, dirt and debris from inside and outside of pipe before assembly.

3. Boss or saddle type fittings or mechanically extracted tube joints will not be allowed.

B. Threaded Pipe: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply thread compound to external pipe threads: Rectorseal No. 5, Permatex No. 1, or equal.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

C. Flanged Joints: Select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for domestic water service. Join flanges with gasket and bolts according to ASME B31.9.

D. Copper Pipe and Tubing (Except pneumatic control piping): All joints shall be brazed according to ASME Section IX, Welding and Brazing Qualifications, except domestic water piping 1-1/4 inches and smaller when not buried in the ground or concrete and type DWV plumbing piping may be soldered.

E. Welded Pipe:
   1. Make up with oxyacetylene or electric arc process.
   2. All welding shall conform to the American Standard Code for Power Piping ASME B-31.1. When requested by the Architect, furnish certification from an approved testing agency or National Certified Pipe Welding Bureau that the welders performing the work are qualified.
   3. All line welds shall be of the single "V" butt type. Welds for flanges shall be of the fillet type.
   4. Where the branch is two pipe sizes smaller than the main or smaller, Bonney Weldolets, Threadolets, Nibco, or equal, may be used in lieu of welding tees.

3.07 UNIONS AND FLANGES
   A. Install Watts, Epco, Nibco, or equal, dielectric unions or flanges at points of connection between copper or brass piping or material and steel or cast iron pipe or material except in drain, waste, vent, or rainwater piping. Bushings or couplings shall not be used. Dielectric unions installed in potable water systems shall conform to the lead-free requirements of the California Health and Safety Code Section 11 68 75.
   B. Install unions in piping NPS 2" and smaller, and flanges in piping NPS 2-1/2" and larger whether shown or not at each connection to all equipment and tanks, and at all connections to all automatic valves, such as temperature control valves. Unions installed in potable water systems shall conform to the lead-free requirements of the California Health and Safety Code Section 11 68 75.
   C. Locate the unions for easy removal of the equipment, tank, or valve.

3.08 ACCESS DOOR
   A. Furnish and install access doors wherever required whether shown or not for easy maintenance of mechanical systems; for example, at concealed valves, strainers, traps, cleanouts, dampers, motors, controls, operating equipment, etc. Access doors shall provide for complete removal and replacement of equipment.

3.09 PIPE IDENTIFICATION
   A. Provide temporary identification of each pipe installed, at the time of installation. Temporary identification shall be removed and replaced with permanent identification as part of the work.
   B. Apply the legend and flow arrow at all valve locations; at all points where the piping enters or leaves a wall, partition, cluster of piping or similar obstruction, at each change of direction and at approximately 20'-0" intervals on pipe runs. Variations or changes in locations and spacing...
may be made with the approval of the Architect. There shall be at least one marking in each room. Markings shall be located for maximum visibility from expected personnel approach.

1. Apply legend and flow arrow at approximately 10'-0" intervals in science classrooms and science prep rooms.

C. Wherever two or more pipes run parallel, the markings shall be supplied in the same relative location on each.

D. Each valve on non-potable water piping shall be labeled with a metal tag stamped "DANGER -- NON-POTABLE WATER" in 1/4 inch high letters.

E. Apply markings after painting and cleaning of piping and insulation is completed.

3.10 TESTS AND ADJUSTMENTS

A. Test the installations in accordance with the following requirements and all applicable codes:

1. Inspector of Record should witness all tests of piping systems.
2. Notify the Architect at least seven days in advance of any test.
3. All piping shall be tested at completion of roughing-in, or at other times as directed by the Architect.
4. Furnish all necessary materials, test pumps, gases, instruments and labor required for testing.
5. Isolate from the system all equipment that may be damaged by test pressure.
6. Make connections to existing systems with flanged connection. During testing of the new work, provide a slip-in plate to restrict test pressure to new systems only. Remove plate and complete connection to existing system at completion of testing.
   a. Inspector of record shall witness final connection to system.

B. Test Schedule: No loss in pressure or visible leaks shall show after four hours at the pressures indicated.

Testing of Sanitary Sewer, Drain, Vent, Storm Drain may be done in segments in order to limit pressure to within manufacturer’s recommendations. Test to 10 feet above the highest point in the system.

<table>
<thead>
<tr>
<th>System Tested</th>
<th>Test Pressure PSI</th>
<th>Test With</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sanitary Sewer, Drain, Vent</td>
<td>10 Ft. Hd.</td>
<td>Water</td>
</tr>
<tr>
<td>Domestic Water</td>
<td>125</td>
<td>Water</td>
</tr>
<tr>
<td>Distilled Deionized Water</td>
<td>50</td>
<td>Water</td>
</tr>
</tbody>
</table>

1. Flush distilled deionized water lines with distilled deionized water after test and approval.
2. Non-corrosive leak test fluid shall be suitable for use with the piping material specified, and with the type of gas conveyed by the piping system.

C. Perform operational tests under simulated or actual service conditions, including one test of complete plumbing installation with all fixtures and other appliances connected, and one test of complete installation of 48 hours each for heating and cooling with all equipment connected and operating.

D. Should any material or work fail in any of these tests, it shall be immediately removed and replaced for new material, and portion of the work replaced shall again be tested by Contractor at his own expense.

E. Lubricate each item of equipment, including motors, before operation.
3.11 OPERATION OF SYSTEMS
A. Do not operate any plumbing equipment for any purpose, temporary or permanent, until all of
the following has been completed:
1. Complete all requirements listed under “Check, Test and Start Requirements.”
2. Piping has been properly cleaned. Piping systems shall be flushed and treated prior to
operation.
3. Filters, strainers etc. are in place.
4. Bearings have been lubricated, and alignment of rotating equipment has been checked.
5. Equipment has been run under observation, and is operating in a satisfactory manner.

B. Provide test and balance agency with one set of Contract Drawings, Specifications, Addenda,
Change orders issued, applicable shop drawings and submittals and temperature control
drawings.

3.12 DEMONSTRATION AND TRAINING
A. An authorized representative of the equipment manufacturer shall train Owner-designated
personnel in maintenance and adjustment of equipment. The representative may be an
employee of the equipment manufacturer, or a manufacturer-certified contractor. Submit written
certification from the manufacturer stating that the representative is qualified to perform the
Owner training for the equipment installed.
1. As part of the submittal process, provide a training agenda outlining major topics and
time allowed for each topic.
2. Some items of specified equipment require that training must be performed by the
manufacturer, using manufacturer’s employees. See specific equipment Articles in these
Specifications for this requirement.
3. Contractor shall provide three copies of certification by Contractor that training has been
completed, signed by Owner’s representative, for inclusion in Operation and Maintenance
Manual. Certificates shall include:
   a. Listing of Owner-designated personnel completing training, by name and title.
   b. Name and title of training instructor.
   c. Date(s) of training.
   d. List of topics covered in training sessions.
4. Refer to specific equipment Articles for minimum training period duration for each piece
of equipment.

END OF SECTION
SECTION 22 10 00

PLUMBING PIPING SYSTEMS

PART 1 - GENERAL

1.01 SECTION INCLUDES
A. Pipe and fittings.
B. Water hammer arrestors.
C. Reduced pressure backflow preventer for potable water system.
D. Reduced pressure backflow preventer for non-potable water system.
E. Cleanouts.
F. Floor drains.
G. Floor sinks.
H. Hopper drains.

1.02 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
B. Section 22 00 50 Basic Plumbing Materials and Methods.

1.03 ADDITIONAL REQUIREMENTS
A. Furnish and install any incidental work not shown or specified which is necessary to provide a complete and workable system.
B. Coordinate all of work in this Section with all of the trades covered in other Sections of the Specifications to provide a complete, operable and sanitary installation of the highest quality workmanship.
C. All plumbing work required in the course of this contract shall be performed in strict accordance with all codes and regulations. Plumbing work done under this contract shall not adversely affect the operation of the existing plumbing systems. All materials shall be new and shall match existing.

1.04 DESCRIPTION OF WORK
A. Furnish and install all plumbing work indicated on the drawings and described herein.

1.05 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. Contractor's Qualifications: Firm with at least 5 years of successful installation experience on projects with piping systems work similar to that required for project.
C. Requirements of Regulatory Agencies: The publications listed below form a part of this specification; comply with provisions of these publications except as otherwise shown or specified.

1. Plumbing Code Compliance: Comply with applicable portions of California Plumbing Code pertaining to selection and installation of plumbing materials and products.
   a. NSF Compliance:
      1) Pipe, tube, and fittings used in potable water systems intended to supply drinking water shall meet the requirements of NSF-61 2010a, “Drinking Water System Components – Health Effects.”
      2) Plastic potable water-service piping shall meet the requirements of NSF 14 2010, “Plastic Piping Components and Related Materials.”

2. California Health and Safety Code Compliance: For products covered under the scope of HSC 116875 for potable water service. Products for potable water service shall be third-party certified by an approved laboratory as complying with California Health and Safety Code Section 11 68 75.

1.06 SUBMITTALS

A. Product Data: Submit manufacturer’s technical product data and installation instructions for plumbing piping systems materials and products.

B. Record Drawings: At project closeout, submit Record Drawings of installed piping systems, in accordance with requirements of Division 01.

C. 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 Operation and Maintenance Manual; in accordance with requirements of Division 01.

D. Pipe, pipe or plumbing fittings, fixtures, solder and flux installed in a system providing water for human consumption shall comply with lead free requirements of the California Health and Safety Code Section 11 68 75. Provide submittal information for products third-party certified by an approved laboratory as complying with California Health and Safety Code Section 11 68 75.

1.07 JOB CONDITIONS

A. Cooperation with other trades: Coordinate Work of this Section with that of other Sections to ensure that Work is carried out in an orderly fashion.

B. Coordinate with other trades all equipment locations, pipe, duct and conduit runs, electrical outlets and fixtures, air inlets and outlets, and structural and architectural features. Provide information on location of piping and seismic bracing to all other trades as required for a completely coordinated project.

PART 2 - PRODUCTS

2.01 MATERIALS AND PRODUCTS

A. Provide piping materials and factory-fabricated piping products of sizes, types, pressure ratings, temperature ratings, and capacities as indicated. Provide materials and products complying with California Plumbing Code. Where more than one type of material or product is indicated, selection from materials or products specified is Contractor's option.
2.02 PIPE AND FITTINGS INSIDE BUILDINGS AND BELOW COVERED WALKS AND CORRIDORS

A. Drain and Waste Pipe Above Grade: Cast iron soil pipe and fittings, asphaltic coated, conforming to ASTM A888 and Cast Iron Soil Pipe Institute Standard (CISPI) 301 and so marked. Pipe and fittings shall be as manufactured by AB&I, Charlotte, Tyler Pipe, or equal. Pipe and fittings shall be the products of a single manufacturer. At Contractor’s option, vertical piping above floor from lavatories, sinks, and drinking fountains may be Schedule 40 galvanized steel pipe with black cast iron drainage fittings, or DWV copper pipe and fittings.

1. Joints above grade: No-Hub pipe conforming to ASTM A888 and CISPI 301. Couplings conforming to ASTM 1277 and CISPI 310, with stainless steel bands. Provide products by ANACO-Husky, Tyler, Ideal or equal. Provide sway brace at 20'-0" maximum spacing for suspended pipe with No-Hub joints. Provide a brace on each side of a change in direction of 90 degrees or more. Brace riser joints at each floor and at 15 foot maximum intervals (also see Specification Section 22 00 50).

B. Drain and Waste Pipe Below Grade: Cast iron soil pipe and fittings, asphaltic coated, conforming to ASTM A888 and CISPI 301 and so marked. Pipe and fittings shall be as manufactured by AB&I, Charlotte, Tyler Pipe, or equal. Pipe and fittings shall be the products of a single manufacturer. At Contractor’s option, hub and spigot cast iron soil pipe and fittings, asphaltic coated, conforming to ASTM A-74 and so marked, may be used.

1. Joints below grade: ANACO-Husky SD 4000, Clamp-All 125, or equal couplings and No-Hub fittings, meeting the requirements of FM 1680, SD Class I and ASTM C1540.

2. Joints below grade (hub and spigot option): neoprene gaskets conforming to ASTM C564, as manufactured by Ty-Seal, Dual-Tite, or equal.

C. Vent Pipe:

1. 3 inch and larger: Cast iron soil pipe and fittings conforming to ASTM A888 and Cast Iron Soil Pipe Institute Standard 301 and so marked.

2. 2-1/2 inch and smaller: Schedule 40 galvanized steel pipe with black cast iron drainage fittings, or DWV copper pipe and fittings.

3. Vent pipe buried in ground and to 6 inches above ground: Cast iron soil pipe and fittings conforming to ASTM A888 and Cast Iron Soil Pipe Institute Standard 301 and so marked. Joints in cast iron vent pipe shall be the same as specified for cast iron waste pipe below ground.


E. Acid Waste (AW) and Vent (AV) Pipe Aboveground:


F. Water Pipe (Tempered Water, Tempered Water Return, Hot Water, Hot Water Return and Cold Water): ASTM B88, Type L copper tubing, hard-temper, with wrought copper fittings. Provide full solder cup for all fittings. Capped or plugged outlets shall be Schedule 40 screwed brass. Water piping below slab: ASTM B88, Type K copper tubing, hard temper, with wrought copper fittings. At Contractor’s option, pipe runs below slab having no branches may be ASTM B88,
Type K annealed copper tubing without joints. See Section 22 00 50 for pipe protection requirements for below slab copper piping.

G. Condensate Drain Piping:
   1. Inside buildings provide ASTM B88, Type L copper tubing and fittings. Provide Wye fittings with capped cleanout plug for tubing up to 1 inch size. Provide wrought or cast DWV fittings for sizes 1-1/4 inch and larger.
   2. Outside buildings provide ASTM B88, Type L copper pipe and fittings, cast iron drain pipe and fittings or Schedule 40 galvanized steel pipe and cast iron drain or vent fittings.
   3. Connect condensate drains to mechanical equipment per equipment manufacturer’s recommendations; provide P-trap where required. Slope piping to drain, with 1 inch in 10 foot minimum pitch. Provide di-electric couplings or unions at connections to dissimilar materials.
   4. Where condensate drain P-traps are required, install trap using Wye fitting on inlet and outlet of trap. Provide cap on top of each Wye, made removable for cleaning and inspection. Drill 1/8 inch diameter hole in cap at outlet of the trap to allow venting of the system. Minimum depth of trap should be 4 inches, or as recommended by the manufacturer in printed literature.
   5. Provide cleanout tees or “Y” at each change in direction.

2.03 FIRE PROTECTION PIPING
   A. Refer to specification Section 21 10 00 “Fire Protection.”

2.04 WATER HAMMER ARRESTORS
   A. Provide water hammer arrestors conforming to lead-free requirements of California Health and Safety Code Section 11 68 75, with nesting type bellows contained within a casing having sufficient displacement volume to dissipate the calculated kinetic energy generated in the piping system. Water hammer arrestors shall be sized for type and number of fixtures served. Provide all stainless steel shell construction with stainless steel bellows and threaded connection to water system.
   B. Water hammer arrestors shall be certified under P.D.I. Standard WH201 and by ASSE Standard 1010.
   C. Select units in accordance with the requirements of Plumbing and Drainage Institute Standard P.D.I. WH201. Install above ceilings or behind wall access door at each plumbing fixture, or where plumbing fixtures are installed in groups, at each group of fixtures.
   D. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:

Josam Company, series 75000
Smith (Jay R.) Mfg. Co., Hydrotrol 5005-5050
Mifab, series WHB

2.05 REDUCED PRESSURE BACKFLOW PREVENTER FOR POTABLE WATER SYSTEMS
   A. Provide reduced pressure principle backflow preventer conforming to lead free requirements of California Health and Safety Code Section 11 68 75.
   1. Reduced-pressure principle backflow preventer assembly, consisting of shutoff valves on inlet and outlet, and strainer on inlet. Backflow preventer shall include test cocks, and pressure differential relief valve located between two positive seating check valves. Construct in accordance with ASSE Standard 1013.
2. Manufacturers: Subject to compliance with requirements and local water authorities having jurisdiction, available manufacturers offering products that may be incorporated into the Work include the following, or equal:
   a. 2 inches and smaller: Wilkins 975XL2, Febco LF825YRP, Watts LF919, or equal.
   b. 2-1/2 thru 10 inches: Wilkins 475AXL, Febco LF860RP, or equal.
   c. 2-1/2 and 3 inches: Watts LF009

B. Provide substantial padlock and chain to lock valves in open position, and turn key over to Project Inspector.
   1. Padlocks shall be as specified under Section 08 70 00.
   2. Chain shall be of carbon steel, 3/8 inch wire diameter, fully welded links and weight of 140 pounds per 100 lineal feet. Chain shall be hot galvanized.

C. Provide capped connections at each test cock. Install in accordance with requirements of Authority Having Jurisdiction.

D. For units installed within buildings, provide drain, connected to unit, to collect spillage from atmospheric vent. Run drain to nearest floor sink or drain.

2.06 REDUCED PRESSURE BACKFLOW PREVENTER FOR NON-POTABLE WATER SYSTEMS

A. Refer to Section 21 10 00 for backflow preventers for fire protection service.

B. Provide reduced-pressure principle backflow preventer consisting of assembly, including shutoff valves on inlet and outlet, and strainer on inlet, equal to Febco 825Y or 880, as required Wilkins, Aames, or equal. Backflow preventer shall include test cocks, and pressure differential relief valve located between two positive seating check valves. Construct in accordance with ASSE Standard 1013.

C. Provide substantial padlock and chain to lock valves in open position, and turn key over to Project Inspector.
   1. Padlocks shall be as specified under Section 08 70 00.
   2. Chain shall be of carbon steel, 3/8 inch wire diameter, fully welded links and weight of 140 pounds per 100 lineal feet. Chain shall be hot galvanized.

D. Provide capped connections at each test cock. Install in accordance with requirements of Authority Having Jurisdiction.

E. For units installed within buildings, provide drain, connected to unit, to collect spillage from atmospheric vent. Run drain to nearest floor sink or drain.

F. Manufacturers: Subject to compliance with requirements and local water authorities having jurisdiction, available manufacturers offering products that may be incorporated into the Work include the following, or equal:

   Ames
   Febco Sales, Inc.
   Watts Regulator Company
   Clow

2.07 CLEANOUTS

A. General: Install cleanouts of same diameter as pipe (4 inch maximum) in all horizontal soil and waste lines where indicated and at all points of change in direction. Cleanouts shall be located not less than 18 inches from building construction so as to provide sufficient space for rodding. No horizontal run over 50 feet inside buildings or 100 feet outside buildings shall be without
cleanout, whether shown on Drawings or not. Provide two-way cleanouts where indicated on
drawings, and where required for satisfactory use.

1. Provide cleanouts in waste drop from each sink and urinal.

2. Provide one wrench for each size and type of cleanout used. Turn over to Owner at
completion of the project, and obtain receipt. Place receipt in Operation and
Maintenance Manuals.

B. Cleanouts in floor and in concrete sidewalks: Duco Cast Iron with nickel bronze top, clamping
collar and ABS plastic plug: Zurn ZN-1400-KC, or equal, with square or round top to suit floor
construction.

C. Cleanouts in composition floors: Zurn ZN-1400-X-DX, or equal (nickel bronze top).

D. Cleanouts in concealed, aboveground cast-iron soil or waste lines: Zurn Z-1440A, or equal, with
ABS plastic plug.

E. Cleanouts in walls: Zurn Z-1441 or Z-1443, or equal, with stainless steel cover. Provide long
sweep elbow or combination wye at connection to riser and install with surface of cleanout
within 1/2 inch of front face of finished wall.

1. Where space does not permit the above installation, provide Zurn Z-1446, or equal, with
stainless steel access cover, and vandal resistant screw.

2. Install face of cleanout plug within 1/2 inch of front face of finished wall.

F. Cleanouts in acid waste systems: Zurn ZN-1404, or equal, cleanout access housing, with ductile
cast iron body and nickel bronze top. Extend acid waste piping within the cleanout, and terminate
with threaded cap. Secure acid waste pipe inside cleanout access housing with setscrews
provided.

G. Manufacturers: Subject to compliance with requirements, available manufacturers offering
products that may be incorporated into the Work include the following, or equal:

Zurn
J.R. Smith
Josam

2.08 FLOOR DRAINS Manufacturers: Drawing schedules indicate Basis of Design products.
Subject to compliance with requirements, provide product indicated on Drawings, or comparable
product by one of the following, or equal:

Zurn
J.R. Smith
Josam

2.09 FLOOR SINKS

A. 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.

B. Manufacturers: Drawing schedules indicate Basis of Design products. Subject to compliance
with requirements, provide product indicated on Drawings, or comparable product by one of the
following, or equal:

Zurn
J.R. Smith
Josam
2.10 HOPPER DRAINS

A. Manufacturers: Drawing schedules indicate Basis of Design products. Subject to compliance with requirements, provide product indicated on Drawings, or comparable product by one of the following, or equal:

Zurn
J.R. Smith

PART 3 - EXECUTION

3.01 INSPECTION

A. Examine areas and conditions under which plumbing piping systems are to be installed. Do not proceed with Work until unsatisfactory conditions have been corrected in manner acceptable to Contractor.

B. Make all arrangements for the utilities required. Pay all costs involved in obtaining the services including gas service and meter, water meter, pressure reducing valve, access boxes, street work. Connect to site utilities. Verify the location of all services. No extra cost will be allowed if services are not as shown.

C. At time of final connection, and prior to opening valve to allow pressurization of water and gas piping from existing systems, on site or off site, perform a pressure test to indicate static pressure of existing systems. If pressure on water piping is greater than 80 psi, or gas pressure is not as indicated on Contract Documents, inform Architect immediately. Do not allow piping systems to be pressurized without written consent of the Architect.

3.02 INSTALLATION OF WATER PIPING

A. Run all water piping generally level, free of traps or unnecessary bends, arranged to conform to the building requirements, and to suit clearance for other mechanical work such as ducts, flues, conduits, and other work. No piping shall be installed so as to cause unusual noise from the flow of water therein under normal conditions.

B. Provide manufactured water hammer arrestors, sized and installed in accordance with Plumbing and Drainage Institute Standard PDI WH201.
   1. Locate water hammer arrestors at every plumbing fixture, or, where fixtures are located in groups, at every group of fixtures, and as indicated on Drawings.
   2. Install water hammer arresters above accessible ceilings, or install access doors for service.

C. Install piping on room side of building insulation.

D. Check final location of rubber rings within couplings on PVC water piping with gauge or as recommended by manufacturer. Make connection to valves with cast iron adapters connected to water pipe with cast iron couplings. Furnish and install anchors or thrust blocks.

E. For all faucets, hose bibbs, or other water outlets delivering industrial hot and/or cold water, provide a sign, permanently mounted, indicating "CAUTION: NON-POTABLE WATER, DO NOT DRINK". Each sign shall be permanently engraved with black uppercase letters on a yellow background. Letters shall be minimum 1-1/4 inch high.

3.03 INSTALLATION OF SANITARY AND STORM DRAINAGE SYSTEMS

A. Sewer Piping: Run all horizontal sanitary drain piping inside of building on a uniform grade of not less than 1/4 inch per foot unless otherwise noted or later approved. Unless otherwise
noted on the plans, piping shall have invert elevations as shown and slope uniformly between given elevations.

B. Run all drainage piping as straight as possible and provide easy bends with long turns; make all offsets at an angle of 45 degrees or less.

C. Grade all vent piping so as to free itself quickly of any water condensation.

D. Where possible, join groups of vent risers together with one enlarged outlet through roof. Maintain minimum of 10 foot horizontal or 3 foot vertical clearance from air intakes.

E. Hubless Cast Iron Joints: Comply with coupling manufacturer's installation instructions.

3.04 INSTALLATION OF ACID WASTE PIPING SYSTEMS

A. Install to comply with all manufacturers' recommendations.

B. All buried pipe shall be bedded in and backfilled with 4 inches of sand, and installed as recommended by manufacturer.

C. Install piping at concrete slabs or footings with 1 inch minimum polystyrene surrounding piping.

D. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Maintain continuous pressure test on piping installed below grade, until all work has progressed to above grade.

E. Electrofusion joints: Make polypropylene drainage piping joints according to ASTM F 1290.

F. Connection to Building Sewer: At point of connection of acid waste piping to building sewer, provide fitting of same material as acid waste piping.

3.05 INSTALLATION OF CLEANOUTS

A. Cleanouts: Install in piping as indicated, as required by California Plumbing Code, at each change in direction of piping greater than 45 degrees. Install at maximum intervals of 50 feet for piping 4 inches and smaller and 100 feet for larger piping inside buildings, and at base of each conductor.

B. Flashing Flanges: Install flashing flange and clamping device with each cleanout passing through water resistant membrane.

3.06 INSTALLATION OF HOPPER DRAINS

A. Install hopper drain in wall, in sheet metal box, with access door.

1. Size access door and box to suit the size required for hopper drain and trap primer, and solder all seams of box. Seal all penetrations to box with non-hardening waterproof sealant. Provide locking door in occupied spaces.

B. Grind top and sides of funnel, if required, to suit wall thickness.

3.07 INSTALLATION OF BACKFLOW PREVENTERS

A. Install backflow preventers where indicated on Drawings. Provide drain connection available from the manufacturer at drain connection, pipe drain outlet to the nearest floor drain.

1. Where drain pans are shown on the Drawings, pipe drain pan outlet to nearest floor drain.

3.08 EQUIPMENT CONNECTIONS

A. Piping Runouts to Fixtures: Provide hot and cold water piping runouts to fixtures of sizes indicated.
B. Mechanical Equipment Connections: Connect hot and cold water piping system and gas piping system to mechanical equipment as indicated, and provide with shutoff valve and union for each connection.

3.09 LABORATORY EQUIPMENT AND CASEWORK

A. Coordinate all work with Specification Section for Laboratory Equipment and Casework.
B. Furnish and install all required P-traps. Traps shall be Enfield, Fuseal, or equal.
C. Provide stops on all hot and cold water lines at equipment in an accessible position.
D. Seal all floor openings watertight.
E. Provide approved vacuum breaker or anti-siphon device on water lines to equipment wherever required.
F. All horizontal piping lines connected to equipment shall be run at the highest possible elevation not less than 6 inches above floor. Piping rough-in shall be stubbed in walls wherever possible.
G. Vent piping for waste lines shall be concealed and vents for island or freestanding equipment shall be looped.

3.10 SPARE PARTS

A. Furnish to Owner, with receipt, one valve key for each key operated hydrant, bibb, or faucet installed.

3.11 DOMESTIC WATER SYSTEM STERILIZATION

A. Clean and disinfect new or altered hot and cold water piping connected to domestic water systems using methods prescribed by the Health Authority. If the Health Authority does not prescribe methods, clean and disinfect new or altered hot and cold water piping using methods given in the California Plumbing Code.
   1. A water treatment company that has a current state EPA license to apply disinfectant chlorine in potable water shall perform the procedure.

3.12 CARE AND CLEANING

A. Repair or replace broken, damaged, or otherwise defective parts, materials, and work. Leave entire work in condition satisfactory to Architect. At completion, carefully clean and adjust equipment, fixtures, and trim that are installed as part of this work. Remove labels from stainless steel sinks, except 316 stainless steel sink labels should be retained to confirm that the correct material has been provided. Leave systems and equipment in satisfactory operating condition.

3.13 OPERATION TEST

A. Test each piece of equipment to show that it will operate in accordance with indicated requirements.

3.14 TESTING AND BALANCING

A. See Section 23 05 93 of these specifications for testing and balancing requirements.
3.15 CLEANING UP

A. Upon completion of Work remove materials, equipment, apparatus, tools, and the like, and leave premises clean, neat, and orderly.

END OF SECTION
SECTION 22 40 00

PLUMBING FIXTURES

PART 1 - GENERAL

1.01 SECTION INCLUDES
   A. Water supplies and stops.
   B. Plumbing fixture hangers and supports.

1.02 RELATED DOCUMENTS
   A. Drawings and general provisions of the Contract, including General and Supplementary
      Conditions and Division 01 Specification Sections, apply to this Section.
   B. Section 22 00 50 Basic Plumbing Materials and Methods.

1.03 ADDITIONAL REQUIREMENTS
   A. Furnish and install any incidental work not shown or specified which is necessary to provide a
      complete and workable system.
   B. Coordinate all of work in this Section with all of the Trades covered in other Sections of the
      Specifications to provide a complete, operable and sanitary installation of the highest quality
      workmanship.

1.04 DESCRIPTION OF WORK
   A. Furnish and install all plumbing work indicated on the Drawings and described herein.

1.05 QUALITY ASSURANCE
   A. Manufacturers: Firms regularly engaged in manufacture of plumbing fixtures of the type, style
      and configuration required. All companies providing products with warranties must have been
      engaged in manufacturing of such products for as long as the warranty states.
   B. Plumbing Fixture Standards: Comply with applicable portions of the following codes and
      requirements for all work in this section:
      - California Building Code – CBC
      - California Plumbing Code – CPC
      - California Health and Safety Code
      - American National Standards Institute - ANSI
      - Federal Standards - F.S.
      - National Sanitary Foundation – NSF International
   C. ANSI Standards: Comply with ANSI/NSF 61, "Drinking Water System Components – Health
      Effects."
   D. PDI Compliance: Comply with standards established by Plumbing and Drainage Institute
      pertaining to plumbing fixture supports.
   E. Americans with Disabilities Act (ADA).
F. California Health and Safety Code Compliance: For products covered under the scope of HSC 116875 for potable water service. Products for potable water service shall be third-party certified by an approved laboratory as complying with California Health and Safety Code Section 11 68 75.

1.06 SUBMITTALS
A. Product Data: Submit manufacturer’s specifications for plumbing fixtures and trim, including catalog cut of each fixture type and trim item furnished.
B. Maintenance Data: Submit maintenance data and parts lists for each fixture type and trim item, including instructions for care of finishes. Include this data in Operation and Maintenance Manual.
C. Pipe, pipe or plumbing fittings, fixtures, solder and flux installed in a system providing water for human consumption shall comply with lead free requirements of the California Health and Safety Code Section 11 68 75. Provide submittal information for products third-party certified by an approved laboratory as complying with California Health and Safety Code Section 11 68 75.

PART 2 - PRODUCTS

2.01 PLUMBING FIXTURES
A. General: Provide factory fabricated fixtures of type, style and material indicated. For each type fixture, provide fixture manufacturer’s standard trim, carrier, and valves as indicated by their published product information; either as designed and constructed, or as recommended by the manufacturer, and as required for a complete, installation. Where more than one type is dedicated, selection is Contractor’s option; but, all fixtures of same type must be furnished by single manufacturer.
1. Take special care with the roughing-in and finished plumbing where batteries of fixtures occur.
2. Take location and mounting heights for roughing-in from Architectural Drawings.
3. Follow schedule on Plumbing Drawings for roughing-in connections. Set roughing-in for all fixtures exactly as per measurements furnished by the manufacturers of the fixtures used.
4. Roughing-in for lavatories and sinks shall be brought in through the wall under the centerline of the drain from the fixture wherever possible and as close to the fixture as possible.

2.02 MATERIALS
A. Provide materials that have been selected for their surface flatness and smoothness. Exposed surfaces that exhibit pitting, seam marks, roller marks, foundry sand holes, stains, discoloration, or other surface imperfections on finished units are not acceptable.
B. Where fittings, trim and accessories are exposed or semi-exposed, provide, chromium plated 17 gauge seamless brass and match faucets and fittings. Provide 17 gauge seamless copper or brass where not exposed.
C. Handles on all faucets and stops shall be all metal chromium plated.

2.03 PLUMBING FITTINGS, TRIM AND ACCESSORIES
A. Water Outlets: At locations where water is supplied (by manual, automatic or remote control), provide commercial quality faucets, valves, or dispensing devices, of type and size indicated, and as required to operate as indicated.
1. Include manual shutoff valves and connecting stem pipes to permit outlet servicing without shut-down of water supply piping systems.

B. P-Traps: Include IAPMO approved removable P-traps where drains are indicated for direct connection to drainage system. P-Traps shall be less trap screw cleanout, and incorporate a chrome plated cast brass body, brass connection nuts, 17 gauge seamless brass wall return and chrome plated wall escutcheon to match trap finish.

C. Carriers: Provide cast iron supports for fixtures of graphitic gray iron, ductile iron, or malleable iron as indicated.

D. Fixture Bolt Caps: Provide manufacturer's standard exposed fixture bolt caps finished to match fixture finish.

E. Escutcheons: Where fixture supplies and drains penetrate walls in exposed location, provide chrome-plated cast brass escutcheons with setscrews.

F. Aerators: Provide aerators of types approved by Health Departments having jurisdiction. Delete aerators where not allowed by CPC for health care occupancies.

G. Comply with additional fixture requirements contained in Fixture Schedule shown on the drawings.

2.04 MANUFACTURERS

A. In accordance with California Plumbing Code, provide indelibly marked or embossed manufacturers name or logo, arranged so as to be visible after installation.

B. Manufacturers: Drawing schedules indicate Basis of Design products. Subject to compliance with requirements, provide product indicated on Drawings, or comparable product by one of the following:

1. Plumbing Trim:
   McGuire Manufacturing Co., Inc.
   Delta Commercial
   Chicago Faucet Co.
   T&S Brass and Bronze Works, Inc.

2. Faucets:
   Chicago Faucet Co.
   Symmons Scott
   T&S Brass and Bronze Works, Inc.
   Delta Commercial

3. Emergency Equipment:
   Haws Corporation
   Gardian
   Symmons
   Bradley
   Encon

2.05 FIXTURE CONNECTIONS

A. Make connection between fixtures and flanges on soil pipe absolutely gastight and watertight with neoprene type gaskets (wall hung fixtures) or bowl wax (floor outlet fixtures). Rubber gaskets or putty will not be permitted.
B. Provide fixtures not having integral traps with P-traps of chromium-plated 17 gauge cast brass, with 17 gauge seamless brass wall return, connected to concealed waste in wall and sanitary fittings. Provide IAPMO approval for trap, and provide less trap screw cleanout.
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:
      Dearborn Brass, Commercial series with brass nuts
      Delta Commercial
      McGuire Manufacturing Co., Inc.

C. Connections from stacks or horizontal wastes to wall or floor finish for wastes from lavatories, urinals, sinks, and drinking fountains and connection between floor drains and traps shall be IPS 85 percent red brass pipe.

D. Plumbing fixture traps connected to special waste systems shall be constructed of materials to suit the waste system.
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:
      Orion
      Enfield

E. Unions on waste pipes on fixture side of traps may be slip or flange joints with soft rubber or lead gaskets. Traps shall rough in full size to waste and vent connection, using deep escutcheon plate to cover wall penetration. Compression adaptor extensions or sweat adaptors are not acceptable.

2.06 WATER SUPPLIES AND STOPS

A. Provide 85 percent IPS threaded red brass nipple, conforming to the lead-free requirements of California Health and Safety Code Section 11 68 75, securely anchored to building construction, for each connection to stops, hose bibbs, etc. Each fixture, except hose bibbs, shall have stop valves installed on water supply lines.

B. Provide water supplies to fixtures with compression shut-off stops with IPS inlets and lock shield-loose key handles. Provide combination fixtures with compression stop and IPS inlet on each water supply fitting. Provide lock shield-loose key handle for each stop.

C. Provide 1/2 inch riser tubes with reducing coupling for fixtures, unless otherwise noted.

D. Provide cast brass escutcheon.

E. Furnish shut-off valves on hose bibbs where directly connected to mains with no intervening valves.

F. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:
   BrassCraft Manufacturing model SR37XC stop with 3-12AC riser and 647 escutcheon.
   McGuire Manufacturing Company, Inc. model LFH2167LK.
   Watts model LF890 203LK.

2.07 PLUMBING FIXTURE HANGERS AND SUPPORTS

A. Residential type fixture supports are not acceptable.

B. Install the following fixtures on concealed support with feet of support securely anchored to floor. Anchor top of support to wall construction in an approved manner.
   1. Wall hung lavatories.
2. Wall mounted urinals.
3. Drinking fountains.
4. Electric water coolers.

2.08 PLUMBING FIXTURES
A. Install all plumbing fixtures at height indicated on Architectural Drawings. Where mounting height is not indicated, install at height required by Code.
B. Special Requirements For Accessible Fixtures:
   1. Operating handle or valve for accessible water closets, urinals, lavatories, and sinks shall operate with less than 5 pounds force. Metering faucets shall be adjusted to operate between 10 and 15 seconds.
   2. Insulate exposed waste piping and domestic water supplies below accessible fixtures with CBC access code compliant molded "closed-cell" vinyl covers. Covers shall be installed using vandal resistant fasteners and must be removable. Covers shall meet flame spread rating not to exceed 25 and smoke density not to exceed 50 when tested in accordance with ASTM E-84, and shall comply with the requirements of California Code of Regulations, Title 24. Plumberex – Handy Shield, Johns Manville – Zeston 2000, or equal.

PART 3 - EXECUTION
3.01 PRODUCT HANDLING AND PROTECTION
A. Deliver packaged materials in their original, unopened wrapping with labels intact. Protect materials from water, the elements and other damage during delivery, storage and handling.

3.02 PREPARATORY PROVISIONS
A. The Contractor is responsible for the examination and acceptance of all conditions affecting the proper construction and/or installation of the Work of this Section. Do not proceed until all unsatisfactory conditions have been corrected. Commencing work will be construed as acceptance of all conditions by the Contractor as satisfactory for the construction and/or installation of the Work.

3.03 INSPECTION AND PREPARATION
A. Examine roughing-in work of domestic water and waste piping systems to verify actual locations of piping connections prior to installing fixtures. Also examine floors and substrates, and conditions under which fixture work is to be accomplished. Correct any incorrect locations of piping, and other unsatisfactory conditions for installation of plumbing fixtures. Do not proceed with work until unsatisfactory conditions have been corrected.
B. Install plumbing fixtures of types indicated where shown and at indicated heights; in accordance with fixture manufacturer's written instructions, roughing-in drawings. Ensure that plumbing fixtures comply with requirements and serve intended purposes. Comply with applicable requirements of the National Standard Plumbing Code pertaining to installation of plumbing fixtures.
C. Fasten plumbing fixtures securely to supports or building structure; and ensure that fixtures are level and plumb. Secure plumbing supplies to blocking behind or within wall construction so as to be rigid, and not subject to pull or push movement.
D. Install CBC accessible fixtures in accordance with Chapter 4 California Plumbing Code, and Chapters 11A and 11B California Building Code.
3.04 INSTALLATION OF FAUCETS
   A. Provide 85 percent IPS red brass pipe, conforming to lead-free requirements of California Health and Safety Code Section 11 68 75, securely anchored to building construction, for each connection to faucets, stops, hose bibbs, etc. Each fixture, except hose bibbs, shall have a stop valve installed on water supply lines to permit repairs without shutting off water mains.
   B. Adjust metering faucets to run for 10 to 15 seconds.

3.05 CLEAN AND PROTECT
   A. Clean plumbing fixtures of dirt and debris upon completion of installation.
   B. Protect installed fixtures from damage during the remainder of the construction period.
   C. Grout voids between all fixtures and adjacent surfaces with white Dow Silicone Sealant, arranged to shed water.

3.06 FIELD QUALITY CONTROL
   A. Upon completion of installation of plumbing fixtures and after units are water pressurized, test fixtures to demonstrate capability and compliance with requirements. When possible, correct malfunctioning units at site, then retest to demonstrate compliance; otherwise, remove and replace with new units and proceed with retesting.

3.07 EXTRA STOCK
   A. General: Furnish special wrenches and other devices necessary for servicing plumbing fixtures and trim to Owner with receipt. Furnish one device for every ten units.

END OF SECTION
SECTION 22 50 00

PLUMBING EQUIPMENT

PART 1 - GENERAL

1.01 SECTION INCLUDES
   A. Neutralizing basin.

1.02 RELATED DOCUMENTS
   A. Drawings and general provisions of the Contract, including General and Supplementary
      Conditions and Division 01 Specification Sections, apply to this Section.
   B. Section 22 00 50 Basic Plumbing Materials and Methods.

1.03 ADDITIONAL REQUIREMENTS
   A. Furnish and install any incidental work not shown or specified which is necessary to provide a
      complete and workable system.
   B. Coordinate all of work in this Section with all of the Trades covered in other Sections of the
      Specifications to provide a complete, operable and sanitary installation of the highest quality
      workmanship.

1.04 DESCRIPTION OF WORK
   A. Furnish and install all plumbing work indicated on the Drawings and described herein.

1.05 QUALITY ASSURANCE
   A. Manufacturers: Firms regularly engaged in manufacture of plumbing equipment of type and
      sizes required, whose products have been in satisfactory use in similar service for not less than
      5 years.
   B. Trade names or catalog numbers stated herein indicates grade or quality of materials desired.
   C. Dimensions, sizes, and capacities shown are minimum and shall not be changed without
      permission of Architect.
   D. UL and NEMA Compliance: Provide electric motors and electrical components required as part
      of plumbing equipment, which have been listed and labeled by Underwriters Laboratories and
      comply with NEMA standards.
   E. CEC Compliance: Comply with California Electrical Code (Title 24, Part 3) as applicable to
      installation and electrical connections of ancillary electrical components of plumbing equipment.
   F. ASME Relief Valve Stamps: Provide water heaters with safety relief valves bearing ASME
      valve markings.
   G. California Energy Commission Compliance: Provide written confirmation of listing of all water
      heaters in the "Appliance Efficiency Database."
   H. California Health and Safety Code Compliance: For products covered under the scope of HSC
      116875 for potable water service. Products for potable water service shall be third-party
      certified by an approved laboratory as complying with California Health and Safety Code
      Section 11 68 75.
1.06 SUBMITTALS

A. Product Data: Submit manufacturer's plumbing equipment specifications, installation and start-up instructions, capacity and ratings, with selection points clearly indicated.

B. Maintenance Data: Submit maintenance data and parts lists for each item of plumbing equipment. Include "trouble-shooting" maintenance guides. Include this data in Operation and Maintenance Manual.

C. Pipe, pipe or plumbing fittings, fixtures, solder and flux installed in a system providing water for human consumption shall comply with lead free requirements of the California Health and Safety Code Section 116875. Provide submittal information for products third-party certified by an approved laboratory as complying with California Health and Safety Code Section 116875.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Insulation products, including insulation, insulation facings, jackets, adhesives, sealants and coatings shall not contain polybrominated diphenyl ethers (PBDEs) in penta, octa, or deca formulations in amounts greater than 0.1 percent (by mass).

2.02 NEUTRALIZING BASIN

A. Furnish and install, where shown and as detailed on the Drawings, a neutralizing basin complete with cover and manhole, and 4 inch vent connection. Cover and manhole shall be bolted and gasketed gas tight.

B. Furnish sufficient limestone or marble chips in chunks 1 inch to 3 inches in size to fill the tank to within 2 inches of the outlet. Place this material in the tank at the completion of the work.

PART 3 - EXECUTION

3.01 PRODUCT HANDLING AND PROTECTION

A. Deliver packaged materials in their original, unopened wrapping with labels intact. Protect materials from water, the elements and other damage during delivery, storage and handling.

3.02 PREPARATORY PROVISIONS

A. The Contractor shall be responsible for the examination and acceptance of all conditions affecting the proper construction and/or installation of the Work of this Section and shall not proceed until all unsatisfactory conditions have been corrected. Commencing work shall be construed as acceptance of all conditions by the Contractor as satisfactory for the construction and/or installation of the Work.

3.03 NEUTRALIZING BASIN INSTALLATION

A. Install per manufacturer's installation instructions.

3.04 TRAINING

A. Provide a minimum of 4 hours of training and orientation of Owners staff in proper care and operation of Plumbing Equipment.
3.05 CARE AND CLEANING
A. Repair or replace broken, damaged, or otherwise defective parts, materials, and work. Leave entire work in condition satisfactory to Architect. At completion, carefully clean and adjust equipment, fixtures, and trim that are installed as part of this work. Leave systems and equipment in satisfactory operating condition.

3.06 OPERATION TEST
A. Test each piece of equipment to show that it will operate in accordance with indicated requirements.

3.07 CLEANING UP
A. Upon completion of Work remove materials, equipment, apparatus, tools, and the like, and leave premises clean, neat, and orderly.

END OF SECTION
SECTION 22 67 19

HIGH PURITY WATER

PART 1 - GENERAL

1.01 SUMMARY
   A. Extent of high purity water systems, required by this section is indicated on drawings and by requirements of this section.
   B. Types of system specified in this section include the following:
      1. Deionized Water.
   C. Types of equipment and services specified in this section include the following:
      1. Pipe and Fittings.
      2. Valves and Piping Specialties.

1.02 SYSTEM DESCRIPTION
   A. The system shall include supply and return piping, valves and piping specialties. The system shall connect to the new Type 2 DI system.

1.03 REFERENCES
   A. ASTM: American Society of Testing Materials

1.04 SUBMITTALS
   A. Treatment Equipment Manufactures Qualifications: Submit data indicating experience in design and operation of similar systems in the area.
   B. Product Data: Submit manufacturer's technical product data, including rated capacities of selected components clearly indicated, weights (shipping, installed and operating), furnished specialties and accessories; and installation and start-up instructions.
   C. Installers Qualifications: Submit qualifications for each installer.
   D. Testing and Performance Data: Submit documentation including test procedures and laboratory results.
   E. Samples: Submit sample joints as required.
   F. Maintenance Data: Submit maintenance data and parts lists for each component. Include this data in maintenance manual; in accordance with requirements of Division 1.

1.05 QUALITY ASSURANCE
   A. Installer's Qualifications: Firm and individuals with not less than 5 years experiences in installation of high purity water systems similar in complexity and type to those required for this Project. Each installer shall demonstrate the ability to install acceptable high purity piping systems.
B. Manufacturers Qualifications: Firms regularly engaged in manufacture of water conditioners, of types, materials, and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

C. Welding: Qualify processes and operators according to the ASME Boiler and Pressure Vessel Code: Section IX, “Welding and Brazing Qualifications.”

D. ASME Compliance: Comply with ASME B31.9, “Building Services Piping,” for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp flash tanks to comply with the ASME Boiler and Pressure Vessel Code, Section VIII, Division 1.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Packing and Shipping: Deliver products in original unopened packaging with legible manufacturer’s identification.

B. Storage and Protection Prior to Cleaning: Comply with manufacturer’s recommendations.
   1. Store all components in a cool, dry place out of direct sunlight.
   2. Protect from damage by the elements and construction procedures.
   3. Store fittings in original cartons.
   4. Store at temperature above 40° F.
   5. Ends of piping, valves, and fittings shall be sealed.
   6. Avoid rough handling of pipe and fittings.

1.07 PROJECT CONDITIONS

A. Field Measurements: Verify space requirements for installation, operation and maintenance.

1.08 SEQUENCE/SCHEDULING

A. Coordinate installation, cleaning and testing with Owner and all trades.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Piping:
   2. Beta Polypropylene Homopolymer, Siemens / US Filter
   4. Or equal.

B. Valves and Specialties:
   1. Injection Molded PolyPure natural polypropylene, Harrington Plastics.
   2. Injection Molded Beta Polypropylene Homopolymer, Siemens / US Filter
   4. Or equal.

2.02 PIPING AND FITTINGS

A. PolyPure natural polypropylene with butt fusion fittings, SDR 11, 150 PSI rated at 73 degrees F.
B. Beta Polypropylene Homopolymer with butt fusion fittings, SDR 11, 150 PSI rated at 73 degrees F.

C. Stainless Steel Pipe: ANSI 36.19, Type 316 L, Schedule 40.


E. Welding Materials: Comply with Section II, Part C, of the ASME Boiler and Pressure Vessel Code for welding materials appropriate for wall thickness and for chemical analysis of pipe being welded.

F. Gasket Material: Thickness, material and type suitable for fluid to be handled; and design temperature and pressures.

G. Unions: Suitable for pressure and temperature and high-purity applications.

H. Factory cleaned and bagged for high purity service.

2.03 VALVES

A. Injection Molded PolyPure natural propylene, Harrington Plastics

B. Injection Molded Beta Polypropylene Homopolymer, Siemens / US Filter

C. Stainless Steel Ball Valves: Apollo Series 86 stainless steel ball valve with butt-weld ends.

D. Factory cleaned and bagged for high purity service.

2.04 FLOW METERS

A. Vertical Rotometer: Suitable for high purity water piping applications, 145 psig at 68° F. pressure rating, polysulphone metering tube, socket end fittings (George Fischer, or equal).

2.05 PRESSURE REGULATORS

A. Automatic, adjustable pressure regulating valve to maintain constant downstream pressure, designed for high purity water service. 150 psig at 75° F. rated, PVC construction (Plast-O-Matic, or equal).

B. Pressure Gages: PVC with Teflon diaphragm gage guards, with ¼” ball valves. 0-100 psig.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verification of Conditions: Examine areas and conditions under which Work is to be performed and identify conditions detrimental to proper or timely completion.
   1. Do not proceed until unsatisfactory conditions have been corrected.
   2. Manufacturer shall review proposed piping layout including pipe sizing, velocities and material for confirmation of system performance.

3.02 GENERAL

A. General: Install piping and valves in accordance with manufacturer’s written instructions and as required to maintain system performance requirements.

3.03 PIPING INSTALLATION

A. Refer to other Division 15 Sections for basic piping installation.
B. Supports: Provide continuous V channel support for all horizontal piping. Supports shall not occur at joints.

3.04 SYSTEM CLEANING, FLUSHING AND FILLING
A. Installed piping system including valves shall be flushed and cleaned prior to connecting to the DI system.
B. As a minimum perform the following flushing, cleaning and filling activities.
   1. Initial water flush (CW).
   2. Detergent strip cleaning and flush (Alkanoz or equal).
   3. Post strip flush (CW).
   4. Sanitization (5% hydrogen peroxide/water).
   5. Post sanitation flush to meet inlet water quality (no trace hydrogen peroxide).
   6. System fill per Owners requirements using DI water from approved outside source meeting existing system requirements.

3.05 BALANCING
A. Balance system to indicate volumes. Verify/record existing system operational (flow and pressure) conditions prior to field connection to existing system.

3.06 JOINT CONSTRUCTION
A. Per manufacturer’s written instructions for high purity applications. The following are minimum requirements for pipe:
   1. All cut piping shall be square and true.
   2. Pipe end shall be joined by butt fusion method in accordance with pipe manufacturer’s installation instructions.
B. Sample Joints: Each installer shall submit to the Owners representative one finished joint per day for inspection.
C. Provide transition and special fittings with pressure ratings equal to piping as approved by the manufacture and treatment equipment manufacturer requirements.

3.07 VALVE INSTALLATION
A. Install valves per manufacturers written requirements.
B. Keep valve in factory package until installation.

3.08 CONNECTIONS
A. Drawings indicate general arrangement of piping, fittings, and specialties.
B. Install piping adjacent to equipment and machines to allow service and maintenance.
C. Provide fittings and transition connections suitable for connection to fixtures and equipment.

3.09 FIELD QUALITY CONTROL
A. The following tasks shall be performed by the Contractor as work of this section.
   1. Pipe, joint and valve assembly.
   2. System rinsing, cleaning and filling.
   3. System pressure testing.
4. System balancing.
5. Preparation of reports indicating compliance.

B. In addition to providing direction for the tasks listed above the treatment equipment manufacture shall perform the following tasks as work of this section:
   2. Submission of report including laboratory water analysis indicating system compliance.

3.10 CLOSEOUT PROCEDURES

A. Treatment equipment manufacturer’s technical representative shall provide a one 8-hour day to instruct Owner’s personnel in operation and maintenance of water conditioners.
   1. Schedule training with Owner; provide at least 7-day notice to Contractor and Engineer of training date.

B. Complete instructions covering installation and operation of the deionized water system shall be provided in booklet form. All component parts must be easily identified, in exposed views, by an individual part number.

END OF SECTION
SECTION 23 00 50

BASIC HVAC MATERIALS AND METHODS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Electric motors.
B. Motor starters.
C. Valves and fittings.
D. Strainers.
E. Gauges.
F. Thermometers.
G. Access Doors.
H. Expansion loops.
I. Insulation.

1.02 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
B. This Section is a part of each Division 23 Section.

1.03 ADDITIONAL REQUIREMENTS

A. Furnish and install incidental work not shown or specified necessary to provide a complete and workable system.
B. Make all temporary connections required to maintain services, including adequate heat and cooling, during the course of the Contract without additional cost to Owner. Notify Owner seven days in advance before disrupting services.
C. Provide for adjustments or modifications to fan and motor sheaves, belts, damper linkages, and other components as required to achieve specified air balance at no additional cost to Owner.

1.04 REFERENCED STANDARDS

A. Where material or equipment is specified to conform to referenced standards, it shall be assumed that the most recent edition of the standard in effect at the time of bid shall be used.
   1. CSA – Canadian Standards Association International
   2. ANSI - American National Standards Institute
   3. ASTM - American Society for Testing and Materials
   4. CCR - California Code of Regulations
      a. Title 8 - Division of Industrial Safety, Subchapter 7; General Industry Safety Orders, Articles 31 through 36
   5. NCPWB - National Certified Pipe Welding Bureau
6. CEC - California Electrical Code
7. NEMA - National Electrical Manufacturers’ Association
8. NFPA - National Fire Protection Association
9. OSHA - Occupational Safety and Health Act
10. UL - Underwriters' Laboratories, Inc.

1.05 DRAWINGS

A. Examine Drawings prior to bidding of work and report discrepancies in writing to Architect.

B. Visit Project site and examine existing conditions in order to become familiar with Project scope. Verify dimensions shown on Drawings at Project site. Bring discrepancies to the attention of Architect. Failure to examine Project site shall not constitute basis for claims for additional work because of lack of knowledge or location of hidden conditions that affect Project scope.

C. Drawings showing location of equipment and materials are diagrammatic and job conditions will not always permit installation in location shown. The HVAC Drawings show general arrangement of equipment and materials, etc., and shall be followed as closely as existing conditions, actual building construction, and work of other trades permit.

1. Architectural and Structural Drawings shall be considered part of the Work. These Drawings furnish Contractor with information relating to design and construction of the Project. Architectural Drawings take precedence over HVAC Drawings.

2. Because of the small scale of HVAC Drawings, not all offsets, fittings, and accessories required are shown. Investigate structural and finish conditions affecting the Work and arrange Work accordingly. Provide offsets, fittings, and accessories required to meet conditions. Inform Architect immediately when job conditions do not permit installation of equipment and materials in the locations shown. Obtain the Architects approval prior to relocation of equipment and materials.


4. Minor changes in locations of equipment, piping, ducts, etc., from locations shown shall be made when directed by the Architect at no additional cost to the Owner providing such change is ordered before such items of work, or work directly connected to same are installed and providing no additional material is required.

D. Execute work mentioned in the Specifications and not shown on the Drawings, or vice versa, the same as if specifically mentioned or shown in both.

1.06 REQUIREMENTS OF REGULATORY AGENCIES

A. The publications listed below form part of this Specification; comply with provisions of these publications except as otherwise shown or specified.

2. California Electrical Code, 2013
8. California Code of Regulations, Title 24
10. CAL-OSHA  
11. California State Fire Marshal, Title 19 CCR  
12. National Fire Protection Association  
13. Occupational Safety and Health Administration  
14. Other applicable state laws

B. Nothing in Drawings or Specifications shall be construed to permit work not conforming to these codes, or to requirements of authorities having jurisdiction. It is not the intent of Drawings or Specifications to repeat requirements of codes except where necessary for clarity.


D. When Contract Documents differ from governing codes, furnish and install larger size or higher standards called for without extra charge.

E. FEES AND PERMITS

F. Obtain and pay for permits and service required in installation of the Work. Arrange for required inspections and secure approvals from authorities having jurisdiction. Comply with requirements of Division 01.

G. Arrange for utility connections and pay charges incurred, including excess service charges.

1.07 FRAMING, CUTTING AND PATCHING

A. Special framing, recesses, chases and backing for Work of this Section, unless otherwise specified, are covered under other Specification Sections.

B. Contractor is responsible for placement of pipe sleeves, hangers, inserts, supports, and location of openings for the Work.

C. Cutting, patching, and repairing of existing construction to permit installation of equipment, and materials is the responsibility of Contractor. Repair or replace damage to existing work with skilled mechanics for each trade.

D. Cut existing concrete construction with a concrete saw. Do not utilize pneumatic devices.

E. Core openings through existing construction for passage of new piping and conduits. Cut holes of minimum diameter to suit size of pipe and associated insulation installed. Coordinate with building structure, and obtain Structural Engineer's approval prior to coring through existing construction.

1.08 SUBMITTALS

A. Submittal packages may be submitted via email as PDF electronic files, or as printed packages. PDFs shall be legible at actual size (100 percent). Provide seven copies of printed submittal packages.

B. Provide submittal of materials proposed for use as part of this Project. Product names in Specifications and on Drawings are used as standards of quality. Furnish standard items on specified equipment at no extra cost to the Contract regardless of disposition of submittal data. Other materials or methods shall not be used unless approved in writing by Architect. Architect's review will be required even though "or equal" or synonymous terms are used. Refer to Division 01 for complete instructions.

1. Partial or incomplete submittals will not be considered.
2. Quantities are Contractor's responsibility and will not be reviewed.
3. Provide materials of the same brand or manufacturer for each class of equipment or material.

4. Identify each item by manufacturer, brand, trade name, number, size, rating, or other data necessary to properly identify and review materials and equipment. Words "as specified" are not sufficient identification.

5. Identify each submittal item by reference to items' Specification Section number and paragraph, by Drawing and detail number, and by unit tag number.

6. Organize submittals in same sequence as in Specification Sections.

7. Show physical arrangement, construction details, finishes, materials used in fabrications, provisions for piping entrance, access requirements for installation and maintenance, physical size, mechanical characteristics, foundation and support details, and weight.
   a. Submit Shop Drawings, performance curves, and other pertinent data, showing size and capacity of proposed materials.
   b. Specifically indicate, by drawn detail or note, that equipment complies with each specifically stated requirement of Contract Documents.
   c. Drawings shall be drawn to scale and dimensioned (except schematic diagrams). Drawings may be prepared by vendor but must be submitted as instruments of Contractor, thoroughly checked and signed by Contractor before submission to Architect for review.
   d. Catalog cuts and published material may be included with supplemental scaled drawings.

C. Review of submittals will be only for general conformance with design concept and general compliance with information given in Contract Documents. Review will not include quantities, dimensions, weights or gauges, fabrication processes, construction methods, coordination with work of other trades, or construction safety precautions, which are sole responsibility of Contractor. Review of a component of an assembly does not indicate acceptance of an assembly. Deviations from Contract Documents not clearly identified by Contractor are Contractor’s responsibility and will not be reviewed by Architect.

D. Within reasonable time after award of contract and in ample time to avoid delay of construction, submit to Architect shop drawings or submittals on all items of equipment and materials provided. Provide submittal as a complete package.
   1. Shop drawings and submittals shall include Specification Section, Paragraph number, and Drawing unit symbol or detail number for reference. Organize submittals into booklets for each Specification section and submit in loose-leaf binders with index. Deviations from the Contract Documents shall be prominently displayed in the front of the submittal package and referenced to the applicable Contract requirement.

E. Provide coordinated layouts for HVAC Ductwork systems, in accordance with Specification Section 23 80 00.

F. Furnish to the Project Inspector complete installation instructions on material and equipment before starting installation.

G. Have fire damper and fire smoke damper installation instructions available at Project site during construction for use by Project Inspector.

H. Product Data for California Green Building Standards Code Compliance: For adhesives and sealants, including primers, documentation of compliance including printed statement of VOC content and chemical components.

I. Provide product data for insulation products, including insulation, insulation facings, jackets, adhesives, sealants, and coatings, indicating compliance with requirement that these products
contain less than 0.1 percent (by mass) polybrominated diphenyl ethers (PBDEs) in penta, octa, or deca formulations.

J. Provide evidence of equipment certification to California Energy Code Section 110.1 or 110.2, if not providing Electrically Commutated motors for HVAC fans sized below 1 hp and above 1/12 hp. Refer to specific equipment articles requiring electrically commutated motors.

K. Delegated-Design Submittal: For seismic supports, anchorages, and restraints indicated to comply with performance requirements and design criteria.
   2. Supports, anchorage and restraints for piping, ductwork, and equipment shall be an OSHPD pre-approved system such as Tolco, Afcon, ISAT, Badger, Mason, or equal. Pipes, ducts and equipment shall be seismically restrained in accordance with requirements of current edition of California Building Code. System shall have current OPM number and shall meet additional requirements of authority having jurisdiction. Provide supporting documentation required by the reviewing authority and the Architect and Engineer. Provide layout drawings showing piping, ductwork and restraint locations.
      a. Bracing of Piping, Ductwork, and Equipment: Specifically state how bracing attachment to structure is accomplished. Provide shop drawings indicating seismic restraints, including details of anchorage to building. In-line equipment must be braced independently of piping and ductwork, and in conformance with applicable building codes. Provide calculations to show that pre-approval numbers have been correctly applied in accordance with general information notes of pre-approval documentation.
   3. In lieu of the above or for non-standard installations not covered in the above pre-approved systems, Contractor shall provide layout drawings showing piping, ductwork, and restraint locations, and detail supports, attachments and restraints, and furnish supporting calculations and legible details sealed by a California registered structural engineer, in accordance with 2013 California Building Code
   4. Additional Requirements: In addition to the above, conform to all state and local requirements.

1.09 SUBSTITUTIONS

A. Refer to Division 01 for complete instructions. Requirements given below are in addition to or are intended to amplify Division 01 requirements. In case of conflict between requirements given herein and those of Division 01, Division 01 requirements shall apply.

B. It is the responsibility of Contractor to assume costs incurred because of additional work and or changes required to incorporate proposed substitute into the Project. Refer to Division 01 for complete instructions.

C. Substitutions will be interpreted to be manufacturers other than those specifically listed in the Contract Documents by brand name, model, or catalog number.

D. Only one request for substitution will be considered for each item of equipment or material.

E. Substitution requests shall include the following:
   1. Reason for substitution request.
   2. Complete submittal information as described herein; see “Submittals.”
   3. Coordinated scale layout drawings depicting position of substituted equipment in relation to other work, with required clearances for operation, maintenance and replacement.
4. List optional features required for substituted equipment to meet functional requirements of the system as indicated in Contract Documents.
5. Explanation of impact on connected utilities.
6. Explanation of impact on structural supports.

F. Installation of reviewed substitution is Contractors' responsibility. Any mechanical, electrical, structural, or other changes required for installation of substituted equipment or material must be made by Contractor without additional cost to Owner. Review by Architect of substituted equipment or material, will not waive these requirements.

G. Contractor may be required to compensate Architect for costs related to substituted equipment or material.

1.10 OPERATION AND MAINTENANCE MANUAL

A. Furnish three complete sets of Operation and Maintenance Manual bound in hardboard binder, and one compact disc containing complete Operation and Maintenance Manual in searchable PDF format. Provide Table of Contents. Provide index tabs for each piece of equipment in binder and disc. Start compiling data upon approval of submittals.

1. Sets shall incorporate the following:
   a. Service telephone number, address and contact person for each category of equipment or system.
   b. Complete operating instructions for each item of heating, ventilating and air conditioning equipment.
   c. Copies of guarantees/warrantees for each item of equipment or systems.
   d. Test data and system balancing reports.
   e. Typewritten maintenance instructions for each item of equipment listing lubricants to be used, frequency of lubrication, inspections required, adjustment, etc.
   f. Manufacturers' bulletins with parts numbers, instructions, etc., for each item of equipment.
   g. Temperature control diagrams and literature.
   h. Check test and start reports for each piece of mechanical equipment provided as part of the Work.
   i. Commissioning and Preliminary Operation Tests required as part of the Work.

B. Post service telephone numbers and addresses in an appropriate place designated by Architect.

1.11 SITE CONDITIONS

A. Information on Drawings relative to existing conditions is approximate. Deviations from Drawings necessary during progress of construction to conform to actual conditions shall be approved by the Architect and shall be made without additional cost to the Owner. The Contractor shall be held responsible for damage caused to existing services. Promptly notify the Architect if services are found which are not shown on Drawings.

1.12 EXISTING MATERIALS

A. Remove existing equipment, piping, wiring, construction, etc., which interferes with Work of this Contract. Promptly return to service upon completion of work in the area. Replace items damaged by Contractor with new material to match existing.
B. Removed materials which will not be re-installed and which are not claimed by Owner shall become the property of Contractor and shall be removed from the Project site. Consult Owner before removing any material from the Project site. Carefully remove materials claimed by Owner to prevent damage and deliver to Owner-designated storage location.

C. Existing piping and wiring not reused and are concealed in building construction may be abandoned in place and all ends shall be capped or plugged. Remove unused piping and wiring exposed in Equipment Rooms or occupied spaces. Material shall be removed from the premises. Disconnect power, water, gas, pump or any other active energy source from piping or electrical service prior to abandoning in place.

1.13 WARRANTY
A. Refer to Division 01 for warranty requirements, including effective date of warranty. Refer to specific items of equipment specified herein for warranty duration if different from that specified in Division 01.

B. Repair or replace defective work, material, or part that appears within the warranty period, including damage caused by leaks.

C. On failure to comply with warranty requirements within a reasonable length of time after notification is given, Architect/Owner shall have repairs made at Contractor's expense.

1.14 RECORD DRAWINGS
A. Refer to Division 01, Record Documents, for requirements governing Work specified herein.

B. Upon completion of the Work, deliver to Architect the following:
   1. Originals of drawings showing the Work exactly as installed.
   2. One complete set of reproducible drawings showing the Work exactly as installed.
   3. One compact disc with complete set of drawings in PDF format showing the Work exactly as installed.
   4. Provide Contractor's signature, verifying accuracy of record drawings.

C. Obtain the signature of the Inspector of Record for all Record Drawings.

1.15 DELIVERY AND STORAGE
A. Protect equipment and materials delivered to Project site from weather, humidity and temperature variations, dirt, dust and other contaminants.

1.16 COORDINATION
A. General:
   1. Coordinate Work in this Section with trades covered in other Specifications Sections to provide a complete, operable and sanitary installation of the highest quality workmanship.

B. Electrical Coordination:
   1. Refer to the Electrical Drawings and Specifications, Division 26, for service voltage and power feed wiring for equipment specified under this section. Contractor has full responsibility for the following items of work:
      a. Review the Electrical Drawings and Division 26 Specifications to verify that electrical services provided are adequate and compatible with equipment requirements.
b. If additional electrical services are required above that indicated on Electrical Drawings and in Division 26, such as more control interlock conductors, larger feeder, or separate 120 volt control power source, include cost to furnish and install additional electrical services as part of the bid.

c. Prior to proceeding with installation of additional electrical work, submit detailed drawings indicating exact scope of additional electrical work.

C. Mechanical Coordination:
   1. Arrange for pipe spaces, chases, slots and openings in building structure during progress of construction, to accommodate mechanical system installation.
   3. Coordinate requirements for access panels and doors for mechanical items requiring access where concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section “Access Doors and Frames.”

PART 2 - PRODUCTS

2.01 GENERAL
   A. Materials or equipment of the same type shall be of the same brand wherever possible. All materials shall be new and in first class condition.
   B. All sizes, capacities, and efficiency ratings shown are minimum, except that gas capacity is maximum available.
   C. Refer to Division 22 10 00 and 23 80 00 for specific system piping materials.

2.02 MATERIALS
   A. No material installed as part of this Work shall contain asbestos.
   B. California Green Building Code Compliance:
      1. HVAC and refrigeration equipment shall not contain CFCs.
      2. HVAC and refrigeration equipment shall not contain Halons.

2.03 ELECTRIC MOTORS
   A. General Motor Requirements: Comply with NEMA MG 1 unless otherwise indicated. Comply with IEEE 841 for severe-duty motors.
      1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:
         a. U.S. Motors
         b. Century Electric
         c. General Electric
         d. Lincoln
         e. Gould
   B. Motor Characteristics: Designed for continuous duty at ambient temperature of 40 deg. C and at altitude of 3300 feet above sea level. Capacity and torque shall be sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.
1. Motors exceeding the nameplate amperage shall be promptly replaced at no cost to the Owner. Horsepower shown is minimum and shall be increased as necessary to comply with above requirements. Furnish motors with splash-proof or weatherproof housings, where required or recommended by the manufacturer. Match the nameplate voltage rating with the electrical service supplied. Check Electrical Drawings. Provide a transformer for each motor not wound specifically for system voltage.

C. Polyphase Motors: NEMA MG 1, Design B, medium induction motor, efficiency as defined in NEMA MG 1. Select motors with service factor of 1.15. Provide motor with random-wound, squirrel cage rotor, and permanently lubricated or regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading. Temperature rise shall match insulation rating. Provide Class F insulation.

1. Multispeed motors shall have separate windings for each speed.

D. Polyphase Motors with Additional Requirements:

1. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method. Provide shaft grounding bearing protection rings.

2. Motors Used with Variable Frequency Controllers:
   a. Separately Connected Motors: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.
   b. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
   c. Energy- and Premium-Efficient Motors: Class B temperature rise; Class F insulation.
   d. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
   e. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.
   f. Provide shaft grounding bearing protection rings.

3. Severe-Duty Motors: Comply with IEEE 841, with 1.15 minimum service factor.

E. Single-Phase Motors:

1. Select motors with service factor of 1.15.

2. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:
   a. Permanent-split capacitor.
   b. Split phase.
   c. Capacitor start, inductor run.
   d. Capacitor start, capacitor run.

3. Motors for HVAC exhaust, transfer, and supply fans larger than 1/12 hp and smaller than 1 hp shall be the following:
   a. Electronically Commutated motor (EC type): Motor shall be electronically commutated type specifically designed for applications, with heavy duty ball bearings. The motor shall be speed controllable down to 20% of full speed and 85% efficient at all speeds.

   1) Exceptions:
      a) Motors in fan-coils and terminal units that operate only when providing heating to the space served.
b) Motors installed in space conditioning equipment certified under 2013 California Energy Code Section 110.1 or 110.2.

4. Contractor’s Option: Motors scheduled on Drawings as single-phase, and larger than 1/12 hp and smaller than 1 hp, for applications other than HVAC fans, may be EC type.


6. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.


8. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

2.04 MOTOR STARTERS

A. Square D, Allen Bradley, or equal, in NEMA Type 1 enclosure, unless otherwise specified or required. Minimum starter size shall be Size 1. Provide NEMA 3R enclosure where exposed to outdoors.

B. Provide magnetic motor starters for all equipment provided under the Mechanical Work. Starters shall be non-combination type. Provide part winding or reduced voltage start motors where shown or as hereinafter specified. Minimum size starter shall be Size 1.

1. All starters shall have the following:
   a. Cover mounted hand-off-automatic switch. Starters installed exposed in occupied spaces shall have key operated HOA switch.
   b. Ambient compensated thermal overload.
   c. Fused control transformer (for 120 or 24 volt service).
   d. Pilot lights, integral with the starters. Starters located outdoors shall be in NEMA IIIR enclosures.

2. Where three phase motors are provided for two-speed operation, provide two speed motor starters.

3. Starters for single-phase motors shall have thermal overloads. NEMA I enclosure for starters located indoors, NEMA IIIR enclosure for starters located outdoors.

4. Provide OSHA label indicating the device starts automatically.

2.05 VALVES AND FITTINGS

A. Gate Valves:
   1. Gate valves are not acceptable for use on this project.

B. Ball Valves:
   1. 2 inches and smaller: 600 psi CWP, 150 psi SWP, cast bronze body, full port, two piece, threaded ends, and reinforced PTFE seal, conforming to MSS SP-110. Nibco T585-70, Milwaukee BA-400, Stockham T-285, or equal.
   2. 2-1/2 inches and larger: Class 150, carbon steel body, full port, two piece, stainless steel vented ball, flanged ends, and reinforced PTFE seal, conforming to MSS SP-72. Nibco F-515-CS-F-66-FS, Milwaukee F20-CS-15-F-02-GO-VB, or equal.

C. Swing Check Valves: Class 125 or 150, bronze body, suitable for regrinding, threaded ends, conforming to MSS SP-80. Stockham B-321, Milwaukee 509, or equal.
D. Butterfly Valves:

1. General: Tight closing, full lug type, with resilient seat suitable for minimum working pressure of 200 psig, conforming to MSS SP-67. Bi-direction dead end service with downstream flange removed.

2. Provide valves with the following:
   a. Seats: Suitable for 40 degrees F for cold water service and 250 degrees F for hot water service. Seats shall cover inside surface of body and extend over body ends.
   b. Bodies: Ductile iron or cast iron.
   c. Discs: Bronze or stainless steel.
   d. Stems or Shafts: Stainless steel.
   e. Control Handles: Suitable for locking in any position or with 10 degree or 15 degree notched throttling plates to hold valve in selected position. Provide extended necks to compensate for insulation thickness. Provide gear operator for valves 5 inches and larger.

3. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:
   a. 2 through 12 inches: Milwaukee Valve, CL series, Nibco, Inc., model LD2000-3, or equal.

E. Calibrated Balance Valves (Symbol CBV): Provide globe style valves for precision regulation and control rated 175 psi for sizes 2-1/2 inches through 12 inches and rated 240 psi for bronze sizes 2 inches and below. Each valve shall have two metering/test ports with internal check valves and protective caps. All valves must be equipped with visual position readout and concealed memory stops for repeatable regulation and control.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:
   a. Bell & Gossett Circuit Setter Plus
   b. Armstrong CBV
   c. Flow Design Inc. Accusetter
   d. Tour & Andersson
   e. Circuit Sensor with butterfly valve above 3 inches.
   f. Illinois Series 5000 through 2 inches.

F. Air Vent Valves:

1. Provide Armstrong #1AV, Hoffman Model 78, Metraflex Model MV-15A, or equal, where automatic type air vent is shown.

2.06 JOINING MATERIALS

A. Refer to Division 22 and 23 piping sections for special joining materials not listed below.

B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.

1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch (3.2-mm) maximum thickness unless thickness or specific material is indicated
   a. Full-Face Type: For flat-face, Class 125, cast iron and cast bronze flanges.
   b. Narrow-Face Type: For raised-face, Class 250, cast iron and steel flanges.
2. AWWA C111, rubber, flat face, 1/8-inch (3.2mm) thick, unless otherwise indicated; and full-face or ring type, unless other indicated.
3. Flange Bolts and Nuts: AWWA C111, carbon steel, unless otherwise indicated.

C. Solder Filler Metals: ASTM B 32, 100 percent lead free alloys. Include water-flushable flux according to ASTM B813.

D. Brazing Filler Metals:
1. General Duty: AWS A5.8, BCup-5 Series, copper-phosphorus unless otherwise indicated. Sil-Fos 15, or equal.

E. Welding Filler Metals: Comply with ASME B31.1 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2.07 STRAINERS
A. Charles M. Bailey #100A, Armstrong, Muessco, or equal, Fig. 11 "Y" pattern, 125 psi WP minimum, with monel screens with 20 square mesh for 2 inches and smaller and 3/64 inch perforations for 2-1/2 inches and larger. Install all strainers with a blow-off hose valve with hose adapter. Strainer shall have gasketed cover with straight thread.

2.08 GAUGES
A. Marsh "Series J", U.S. Gage, Danton 800, or equal, with bronze bushed movement and front recalibration. Dials shall be white with black numerals, 3-1/2 inch dial face. Normal reading shall be at mid-scale. Provide a needle valve on each gauge connection. Supply a gauge piped with branch isolation valves across the inlet and outlet of each pump and where shown on the Drawings.

B. Provide Pete's Plug II, Sisco P/T, or equal, test plug with Nordel core {and gasketed cap}, on inlet and outlet of each coil, boiler, condenser, chiller and heat exchanger and where shown on Drawings.

2.09 THERMOMETERS
A. Marsh, Taylor, Palmer, or equal, 5 inch diameter bimetal dial, adjustable from face, with adjustable positioner, located to be easily read from normal personnel approach. Normal reading shall be at mid-scale.
1. Provide extension for insulation.
2. Provide thermometers with steel bulb chambers and brass separable sockets.
3. Thermometers for air temperature shall have 8 inch minimum stem.

B. Provide Ventlock, Durodyne, or equal thermometer test holes at each air conditioning unit, furnace, and make-up air unit, in mixed air and supply air, and at all locations shown or scheduled on the Drawings. Provide two portable thermometers, with sensing connection arranged to suit test connections.

C. Provide Pete's Plug II, Sisco P/T, or equal, test plug with Nordel core, on inlet and outlet of each coil, boiler, condenser, chiller and heat exchanger and provide two digital electronic test thermometers for each range of fluid temperature and where shown on Drawings.

2.10 ACCESS DOORS
A. Where floors, walls, or ceilings must be penetrated for access to mechanical equipment, provide access doors, 14 inch by 14 inch minimum size in usable opening. Where entrance of a
serviceman may be required, provide 20 inch by 30 inch minimum usable opening. Locate access doors/panels for non-obstructed and easy reach.

1. All access doors less than 7'-0" above floors and exposed to public access shall have keyed locks.

B. Access doors shall match those supplied in Division 08 in all respects, except as noted herein.

C. Provide stainless steel access doors for use in toilet rooms, shower rooms, kitchens and other damp areas. Provide steel access doors with prime coat of baked-on paint for all other areas.

D. Where panels are located on ducts or plenums, provide neoprene gaskets to prevent air leakage, and use frames to set door out to flush with insulation.

E. Provide insulated doors where located in internally insulated ducts or casings.

F. Do not locate access doors in highly visible public areas such as lobbies, waiting areas, and primary entrance areas. Coordinate with the Architect when access is required in these areas.

G. Where specific information or details relating to access panels different from the above is shown or given on the Drawings or other Divisions of work, then that information shall supersede this specification.

H. Manufacturers: Subject to compliance with requirements, available manufacturers offering products which may be incorporated into the Work include Milcor, Karp, Nystrom, or Cesco, equal to the following:

1. Milcor
   a. Style K (plaster)
   b. Style DW (gypsum board)
   c. Style M (Masonry)
   d. Style "Fire Rated" where required.

2.11 EXPANSION LOOPS

A. Manufactured assembly consisting of inlet and outlet elbow fittings, two sections of flexible metal hose and braid, and 180-degree return bend or center section of flexible hose. Flexible hose shall consist of corrugated metal inner hose and braided outer sheath.

B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:

   Metraflex Inc., Metraloop series.
   Unisource Manufacturing, Inc., V series.

2.12 PIPE GUIDES

A. Where flexible connections are indicated on Drawings, provide Metraflex style IV, B-Line, or equal, pipe guides in locations recommended by manufacturer. Maximum spacing from flexible connection to first pipe guide is 4 pipe diameters, and maximum spacing from second pipe guide is 14 pipe diameters.

2.13 EQUIPMENT IDENTIFICATION

A. Identify each piece of equipment with a permanently attached engraved bakelite plate, 1/2 inch high white letters on black background.

2.14 PIPE IDENTIFICATION
A. Identify each piping system and indicate the direction of flow by means of Seton, Inc., Marking Services Inc., Reef Industries, Inc., or equal, pre-tensioned, coiled semi-rigid plastic pipe labels formed to circumference of pipe, requiring no fasteners or adhesive for attachment to pipe.

B. The legend and flow arrow shall conform to ASME A13.1.

2.15 INSULATION WORK

A. General:

1. Insulation products, including insulation, insulation facings, jackets, adhesives, sealants and coatings shall not contain polybrominated diphenyl ethers (PBDEs) in penta, octa, or deca formulations in amounts greater than 0.1 percent (by mass).

2. Adhesives and sealants shall comply with testing and product requirements of South Coast Air Quality Management District, Rule 1168.

3. The term "piping" used herein includes pipe, air separators, valves, strainers and fittings.

4. Apply insulating cement to fittings, valves and strainers and trowel smooth to the thickness of adjacent covering. Cover with jacket to match piping. Extend covering on valves up to the bonnet. Leave strainer cleanout plugs accessible.

5. Provide pre-formed PVC valve and fitting covers for indoor piping.

6. Provide factory-fabricated aluminum valve and fitting covers for outdoor piping.

7. Provide Calcium Silicate rigid insulation and sheet metal sleeve, 18 inch minimum length at each pipe hanger. Seal ends of insulation to make vapor tight with jacket.

8. Urethane insulation will not be allowed above ground or on hot water piping.

9. Test insulation, jackets, and lap-seal adhesives as a composite product and confirm flame spread of not more than 25 and a smoke developed rating of not more than 50 when tested in accordance with UL723, ASTM E84, or NFPA 255.

10. Clean thoroughly, test and have approved, all piping and equipment before installing insulation and/or covering.

11. Repair all damage to existing pipe and duct insulation whether or not caused during the work of this contract, to match existing adjacent insulation for thickness and finish, but conforming to flame spread and smoke ratings specified above.

B. Insulation of Piping:

1. Exposed insulated piping within the building shall have a Zeston 2000 25/50, Proto Lo-Smoke, or equal, PVC jacket and fitting cover installed over the insulation, applied per manufacturer's instructions. Verify suitability with manufacturer of insulation. Insulation with pre-applied polymer jacket may be substituted at Contractor's option.

2. Insulate refrigerant suction piping and chilled water supply and return piping, including fittings, with 3-1/2 pound per cubic foot minimum density fiberglass with factory-applied ASJ-SSL jacket. Insulate valves and irregular surfaces to match adjacent insulation and cover with two layers of Glasfab saturated in Foster Sealfas 30-36, 3M, or equal, carried 3 inches over the adjoining pipe insulation. Finish with a coat of Foster Sealfas 30-36, 3M, or equal. The 3 inch wide SSL end laps furnished with the insulation shall be adhered over the end joints. Seal entire surface of insulation vapor tight, including joints and ends of PVC or aluminum fitting covers. Insulation thicknesses per application follow:

   a. Indoor chilled water piping 3/4 inches diameter and smaller: 1" thick.

   b. Indoor chilled water piping 1-12 inches diameter: 1-1/2 inches thick.

   c. Outdoor Chilled water piping; all sizes: 2 inches thick.
3. Where insulated piping is exposed to the weather apply aluminum jacket secured with 1/2 inch stainless-steel bands on 12 inch centers. Insulation shall be vapor tight before applying metal jacket, and aluminum fitting covers. Install jacketing with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Cover fittings with glass cloth, two coats of Foster Sealfas 30-36, and factory-fabricated aluminum fitting covers, of same material, finish, and thickness as jacket.
   a. Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
   b. Tee covers.
   c. Flange and union covers.
   d. End caps.
   e. Beveled collars.
   f. Valve covers.
   g. Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

4. Jacket thickness:
   a. Pipes 10 inches diameter and smaller: Minimum .016 inch thick jacket with smooth finish.
   b. Pipes 12 inches diameter and larger: Minimum .020 inch thick jacket with smooth finish.

5. Insulate indoor heating hot water piping with 3-1/2# per cubic foot minimum density fiberglass with factory applied ASJ-SSL jacket, 1-1/2 inches thick for pipes 1-1/4 inches and smaller, 2 inches thick for pipes 1-1/2 inches and larger. Outdoor piping shall be insulated as described for indoor piping; 2 inches thick for all pipe sizes.

C. Duct Insulation:
   1. All duct insulation shall meet minimum R-value of R-8 at 3 inch thickness 3/4 pound per cubic foot density for ductwork installed outside the building insulation envelope. For ductwork installed within the building insulation envelope, duct insulation shall have a minimum R-value of R-4.2 at 2 inch thickness, 3/4 pound per cubic foot density.
   2. General: Insulation applied to the exterior surface of ducts located in buildings shall have a flame spread of not more than 25 and a smoke-developed rating of not more than 50 when tested as a composite installation including insulation, facing materials, tapes and adhesives as normally applied. Material exposed within ducts or plenum shall have a flame-spread rating of not more than 25 and a smoke-developed rating of not more than 50.
   3. Wrap all unlined concealed supply and return ducts with fiberglass duct wrap, manufactured as a blanket of glass fibers factory laminated to a reinforced foil/kraft vapor retarding facing. Provide 2 inch stapling and taping flange. Wrap insulation entirely around duct and secure with outward clinching staples on 6 inch centers. Provide mechanical fasteners at maximum 18 inch centers for all bottoms of duct which are greater than 24 inches. Lap all insulation joints 3" minimum. Insulate ducts installed tight against other work before hanging in place. Seal all seams, both longitudinal and transverse, and all staple and mechanical fastener penetrations of facing with scrim backed foil tape or recommended sealant, to provide a vapor tight installation.
   4. On all supply and return ductwork exposed to weather and not internally lined, field apply minimum 2" thick mineral-fiber board thermal insulation, glass fibers bonded with thermostetting resin. Comply with ASTM C612, type IB without facing and with all service jacket with factory applied FRK-25 foil reinforced kraft paper. Aluminum jacket, 0.024
inch thickness sheets manufactured from aluminum alloy complying with ASTM B209, stucco embossed finish and having an integrally bonded moisture barrier over entire surface in contract with insulation.

5. Provide internal duct lining in accordance with specification section 23 80 00.

PART 3 - EXECUTION

3.01 MECHANICAL DEMOLITION

A. Refer to Division 01 Sections “Cutting and Patching” and “Selective Demolition” for general demolition requirements and procedures.

B. Disconnect, dismantle and remove mechanical systems, equipment, and components indicated to be removed. Coordinate with all other trades.

1. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.

2. Piping to Be Abandoned in Place: Drain piping and cap or plug piping to remain with same or compatible piping material. Refrigerant system must be evacuated per EPA requirements.

3. Ducts to Be Removed: Remove portion of ducts indicated to be removed and cap remaining ducts with same or compatible ductwork material.

4. Ducts to Be Abandoned in Place: Cap or plug ducts with same or compatible ductwork material.

5. Equipment to Be Removed: Drain down and cap remaining services and remove equipment.

6. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.

7. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.

C. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

3.02 ELECTRICAL REQUIREMENTS

A. Provide adequate working space around electrical equipment in compliance with the California Electrical Code. Coordinate the Mechanical Work with the Electrical Work to comply.

B. Furnish necessary control diagrams and instructions for the controls. Before permitting operation of any equipment which is furnished, installed, or modified under this Section, review all associated electrical work, including overload protection devices, and assume complete responsibility for the correctness of the electrical connections and protective devices. Motors and control equipment shall conform to the Standards of the National Electrical Manufacturers’ Association. All equipment and connections exposed to the weather shall be NEMA IIIR with factory-wired strip heaters in each starter enclosure and temperature control panel where required to inhibit condensation.

C. All line voltage and low voltage wiring and conduit associated with the Temperature Control System are included in this Section. Wiring and conduit shall comply with Division 26.

3.03 PIPING SYSTEM REQUIREMENTS
A. Drawing plans, schematic and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.

3.04 PRIMING AND PAINTING

A. Perform all priming and painting on the equipment and materials as specified herein.

B. Priming:
   1. Exposed ferrous metals, including piping, which are not galvanized or factory-finished shall be primed. Black steel pipe exposed to the weather shall be painted one coat of Rust-Oleum #1069 primer for black steel piping or Rust-Oleum #5260, Kelly Moore, or equal, primer for galvanized piping.
   2. Metal surfaces of items to be jacketed or insulated except ductwork and piping shall be given two coats of primer unless furnished with equivalent factory finish. Items to be primed shall be properly cleaned by effective means free of rust, dirt, scale, grease and other deleterious matter and then primed with the best available grade of zinc rich primer. After erection or installation, all primed surfaces shall be properly cleaned of any foreign or deleterious matter that might impair proper bonding of subsequent paint coatings. Any abrasion or other damage to the shop or field prime coat shall be properly repaired and touched up with the same material used for the original priming.
   3. Where equipment is provided with nameplate data, the nameplate should be masked off prior to painting. When painting is completed, remove masking material.

C. See Painting Section for detailed requirements.

3.05 INSTALLATION OF VALVES

A. General:
   1. Valves shall be full line size unless indicated otherwise on Drawings.
   2. Install horizontal valves with valve stem above horizontal, except butterfly valves.
   3. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
   4. Locate valves for easy access and provide separate support where necessary.
   5. Install valves in position to allow full stem movement.
   6. Install exposed polished or enameled connections with special care showing no tool marks or exposed threads.
   7. Butterfly valves conforming to the paragraph "Butterfly Valves" may be used in lieu of gate or globe valves for locations above grade.
   8. Ball valves conforming to the paragraph "Ball Valves" may be used in lieu of gate valves for locations above grade for services 2-1/2 inches and smaller.
   9. Valves 2-1/2 inches and smaller (except ball valves) in nonferrous water piping systems may be solder joint type with bronze body and trim.
   10. Provide ball or globe valves on inlet and outlet of each pump.

B. Gate Valves:
   1. Furnish valves in copper lines with adapters to suit valve / line requirements.

C. Swing Check Valves: Install in horizontal position with hinge pin level.

D. Butterfly Valves: Install with stems horizontal.
E. Calibrated Balancing Valves: Install calibrated balancing valves per manufacturers’ recommendations, including requirements for straight pipe lengths at valve inlet and outlet.

F. Air Vent Valves:
   1. Install with shutoff valves or cocks and drain to floor sink or drain.
   2. At each high point of piping provide manual air vent connection at top of pipe. Provide ball valve within 18 inches of ceiling in accessible location, and extend drain line to allow convenient access.

G. Valve Adjustment: Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.06 INSTALLATION OF PIPING AND DUCT SYSTEMS

A. General:
   1. All piping shall be concealed unless shown or otherwise directed. Allow sufficient space for ceiling panel removal.
   2. Installation of piping shall be made with appropriate fittings. Bending of piping will not be accepted.
   3. Install piping to permit application of insulation and to allow valve servicing.
   4. Where piping, conduit, or ductwork is left exposed within a room, the same shall be run true to plumb, horizontal, or intended planes. Where possible, uniform margins are to be maintained between parallel lines and/or adjacent wall, floor, or ceiling surfaces.
   5. Horizontal runs of pipes, conduits, or ductwork suspended from ceilings shall provide for a maximum headroom clearance. The clearance shall not be less than 6'-6" without written approval from the Architect.
   6. Close ends of pipe immediately after installation. Leave closure in place until removal is necessary for completion of installation.
   7. At the time of rough installation, or during storage on the construction site and until final startup of the heating and cooling equipment, all duct and other related air distribution component opening shall be covered with tape, plastic, sheet metal, or other methods acceptable to the enforcing agency.
   8. Each piping system shall be thoroughly flushed and proved clean before connection to equipment.
   9. Pipe the discharge of each relief valve, air vent, backflow preventer, and similar device to floor sink or drain.
   10. Install exposed polished or enameled connections with special care showing no tool marks or threads at fittings.
   11. Install horizontal valves with valve stem above horizontal.
   12. Use reducing fittings; bushings shall not be allowed. Use eccentric reducing fittings wherever necessary to provide free drainage of lines and passage of air.
   13. Verify final equipment locations for roughing-in.
   14. Where piping is installed in walls within one inch of the face of stud, provide a 16 gauge sheet metal shield plate on the face of the stud. The shield plate shall extend a minimum of 1-1/2 inches beyond the outside diameter of the pipe.

B. Expansion Loops:
   1. Install expansion loops where piping crosses building expansion or seismic joints, between buildings, between buildings and canopies, and as indicated on Drawings.
2. Install expansion loops of sizes matching sizes of connected piping.
3. Install grooved-joint expansion joints to grooved-end steel piping.
4. Materials of construction and end fitting type shall be consistent with pipe material and type of gas or liquid conveyed by the piping system in which expansion loop is installed.

C. Sleeves:
1. Install Adjus-to-Crete, Pipeline Seal and Insulator, or equal, pipe sleeves of sufficient size to allow for free motion of pipe, 24 gauge galvanized steel. The space between pipe and sleeves through floor slabs on ground, through outside walls above or below grade, through roof, and other locations as directed shall be caulked with oakum and mastic and made watertight. The space between pipe and sleeve and between sleeve and slab or wall shall be sealed watertight.
2. At Contractor's option, Link-Seal, Metraflex Metraseal, or equal, casing seals may be used in lieu of caulkng. Wrap pipes through slabs on grade with 1 inch thick fiberglass insulation to completely isolate the pipe from the concrete.

D. Floor, Wall, and Ceiling Plates:
1. Fit all pipes with or without insulation passing through walls, floors, or ceilings, and all hanger rods penetrating finished ceilings with chrome-plated or stainless escutcheon plates.

E. Firestopping:
1. Pack the annular space between the pipe sleeves and the pipe and between duct openings and ducts through all floors and walls with UL listed fire stop, and sealed at the ends. All pipe penetrations shall be UL listed, Hilti, 3M Pro-Set, or equal.
   a. Install fire caulking behind mechanical services installed within fire rated walls, to maintain continuous rating of wall construction.
2. Provide SpecSeal Systems UL fire rated sleeve/coupling penetrators for each pipe penetration or fixture opening passing through floors, walls, partitions or floor/ceiling assemblies. All Penetrators shall comply with UL Fire Resistance Directory (Latest Edition), and in accordance with CBC requirements.
3. Sleeve penetrators shall have a built in anchor ring for waterproofing and anchoring into concrete pours or use the special fit cored hole penetrator for cored holes.
4. Copper and steel piping shall have SpecSeal plugs on both sides of the penetrator to reduce noise and to provide waterproofing.
5. All above Firestopping systems to be installed in strict accordance with manufacturer's instructions.
6. Alternate firestopping systems are acceptable if approved equal. However, any deviation from the above specification requires the Contractor to be responsible for determining the suitability of the proposed products and their intended use, and the Contractor shall assume all risks and liabilities whatsoever in connection therewith.

F. Flashing:
1. Flashing for penetrations of metal or membrane roof for mechanical items such as flues, ducts, and pipes shall be coordinated with the roofing manufacturer and roofing installer for the specific roofing type. The work of this section shall include furnishing, layout, sizing, and coordination of penetrations required for the mechanical work.
   a. Furnish and install flashing and counterflashing in strict conformance with the requirements of the roofing manufacturer. Submit shop drawing details for review prior to installation.
b. Furnish and install counterflashing above each flashing required. Provide Stoneman, or equal, vandalproof top and flashing combination. Elmendor/Stoneman Model 1540.

c. Flues and ducts shall have 24 gauge galvanized sheet metal storm collar securely clamped to the flue above the flashing.

2. For all other types of roofing system, furnish and install around each pipe, where it passes through roof, a flashing and counterflashing. All flashing shall be made of four pound seamless sheet lead with 6 inch minimum skirt and steel reinforced boot. Counterflashing shall be cast iron. For vents, provide vandalproof top and flashing combination. Elmendor/Stoneman Model 1100-4.

G. Hangers and Supports:

1. General: Support all ductwork, equipment and piping so that it is firmly held in place by approved iron hangers and supports, and special hangers as required. All components shall support weight of ductwork, equipment and pipe, fluid, and pipe insulation based on spacing between supports with minimum factor of safety of five based on ultimate strength of material used. Do not exceed manufacturer’s load rating. Pipe attachments or hangers, of same size as pipe or tubing on which used, or nearest available. Rigidly fasten hose faucets, fixture stops, compressed air outlets, and similar items to the building construction. The Architect shall approve all hanger material before installation. Do not support piping or ductwork with plumbers’ tape, wire rope, wood, or other makeshift devices. Where building structural members do not match piping and ductwork support spacing, provide all “bridging” support members as required firmly attached to building structural members in a fashion approved by the Structural Engineer.

   a. Materials, design, and type numbers for support of piping per Manufacturers’ Standardization Society (MSS), Standard Practice (SP)-58.

   b. Materials and design for ductwork support shall be per SMACNA “HVAC Duct Construction Standards, Metal and Flexible.”

2. All hanger components shall be provided by one manufacturer: B-Line, Grinnell, Uni-Strut, Badger, or equal.

3. Pipe Hanger and Support Spacing:

   a. Vertical piping support spacing: B-line B3373 clamps attached to the pipe above each floor to rest on the floor. Provide with lead or Teflon liners on copper tubing. Provide additional support at base of cast iron risers and support at unsupported riser joints and horizontal offsets per 2007 Mason Industries Seismic Restraint Guidelines. Provide intermediate support for vertical piping, spaced at or within the following maximum limits.

   | Pipe Diameter | Steel Fluid | Steel Vapor | Copper Fluid | Copper Vapor | CPVC & PVC
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1/2 - 1&quot;</td>
<td>12</td>
<td>6</td>
<td>10</td>
<td>6</td>
<td>Base and Each Floor (Note 1)</td>
</tr>
<tr>
<td>1-1/4 - 2&quot;</td>
<td>12</td>
<td>Each Floor</td>
<td>10</td>
<td>6</td>
<td>Base and Each Floor (Note 1)</td>
</tr>
<tr>
<td>2-1/2 - 3&quot;</td>
<td>12</td>
<td>Each Floor</td>
<td>10</td>
<td>10</td>
<td>Base and Each Floor (Note 1)</td>
</tr>
<tr>
<td>Over 4&quot;</td>
<td>12</td>
<td>Each Floor</td>
<td>10</td>
<td>10</td>
<td>Base and Each Floor</td>
</tr>
</tbody>
</table>

BASIC HVAC MATERIALS AND METHODS
23 00 50 - 20
Note 1: Provide mid-story guides.

Note 2: For PVC piping, provide for expansion every 30 feet per IAPMO installation standard.

b. Vertical cast iron piping support spacing: Base and each floor not to exceed 15 feet.

c. Horizontal piping, hanger and support spacing: Locate hangers and supports at each change of direction, within one foot of elbow, and spaced at or within following maximum limits.

<table>
<thead>
<tr>
<th>Pipe Diameter</th>
<th>Steel Fluid</th>
<th>Steel Vapor</th>
<th>Copper Fluid</th>
<th>Copper Vapor</th>
<th>CPVC &amp; PVC</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/2 - 1&quot;</td>
<td>6</td>
<td>6</td>
<td>5</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>1-1/4 - 2&quot;</td>
<td>7</td>
<td>10</td>
<td>6</td>
<td>6</td>
<td>4</td>
</tr>
<tr>
<td>2-1/2 - 3&quot;</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>4</td>
</tr>
<tr>
<td>Over 4&quot;</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>4</td>
</tr>
</tbody>
</table>

d. Horizontal cast iron piping support spacing:
   1) Support piping at every other joint for piping length of less than 4 feet.
   2) For piping longer than 4 feet, provide support on each side of the coupling, within 18 inches of each joint.
   3) Hanger shall not be installed on the coupling.
   4) Provide support at each horizontal branch connection.
   5) Provide sway brace at 40 foot maximum spacing for all suspended pipe with no-hub joints, except where a lesser spacing is indicated in the 2007 Mason Industries Seismic Restraint Guidelines. Provide a brace on each side of a change in direction of 90 degrees or more. Brace riser joints at each floor and at 15 foot maximum intervals.

4. Suspended Piping:
   a. Individually suspended piping: B-Line B3690 J-Hanger or B3100 Clevis, complete with threaded rod, or equal. All hangers on supply and return piping handling heating hot water or steam shall have a swing connector at point of support.

<table>
<thead>
<tr>
<th>Pipe Size</th>
<th>Rod Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>2&quot; and Smaller</td>
<td>3/8&quot;</td>
</tr>
<tr>
<td>2-1/2&quot; to 3-1/2&quot;</td>
<td>1/2&quot;</td>
</tr>
<tr>
<td>4&quot; to 5&quot;</td>
<td>5/8&quot;</td>
</tr>
<tr>
<td>6&quot;</td>
<td>3/4&quot;</td>
</tr>
</tbody>
</table>

b. Trapeze Suspension: B-Line 1-5/8 inch width channel in accordance with manufacturers' published load ratings. No deflection to exceed 1/180 of a span.

c. Trapeze Supporting Rods: Shall have a safety factor of five; securely anchor to building structure.

d. Pipe Clamps and Straps: B-Line B2000, B2400; isolate copper pipe with two thicknesses of 2 inches wide 10-mil polyvinyl tape. Where used for seismic support systems, provide B-Line B2400 series pipe straps.

e. Above Roof: H frame made from Uni-Strut hot-dipped galvanized 1-5/8 inch single or double channel with P-2072A or P-2073A foot secured to roof and surrounded with waterproof roofed-in sleeper. Secure to sleeper with lag screws, and secure sleeper to blocking under roof.
f. Steel Connectors: Beam clamps with retainers.

5. Duct Hanger and Support Spacing: Conform to Requirements of CMC and SMACNA "HVAC Duct Construction Standards, Metal and Flexible."

6. Support to Structure:
   a. Steel Structure: Provide and install additional steel bracing as required to suit structure. Provide through bolts with length to suit requirements of the structural components. Burning or welding on any structural member may only be done if approved by the Architect.

7. Rubber Neoprene Pipe Isolators:
   a. Pipe isolators shall comprise an internal rubber or neoprene material that isolates pipe from hanger and structure. Install at all piping located in acoustical walls. Refer to Architectural Drawings for location of acoustical walls.
   b. Isolation material shall be either a rubber or neoprene material that prevents contact between the pipe and the structure. The rubber shall have between a 45 to 55 durometer rating and a minimum thickness of 1/2 inch.
   c. Acceptable Suppliers:
      1) Vertical runs: Acousto-Plumb or equal.
      2) Horizontal runs: B-Line, Vbraclamp; Acousto-Plumb or equal.

8. Provide support for piping through roof, arranged to anchor piping solidly in place at the roof penetration.

9. Provide rigid insulation and a 12 inch long, 18 gauge galvanized sheet iron shield between the covering and the hanger whenever hangers are installed on the outside of the pipe covering.

10. Insulate copper tubing from ferrous materials and hangers with two thicknesses of 3 inch wide, 10 mil polyvinyl tape wrapped around pipe.

11. Provide a support or hanger close to each change of direction of pipe either horizontal or vertical and as near as possible to concentrated loads.

12. Suspend rods from concrete inserts with removable nuts where suspended from concrete decks. Power actuated inserts will not be allowed.

13. On chilled or combination hot and chilled water or refrigerant pipes, install the hangers on the outside of the pipe covering and not in contact with the pipe. Provide rigid insulation and a 12 inch long, 18 gauge galvanized sheet iron shield between the covering and the hanger whenever hangers are installed on the outside of the pipe covering.

3.07 PIPE JOINTS AND CONNECTIONS

A. General:
   1. Cutting: Cut pipe and tubing square, remove rough edges or burrs. Bevel plain ends of steel pipe.
   2. Remove scale, slag, dirt and debris from inside and outside of pipe before assembly.
   3. Boss or saddle type fittings or mechanically extracted tube joints will not be allowed.

B. Threaded Pipe: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
   1. Apply thread compound to external pipe threads: Rectorseal No. 5, Permatex No. 1, or equal.
   2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
C. Flanged Joints: Select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for type of water conveyed by pipe. Join flanges with gasket and bolts according to ASME B31.9.

D. Copper Pipe and Tubing: All joints shall be brazed according to ASME Section IX, Welding and Brazing Qualifications, except pneumatic control piping, and hydronic piping having grooved-end fittings and couplings.

E. Welded Pipe:
   1. Make up with oxyacetylene or electric arc process.
   2. All welding shall conform to the American Standard Code for Power Piping ASME B-31.1. When requested by the Architect, furnish certification from an approved testing agency or National Certified Pipe Welding Bureau that the welders performing the work are qualified.
   3. All line welds shall be of the single "V" butt type. Welds for flanges shall be of the fillet type.
   4. Where the branch is two pipe sizes smaller than the main or smaller, Bonney Weldolets, Threadolets, Nibco, or equal, may be used in lieu of welding tees.

F. Flexible Connections:
   1. Furnish and install Thermo Tech., Inc. F/J/R, Metaflex, or equal, flexible couplings with limitier bolts on piping connections to all equipment mounted on anti-vibration bases, except fan coil units under 2000 cfm, on each connection to each base mounted pump and where shown. Couplings shall be suitable for pressure and type of service.
   2. Flexible connections in refrigerant lines; Flexonic, Anaconda or equal, metal hose, full size.
   3. Anchor piping securely on the system side of each flexible connection.

G. Grooved-End Fittings and Couplings: Assemble joints with coupling and gasket, lubricant, and bolts. Cut or roll grooves in ends of pipe based on pipe and coupling manufacturer's written instructions for pipe wall thickness. Use grooved-end fittings and rigid, grooved-end couplings.

3.08 UNIONS AND FLANGES
A. Install Epco, Nibco, or equal, dielectric unions or flanges at points of connection between copper or brass piping or material and steel or cast iron pipe or material except in drain piping. Bushings or couplings shall not be used.
B. Install unions in piping NPS 2" and smaller 3 or flanges in piping NPS 2-1/2" and larger whether shown or not at each connection to all equipment and tanks, and at all connections to all automatic valves, such as temperature control valves.
C. Locate the unions for easy removal of the equipment, tank, or valve.
D. Do not install unions or flanges in refrigerant piping systems.

3.09 ACCESS DOOR
A. Furnish and install access doors wherever required whether shown or not for easy maintenance of mechanical systems; for example, at concealed valves, strainers, traps, cleanouts, dampers, motors, controls, operating equipment, etc. Access doors shall provide for complete removal and replacement of equipment.

3.10 PIPE IDENTIFICATION
A. Provide temporary identification of each pipe installed, at the time of installation. Temporary identification shall be removed and replaced with permanent identification as part of the work.

B. Apply the legend and flow arrow at all valve locations; at all points where the piping enters or leaves a wall, partition, cluster of piping or similar obstruction, at each change of direction, and at approximately 20'-0" intervals on pipe runs. Variations or changes in locations and spacing may be made with the approval of the Architect. There shall be at least one marking in each room. Markings shall be located for maximum visibility from expected personnel approach.
   1. Apply legend and flow arrow at approximately 10'-0" intervals in science classrooms and science prep rooms.

C. Wherever two or more pipes run parallel, the markings shall be supplied in the same relative location on each.

D. Each valve on non-potable water piping shall be labeled with a metal tag stamped "DANGER -- NON-POTABLE WATER" in 1/4 inch high letters.

E. Apply the markings after painting and cleaning of piping and insulation is completed.

3.11 TESTS AND ADJUSTMENTS

A. Test the installations in accordance with the following requirements and all applicable codes:
   1. Notify the Architect at least seven days in advance of any test.
   2. Inspector of Record should witness all tests of piping systems.
   3. All piping shall be tested at completion of roughing-in, or at other times as directed by the Architect.
   4. Furnish all necessary materials, test pumps, gases, instruments and labor required for testing.
   5. Isolate from the system all equipment that may be damaged by test pressure.
   6. Make connections to existing systems with flanged connection. During testing of the new work, provide a slip-in plate to restrict test pressure to new systems only. Remove plate and complete connection to existing system at completion of testing.
      a. Inspector of record shall witness final connection to system.

B. Test Schedule: No loss in pressure or visible leaks shall show after four hours at the pressures indicated.

<table>
<thead>
<tr>
<th>System Tested</th>
<th>Test Pressure PSI</th>
<th>Test With</th>
</tr>
</thead>
<tbody>
<tr>
<td>All Hot and Chilled Water Piping</td>
<td>125</td>
<td>Water</td>
</tr>
</tbody>
</table>

1. Non-corrosive leak test fluid shall be suitable for use with the piping material specified.

C. Perform operational tests under simulated or actual service conditions, including one test of complete plumbing installation with all fixtures and other appliances connected, and one test of complete installation of 48 hours each for heating and cooling with all equipment connected and operating.

D. Should any material or work fail in any of these tests, it shall be immediately removed and replaced for new material, and portion of the work replaced shall again be tested by Contractor at his own expense.

E. Lubricate each item of equipment, including motors, before operation.

3.12 OPERATION OF SYSTEMS
A. Do not operate any mechanical equipment for any purpose, temporary or permanent, until all of the following has been completed:
1. Complete all requirements listed under “Check, Test and Start Requirements.”
2. Ductwork and piping has been properly cleaned. Piping systems shall be flushed and treated prior to operation.
3. Filters, strainers etc. are in place.
4. Bearings have been lubricated, and alignment of rotating equipment has been checked.
5. Equipment has been run under observation, and is operating in a satisfactory manner.

B. Provide test and balance agency with one set of Contract Drawings, Specifications, Addenda, Change orders issued, applicable shop drawings and submittals and temperature control drawings.

C. Operate every fire damper, smoke damper, combination smoke and fire damper under normal operating conditions. Activate smoke detectors as required to operate the damper, stage fan, etc. Provide written confirmation that all systems operate in a satisfactory manner.

3.13 CHECK, TEST AND START REQUIREMENTS

A. An authorized representative of the equipment manufacturer shall perform check, test and start of each piece of mechanical equipment. The representative may be an employee of the equipment manufacturer, or a manufacturer-certified contractor. Submit written certification from the manufacturer stating that the representative is qualified to perform the check test and start of the equipment.
1. As part of the submittal process, provide a copy of each manufacturer’s printed startup form to be used.
2. Some items of specified equipment may require that check, test and start of equipment must be performed by the manufacturer, using manufacturer’s employees. See specific equipment Articles in these Specifications for this requirement.
3. Provide all personnel, test instruments, and equipment to properly perform the check, test and start work.
4. When work has been completed, provide copies of reports for review, prior to final observation of work.

B. Provide copies of the completed check, test and start report of each item of equipment, bound with the Operation and Maintenance Manual.

C. Upon completion of the work, provide a schedule of planned maintenance for each piece of equipment. Indicate frequency of service, recommended spare parts (including filters and lubricants), and methods for adjustment and alignment of all equipment components. Provide a copy of the schedule with each Operation and Maintenance Manual. Provide a copy of certification from the Owner’s representative indicating that they have been properly instructed in maintenance requirements for the equipment installed.

3.14 PRELIMINARY OPERATIONAL REQUIREMENTS AND TESTS

A. Prior to observation to determine final acceptance, put HVAC, plumbing, and fire protection systems into service and check that work required for that purpose has been done, including but not limited to the following condensed check list. Provide indexed report to tabulating the results of all work.
1. All equipment has been started, checked, lubricated and adjusted in accordance with the manufacturer’s recommendations, including modulating power exhausts if present.
2. Correct rotation of motors and ratings of overload heaters are verified.
3. Specified filters are installed and spare filters have been turned over to Owner.
4. All manufacturers' certificates of start-up specified have been delivered to the Owner.
5. All equipment has been cleaned, and damaged painted finishes touched up.
6. Damaged fins on heat exchangers have been combed out.
7. Missing or damaged parts have been replaced.
8. Flushing and chemical treatment of piping systems has been completed and water treatment equipment, where specified, is in operation.
9. Equipment labels, pipe marker labels, ceiling markers and valve tags are installed.
10. Valve tag schedules, corrected control diagrams, sequence of operation lists and start-stop instructions have been posted.
11. Preliminary test and balance work is complete, and reports have been forwarded for review.
12. Automatic control set points are as designated and performance of controls checks out to agree with the sequence of operation.
13. Operation and Maintenance Manuals have been delivered and instructions to the operating personnel have been made.

B. Prior to the observation to determine final acceptance, operate all mechanical systems as required to demonstrate that the installation and performance of these systems conform to the requirements of these specifications.

1. Operate and test all mechanical equipment and systems for a period of at least five consecutive 8 hour days to demonstrate the satisfactory overall operation of the project as a complete unit.
2. Include operation of heating and air conditioning equipment and systems for a period of not less than two 8 hour days at not less than 90 percent of full specified heating and cooling capacities in tests.
3. Commence tests after preliminary balancing and adjustments to equipment have been checked. Immediately before starting tests, install air filters and lubricate all running equipment. Notify the Architect at least seven calendar days in advance of starting the above tests.
4. During the test period, make final adjustments and balancing of equipment, systems controls, and circuits so that all are placed in first class operating condition.
5. Where Utility District rebates are applicable, demonstrate that the systems meet the rebate program requirements.

C. Before handing over the system to Owner replace all filters with complete new set of filters.

D. Review of Contractor's Tests:

1. All tests made by the Contractor or manufacturers' representatives are subject to observation and review by the Owner. Provide timely notice prior to start of each test, in order to allow for observation of testing. Upon the completion of all tests, provide a letter to confirm that all testing has been successful.

E. Test Logs:

1. Maintain test logs listing the tests on all mechanical systems showing dates, items tested, inspectors' names, remarks on success or failure of the tests.

F. Preliminary Operation:

1. The Owner reserves the right to operate portions of the mechanical system on a preliminary basis without voiding the guarantee.
G. Operational Tests:
   1. Before operational tests are performed, demonstrate that all systems and components are complete and fully charged with operating fluid and lubricants.
   2. Systems shall be operable and capable of maintaining continuous uninterrupted operation during the operating and demonstration period. After all systems have been completely installed, connections made, and tests completed, operate the systems continuously for a period of five working days during the hours of a normal working day.
   3. This period of continuous systems operation may be coordinated with the removal of Volatile Organic Compounds (VOCs) from the building prior to occupancy should the Owner decide to implement such a program.
   4. Control systems shall be completely operable with settings properly calibrated and adjusted.
   5. Rotating equipment shall be in dynamic balance and alignment.
   6. If the system fails to operate continuously during the test period, the deficiencies shall be corrected and the entire test repeated.

3.15 CERTIFICATES OF INSTALLATION
A. Contractor shall complete applicable “Certificates of Installation” forms contained in the California Building Energy Efficiency Standards and submit to the authorities having jurisdiction for approval and issuance of final occupancy permit, as described in the California Energy Code.

3.16 ACCEPTANCE REQUIREMENTS
A. Contractor shall complete the applicable Acceptance Requirements for Code Compliance contained in the California Building Energy Efficiency Standards. Refer to forms MCH-01-E on Drawings for systems having Acceptance testing requirements. Contractor shall perform Acceptance tests and shall complete the appropriate “Certificates of Acceptance” and submit certificates to the authorities having jurisdiction for approval and issuance of final occupancy permit.

3.17 DEMONSTRATION AND TRAINING
A. An authorized representative of the equipment manufacturer shall train Owner-designated personnel in maintenance and adjustment of equipment. The representative may be an employee of the equipment manufacturer, or a manufacturer-certified contractor. Submit written certification from the manufacturer stating that the representative is qualified to perform the Owner training for the equipment installed.
   1. As part of the submittal process, provide a training agenda outlining major topics and time allowed for each topic.
   2. Some items of specified equipment require that training must be performed by the manufacturer, using manufacturer’s employees. See specific equipment Articles in these Specifications for this requirement.
   3. Contractor shall provide three copies of certification by Contractor that training has been completed, signed by Owner’s representative, for inclusion in Operation and Maintenance Manual. Certificates shall include:
      a. Listing of Owner-designated personnel completing training, by name and title.
      b. Name and title of training instructor.
      c. Date(s) of training.
      d. List of topics covered in training sessions.
4. Refer to specific equipment Articles for minimum training period duration for each piece of equipment.

END OF SECTION
SECTION 23 05 93
TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

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

1.02 SUMMARY
A. Section Includes:
   1. Balancing Air Systems:
      a. Constant-volume air systems.
      b. Variable-air-volume systems.
      c. Fume hood systems.
   2. Balancing Hydronic Piping Systems:
      a. Variable-flow hydronic systems.
      b. Primary-secondary hydronic systems.

1.03 REFERENCES
A. Associated Air Balance Council (AABC)

B. National Environmental Balancing Bureau (NEBB)

1.04 DEFINITIONS
A. The intent of this Section is to use the standards pertaining to the TAB specialist engaged to perform the Work of this Contract, with additional requirements specified in this Section. Contract requirements take precedence over corresponding AABC or NEBB standards requirements. Differences in terminology between the Specifications and the specified TAB organization standards do not relieve the TAB entity engaged to perform the Work of this Contract of responsibility from completing the Work as described in the Specifications.

B. Similar Terms: The following table is provided for clarification only:

<table>
<thead>
<tr>
<th>Similar Terms</th>
<th>AABC Term</th>
<th>NEBB Term</th>
</tr>
</thead>
<tbody>
<tr>
<td>TAB Specialist</td>
<td>TAB Agency</td>
<td>NEBB Certified Firm</td>
</tr>
<tr>
<td>-------------</td>
<td>---------------------------------------------------------------------------------------------</td>
<td>-------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>TAB Field Supervisor</td>
<td>Test and Balance Engineer</td>
<td>Test and Balance Supervisor</td>
</tr>
</tbody>
</table>

E. TAB: Testing, adjusting, and balancing.
F. TAB Organization: Body governing practices of TAB Specialists.
G. TAB Specialist: An entity engaged to perform TAB Work.

1.05 INFORMATIONAL SUBMITTALS

A. Qualification Data: Within 30 days of Contractor's Notice to Proceed, submit documentation that the TAB specialist and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.
   1. Provide list of similar projects completed by proposed TAB field supervisor.
   2. Provide copy of completed TAB report, approved by mechanical engineer of record for a completed project with similar system types and of similar complexity.
   1. Submit examinations report with qualifications data.
D. Interim Reports. Submit interim reports as specified in Part 3. Include list of system conditions requiring correction and problems not identified in Contract Documents examination report.
E. Certified TAB reports.
   1. Provide three printed copies of final TAB report. Provide one electronic file copy in PDF format.
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.
      a. Instruments to be used for testing and balancing shall have been calibrated within a period of one year, or less if so recommended by instrument manufacturer. and be checked for accuracy prior to start of work.

1.06 QUALITY ASSURANCE

A. Independent TAB Specialist Qualifications: Engage a TAB entity certified by AABC or NEBB.
1. The certification shall be maintained for the entire duration of TAB work for this Project. If TAB specialist loses certification during this period, the Contractor shall immediately notify the Architect and submit another TAB specialist for approval. All work specified in this Section and in other related Sections performed by the TAB specialist shall be invalidated if the TAB specialist loses certification, and shall be performed by an approved successor.

B. To secure approval for the proposed TAB specialist, submit information certifying that the TAB specialist is either a first tier subcontractor engaged and paid by the Contractor, or is engaged and paid directly by the Owner. TAB specialist shall not be affiliated with any other entity participating in Work of this Contract, including design, furnishing equipment, or construction. In addition, submit evidence of the following:
   1. TAB Field Supervisor: Full-time employee of the TAB specialist and certified by AABC or NEBB.
      a. TAB field supervisor shall have minimum 10 years supervisory experience in TAB work.
   2. TAB Technician: Full-time employee of the TAB specialist and who is certified by AABC or NEBB as a TAB technician.
      a. TAB technician shall have minimum 4 years TAB field experience.

C. TAB Specialist engaged to perform TAB work in this Project shall be a business limited to and specializing in TAB work, or in TAB work and Commissioning.

D. TAB specialist engaged to perform TAB work shall not also perform commissioning activities on this Project.

E. Certified TAB field supervisor or certified TAB technician shall be present at the Project site at all times when TAB work is performed.
   1. TAB specialist shall maintain at the Project site a minimum ratio of one certified field supervisor or technician for each non-certified employee at times when TAB work is being performed.

F. Contractor shall notify Architect in writing within three days of receiving direction resulting in reduction of test and balance scope or other deviations from Contract Documents. Deviations from the TAB plan shall be approved in writing by the mechanical engineer of record for the Project.

G. TAB Standard:
   1. Perform TAB work in accordance with the requirements of the standard under which the TAB agencies' qualifications are approved unless Specifications contain different or more stringent requirements:
      a. AABC National Standards for Total System Balance, or
   2. All recommendations and suggested practices contained in the TAB standard are mandatory. Use provisions of the TAB standard, including checklists and report forms, to the extent to which they are applicable to this Project.
   3. Testing, adjusting, balancing procedures, and reporting required for this Project, and not covered by the TAB standard applicable to the TAB specialist engaged to perform the Work of this Contract, shall be submitted for approval by the design engineer.

H. TAB Conference: Meet with Architect and mechanical engineer on approval of the TAB strategies and procedures plan to develop a mutual understanding of the project requirements. Require the participation of the TAB field supervisor. Provide seven 'days' advance notice of
scheduled meeting time and location. TAB conference shall take place at location selected by Architect.

1. Agenda Items:
   b. The TAB plan.
   c. Coordination and cooperation of trades and subcontractors.
   d. Coordination of documentation and communication flow, including protocol for resolution tracking and documentation.

2. The requirement for TAB conference may be waived at the discretion of the mechanical engineer of record for the Project.

I. Certify TAB field data reports and perform the following:
   1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
   2. Certify that the TAB team complied with the approved TAB plan and the procedures specified and referenced in this Specification.


K. Instrumentation Type, Quantity, Accuracy, and Calibration: As described in ASHRAE 111, Section 5, "Instrumentation."

1.07 WARRANTY

A. Provide workmanship and performance warranty applicable to TAB specialist engaged to perform Work of this Contract:
   1. AABC Performance Guarantee.
   2. NEBB Quality Assurance Program.

B. Refer to Division 01 Specifications for additional requirements.

1.08 COORDINATION

A. Notice: Provide seven days' advance notice for each test. Include scheduled test dates and times.

B. Perform TAB after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

C. Coordinate TAB work with work of other trades.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.01 EXAMINATION

A. Contract Documents Examination Report:
   1. TAB specialist shall review Contract Documents, including plans and specifications. Provide report listing conditions that would prevent the system(s) from operating in accordance with the sequence of operations specified, or would prevent accurate testing and balancing:
a. Identify each condition requiring correction using equipment designation shown on Drawings. Provide room number, nearest building grid line intersection, or other information necessary to identify location of condition requiring correction.

b. Proposed corrective action necessary for proper system operation.

B. Examine systems for installed balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are accessible.

C. Examine the approved submittals for HVAC systems and equipment.

D. Examine design data including HVAC system descriptions, statements of design assumptions for environmental conditions and systems’ output, and statements of philosophies and assumptions about HVAC system and equipment controls.

E. Examine equipment performance data including fan and pump curves.
   1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.

F. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.

G. Examine test reports specified in individual system and equipment Sections.

H. Examine HVAC equipment and filters and verify that bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.

I. Examine terminal units, such as variable-air-volume boxes, and verify that they are accessible and their controls are connected and functioning.

J. Examine strainers. Verify that startup screens are replaced by permanent screens with indicated perforations.

K. Examine three-way valves for proper installation for their intended function of diverting or mixing fluid flows.

L. Examine heat-transfer coils for correct piping connections and for clean and straight fins.

M. Examine system pumps to ensure absence of entrained air in the suction piping.

N. Examine operating safety interlocks and controls on HVAC equipment.

O. Report conditions requiring correction discovered before and during performance of TAB procedures.

P. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.02 PREPARATION

A. Prepare a TAB plan that includes strategies and step-by-step procedures. TAB plan shall be specific to Project and include the following:
   1. General description of each air system and sequence(s) of operation.
   2. Complete list of measurements to be performed.
   3. Complete list of measurement procedures. Specify types of instruments to be utilized and method of instrument application.
   4. Qualifications of personnel assigned to Project.
   5. Single-line CAD drawings reflecting all test locations (terminal units, grilles, diffusers, traverse locations, etc.)
6. Air terminal correction factors for the following:
   a. Air terminal configuration.
   b. Flow direction (supply or return/exhaust).
   c. Effective area of each size and type of air terminal.
   d. Air density.

B. Complete system-readiness checks and prepare reports. Verify the following:
   1. Permanent electrical-power wiring is complete.
   2. 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.

3.03 GENERAL PROCEDURES FOR TESTING AND BALANCING
   A. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Total System Balance" or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" and in this Section.
   B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.
      1. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts.
      2. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Section 23 80 00 Heating, Ventilating, and Air Conditioning."
   C. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.
   D. Take and report testing and balancing measurements in inch-pound (IP) units.

3.04 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS
   A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.
   B. Test each system to verify building or space operating pressure, including all stages of economizer cycle. Maximum building pressure shall not exceed 0.03 inches of pressure.
   C. Except as specifically indicated in this Specification, Pitot tube traverses shall be made of each duct to measure airflow. Pitot tubes, associated instruments, traverses, and techniques shall conform to ASHRAE Handbook, HVAC Applications, and ASHRAE Handbook, HVAC Systems and Equipment.
      1. Use state-of-the-art instrumentation approved by TAB specialists governing agency.
2. Where ducts' design velocity and air quantity are both less than 1000 fpm/CFM, air quantity may be determined by measurements at terminals served.

D. Test holes shall be placed in straight duct, as far as possible downstream from elbow, bends, take-offs, and other turbulence-generating devices.

E. For variable-air-volume systems, develop a plan to simulate diversity.

F. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.

G. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.

H. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.

I. Verify that motor starters are equipped with properly sized thermal protection.

J. Check dampers for proper position to achieve desired airflow path.

K. Check for airflow blockages.

L. Check condensate drains for proper connections and functioning.

M. Check for proper sealing of air-handling-unit components.

N. Verify that air duct system is sealed as specified in Section 23 80 00 "Heating, Ventilating, and Air Conditioning."

O. Provide for adjustments or modifications to fan and motor sheaves, belts, damper linkages, and other components as required to achieve specified air balance at no additional cost to Owner.

P. Automatically operated dampers shall be adjusted to operate as indicated in Contract Documents. Controls shall be checked for proper calibration.

3.05 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.

1. Measure total airflow.
   a. Where sufficient space in ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow. Alternative methods shall be examined for determining total CFM, i.e., Pitot-tube traversing of branch ducts, coil or filter velocity profiles, prior to utilizing airflow values at terminal outlets and inlets.

2. Measure fan static pressures as follows to determine actual static pressure:
   a. Measure outlet static pressure as far downstream from the fan as practical and upstream from restrictions in ducts such as elbows and transitions.
   b. Measure static pressure directly at the fan outlet.
   c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from the flexible connection, and downstream from duct restrictions.
   d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.

3. Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and -treating equipment.
   a. Report the cleanliness status of filters and the time static pressures are measured.

4. Measure static pressures entering and leaving other devices, such as sound traps, heat-recovery equipment, and air washers, under final balanced conditions.
5. Review Record Documents to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.

6. Obtain approval from Architect for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in HVAC Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.

7. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.

B. Check operation of outside air dampers. Measure total outside air quantity at each stage of normal, economizer, power exhaust, or power exhaust economizer operation, as applicable to installed equipment. Adjust outside air dampers to provide 100 percent outside air in economizer mode. Ensure that outside air dampers close completely upon unit shutdown.

C. 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.

D. Measure air outlets and inlets without making adjustments.
   1. Measure terminal outlets using a direct-reading digital backflow compensating hood. Use outlet manufacturer’s written instructions and calculating factors only when direct-reading hood cannot be used due to physical obstruction or other limiting factors. Final report shall indicate where values listed have not been obtained by direct measurement.

E. Adjust air outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using branch volume dampers rather than extractors and the dampers at air terminals.
   1. Adjust each outlet in same room or space to within specified tolerances of indicated quantities without generating noise levels above the limitations prescribed by the Contract Documents, if included.
   2. Adjust patterns of adjustable outlets for proper distribution without drafts. Terminal air velocity at five feet above finished floor shall not exceed 50 feet per minute in occupied air conditioned spaces.

F. Do not overpressurize ducts.

3.06 PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS

A. Comply with applicable requirements for constant-volume air systems in addition to those listed below.

B. Compensating for Diversity: When the total airflow of all terminal units is more than the indicated airflow of the fan, place a selected number of terminal units at a minimum set-point airflow with the remainder at maximum-airflow condition until the total airflow of the terminal
units equals the indicated airflow of the fan. Select the reduced-airflow terminal units so they are distributed evenly among the branch ducts.

C. Pressure-Independent, Variable-Air-Volume Systems: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:

1. Set outdoor-air dampers at minimum, and set return- and exhaust-air dampers at a position that simulates full-cooling load.

2. Select the terminal unit that is most critical to the supply-fan airflow and static pressure. Measure static pressure. Adjust system static pressure so the entering static pressure for the critical terminal unit is not less than the sum of the terminal-unit manufacturer's recommended minimum inlet static pressure plus the static pressure needed to overcome terminal-unit discharge system losses.

3. Measure total system airflow. Adjust to within indicated airflow.

4. Set terminal units at maximum airflow and adjust controller or regulator to deliver the designed maximum airflow. Use terminal-unit manufacturer's written instructions to make this adjustment. When total airflow is correct, balance the air outlets downstream from terminal units the same as described for constant-volume air systems.

5. Set terminal units at minimum airflow and adjust controller or regulator to deliver the designed minimum airflow. Check air outlets for a proportional reduction in airflow the same as described for constant-volume air systems.

   a. If air outlets are out of balance at minimum airflow, report the condition but leave outlets balanced for maximum airflow.

6. Remeasure the return airflow to the fan while operating at maximum return airflow and minimum outdoor airflow.

   a. Adjust the fan and balance the return-air ducts and inlets the same as described for constant-volume air systems.

7. Measure static pressure at the most critical terminal unit and adjust the static-pressure controller at the main supply-air sensing station to ensure that adequate static pressure is maintained at the most critical unit.

8. Record final fan-performance data including optimum operating static control set point.

3.07 PROCEDURES FOR FUME HOODS

A. Fume Hood Air Flow Measurement Procedures:

1. Rooms under study cleared of all but study personnel.

2. All doors in rooms under study closed securely (unless otherwise indicated on fume exhaust hood data sheets) to simulate most adverse conditions.

3. Power supply to all fans operating the fume hoods in rooms under study activated.

4. All fume hood sashes positioned wide open or to facility or manufacturer required operating height.

5. Airflow data obtained by holding test instrument flush with and in plane of the hood sash.

6. With survey personnel standing well clear of the measurement area, record velocities on evenly spaced grid pattern with a maximum of 6 inches between test points. Test instrument shall record directional flow to ensure reverse flow conditions do not occur.

3.08 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS

A. Complete air balance prior to hydronic systems balancing.
B. 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 ranges given in article, Tolerances.

C. Prepare schematic diagrams of systems’ "as-built" piping layouts.

D. 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 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.

3.10 PROCEDURES FOR PRIMARY-SECONDARY HYDRONIC SYSTEMS
   A. Balance the primary circuit flow first and then balance the secondary circuits.

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.
      4. Efficiency rating.
      5. Nameplate and measured voltage, each phase.
      6. Nameplate and measured amperage, each phase.
      7. Starter manufacturer's name, model number, size, type, and thermal-protection-element rating.
         a. Starter strip heater size, type, and rating.
   B. Motors Driven by Variable-Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum. Test the manual bypass of the controller to prove proper operation. Record observations including name of controller manufacturer, model number, serial number, and nameplate data.

3.12 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.

3.13 PROCEDURES FOR TESTING, ADJUSTING, AND BALANCING EXISTING SYSTEMS

A. Perform a preconstruction inspection of existing equipment that is to remain and be reused. Measure and record the operating speed, airflow, and static pressure of each fan.
1. Measure motor voltage and amperage. Compare the values to motor nameplate information.
3. Check the condition of filters.
4. Check the condition of coils.
5. Check the operation of the drain pan and condensate-drain trap.
6. Check bearings and other lubricated parts for proper lubrication.
7. Report on the operating condition of the equipment and the results of the measurements taken. Report conditions requiring correction.

B. Before performing testing and balancing of existing systems, inspect existing equipment that is to remain and be reused to verify that existing equipment has been cleaned and refurbished. Verify the following:
1. New filters are installed.
2. Coils are clean and fins combed.
3. Drain pans are clean.
4. Fans are clean.
5. Bearings and other parts are properly lubricated.
6. Conditions requiring correction noted in the preconstruction report are corrected.

C. Perform testing and balancing of existing systems to the extent that existing systems are affected by the renovation work.
1. Compare the indicated airflow of the renovated work to the measured fan airflows, and determine the new fan speed and the face velocity of filters and coils.
2. Verify that the indicated airflows of the renovated work result in filter and coil face velocities and fan speeds that are within the acceptable limits defined by equipment manufacturer.
3. If calculations increase or decrease the air flow rates and water flow rates by more than 5 percent, make equipment adjustments to achieve the calculated rates. If increase or decrease is 5 percent or less, equipment adjustments are not required.
4. Balance each air outlet.

3.14 GENERAL PROCEDURES FOR PLUMBING SYSTEMS

A. Measure pressure drop across each backflow preventer assembly at design flows.

B. Measure water flow at pumps. Use the following procedures except for positive-displacement pumps:
1. Verify impeller size by operating the pump with the discharge valve closed. Read pressure differential across the pump. Convert pressure to head and correct for

TESTING, ADJUSTING, AND BALANCING FOR HVAC
23 05 93 - 11
differences in gage heights. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.

a. If impeller sizes must be adjusted to achieve pump performance, obtain approval from Architect and comply with requirements in Section 22 50 00 "Plumbing Equipment"

2. Check system resistance. With all valves open, read pressure differential across the pump and mark pump manufacturer's head-capacity curve. Adjust pump discharge valve until indicated water flow is achieved.

a. Monitor motor performance during procedures and do not operate motors in overload conditions.

3. Verify pump-motor brake horsepower. Calculate the intended brake horsepower for the system based on pump manufacturer's performance data. Compare calculated brake horsepower with nameplate data on the pump motor. Report conditions where actual amperage exceeds motor nameplate amperage.

4. Report flow rates that are not within range given in article, Tolerances.

C. Set calibrated balancing valves, if installed, at calculated presettings.

D. Measure flow at all stations and adjust, where necessary, to obtain first balance.

1. System components that have Cv rating or an accurately cataloged flow-pressure-drop relationship may be used as a flow-indicating device.

E. Measure flow at main balancing station and set main balancing device to achieve flow that is 5 percent greater than indicated flow.

F. Adjust balancing stations to within specified tolerances of indicated flow rate as follows:

1. Determine the balancing station with the highest percentage over indicated flow.

2. Adjust each station in turn, beginning with the station with the highest percentage over indicated flow and proceeding to the station with the lowest percentage over indicated flow.

3. Record settings and mark balancing devices.

G. Measure pump flow rate and make final measurements of pump amperage, voltage, rpm, pump heads, and systems' pressures and temperatures including outdoor-air temperature.

H. Measure the differential-pressure-control-valve settings existing at the conclusion of balancing.

I. Check settings and operation of each safety valve. Record settings.

3.15 TOLERANCES

A. Set HVAC system's air flow rates and water flow rates within the following tolerances:

1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus 10 percent and minus 0 percent.

2. Air Outlets and Inlets: Plus 5 percent and minus 5 percent.

3. Multiple outlets within single room: Plus 5 percent and minus 0 percent for total airflow within room. Tolerance for individual outlets within a single room having multiple outlets shall be as for "Air Outlets and Inlets".

a. Room shall be balanced to create pressure relationship (positive, negative, or neutral) with adjacent spaces as indicated on Drawings. Maintain airflow differentials between supply, return, and exhaust indicated on Drawings.

4. Heating-Water Flow Rate: Plus or minus 10 percent.

5. Cooling-Water Flow Rate: Plus or minus 10 percent.
B. Set plumbing systems water flow rates within plus or minus 10 percent.

3.16 REPORTING

A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for systems' balancing devices. Recommend changes and additions to systems' balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.

B. Interim Reports: Prepare periodic lists of conditions requiring correction and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

3.17 FINAL REPORT

A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.
1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing field supervisor. Report shall be co-signed by the Contractor, attesting that he has reviewed the report, and the report has been found to be complete and accurate.
2. The certification sheet shall be followed by sheet(s) listing items for which balancing objectives could not be achieved. Provide explanation for failure to achieve balancing objectives for each item listed.
3. Include a list of instruments used for procedures, along with proof of calibration.

B. Final Report Contents: In addition to certified field-report data, include the following:
1. Pump curves.
2. Fan curves.
3. Manufacturers' test data.
4. Field test reports prepared by system and equipment installers.
5. Other information relative to equipment performance; do not include Shop Drawings and product data.

C. General Report Data: In addition to form titles and entries, include the following data:
1. Title page.
2. Name and address of the TAB specialist.
3. Project name.
4. Project location.
5. Project Performance Guaranty
6. Architect's name and address.
7. Engineer's name and address.
8. Contractor's name and address.
10. Signature of TAB supervisor who certifies the report.
11. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
12. Summary of contents including the following:
   a. Indicated versus final performance.
b. Notable characteristics of systems.
c. Description of system operation sequence if it varies from the Contract Documents.

13. Nomenclature sheets for each item of equipment.
14. Data for terminal units, including manufacturer's name, type, size, and fittings.
15. Test conditions for fans and pump performance forms including the following:
   a. Settings for outdoor-, return-, and exhaust-air dampers.
   b. Conditions of filters.
   c. Cooling coil, wet- and dry-bulb conditions.
   d. Fan drive settings including settings and percentage of maximum pitch diameter.
   e. Settings for supply-air, static-pressure controller.
   f. 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 flow rates.
   3. Duct, outlet, and inlet sizes.
   4. Pipe and valve sizes and locations.
   5. Terminal units.

E. Air distribution outlets and inlets shall be shown on keyed plans with designation for each outlet and inlet matching designation used in Contract Documents and TAB test reports. Room numbers shall be included in keyed plans and test reports. Where multiple outlets and inlets are installed within a single room, a designation shall be assigned and listed for each outlet and inlet in addition to room number.

F. Test Reports – General:
   1. All test reports containing air or liquid flow data shall record flow values prior to system adjustment in addition to required data listed for each test report.

G. Air-Handling-Unit Test Reports: For air-handling units with coils, include the following:
   1. Unit Data:
      a. Unit identification.
      b. Location.
      c. Make and type.
      d. Model number and unit size.
      e. Manufacturer's serial number.
      f. Unit arrangement and class.
      g. Discharge arrangement.
      h. Sheave make, size in inches, and bore.
      i. Center-to-center dimensions of sheave, and amount of adjustments in inches.
      j. Number, make, and size of belts.
      k. Number, type, and size of filters.
   2. Motor Data:
a. Motor make, and frame type and size.
b. Horsepower and rpm.
c. Volts, phase, and hertz.
d. Full-load amperage and service factor.
e. Sheave make, size in inches, and bore.
f. Center-to-center dimensions of sheave, and amount of adjustments in inches.

3. Test Data (Indicated and Actual Values):
   a. Total air flow rate in cfm.
   b. Total system static pressure in inches wg.
   c. Fan rpm.
   d. Discharge static pressure in inches wg.
   e. Filter static-pressure differential in inches wg.
   f. Preheat-coil static-pressure differential in inches wg.
   g. Cooling-coil static-pressure differential in inches wg.
   h. Heating-coil static-pressure differential in inches wg.
   i. Outdoor airflow in cfm.
   j. Return airflow in cfm.
   k. Relief airflow in cfm.
   l. Outdoor-air damper position, normal and economizer, power exhaust, or power
      exhaust economizer modes, as applicable to installed equipment.
   m. Return-air damper position.
   n. Relief-air damper position, normal and economizer, power exhaust, or power
      exhaust economizer modes, as applicable to installed equipment.

H. Apparatus-Coil Test Reports:
   1. Coil Data:
      a. System identification.
      b. Location.
      c. Coil type.
      d. Number of rows.
      e. Fin spacing in fins per inch o.c.
      f. Make and model number.
      g. Face area in sq. ft.
      h. Tube size in NPS.
      i. Tube and fin materials.
      j. Circuiting arrangement.
   2. Test Data (Indicated and Actual Values):
      a. Air flow rate in cfm.
      b. Average face velocity in fpm.
      c. Air pressure drop in inches wg.
      d. Outdoor-air, wet- and dry-bulb temperatures in deg F.
      e. Return-air, wet- and dry-bulb temperatures in deg F.
      f. Entering-air, wet- and dry-bulb temperatures in deg F.
      g. Leaving-air, wet- and dry-bulb temperatures in deg F.
h. 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.

I. 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.

J. 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.
K. Air-Terminal-Device Reports:
   1. Unit Data:
      a. System and air-handling unit identification.
      b. Location and zone.
      c. Apparatus used for test.
      d. Area served.
      e. Make.
      f. Number from system diagram.
      g. Type and model number.
      h. Size.
      i. Effective area in sq. ft.
   2. Test Data (Indicated and Actual Values):
      a. Air flow rate in cfm.
      b. Air velocity in fpm.
      c. Preliminary air flow rate as needed in cfm.
      d. Preliminary velocity as needed in fpm.
      e. Final air flow rate in cfm.
      f. Final velocity in fpm.
      g. Space temperature in deg F.

L. 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.

M. Pump Test Reports: Calculate impeller size by plotting the shutoff head on pump curves and include the following:
   1. Unit Data:
      a. Unit identification.
      b. Location.
      c. Service.
      d. Make and size.
      e. Model number and serial number.
      f. Water flow rate in gpm.
      g. Water pressure differential in feet of head or psig.
h. Required net positive suction head in feet of head or psig.
i. Pump rpm.
j. Impeller diameter in inches.
k. Motor make and frame size.
l. Motor horsepower and rpm.
m. Voltage at each connection.
n. Amperage for each phase.
o. Full-load amperage and service factor.
p. Seal type.

2. Test Data (Indicated and Actual Values):
   a. Static head in feet of head or psig.
   b. Pump shutoff pressure in feet of head or psig.
   c. Actual impeller size in inches.
   d. Full-open flow rate in gpm.
   e. Full-open pressure in feet of head or psig.
   f. Final discharge pressure in feet of head or psig.
   g. Final suction pressure in feet of head or psig.
   h. Final total pressure in feet of head or psig.
   i. Final water flow rate in gpm.
   j. Voltage at each connection.
   k. Amperage for each phase.

N. Instrument Calibration Reports:
   1. Report Data:
      a. Instrument type and make.
      b. Serial number.
      c. Application.
      d. Dates of use.
      e. Dates of calibration.

3.18 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 10 percent of terminals.
      c. Measure room temperature at each thermostat/temperature sensor. Compare the
         reading to the set point.
      d. Verify that balancing devices are marked with final balance position.
      e. Note deviations from the Contract Documents in the final report.
B. Final Inspection:
   1. After initial inspection is complete and documentation by random checks verifies that testing and balancing are complete and accurately documented in the final report, request that a final inspection be made by Architect.
   2. The TAB specialist's test and balance engineer shall conduct the inspection in the presence of Architect.
   3. Architect shall randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to either 10 percent of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.
   4. If rechecks yield measurements that differ from the measurements documented in the final report by more than 10 percent, the measurements shall be noted as "FAILED."
   5. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.

C. TAB Work will be considered defective if it does not pass final inspections. If TAB Work fails, proceed as follows:
   1. Recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection.
   2. If the second final inspection also fails, Owner may contact the TAB specialists' governing organization for remedial action by the governing organization under the workmanship and performance warranty. See article, Warranty.
   3. If remedial action is not provided by the TAB specialists' governing organization in a timely manner, Owner may contract the services of another TAB specialist to complete the TAB Work according to the Contract Documents and deduct the cost of the services from the original TAB specialists' final payment.

D. Prepare test and inspection reports.

3.19 ADDITIONAL TESTS
A. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional TAB during near-peak summer and winter conditions.

END OF SECTION
SECTION 23 80 00

HEATING, VENTILATING AND AIR CONDITIONING

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Fans.
B. Air inlets and outlets.
C. Filters.
D. Dampers.
E. Ductwork.
F. Hydronic Piping.

1.02 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
B. Section 23 00 50, Basic HVAC Materials and Methods.
C. 23 05 93, Testing, Adjusting, and Balancing for HVAC.
D. Section 25 50 00, Automation Facility Controls.

1.03 ADDITIONAL REQUIREMENTS

A. Furnish and install any incidental work not shown or specified which is necessary to provide a complete and workable system.
B. Coordinate all of work in this Section with all of the Trades covered in other Sections of the Specifications to provide a complete, operable and sanitary installation of the highest quality workmanship.

1.04 DESCRIPTION OF WORK

A. Work of this section includes, but is not necessarily limited to Heating, Ventilating and Air Conditioning work indicated on the drawings and described herein.

1.05 QUALITY ASSURANCE

A. Design Criteria:
   1. All equipment and accessories to be the product of a manufacturer regularly engaged in its manufacture. All gas-fired equipment shall be UL, ETL or CSA listed.
   2. Supply all equipment and accessories in accordance with requirements of applicable national, state and local codes.
   3. All items of a given type shall be products of the same manufacturer.
   4. Scheduled equipment performance is minimum capacity required.
   5. Scheduled electrical capacity shall be considered as maximum available.
   6. Scheduled gas BTU input shall be considered as maximum available.
1.06 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data, including rated capacities of selected model clearly indicated, dimensions, weight, corner or mounting point weights, furnished specialties and accessories; and installation and start-up instructions. Product data shall include applicable product listings and standards. Refer to Section 23 00 50, Basic HVAC Material and Methods for additional requirements.
   1. Upon approval of submittal, provide manufacturer's installation and operating instructions to the Project inspector for the following:
      a. Fire dampers, smoke dampers, and combination smoke-fire dampers.

B. Roof Curb Data: For roof mounted equipment where combined weight of equipment unit and roof curb or rail exceeds 400 pounds, submit calculations from manufacturer for roof curbs proving compliance with the seismic requirements of the California Building Code, and ASCE 7-10. Manufacturer shall certify that roof curbs are suitable for use indicated on Drawings and in Specifications for the seismic design category indicated in structural Contract Documents. Calculations shall be stamped and signed by a State of California registered structural engineer.

C. Engineering Data: Submit fan curves and sound power level data for each fan unit. Data shall be at the scheduled capacity. Data shall include the name of the rating agency or independent laboratory.

D. Maintenance Data: Submit maintenance data and parts list for each piece of equipment, control, and accessory; including "trouble-shooting guide," in Operation and Maintenance Manual.

E. Record Drawings: At project close-out, submit Record Drawings of installed ductwork, duct accessories, and outlets and inlets in accordance with requirements of Division 01.

F. Product Data for California Green Building Standards Code Compliance: For adhesives and sealants, including primers, documentation of compliance including printed statement of VOC content and chemical components.

1.07 COORDINATED LAYOUT

A. Coordinated layouts are required to amplify, expand and coordinate the information contained in the Contract Documents.

B. Provide minimum 1/4 inch equals one foot scaled coordination drawings showing plan and pertinent section or elevation views of all piping, ductwork and electrical systems. Drawings shall be on vellum or sepia mylar, reproducible and 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 sheet. Contractor may use either size D (24 inch x 36 inch) or E (36 inch x 42 inch). Drawings graphics shall fully comply with A I A. Architectural Graphic Standards and ANSI Y14. Drawings may be hand drawn or computer generated using AutoCad or "Quick Pen". All drawings shall have title block, key plan, north arrow and sufficient grid lines to provide cross-reference to the design drawings.
   1. Provide a stamp or title block on each drawing with locations for signatures from all contractors involved, including but not limited to the General, HVAC, Plumbing, Fire Protection, and Electrical contractors. Include statement for signature that the contractor has reviewed the coordination drawings in detail and has coordinated the work of his trade.
   2. Show on drawings the intended elevation of all ductwork in accordance with the following example.
      B.O.D. = 9'-0"
      OFFSET UP 6"
B.O.D. = 9'-6"

3. Highlight, encircle or otherwise indicate deviations from the Contract Documents on the coordinated layouts. Architect will not be responsible for “finding” changes or deviations to the original Contract Documents.

C. Since scale of contract drawings is small and all offsets and fittings are not shown, contractor shall make allowances in bid for additional coordination time, detailing, fittings, offsets, hangers and the like to achieve a fully coordinated installation. If changes in duct size are required, equivalent area shall be maintained and the aspect ratio shall not be in excess of 2 to 1 unless approved by the engineer. Drawings shall be submitted for review prior to fabrication and installation. Drawings may be submitted in packages representing at least one quarter of the building ductwork.

D. Check routing on all ductwork before fabricating. Report any discrepancies to Architect. No extra cost will be allowed for failure to conform to above.

E. It shall be responsibility of the General Contractor to ensure that the Heating, Ventilating and Air Conditioning Contractor coordinates all of his work with all other trades, including mechanical and electrical trades, so that complete job is neat and in conformity with plans and specifications.

1.08 REFERENCES

A. AABC - Associated Air Balance Council
B. AFBMA - Anti Friction Bearing Manufacturer's Association
C. CSA – Canadian Standards Association International
D. AMCA - Air Moving and Control Association Inc.
   1. Standard 210 - Laboratory Methods of Testing Fans
E. ANSI - American National Standards Institute
F. ARI - Air-Conditioning and Refrigeration Institute
G. ASHRAE - American Society of Heating, Refrigerating and Air Conditioning Engineers
H. ASME - American Society of Mechanical Engineers
I. ASTM - American Society of Testing and Materials
J. CCR - California Code of Regulations
K. CSFM - California State Fire Marshal
L. NIST - National Institute of Standards and Technology
M. NEMA - National Electrical Manufacturer's Association
N. NFPA - National Fire Protection Association
O. OSHA - Occupational Safety and Health Act
P. SMACNA - Duct Manuals
Q. CBC - California Building Code
R. UL - Underwriters' Laboratories, Inc.
S. CMC - California Mechanical Code
T. CPC - California Plumbing Code
U. CEC - California Electrical Code
PART 2 - PRODUCTS

2.01 MATERIALS

A. Insulation products, including insulation, insulation facings, jackets, adhesives, sealants and coatings shall not contain polybrominated diphenyl ethers (PBDEs) in penta, octa, or deca formulations in amounts greater than 0.1 percent (by mass).

2.02 FANS

A. All fans shall be Air Moving and Control Association Inc. (AMCA) labeled.

B. Provide self-aligning, enclosed ball bearings, accessible for lubrication unless specified otherwise.

C. Provide variable speed switch for all direct drive fans.

D. Roof Mounted:
   1. Direct or V-belt Drive: Provide one-piece heavy-duty ventilator housings, one piece heavy gauge spun aluminum construction, with weatherproof assembly and integral weather shield. Mount ventilators on curbs furnished by the fan manufacturer. Install with fan assembly level.
   2. Fan wheels shall be centrifugal design, statically and dynamically balanced. Tip speed, rpm and motor horsepower shall not exceed listing in manufacturer's catalog for unit specified.
   3. Fans shall have integral factory formed base and one piece spinning without welding. Housings shall be provided with wiring channel and are to be of the direct discharge design. Motor and fan assembly shall be on vibration isolating mounts. Fans shall have capacity, speeds and motor sizes as shown.
   4. Provide the following accessories:
      a. Gravity backdraft dampers.
      b. Aluminum bird screen with a minimum of 85 percent free area.
      c. Adjustable motor pulley.
      d. Laboratory fume hood exhaust fans shall be Keysite coated.

E. Fan Drives:
   1. Drive Design: The design horsepower rating of each drive shall be at least 1.5 times, single belt drives 2 times, the nameplate rating of the motor with proper allowances for sheave diameters, speed ratio, arcs of contact and belt length.
   2. Provide variable speed drives, Dayco, Browning, Woods, or equal. Allow for replacement of fan and motor drives and belts as required to suit the balance requirements of the project.
   3. Select variable speed drives to allow an increase or decrease of minimum of ten percent of design fan speed.

F. Motors:
   1. Motors of 25 HP and less shall have adjustable pitch sheaves; sheaves on motors above 25 HP may be non-adjustable. Change, at no extra cost to Owner, the non-adjustable sheaves to obtain desired air quantities.
   2. For single-phase fan motors sized larger than 1/12 hp and smaller than 1 hp, refer to Article, Electric Motors, in Section 23 00 50, Basic HVAC Materials and Methods.

G. 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.
H. Belts:
   1. All belts shall be furnished in matched sets.
   2. Provide a minimum of two belts for all drives with motors 5 horsepower motors and larger.
   3. Belts shall be within 1 degree 30 minutes of true alignment in all cases.

I. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:
   Greenheck Fan Corporation
   Loren Cook Company
   PennBarry
   American Coolair Corporation

J. Owner Training: Manufacturer shall provide one on-site 1-hour training session for Owners' maintenance personnel.

2.03 AIR INLETS AND OUTLETS

A. Except as otherwise indicated, provide manufacturer's standard outlets and inlets where shown; of size, shape, capacity and type indicated; constructed of materials and components as indicated, and as required for complete installation.

B. Ceiling, wall or floor Compatibility: Provide outlets with border styles that are compatible with adjacent ceiling, wall or floor systems, and that are specifically manufactured to fit into ceiling, wall or floor module with accurate fit and adequate support. Refer to general construction drawings and specifications for types of ceiling systems that will contain each type of air outlet and inlet.

C. Refer to Schedule on Mechanical Drawings for details of inlets and outlets to be used.

2.04 AIR FILTERS

A. Provide MERV 8 disposable pleated media type. Refer to specific equipment Articles for filter depth and for exceptions to this specification. Filters shall conform to the following:

1. Standards:

2. Construction:
   a. Media: Synthetic or cotton-synthetic blend with radial pleats.
   b. Media Frame: High wet-strength beverage board.
   c. Media Support: Welded wire or expanded metal grid bonded to air leaving side of the media.

3. Performance: 2" deep filter shall have a maximum initial air resistance of 0.31 inches w.g.

B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:
   Camfil Farr, Inc., model 30/30.
   Flanders Corporation, model 40 LPD.

C. Temporary (Construction Period) Filters:
   1. Install new temporary filters in all units that have filter systems installed. Temporary filters shall match the permanent filters that are specified for the units. Replace filters as
needed, in accordance with manufacturer’s directions, in order to provide protection for the unit prior to occupancy by the Owner.

2. If air handling units are operated during construction of the project, install temporary filters directly over each return air inlet. Filters shall match the permanent filters that are specified for the units. Select size of filter to completely cover the frame of the return air inlet, and tape filters firmly in place to eliminate any construction debris from entering the duct system or unit. Remove the temporary filters upon completion of the work, and repair all damaged paintwork.

D. Spare Filters:
1. Furnish two new, complete sets of filter cartridges for each filter bank on completion and acceptance of the work. Install one set of filters in units (prior to final air balance) and leave the remaining filters in location designated by the Owner. Provide units designed to accommodate washable, permanent filters with one washable, permanent filter.

2.05 FILTER GAUGE
A. Furnish and install for each bank of air filters at air handlers a magnehelic air filter gauge.
1. Provide 0 to 1 inch range for pre-filter systems, with a permanent red line to indicate change out pressure.
2. Provide 0 to 2 inch range for final filter systems, with a permanent red line to indicate change out pressure.

2.06 DAMPERS
A. Manual Air and Balance Dampers: Provide dampers of single blade type or multi-blade type constructed in accordance with SMACNA, "HVAC Duct Construction Standards," except as noted herein.
1. Rectangular Ductwork:
   a. Single damper blades may be used in ducts up to 10 inches in height. Dampers shall be 16 gauge minimum. Provide self-locking regulators, equal to Ventlok 641. Provide end bearings equal to Ventlok 607 at each damper. Provide continuous solid 3/8 inch square shafts.
   b. Multiple blade dampers shall be equal to Ruskin CD35 Standard Control Damper. Maximum width for multiple damper blades for use in rectangular duct shall not exceed 6 inches.
   c. Where duct velocity may be expected to exceed 1500 fpm, provide Ruskin CD-50, or equal, low leakage dampers with airfoil blades.
2. Round Ductwork:
   a. Single damper blades may be used in ducts up to 12 inches in diameter. Provide multiple blade opposed blade dampers, with connected linkage, for ductwork larger than 12 inches in diameter.
   b. Damper blades for round ductwork shall be 20 gauge steel for ducts up to 12 inches diameter and 16 gauge steel for dampers larger than 12 inches damper. Provide self-locking regulators, equal to Ventlok 641, Durodyne, or equal for operation of dampers. Provide end bearings equal to Ventlok 607 and provide continuous solid 3/8 inch square shafts.
3. Where ductwork is externally insulated, provide self-locking regulators equal to Ventlok 644, Durodyne, or equal for rectangular ductwork, and Ventlok 637, Durodyne, or equal for round ducts.
B. Fire Dampers and Combination Fire/Smoke Dampers:

1. Fire dampers and combination fire/smoke dampers shall be listed and approved by the California State Fire Marshal. Installation shall conform to the manufacturer’s UL approved installation instructions.

a. Fire dampers shall be UL 555 classified and labeled as dynamic fire dampers approved for wall and floor installation. They shall ship from the manufacturer as an assembly with a minimum 20-gauge factory installed sleeve. Sleeve length shall suit the requirements of the wall construction. Each dynamic fire damper/sleeve assembly shall ship complete with factory “roll formed” one-piece angles with pre-punched holes for easy installation. Dynamic fire dampers for vertical installation must consist of a single section on sizes up to 33” x 36” and a single section on sizes up to 24” x 24” for horizontal installation. 1-1/2 hour dynamic fire dampers shall be Ruskin DIBD20, Pottorff. 3 hour dynamic fire dampers shall be Ruskin DIBD230, Pottorff.

b. Fire dampers for high pressure/velocity systems where velocities exceed 2000 fpm and/or 4” w.g. pressure fire damper shall be Ruskin FD60 or equal by Pottorff.

c. Fire dampers for ceiling installation shall be UL 555C classified and labeled as ceiling dampers. They shall be provided with a thermal insulating blanket to fit the inlet or outlet condition if required by the application. Ceiling dampers shall be Ruskin CFD 2, 3, 4 or 5. Ceiling dampers for ceilings constructed of wood shall have UL tested in design L501 and shall be Ruskin CFD7, equal by Pottorff.

d. Combination fire/smoke dampers. Dampers shall be UL classified and labeled as Leakage Class I Smoke Dampers in accordance with the latest version of UL 555S. Dampers shall be warranted to be free from defects in material and workmanship for a period of 5 years after date of shipment. Damper/actuator assembly shall be tested to full open and full close at minimum 2000 fpm 250°F heated air and 4” w.g. with airflow in both directions. (Specified select: 250° / 350°, 2000 fpm/3000 fpm). Each damper shall be equipped with EZ reset “controlled closure” quick detect heat actuated release device to prevent duct and HVAC component damage resulting from instantaneous damper closure. Release device shall be EFL type and shall allow easy reset from outside the sleeve after moderate temperature exposure. (Replacement type fusible links not acceptable.)

e. Two position combination fire smoke dampers shall be equipped with one or more factory installed, direct coupled, 120 volt, single phase, electric actuator for energize open – fail close operation. Dampers with multiple actuators shall be factory wired with single point connection at the EFL heat release devise for connection to poser. Damper actuator shall include minimum one-year energized hold open (no cycles) and spring return (fail) close reliability. Damper/actuator shall include minimum 20,000 full open-full close cycle performances.

f. Modulating combination fire smoke dampers shall be equipped with one or more factory installed contact for modulating signal connection. Damper/actuator shall include minimum 100,000 full open-full close cycle performances with spring return (fail) close on loss of power.

g. Round combination fire smoke dampers up to 24” diameter shall be true round type with minimum 2- gauge minimum galvanized designed for lowest pressure drop and noise performance. Bearings shall be stainless steel sleeve turning in an extruded hole in the frame. Blade seals shall be silicone edge designed to withstand 450° F and galvanized steel mechanically locked in to the blade edge (adhesive type seals are not acceptable). Each damper shall be equipped with a factory-installed sleeve of 17” minimum length and factory “roll formed” one-piece angles with pre-punched holes for easy installation. Dampers shall be Ruskin FSDR25 or equal by Pottorff.
h. Round (larger than 24" diameter) or rectangular combination fire smoke dampers shall include roll-formed structural hat channel frame, reinforced at the corners, formed from a single piece of minimum 16 gauge equivalent thickness formed from single piece galvanized steel. Bearings shall be stainless steel turning in an extruded hole in the frame. Blade edge seals shall be silicone rubber designed to withstand 450° F and galvanized steel mechanically locked in to the blade edge (adhesive type seals are not acceptable). Each damper shall be equipped with a factory-installed sleeve of 17" minimum length and factory “roll formed” one-piece angles with pre-punched holes for easy installation. Dampers shall be Ruskin FSD60 or equal by Pottorff.

i. 3-hour rated combination fire smoke dampers shall be Ruskin model FSD60-3 or equal by Pottorff.

j. All FSD60 type dampers shall be AMCA licensed and shall bear the AMCA Seal for Air Performance. AMCA certified testing shall verify pressure drop does not exceed .03” w.g. at a face velocity of 1,000 fpm on a 24” x 24” damper.

k. Wall type fire/smoke damper:

1) Combination fire/smoke dampers for use in the wall of exit corridors shall be classified and labeled as Leakage Class II Smoke Dampers in accordance with the latest version of UL 555S. Dampers shall meet the requirements for combination fire/smoke dampers in paragraph 3 above except AMCA certified testing shall verify pressure drop does not exceed .07” w.g. at a face velocity of 1,000 fpm on a 24” x 24” damper and blades shall be single skin galvanized steel 10 gauge minimum with 3 longitudinal grooves for reinforcement. Dampers shall be Ruskin FSD36 or equal by Pottorff.

2) Front access combination fire/smoke dampers shall meet all the requirements for combination fire/smoke dampers in paragraph 3 above except pressure drop requirement. In addition the dampers shall be constructed so that actuators and all accessories are accessible from the grille side. Actuators and accessories shall be housed within an integral cabinet on the side of the damper frame and shall not be installed in the air stream in front of the damper. The damper sleeve shall be minimum 14” and flanged to accept a steel framed grille. The sleeve shall be covered with fire resistant material. Dampers shall be Ruskin FSD60FA or equal by Pottorff.

l. Ceiling type fire/smoke damper for tunnel type corridor construction: Combination fire/smoke dampers for use in the corridor ceiling of tunnel type corridor construction shall be UL classified and labeled as Corridor Damper. Dampers shall meet the requirements of paragraph 4a above except pressure drop testing does not require AMCA certification. Dampers shall be Ruskin FSD36C or equal by Pottorff.

m. Fusible links shall have temperature rating approximately 50° F above normal maximum operating temperature of the heat producing appliance.

1) If project requires re-openable fire/smoke dampers, provide Ruskin 165 ° F / 350° F TS150, NCA or equal. The TS150 firestat replaces the EFL and allows the damper to be re-opened from remote location up to 350 ° F. TS150 shall include full open and full closed damper position contacts for interface with remote position indication panel.

2) Each fire/smoke damper shall be equipped with "controlled closure" quick detect heat actuated release device to prevent duct and HVAC component damage. Release device shall allow easy reset after moderate temperature
rise outside the sleeve. Heat release device shall be the Ruskin EFL, NCA or equal.

3) Unless the system is using a validation control system, each fire/smoke damper shall be equipped with a control panel including blade position indicator lights and a key operated switch. The panel cover shall be oversized for flush mount into the wall or ceiling and shall have a brushed look. Control panel shall be Ruskin MCP2, or equal by Potterff.

2. All actuators used for smoke dampers or combination fire/smoke dampers shall have a cycle time requirement of not more than every twelve months and shall be rated for continuous "0n" duty and shall be provided with internal spring return. Actuators shall be equipped with pilot light, remote key test switch, end switch and circuitry to activate pilot light on remote key (test) switch located in corridor ceiling adjacent to damper. Electric motors shall be Invensys MA-250, MA-253, Honeywell H2000, or equal.

2.07 DUCTWORK

A. Construct and install sheet metal ductwork in accordance with the California Mechanical Code for 4 inches static pressure upstream of Lab Valve terminal units and 2 inches minimum downstream of Lab Valve terminal units for supply air, and 2 inches minimum for return and exhaust air unless otherwise noted on Drawings.


2. Provide variations in duct size, and additional duct fittings as required to clear obstructions and maintain clearances as approved by the Architect at no extra cost to the Owner.

3. Gauges, joints and bracing shall be in accordance with the California Mechanical Code.

4. Provide beading or cross breaking for all ductwork inside building. Provide cross breaking for ductwork exposed to weather.

5. At the contractor's option, ductwork may be fabricated using the Ductmate, Nexus, Quickduct, Transverse Duct Connection (TDC), Pyramid-Loc duct connection systems, or equal. Fabricate in strict conformance with manufacturer's written installation instructions and in accordance with California Mechanical Code.

   a. Seal flanged ends with pressure sensitive high density, closed cell neoprene or polyethylene tape gasket, Thermo 440, or equal.

   b. Provide metal clips for duct connections, except at breakaway connections for fire dampers and fire smoke dampers. Provide corner clips at each corner of duct, through bolted, at all locations except at breakaway connections for fire dampers and fire smoke dampers. Where used on locations exposed to weather, provide continuous metal clip at top and sides of duct, with 1 inch overhang for top side.

B. Design and installation standards:

1. SMACNA Compliance: Comply with applicable portions of Sheet Metal and Air Conditioning Contractor's National Association (SMACNA) for all work in this section.


C. Fabricate all ductwork with sheet metal. Fiberglass ductwork will not be accepted for use on this project.
D. Duct sizes indicated are external sizes.

E. Galvanized Sheet Steel: Lock-forming quality, ASTM A924 and ASTM A653, Coating Designation G 90. Provide mill phosphatized finish for exposed surfaces of ducts exposed to view.
   1. Provide mill certification for galvanized material at request of the Project Inspector.

F. Duct Sealing:
   1. Sealant shall have a VOC content of 250 g/L or less.
   2. Sealant shall comply with testing and product requirements of South Coast Air Quality Management District, Rule 1168.
   3. Seal air-tight all joints and seams, including standing seams and manufactured joints and seams, of all supply, return and exhaust ducts except those exposed in conditioned space. Provide one part, non-sag, synthetic latex sealant, formulated with a minimum of 68 percent solids. Sealant shall comply with ASTM E84, Surface Burning Characteristics.
      a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:
         1) Design Polymeric, model DP1010
         2) Polymer Adhesive Sealant Systems Inc, model Airseal #11
         3) McGill Airseal, LLC
   4. Seal air-tight and watertight joints and seams of ductwork exposed to weather with 6 ounce canvas bonded to ductwork with Foster 30-36 adhesive; cover canvas with heavy coat of Foster 56-10 coating, no dilution. Provide basis of design product or equal by Mon-Eco Industries, Inc., or McGill Airseal, LLC.
      a. Pressure-sensitive tapes or single part sealant not acceptable.
      b. Where seams are exposed to weather, paint seams with aluminum paint. Provide cross broken ductwork, and ensure that the ductwork will shed water. Beading of duct work exposed to weather will not be considered acceptable.

G. Provide sheet metal angle frame at all duct penetrations to wall, floor, roof, or ceiling.

H. Duct Support Materials: Except as otherwise indicated, provide hot-dipped galvanized steel fasteners, anchors, straps, trim, and angles for support of ductwork.

I. Rectangular Duct Fabrication:
   1. Shop fabricate ductwork of gauges and reinforcement complying with the more stringent of the following standards, except as noted herein.
      a. SMACNA HVAC Duct Construction Standards
      b. California Mechanical Code
   2. Fabricate ducts for 2 inch pressure class with minimum duct gauges and reinforcement as follows, except as otherwise noted:

<table>
<thead>
<tr>
<th>Duct Dimension</th>
<th>Minimum Gauge</th>
<th>Joint Reinforcement Per CMC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Through 12&quot;</td>
<td>26</td>
<td>Not Required</td>
</tr>
<tr>
<td>13&quot; through 18&quot;</td>
<td>24</td>
<td>Not Required</td>
</tr>
<tr>
<td>19&quot; through 30&quot;</td>
<td>24</td>
<td>C/4</td>
</tr>
<tr>
<td>31&quot; through 42&quot;</td>
<td>22</td>
<td>E/4</td>
</tr>
</tbody>
</table>
43" through 54"  22  F/2
55" through 60"  20  G/4
61" through 84"  20  I/2
85" through 96"  20  J/2
Over 96"      18  K/2

3. Fabricate duct fittings to match adjoining ducts and to comply with duct requirements as applicable to fittings. Except as otherwise indicated, fabricate elbows with center-line radius equal to 1.5 times associated duct width. Fabricate to include single thickness turning vane in elbows where space does not permit the above radius or where square elbows are shown. Limit angular tapers to 30 degrees for contracting tapers and 20 degrees for expanding tapers. Turning vanes shall be E-Z Rail II, Durodyne, or equal.

4. Fabricate round supply connections at rectangular, plenum type fittings using spin-in type fittings, complete with extractor and volume control damper. Refer to Paragraph “DAMPERS” for damper requirements.

5. Provide drive slip or equivalent flat seams for ducts exposed in the conditioned space or where necessary due to space limitations. On ducts with flat seams, provide standard reinforcing on inside of duct. Duct connection to outlet on exposed duct shall be full size of outer perimeter of outlet flange.

6. Ducts exposed in the conditioned space shall be free of dents and blemishes and be mounted tight against adjacent surface with flat hangers. Remove all fabrication labels from ductwork.

7. Provide 20 gauge minimum for ductwork exposed within occupied spaces.

J. Rectangular Internally Insulated Duct Fabrication:

1. Provide internal duct lining where indicated on the Drawings, with a minimum of 10'-0" length in each direction from the fan, fan casing, or unit casing. Line all transfer ducts.
   a. Where ductwork is exposed to weather or outside the building insulation envelope, provide 2 inch thick, 1-1/2 pound density internal lining with matte facing, with an R-Value of 8.0 minimum.
   b. Where ductwork is within the building insulation envelope, lining shall be 1" thick, 1-1/2 pound density, with R-value of 4.2 minimum.
   c. Ducts exposed in the conditioned space shall be free of dents and blemishes and be mounted tight against adjacent surface with flat hangers. Remove all fabrication labels from ductwork.
   d. Where installed exposed in the conditioned space, duct shall be minimum 20 gauge with 1 inch insulation layer (minimum R-value – R-4.2).
   e. Cement duct liner in place with nonflammable, non-hardening duct adhesive. Seal all raw edges of insulation inside ductwork with adhesive, including longitudinal liner edges.
   f. Provide metal nosing at all locations where liner is preceded by unlined metal.
   g. Provide sheet metal weld pins and washers or clinch pins and washers on all ductwork on 12 inch intervals with the first row within 3 inches of the leading edge of each piece of insulation and within 4 inches of corners. No use of adhesive mounted pins will be considered.
      1) Install clinched pin fasteners with properly adjusted automatic fastening equipment. Manual installation will not be considered.
2) Install weld pins with properly adjusted automatic fastening equipment. Installation shall not damage the galvanized coating on the outside of the duct.

h. All ductwork, adhesives, lining, sealant, flex duct and the like shall have a flame spread of 25 or less and developed smoke rating of 50 or less when tested in accordance with one of the following test methods: NFPA 255, ASTM E84, or UL 723.

i. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>Product</th>
</tr>
</thead>
<tbody>
<tr>
<td>Johns Manville</td>
<td>Duct Liner PM</td>
</tr>
<tr>
<td>CertainTeed Corporation</td>
<td>ToughGard</td>
</tr>
<tr>
<td>Fosters Adhesive</td>
<td>85-62</td>
</tr>
<tr>
<td>Swifts Adhesive</td>
<td>7336</td>
</tr>
</tbody>
</table>

K. Round and Oval Ductwork Fabrication:

1. Round and oval duct and fittings shall be spiral lockseam or longitudinal seam as indicated in table below. Provide couplings to join each length of duct.

   a. At contractors' option, round or oval ductwork may be utilized in place of rectangular ductwork shown on Drawings, provided available space allows installation of round or oval ductwork without compromising space required for installation of products and systems of other trades.
      1) Round or oval ductwork utilized in place of rectangular ductwork shown on Drawings shall be sized to have a static pressure loss equivalent to rectangular duct shown on Drawings.
      2) Unlined round or oval duct shall not be utilized in place of rectangular internally lined ductwork shown on Drawings.

2. Fabricate duct fittings to match adjoining ducts and to comply with duct requirements as applicable to fittings. Except as otherwise indicated, fabricate elbows with center-line radius equal to 1.5 times associated duct width. Provide two-piece, die-stamped, 45-degree to 90-degree elbows for sizes up to 12 inches; five-piece, 90-degree elbows for sizes 12 inches and above; conical tees; and conical laterals. All reducers shall be placed after a tap has been made on the duct main. Reducers shall be long-taper style.

3. Round Ductwork: Construct of galvanized sheet steel complying with ANSI/ASTM A 653 by the following methods and in minimum gauges listed.

<table>
<thead>
<tr>
<th>Diameter</th>
<th>Minimum Gauge</th>
<th>Method of Manufacture</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to 14&quot;</td>
<td>26</td>
<td>Spiral Lockseam</td>
</tr>
<tr>
<td>15&quot; to 23&quot;</td>
<td>24</td>
<td>Spiral Lockseam</td>
</tr>
<tr>
<td>24&quot; to 36&quot;</td>
<td>22</td>
<td>Spiral Lockseam</td>
</tr>
<tr>
<td>37&quot; to 50&quot;</td>
<td>20</td>
<td>Spiral Lockseam</td>
</tr>
<tr>
<td>51&quot; to 60&quot;</td>
<td>18</td>
<td>Spiral Lockseam</td>
</tr>
</tbody>
</table>
4. Provide locked seams for spiral duct; fusion welded butt seam for longitudinal seam duct.

5. Fittings and Couplings: Construct of minimum gauges listed. Provide continuous welds along seams at exposed ducts. Provide spot weld bonded seams at concealed ducts.

<table>
<thead>
<tr>
<th>Diameter</th>
<th>Minimum Gauge</th>
</tr>
</thead>
<tbody>
<tr>
<td>3&quot; to 36&quot;</td>
<td>20</td>
</tr>
<tr>
<td>38&quot; to 50&quot;</td>
<td>18</td>
</tr>
<tr>
<td>Over 50&quot;</td>
<td>16</td>
</tr>
</tbody>
</table>

6. Ducts exposed in the conditioned space shall be free of dents and blemishes and be mounted tight against adjacent surface with flat hangers. Remove all fabrication labels from ductwork.

7. Provide 20 gauge minimum for ductwork exposed within occupied spaces.

L. Round Internally Insulated Duct and Fittings: Where ductwork is exposed to weather or outside the building insulation envelope, construct with outer pressure shell, 2 inch thick (Minimum R-value = R-8) insulation layer, and perforated inner liner. Where ductwork is within the building insulation envelope, construct with outer pressure shell, 1 inch thick (minimum R-value = R4.2) insulation layer, and perforated inner liner. Construct shell and liner of galvanized sheet steel complying with ANSI/ASTM A 653, of spiral lockseam construction (use longitudinal seam for over 59 inches), in minimum gauges listed in table below. Where installed exposed in the conditioned space: duct and fitting outer pressure shell shall be minimum 20 gauge with 1 inch insulation layer (minimum R-value = R-4.2), and perforated inner liner.

<table>
<thead>
<tr>
<th>Nominal Duct Diameter</th>
<th>Outer Shell</th>
<th>Inner Liner</th>
</tr>
</thead>
<tbody>
<tr>
<td>3&quot; TO 12&quot;</td>
<td>26 gauge</td>
<td>24 gauge</td>
</tr>
<tr>
<td>13&quot; TO 24&quot;</td>
<td>24 gauge</td>
<td>24 gauge</td>
</tr>
<tr>
<td>25&quot; to 34&quot;</td>
<td>22 gauge</td>
<td>24 gauge</td>
</tr>
<tr>
<td>35&quot; to 48&quot;</td>
<td>20 gauge</td>
<td>24 gauge</td>
</tr>
<tr>
<td>49&quot; to 58&quot;</td>
<td>18 gauge</td>
<td>24 gauge</td>
</tr>
<tr>
<td>Over 59&quot;</td>
<td>16 gauge</td>
<td>20 gauge</td>
</tr>
</tbody>
</table>

1. Fittings and Couplings: Construct of minimum gauges listed. Provide continuous weld along seams of outer shell at exposed ducts. Provide spot weld bonded seams at concealed ducts.

<table>
<thead>
<tr>
<th>Nominal Duct Diameter</th>
<th>Outer Shell</th>
<th>Inner Liner</th>
</tr>
</thead>
<tbody>
<tr>
<td>3&quot; to 34&quot;</td>
<td>20 gauge</td>
<td>24 gauge</td>
</tr>
<tr>
<td>36&quot; to 48&quot;</td>
<td>18 gauge</td>
<td>24 gauge</td>
</tr>
<tr>
<td>Over 48&quot;</td>
<td>16 gauge</td>
<td>24 gauge</td>
</tr>
</tbody>
</table>

2. Inner Liner: Perforate with 3/32 inch holes for 22 percent open area. Provide metal spacers welded in position to maintain spacing and concentricity.
3. Ducts exposed in the conditioned space shall be free of dents and blemishes and be mounted tight against adjacent surface with flat hangers. Remove all fabrication labels from ductwork.

4. Where installed exposed in the conditioned space, duct shall be minimum 20 gauge with 1 inch insulation layer (minimum R-value – R-4.2).

5. All ductwork, adhesives, lining, sealant, flex duct and the like shall have a flame spread of 25 or less and developed smoke rating of 50 or less when tested in accordance with one of the following test methods: NFPA 255, ASTM E84, or UL 723.

6. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:
   a. Sheet Metal Div., McGill Airflow, LLC., Acousti-k27
   b. Semco Duct and Acoustical Products, Inc.
   c. Air Systems Manufacturing, Inc. - Las Vegas

M. Duct Access Doors:

1. Duct Access: Provide hinged access door in rectangular ducts for access to fire dampers, control equipment, etc. Access door size shall be duct diameter wide by duct diameter high for all ducts under 24 inches. Ducts over 24 inches in diameter shall have 24-inch by 18-inch access doors. Minimum size access doors shall be 6 inches by 6 inches.

2. Provide hinged style access doors for round ductwork, NCA Manufacturing, Inc., Model AD-RD-87, Pottorf Series 60, or equal. Access doors shall be 16 gauge galvanized steel with continuous piano hinge. Locks shall be plated steel strike and catch. Provide 1" x 3/8" Polyethylene "Perma Stik" gasket all around door.

N. Flexible Air Ducts:

1. Provide exterior reinforced laminated vapor barrier, fiberglass insulation, encapsulated spring steel wire Helix, and impervious, smooth, non-perforated interior vinyl liner. Individual lengths of flexible ducts shall contain factory fabricated steel connection collars.
   a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:
      C.A. Schroeder, Inc., Cal Flex model 2PMJ
      ThermaFlex model M KC

2. Factory made air ducts shall be approved for the use intended and shall conform to the requirements of UL 181 and NFPA 90A. Each portion of a factory-made air duct system shall be identified by the manufacturer with a label or other suitable identification indicating compliance with UL 181, Class 1. Ducts shall be UL listed Class 1, maximum 25/50 smoke and flame spread and shall be installed in accordance with the terms of their listing and the requirements of SMACNA HVAC Duct Construction Standards (Metal and Flexible). Factory-made air ducts shall have the following minimum R-values: R-6.0 for ductwork installed within the building insulation envelope, R-8.0 for ductwork installed outside the building insulation envelope.

3. Flexible ductwork shall be maximum of 8 feet long, and shall be extended to the fullest possible length, in order to minimize pressure drop in the duct.

4. Flexible ducts shall be selected for minimum of 6 inch positive static pressure and minimum of 1 inch negative static pressure.

5. Duct Access Panels:
   a. Provide duct access panel assembly of the same material and gauge used for the duct. Duct access panels shall conform to the following:
1) Fasteners: Black steel or stainless steel to match material used for the duct. Panel fasteners shall not penetrate duct wall.

2) Gasket: Comply with NFPA 96, grease-tight, high temperature ceramic fiber, rated for minimum 1500 °F.

O. Fume hood exhaust ductwork: Provide 304 Stainless steel, all welded joints for fittings, 22 gauge minimum, except 20 gauge minimum where exposed to weather. Prefabricated United McGill Corp. Low Pressure Spiral stainless steel duct and fittings, Semco Manufacturing, or equal, may be used. Assemble with acid-resistant duct sealant and stainless steel screws.

P. Provide Vention, or equal, flexible connections on inlet and outlet of AC Unit, air handler and exhaust fans. Provide galvanized weather hood over flexible connections exposed to the weather.

2.08 HYDRONIC PIPING

A. Provide piping materials and factory-fabricated piping products of sizes, types, pressure ratings, temperature ratings, and capacities as indicated. Provide materials and products complying with California Mechanical Code. Where more than one type of material or product is indicated, selection from materials or products specified is Contractor's option.

B. Chilled Water and Heating Hot Water Piping shall match existing piping to which it is being connected, Contractor shall field confirm if copper or steel, then provide the following as applicable:

1. Copper Tube and Fittings Aboveground:

2. Steel Pipe and Fittings Aboveground:
   a. 2 inches and smaller: ASTM A 53/A 53M, Schedule 40 black steel with plain ends, 150 psig minimum working pressure at 200 deg. F. Provide malleable-iron threaded fittings, ASTM B16.3, Class 150, and unions, ASTM B16.39, Class 150, and cast-iron flanges and flange fittings, and threaded joints.
   b. 2-1/2 inches and larger: ASTM A 53/A 53M, Schedule 40 black steel with plain ends, 150 psig minimum working pressure at 200 deg. F. Provide wrought-steel fittings, ASTM A 234/A 234M, and wrought-cast or forged-steel flanges and flange fittings, ASME B16.5, material group 1.1, with butt welding end connections and raised face.

2.09 TEMPERATURE CONTROL SYSTEM

A. Refer to Section 25 50 00, Automation Facility Controls

PART 3 - EXECUTION

3.01 ROOF MOUNTED EQUIPMENT

A. Mount and anchor equipment in strict compliance with drawings details. Alternate anchorage methods will not be considered for roof mounted equipment.

B. Examine rough-in for roof mounted equipment to verify actual locations of piping and duct connections prior to final equipment installation.
C. Verify that piping to be installed adjacent to roof mounted equipment allows service and maintenance.

D. Install ducts to termination at top of roof curb and install heavy duty rubber gaskets on supply and return openings and on full perimeter of curb, or as required for an airtight installation, prior to setting unit on curb.

E. Cover roof inside each roof mounted air conditioning unit, heat pump unit, and heating and ventilating unit roof curb with 2 inch thick, 3 pound density fiberglass insulation board.

F. Connect supply and return air ducts to horizontal discharge roof mounted equipment with flexible duct connectors specified elsewhere in these Specifications.

G. Remove roof decking only as required for passage of ducts. Do not cut out decking under entire roof curb.

3.02 INSTALLATION OF FANS

A. Provide access doors for fans or motors mounted in ductwork.

B. Mount all fans as detailed on Drawings and in compliance with CBC standards.

C. Fan motors mounted in air-stream to be totally enclosed.

D. Completely line supply, return or exhaust fan cabinets with 1 inch thick, 3/4 pound density acoustic insulation securely cemented in place.

E. Roof fans shall be mounted level.

F. Provide heavy-duty rubber gasket between exhaust fan mounting flange and roof curb, or as required for an airtight installation.

G. Label fume hood fans with sign "CAUTION - HAZARDOUS EXHAUST."

3.03 AIR INLETS AND OUTLETS

A. Provide all air inlets and outlets with gaskets and install so that there will be no streaking of the walls or ceilings due to leakage. Duct connection to outlet on exposed duct shall be full size of outer perimeter of outlet flange.

B. Unless otherwise indicated on Drawings, provide rectangular plenum on top of each diffuser and ceiling return for connection to ductwork. Line plenum with internal insulation as indicated for lined ductwork. Size plenum to allow full opening into air terminal.

C. Ceiling-mounted air terminals or services installed in T-Bar type ceiling systems shall be positively attached to the ceiling suspension main runners or to cross runners with the same carrying capacity as the main runners.

1. 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.

2. Support terminals or services weighing more than 56 pounds directly from the structure above by approved hangers. Provide 4 taut 12 gauge wires each, attached to the fixture and to the structure above. The 4 taut 12 gauge wires, including their attachment to the structure above must be capable of supporting 4 times the weight of the unit.

3. Secure air inlets and outlets to main runners of ceiling suspension system with two #8 sheet metal screws at opposing corners.

D. Furnish all air inlets and outlets with a baked prime coat unless otherwise noted. Provide off-white baked enamel finish on ceiling-mounted air inlets and outlets. Paint exposed mounting screws to match the material being secured.
E. Air inlets and outlets shall match all qualities of these specified including appearance, throw, noise level, adjustability, etc.

3.04 FILTERS
A. Mount filters in airtight frames furnished by the filter manufacturer, and install in accordance with manufacturer's recommendations.

B. Air filters shall be accessible for cleaning or replacement.

C. Identify each filter access door with 1/2 inch high minimum stenciled letters.

D. Provide temporary filters for all fans that are operated during construction; after all construction dirt has been removed from the building install new filters at no additional cost to the Owner. In addition to temporary filters at filter location, provide temporary filters on all duct openings which will operate under a negative pressure.
   1. Filters used for temporary operation shall be the same as permanent filters for the application. Filters used for duct openings may be 1 inch thick pleated media disposable type.

3.05 DAMPERS
A. All dampers automatically controlled by damper motors are specified under "Temperature Control System" except those specified with items of equipment.

B. Provide opposed blade manual air dampers at each branch duct connection and at locations indicated on the drawings and where necessary to control air flow for balancing system. Provide an opposed blade balancing damper in each zone supply duct. Provide an access panel or Ventlok flush type damper regulator on ceiling or wall for each concealed damper.

C. Install fusible link fire dampers full size of duct at points where shown or required.

D. Provide 18 inch x 12 inch minimum hinged access doors in ductwork and furring for easy access to each fire damper; insulated access doors in insulated ducts. Label access doors with 1/2 inch high red letters.
   1. Provide Ventlok Series 100, Durodyne, or equal access doors with hardware for convenient access to all automatic dampers and other components of the system, insulated type in insulated ducts. Provide Ventlok #202 for light duty up to 2 inch thick doors, #260 heavy-duty up to 2 inch thick doors and #310 heavy-duty for greater than 2 inch thick doors. Provide #260 hinges on all hinged and personnel access doors; include gasketing.

3.06 INSTALLATION OF DUCTWORK
A. Assemble and install ductwork in accordance with recognized industry practices which will achieve air tight and noiseless (no objectionable noise) systems capable of performing each indicated service. Install each run with minimum of joints. Align ductwork accurately at connections within 1/8 inch misalignment tolerance and with internal surfaces smooth. Support ducts rigidly with suitable ties, braces, hangers, and anchors of type which will hold ducts true to shape and to prevent buckling. Where possible, install ductwork to clear construction by 1/4 inch minimum, except at air inlets and outlets. Where ductwork will not clear construction, secure duct firmly to eliminate noise in the system.

B. Duct Joints: Install duct sealers, pop rivets or sheet metal screws at each fitting and joint. Duct sealer shall be fire retardant. Sheet metal screw for joints shall be minimum #10 size galvanized.
C. Applicable Leakage Classes:

<table>
<thead>
<tr>
<th>Pressure Class</th>
<th>Leakage Class</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Round Duct</td>
</tr>
<tr>
<td>2&quot; W.G. or less</td>
<td>12</td>
</tr>
<tr>
<td>4&quot; W.G. or greater</td>
<td>3</td>
</tr>
</tbody>
</table>

D. Upper connection of support to wood structure shall be with wood screws or lag screws in shear fastened in the upper one half of the wood structural member. Fasteners shall conform to the following schedule:

- For ducts with P/2=30"  #10 x 1-1/2" wood screw
- For ducts with P/2=72"  1/4"x 1-1/2" lag screw
- For ducts with P/2 over 73"  3/8"x 1-1/2" lag screw

E. Upper connection in tension to wood shall not be used unless absolutely necessary. Where deemed necessary the contractor shall submit calculations to show the size fastener and penetration required to support loads in tension from wood in accordance with the following schedule:

- For ducts with P/2=30"  260 pounds per hanger
- For ducts with P/2=72"  320 pounds per hanger
- For ducts with P/2=96"  460 pounds per hanger
- For duct with P/2 larger than 120"  NOT ALLOWED

F. 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.

G. Support ductwork in manner complying with SMACNA "HVAC Duct Construction Standards," hangers and supports sections. Where special hanging of ductwork is detailed or shown on Drawings, Drawings shall be followed. Angles shall be attached to overhead construction in a manner so as to allow a minimum of 2 inches of movement in all directions with no bending or sagging of the angle.

1. Except where modified in individual paragraphs of this Section, provide hanger support with minimum 18 gauge straps, 1 inch wide. Fold duct strap over at bottom of duct.

2. Install duct supports to rectangular ducts with sheet metal screws. Provide one screw at top of duct and one screw into strap at bottom of duct.

H. Installation of Flexible Ductwork:

1. Provide flexible ducts with supports at 30 inch centers with 2 inch wide, 26 gauge steel hanger collar attached to the structure with an approved duct hanger. Installation shall minimize sharp radius turns or offsets.
   a. Supports shall be in accordance with SMACNA HVAC Duct Construction Standards (Metal and Flexible).
   b. Make bends to maintain R/W-1.5.

2. Make connections to rigid duct and units with Panduit style draw band at inner liner material, and a second draw band over the outer vapor barrier material.
3. Make connection to duct with spin-in fittings, with air scoop and balance damper.

3.07 DUCTWORK SEALING AND LEAK TESTING
A. Retrofit Construction, including alterations to existing duct system or space conditioning equipment: All duct systems (supply, return, outside air intake and exhaust), except those exposed in the conditioned space, shall be sealed and leak tested in strict conformance with the requirements of the 2013 California Building Energy Efficiency Standards. See drawings for extent of this work and leakage rate requirements. The leakage rate shall be confirmed through field verification and diagnostic testing in accordance with the procedures set forth in the 2013 California Building Energy Efficiency Standards Reference Appendices. Contractor shall also complete the Acceptance Requirements in the standards for duct sealing/leak testing. Refer to Section 23 00 50 for additional information on Acceptance Requirements.

3.08 TEMPERATURE CONTROL SYSTEM
A. Provide thermostats or room sensors where indicated on drawings. All wiring shall be in conduit. Provide all relays, transformers and the like to render the control system complete and fully operable. All control conduit to be rigid steel type.

3.09 EQUIPMENT START-UP
A. Initial start-up of the systems and pumps shall be under the direct supervision of the Contractor.
B. Equipment start-up shall not be performed until the piping systems have been flushed and treated and the initial water flow balance has been completed.
C. It shall be the responsibility of the Contractor to assemble and supervise a start-up team consisting of controls contractor, start-up technician, and test and balance contractor; all to work in concert to assure that the systems are started, balanced, and operate in accordance with the design.
D. After start-up is complete, instruct the Owner's personnel in the operation and maintenance of the systems. Obtain from the Owner's representative a signed memo certifying that instruction has been received.

3.10 TESTING AND BALANCING
A. For testing and balancing requirements, refer to Section 23 05 93, Testing and Balancing for HVAC.

3.11 CLEANING AND PROTECTION
A. As each duct section is installed, clean interior of ductwork of dust and debris. Clean external surfaces of foreign substances that might cause corrosive deterioration of metal or where ductwork is to be painted.
B. Strip protective paper from stainless steel ductwork surfaces, and repair finish wherever it has been damaged.
C. Temporary Closure: At ends of ducts that are not connected to equipment or air distribution devices at time of ductwork installation, provide temporary closure of polyethylene film or other covering that will prevent entrance of dust and debris until connections are to be completed.
D. As each internally lined duct section is installed, check internal lining for small cuts, tears, or abrasions. Repair all damage with fire retardant adhesive.
3.12 ACCEPTANCE REQUIREMENTS

A. In addition to the testing and balancing requirements specified in Section 23 05 93, the Contractor shall also be responsible to complete the Acceptance Requirements of the 2013 California Building Energy Efficiency Standards. Refer to Section 23 00 50 for additional information on Acceptance Requirements.

3.13 EQUIPMENT MOUNTING

A. Mount and anchor equipment in strict compliance with Drawings details. Alternate anchorage methods will not be considered for roof mounted equipment.

END OF SECTION
SECTION 23 80 70

BUILDING AUTOMATION SYSTEM

PART 1 - GENERAL

1.01 CONDITIONS OF THE CONTRACT

A. The Conditions of the Contract (General, Supplementary, and other Conditions) and the General Requirements (Sections of Division 1) are hereby made a part of this Section.

B. Division - 23 Basic HVAC Materials and Methods apply to work of this section.

1.02 WORK INCLUDED

A. Related Documents: The General Provisions of the Contract, including General, Supplementary, and Special Conditions, and Division 1 - General Requirements, apply to work specified in this section. Subcontractor must familiarize himself with the terms of the above documents.

B. BAS Contractor-Division 23 80 70:

1. The Building Automation System (BAS) is to be furnished and installed by a factory authorized Andover distributor with factory warranted Andover parts. The designated distributor for this work is EMCOR Services Integrated Solutions (Contractor). Contact: Andy Bruch; andy_bruch@emcorgroup.com; 510-909-9980

a. All bidders must be building automation contractors in the business of installing Direct Digital Controls (DDC) for a minimum of 3 years.

b. All bidders must have an office in the San Francisco Bay/Central Valley area.

c. All bidders must be a channel partner for “Andover Controls”.

d. All bidders must have a trained staff of application engineers, who have been certified by Andover in Administration, Networking, Configuration, Programming and service of the automation system.

e. All installers must have a factory-trained technician on-site at all times during installation of the DDC controls.

2. Integration of the BAS system to the central BAS system shall be coordinated with the Facilities Manager at the work site.

C. Scope of Work

1. The BAS contractor shall review and study all HVAC drawings and the entire specification to familiarize him with the equipment and system operation and to verify the quantities and types of valves, operators, alarms, etc. to be provided.

2. The Contractor shall furnish and install a complete building automation system including all necessary hardware and all operating and applications software necessary to perform the control sequences of operation as called for in this specification. Andover Controls Only to match existing campus system architecture. At a minimum, provide controls for the following:

a. Air handling units.

b. Exhaust fans.

c. VAVs w/reheat.

d. Power wiring to DDC devices VAV and BAS panels by Division 26000.
e. Lighting.

3. Provide services and manpower necessary for commissioning of system in coordination with the HVAC Contractor, Balancing Contractor and Owner’s representative.

4. All work performed under this section of the specifications will comply with all codes, laws and governing bodies. If the drawings and/or specifications are in conflict with governing codes, the Contractor shall submit a proposal with appropriate modifications to the project to meet code restrictions. If this specification and associated drawings exceed governing code requirements, the specification will govern.

D. Training: Provide a minimum of (40) hours of on-site training for (3) system operators. The training will be hands-on type at the owner’s office. The training class will use the actual Operator’s Manual that will be submitted for this project. In addition to: projects over $100,000 will include (2) weeks of classroom training for one individual at the Manufacturer’s sponsored training courses.

E. Portable handheld assist tools: Provide owner with one Roam I/O remote assist tool as indicated by Facilities at time of completion.

F. System Description:

1. The Building Automation System (BAS) shall consist of PC-based workstation (existing) and microcomputer controllers of modular design providing distributed processing capability, and allowing future expansion of both input/output points and processing/control functions:

   a. For this project the system shall consist of the following (new) components:
      1) Ethernet-based Network Controller.
      2) Stand-alone Digital Control Units.

G. Ethernet-based Network Controller: The BAS Contractor shall furnish (1) Ethernet-based network controller. This controller will connect directly to the campus LAN over the existing Ethernet system. (1) Building network controller (as required) and shall be assigned to an existing Infinet Loop.

H. Provide the necessary quantity and types of SDCUs to meet the requirements of the project for mechanical equipment control including air handlers, return/exhaust fans, and terminal unit control. Each SDCU will operate completely standalone, containing all of the I/O and programs to control its associated equipment; i2 series and Infinet II.

I. Work by Others

1. The BAS Contractor shall cooperate with other contractors performing work on this project necessary to achieve a complete and neat installation. To that end, each contractor shall consult the drawings and specifications for all trades to determine the nature and extent of others’ work.

2. The BAS Contractor shall furnish all control valves, sensor wells, flow meters and other similar equipment for installation by the Mechanical Contractor.

3. The Electrical Contractor shall provide:
   a. All power wiring to VAV Transformer Disconnects see floor plan for location, and BAS panels.

J. Code Compliance

1. All wiring shall conform to the National Electrical Code.

2. Comply with FCC rules, Part 15 regarding Class A radiation for computing devices and low power communication equipment operating in commercial environments.

K. Submittals

1. All shop drawings shall be prepared in AutoCAD software. In addition to the drawings, the Contractor shall furnish a diskette containing the identical information. Drawings shall be B size or larger.

2. Shop drawings shall include a riser diagram depicting locations of all controllers and workstations, with associated network wiring. Also included shall be individual schematics of each mechanical system showing all connected points with reference to their associated controller. Typical will be allowed where appropriate.

3. Submittal data shall contain manufacturer's data on all hardware and software products required by the specification. Valve, damper and airflow station schedules shall indicate size, configuration, capacity and location of all equipment.

4. Software submittals shall contain narrative descriptions of sequences of operation, program listings, point lists, and a complete description of the graphics, reports, alarms and configuration to be furnished with the workstation software. Information shall be bound or in a three ring binder with an index and tabs.

5. Submit five (5) copies of submittal data and shop drawings to the Engineer and (one) copy to Facilities for review prior to ordering or fabrication of the equipment. The Contractor prior to submitting shall check all documents for accuracy.

6. The Engineer will make corrections, if required, and forward to Facilities prior to returning to the Contractor. The Contractor will then resubmit with the corrected or additional data. This procedure shall be repeated until all corrections are made to the satisfaction of the Engineer and the submittals are fully approved.

L. System Startup & Commissioning

1. Each point in the system shall be tested for both hardware and software functionality. In addition, each mechanical and electrical system under control of the BAS will be tested against the appropriate sequence of operation specified herein. Successful completion of the system test shall constitute the beginning of the warranty period. A written report will be submitted to the owner indicating that the installed system functions in accordance with the plans and specifications.

2. The BAS contractor shall commission and set in operating condition all major equipment and systems, such as the chilled water, hot water and all air handling systems, in the presence of the equipment manufacturer’s representatives, as applicable, and the Owner and Architect’s representatives.

3. The BAS Contractor shall provide all manpower and engineering services required to assist the HVAC Contractor and Balancing Contractor in testing, adjusting, and balancing all systems in the building. The BAS Contractor shall have a trained technician available on request during the balancing of the systems. The BAS Contractor shall coordinate all requirements to provide a complete air balance with the Balancing Contractor and shall include all labor and materials in his contract.

M. Training

1. The BAS Contractor shall provide both on-site and classroom training to the Owner’s representative and maintenance personnel per the following description:

2. On-site training shall be per section 1.02 D and shall consists of "hands-on" instruction geared at the operation and maintenance of the systems. The curriculum shall include

   a. System Overview.
   c. System access.
   d. Software features overview.
   e. Changing setpoints and other attributes.
f. Scheduling.
g. Editing programmed variables.
h. Displaying color graphics.
i. Running reports.
j. Workstation maintenance.
k. Application programming.
l. Operational sequences including start-up, shutdown, adjusting and balancing.
m. Equipment maintenance.

N. Operating and Maintenance Manuals
1. The operation and maintenance manuals shall contain all information necessary for the operation, maintenance, replacement, installation, and parts procurement for the entire BAS. This documentation shall include specific part numbers and software versions and dates. A complete list of recommended spare parts shall be included with the leadtime and expected frequency of use of each part clearly identified.
2. Following project completion and testing, the BAS contractor will submit as-built drawings reflecting the exact installation of the system. The as-built documentation shall also include a copy of all application software both in written form and on diskette.

O. Warranty: The BAS contractor shall warrant the system for 12 months after system acceptance and beneficial use by the owner. During the warranty period, the BAS contractor shall be responsible for all necessary revisions to the software as required to provide a complete and workable system consistent with the letter and intent of the Sequence of Operation section of the specification.

PART 2 - PRODUCTS

2.01 SYSTEM ARCHITECTURE

A. General: The Building Automation System (BAS) shall consist of Network Control Units (NCUs), a family of Standalone Digital Control Units (SDCUs), Input/Output Unit Modules (IOU Modules), Operator Workstations (OWs), and one File Server to support system configurations where more than one operator workstation is required. The BAS shall provide control, alarm detection, scheduling, reporting and information management for the entire facility, and Wide Area Network (WAN) if applicable, from a single ODBC-compliant database.

B. Level 1 Network Description: Level 1, the main backbone of the system, shall be an Ethernet LAN/WAN. Network Control Units, Operator Workstations, and the Central File Server shall connect directly to this network without the need for Gateway devices.

C. Level 2 Network Description
1. Level 2 of the system shall consist of one or more field buses managed by the Network Control Units. The Level 2 field buses may consist of one or both of the following types:
   a. An RS485, token passing bus that supports up to 127 Standalone Digital Control Units (SDCUs) per communication port for operation of HVAC equipment and lighting, or
   b. An RS485 field bus that supports up to 32 devices from a family of plug-in, IOU modules.
2. These IOU modules may be mounted within the NCU enclosure or remotely mounted via a single, twisted, shielded pair of wires.

D. BAS: The BAS shall be capable of being segmented, through software, into multiple local area networks (LANs) distributed over a wide area network (WAN), sharing a single file server. This
enables workstations to manage a single LAN (or building), and/or the entire system with all devices being assured of being updated by and sharing the most current database. In the case of a single workstation system, the workstation shall contain the entire database – with no need for a separate file server.

E. Standard Network Support: All NCUs, Workstation(s) and File Server shall be capable of residing directly on the owner’s Ethernet TCP/IP LAN/WAN with no required gateways. Furthermore, the NCU’s, Workstation(s) and File Server shall be capable of using standard, commercially available, off-the-shelf Ethernet infrastructure components such as routers, switches and hubs. With this design the owner may utilize the investment of an existing or new enterprise network or structured cabling system. This also allows the option of the maintenance of the LAN/WAN to be performed by the owner’s Information Systems Department as all devices utilize standard TCP/IP components.

F. System Expansion
   1. The BAS system shall be scalable and expandable at all levels of the system using the same software interface, and the same Level 1 and Level 2 controllers. Systems that require replacement of either the workstation software or field controllers in order to expand the system shall not be acceptable.
   2. The BAS shall be expandable to include Security and Access Control functions at any time in the future with no additional workstations, front-end software or Level 1 controllers required. Standalone Digital Control Units or IOU modules shall be able to be added to the existing Level 1 controller’s field bus (es), to perform security and card access applications. In this way, an owner’s existing investment in wiring infrastructure may be leveraged and the cost and inconvenience of adding new field bus wiring will be minimized.
   3. Additionally, an integrated video badging option must be able to be included with no additional workstations required. This photo ID option must share the same database as the BAS in order to eliminate the need for updating multiple databases.
   4. The system shall use the same application programming language for all levels: Operator Workstation, Network Control Unit, Remote Site Control Unit and Standalone Digital Control Unit. Furthermore, this single programming language shall be used for all applications: environmental control, card access control, intrusion detection and security, lighting control, leak detection / underground storage tank monitoring, and digital data communication interfaces to third party microprocessor-based devices.

G. Support for Open Systems Protocols
   1. The BAS design must include solutions for the integration of the following “open systems” protocols: BACnet, LonTalk™, MODBUS and digital data communication to third party microprocessors such as chiller controllers, fire panels and variable frequency drives (VFDs).
   2. The system shall also provide the ability to program custom ASCII communication drivers that will reside in the NCU, for communication to third party systems and devices. These drivers will provide real time monitoring and control of the third party systems.

2.02 NETWORK CONTROL UNITS (NCUs)

A. General
   1. Network Control Units shall be microprocessor based, multi-tasking, multi-user, and employ a real time operating system. Each NCU control panel shall consist of modular hardware including power supply, CPU board, and input/output modules. A sufficient number of NCUs shall be supplied to fully meet the requirements of this specification and the attached point list.
2. NCUs for telephone dialup sites shall be of the same design as the Ethernet control units but without the plug-in Ethernet network interface card (NIC), i.e., NCUs, which include a NIC, shall be interchangeable whether used on a LAN/WAN or a dialup site.

B. Webservice Functionality

1. All NCUs on the Ethernet TCP/IP LAN/WAN shall be capable, out-of-the-box, to be set up as a Web Server. The NCU shall have the ability to store HTML code and "serve" pages to a web browser. This provides the ability for any computing device utilizing a TCP/IP Ethernet connection and capable of running a standard Internet browser (Microsoft Internet Explorer™, Netscape Navigator™, etc.) to access real-time data from the entire BAS via any NCUs.

2. Graphics and text-based web pages shall be constructed using standard HTML code. The interface shall allow the user to choose any of the standard text or graphics-based HTML editors for page creation. It shall also allow the operator to generate custom graphical pages and forms.

3. The WEB server interface shall be capable of password security, including validation of the requesting PC’s IP address. The WEB server interface shall allow the sharing of data or information between any controller, or process or network interface (BACnet, LonTalk and TCP/IP) that the BMS has knowledge of, regardless of where the point is connected on the BAS network or where it is acquired from.

4. The BAS network controller must act directly as the WEB server. It must directly generate the HTML code to the requesting user (i.e. WEB browser), eliminating the need for and reliance on any PC-based WEB server hardware or software. To simplify graphic space allocation, HTML graphic images, if desired, shall be stored on any shared network device. The BAS WEB server shall have the ability to acquire any necessary graphics using standard pathing syntax within the HTML code mounted within the BAS WEB server. External WEB server hardware and software are not acceptable.

C. Hardware Specifications

1. Memory: A minimum of 32 MB of RAM shall be provided for NCUs and shall include a floating-point math co-processor.

D. Communication Ports: Each NCU shall provide communication to both the Workstation(s) and the field buses. In addition, each NCU must have at least 3 other communications ports that support a telephone modem, portable service tool, serial printer and connection to third party controllers such as a chiller control panel. On a LAN/WAN system the NCU shall be provided with a 10/100 baseT Mbps plug-in Ethernet TCP/IP network interface card (NIC).

E. Input/Output (I/O):

1. Each NCU shall support the addition of the following types of inputs and outputs:
   a. Digital Inputs for status/alarm contacts.
   b. Counter Inputs for summing pulses from meters.
   c. Thermistor inputs for measuring temperatures in space, ducts and thermowells.
   d. Analog inputs for pressure, humidity, flow and position measurements.
   e. Digital Outputs for on/off equipment control.
   f. Analog Outputs for valve and damper position control, and capacity control of primary equipment.

F. Modular Expandability: The system shall employ a modular I/O design to allow easy expansion. Input and output capacity is to be provided through plug-in modules of various types or DIN-mountable IOU modules. It shall be possible to combine I/O modules as desired to meet the I/O requirements for individual control applications.
G. Real Time Clock (RTC): Each NCU shall include a battery-backed, real time clock, accurate to 10 seconds per day. The RTC shall provide the following: time of day, day, month, year, and day of week. In normal operation the system clock will be based on the frequency of the AC power. The system shall automatically correct for daylight savings time and leap years and be Year 2000 compliant.

H. Power Supply: The power supply for the NCUs shall be auto sensing, 120-220VAC, 60/50 Hz power, with a tolerance of +/- 20%. Line voltage below the operating range of the system shall be considered outages. The controller shall contain over voltage surge protection, and require no additional AC power signal conditioning. Optionally, if indicated on the drawings, the power supply shall accept an input voltage of (–48 VDC).

I. Automatic Restart After Power Failure: Upon restoration of power after an outage, the ECU shall automatically and without human intervention: update all monitored functions; resume operation based on current, synchronized time and status, and implement special start-up strategies as required.

J. Battery backup: Each NCU with the standard 120-220VAC power supply shall include a programmable DC power backup system rated for a minimum of 72 hours of battery backup to maintain all volatile memory or, a minimum of 2 hours of full UPS including modem power. This power backup system shall be configurable such that at the end of a selectable timeframe (such as 1 hour) of running on full UPS, the unit will shut off full UPS and switch to memory retention-only mode for the remainder of the battery power. The system shall allow the simple addition of more batteries to extend the above minimum battery backup times. Each NCU with a control transformer shall include a minimum of 7 days of power failure backup of RAM memory.

K. Software Specifications: User Programming Language: The application software shall be user programmable. This includes all strategies, sequences of operation, control algorithms, parameters, and setpoints. The source program shall be English language-based and programmable by the user. The language shall be structured to allow for the easy configuration of control programs, schedules, alarms, reports, telecommunications, local displays, mathematical calculations, passwords, and histories. The language shall be self-documenting. Users shall be able to place comments anywhere in the body of a program. Program listings shall be configurable by the user in logical groupings.

L. Control Software:
   1. The NCU shall have the ability to perform the following pre-tested control algorithms:
      a. Proportional, Integral plus Derivative Control (PID).
      b. Self Tuning PID.
      c. Two Position Control.
      d. Digital Filter.
      e. Ratio Calculator.
      f. Equipment Cycling Protection.

M. Mathematical Functions: Each controller shall be capable of performing basic mathematical functions (+, -, *, /), squares, square roots, exponential, logarithms, Boolean logic statements, or combinations of both. The controllers shall be capable of performing complex logical statements including operators such as >, <, =, and, or, exclusive or, etc. These must be able to be used in the same equations with the mathematical operators and nested up to five parentheses deep.

N. Energy Management Applications:
   1. NCUs shall have the ability to perform any or all of the following energy management routines:
      a. Time of Day Scheduling.
      b. Calendar Based Scheduling.
c. Holiday Scheduling.
d. Temporary Schedule Overrides.
e. Optimal Start.
f. Optimal Stop.
g. Night Setback Control.
h. Enthalpy Switchover (Economizer).
i. Peak Demand Limiting.
j. Temperature Compensated Duty Cycling.
k. CFM Tracking.
l. Heating/Cooling Interlock.
m. Hot/Cold Deck Reset.
n. Free Cooling.
o. Hot Water Reset.

O. History Logging: Each controller shall be capable of logging any system variable over user defined time intervals ranging from 1 second to 1440 minutes. Any system variables (inputs, outputs, math calculations, flags, etc.) can be logged in history. A maximum of 32767 values can be stored in each log. Each log can record either the instantaneous, average, minimum or maximum value of the point. Logs can be automatic or manual. Logged data shall be downloadable to the Operator Workstation for long term archiving based upon user-defined time intervals, or manual command.

P. Alarm Management: For each system point, alarms can be created based on high/low limits or conditional expressions. All alarms will be tested each scan of the NCU and can result in the display of one or more alarm messages or reports.

Q. Up to 8 alarms can be configured for each point in the controller.

R. Messages and reports can be sent to a local terminal, to the front-end workstation(s), or via modem to a remote-computing device.

S. Alarms will be generated based on their priority. A minimum of 255 priority levels shall be provided: If communication with the Operator Workstation is temporarily interrupted, the alarm will be buffered in the NCU. When communications return, the alarm will be transmitted to the Operator Workstation if the point is still in the alarm condition.

T. Reporting: The NCU shall be able to generate user-definable reports to a locally connected printer or terminal. The reports shall contain any combination of text and system variables. Report templates shall be able to be created by users in a word processing environment. Reports can be displayed based on any logical condition or through a user command.

2.03 STANDALONE DIGITAL CONTROL UNITS (SDCUs)

A. General: Standalone Digital Control Units shall provide control of HVAC and lighting. Each controller shall have its own control programs and will continue to operate in the event of a failure or communication loss to its associated NCU.

B. Memory: Control programs shall be stored in battery backed-up RAM and EPROM. Each controller shall have a minimum of 128K bytes of user RAM memory and 128K bytes of EPROM.

C. Communication Ports: SDCUs shall provide a communication port to the field bus. In addition, a port shall be provided for connection of a portable service tool to support local commissioning and parameter changes with or without the NCU online. It shall be possible from a service port
on any SDCU to view, enable/disable, and modify values of any point or program on any controller on the local field bus, any NCU or any SDCU on a different field bus.

D. Input/Output:
1. Each SDCU shall support the addition of the following types of inputs and outputs:
   a. Digital Inputs for status/alarm contacts.
   b. Counter Inputs for summing pulses from meters.
   c. Thermistor Inputs for measuring temperatures in space, ducts and thermowells.
   d. Analog inputs for pressure, humidity, flow and position measurements.
   e. Digital Outputs for on/off equipment control.
   f. Analog Outputs for valve and damper position control, and capacity control of primary equipment.

E. Expandability: Input and output capacity shall be expandable through the use of plug-in modules. A minimum of two modules shall be added to the base SDCU before additional power is required.

F. Networking: Each SDCU will be able to exchange information on a peer-to-peer basis with other Standalone Digital Control Units during each field bus scan. Each SDCU shall be capable of storing and referencing global variables (on the LAN) with or without any workstations online. Each SDCU shall be able to have its program viewed and/or enabled/disabled either locally through a portable service tool or through a workstation connected to an NCU.

G. Indicator Lamps: SDCUs will have as a minimum, LED indication of CPU status, and field bus status.

H. Real Time Clock (RTC): An SDCU shall have a real time clock in either hardware or software. The accuracy shall be within 10 seconds per day. The RTC shall provide the following information: time of day, day, month, year, and day of week. Each SDCU shall receive a signal, every hour, over the network from the NCU, which synchronizes all SDCU real time clocks.

I. Automatic Restart after Power Failure: Upon restoration of power, the SDCU shall automatically and without human intervention, update all monitored functions, resume operation based on current, synchronized time and status, and implement special start-up strategies as required.

J. Battery Back Up: Each SDCU shall have at least 3 years of battery back up to maintain all volatile memory.

K. Alarm Management:
1. For each system point, alarms can be created based on high/low limits or conditional expressions. All alarms will be tested each scan of the SDCU and can result in the display of one or more alarm messages or reports.
2. Up to 8 alarms can be configured for each point in the controller enabling the escalation of the alarm priority (urgency) based upon which alarm(s) is/are triggered.
3. Alarm messages can be sent to a local terminal or modem connected to an NCU or to the Operator’s Workstation(s).
4. Alarms will be generated based on their priority. A minimum of 255 priority levels shall be provided.
5. If communication with the NCU is temporarily interrupted, the alarm will be buffered in the SDCU. When communications return, the alarm will be transmitted to the NCU if the point is still in the alarm condition.

L. Air Handler Controllers (To be used on units with less than 40 points)
1. AHU Controllers shall be capable of meeting the requirements of the sequence of operation found in the Execution portion of this specification and for future expansion.

2. AHU Controllers shall support all the necessary point inputs and outputs as required by the sequence and operate in a standalone fashion.

3. AHU Controllers shall be fully user programmable to allow for modification of the application software.

4. An LCD display shall be optionally available for readout of point values and to allow operators to change setpoints and system parameters.

5. A manual override switch shall be provided for all digital and analog outputs on the AHU Controller. The position of the switch shall be monitored in software and available for operator displays and alarm notification.

M. VAV Terminal Unit Controllers

1. VAV Terminal Unit Controllers shall support, but not be limited to the control of the following configurations of VAV boxes to address current requirements as described in the Execution portion of this specification, and for future expansion:
   a. VAVR.
   b. Single Duct Cooling with Reheat (Hot Water).

2. VAV Controllers to be Andover 2865-V, 2865-V with LED smart stats.

3. VAV Controllers for single duct applications will come equipped with a built-in actuator for modulation of the air damper. The actuator shall have a minimum torque rating of 50 in.-lb., and contain an override mechanism for manual positioning of the damper during startup and service.

4. VAV Controllers shall contain an integral velocity sensor accurate to +/- 5% of the full range of the box's CFM rating.

5. Each controller shall perform the sequence of operation described in Part 3 of this specification, and have the capability for time of day scheduling, occupancy mode control, after hours operation, lighting control, alarming, and trending.

6. VAV Controllers shall be able to communicate with any other Standalone Digital Control Unit on the same field bus with or without communication to the NCU managing the field bus. Systems that fail to provide this (true peer-to-peer) capability will be limited to a maximum of 32 VAV controllers per field bus.

N. Display Controllers

1. Display controllers are standalone, touch screen based operator interfaces. The controller shall be designed for flush mounting in a finished space, with a minimum display size of 9 x 9 inches.

2. Software shall be user programmable allowing for custom graphical images that simulate floor plans, menus, equipment schematics along with associated real time point values coming from any NCU on the network.

3. The touch screen display shall contain a minimum of 64 possible touch cells that permit user interaction for changing screens, modifying setpoints or operating equipment.

4. Systems that do not offer a display controller as specified must provide a panel mounted computer with touch screen capability as an alternative.

2.04 OPERATOR WORKSTATION REQUIREMENTS (existing LAN System) Workstation and Server are not added to this project. However all controllers will be added to the existing Infinet and LAN system.

A. General.
1. The BAS workstation software shall be configurable as either a single workstation system (with a local database) or multi-workstation system where the database is located on a central file server. The client software on multi-workstation system shall access the file server database program via an Ethernet TCP/IP network running at either 10MBPS or 100MBPS.

2. New Workstation shall be:

<table>
<thead>
<tr>
<th>PROCESSOR</th>
<th>Intel® Core™ i5 Processor 680 with VT (3.60GHz, 4M)</th>
</tr>
</thead>
<tbody>
<tr>
<td>OPERATING SYSTEM</td>
<td>Windows 7 Professional</td>
</tr>
<tr>
<td>WARRANTY &amp; SERVICE</td>
<td>3 Year ProSupport and 3 Year NBD Onsite Service</td>
</tr>
<tr>
<td>SYSTEMS MANAGEMENT MODE</td>
<td>Intel Core i7/i5 vPro Technology Enabled</td>
</tr>
<tr>
<td>MEMORY</td>
<td>4GB DDR3 Non-ECC SDRAM,1333MHz, (2 DIMM)</td>
</tr>
<tr>
<td>HARD DRIVE</td>
<td>500GB 2.5 SATA 3.0Gb/s and 16MB DataBurst Cache™</td>
</tr>
<tr>
<td>OPTICAL DRIVE</td>
<td>16X DVD+/-RW SATA, Roxio Creator™ Cyberlink PowerDVD™</td>
</tr>
<tr>
<td>VIDEO CARD</td>
<td>Integrated Intel® Graphics Media Accelerator HD, DisplayPort/ VGA</td>
</tr>
<tr>
<td>MONITOR</td>
<td>Dell UltraSharp™ 2007FP 20in HAS Monitor, VGA/ DVI</td>
</tr>
<tr>
<td>ENERGY SMART</td>
<td>Dell Energy Smart Enable (ESMART)</td>
</tr>
<tr>
<td>FILE SYSTEM</td>
<td>NTFS File System for all Operating Systems</td>
</tr>
<tr>
<td>SYSTEM DOCUMENTATION</td>
<td>Resource DVD contains Diagnostics and Driver for Dell OptiPlex System</td>
</tr>
<tr>
<td>KEYBOARD</td>
<td>Dell Multimedia Pro Keyboard, English</td>
</tr>
<tr>
<td>MOUSE</td>
<td>Dell MS111 USB Optical Mouse</td>
</tr>
</tbody>
</table>

*The application software shall be capable of communication to all Network Control Units and Standalone Digital Control Units, feature high-resolution color graphics, alarming, reporting, and be user configurable for all data collection and data presentation functions.

3. For multi-workstation systems, a minimum of 256 workstations shall be allowed on the Ethernet network along with the central file server. In this client/server configuration, any changes or additions made from one workstation will automatically appear on all other workstations without the requirement for manual copying of files. Multi-workstation
systems with no central database will not be acceptable. Multi-workstation systems with distributed/tiered file servers and a central (master) database will be acceptable.

B. Workstation Software

1. General Description:
   a. The software architecture must be object-oriented in design, a true 32-bit application suite utilizing Microsoft’s OLE, COM, DCOM and ODBC technologies. These technologies make it easy to fully utilize the power of the operating system to share, among applications (and therefore to the users of those applications), the wealth of data available from the BAS.
   b. The workstation functions shall include monitoring and programming of all DDC controllers. Monitoring consists of alarming, reporting, graphic displays, long-term data storage, automatic data collection, and operator-initiated control actions such as schedule and setpoint adjustments.
   c. Programming of controllers shall be capable of being done either off-line or online from any operator workstation. All information will be available in graphic or text displays. Graphic displays will feature animation effects to enhance the presentation of the data, to alert operators of problems, and to facilitate location of information throughout the DDC system. All operator functions shall be selectable through a mouse.

C. System Database: The files server database engine must be Microsoft SQL Server (depending on Continuum version). This ODBC (Open Database Connectivity) compliant database engine allows for an owner to utilize “their” choice of database and due to its "open" architecture, allows an owner to write custom applications and/or reports which communicate directly with the database avoiding data transfer routines to update other applications. The system database shall contain all point configurations and programs in each of the controllers that have been assigned to the network. In addition, the database will contain all workstation files including alarm reports, text reports, historical data logs, schedules, and polling records.

1. New Workstation shall be:

<table>
<thead>
<tr>
<th>PRIMARY PROCESSOR</th>
<th>Intel® Xeon® E5620 2.4Ghz, 12M Cache, Turbo, HT, 1066MHz Max Mem</th>
</tr>
</thead>
<tbody>
<tr>
<td>MEMORY</td>
<td>8GB Memory (4x2GB), 1333MHz 1R LV UDIMMs for 1 Processor, Advanced ECC</td>
</tr>
<tr>
<td>SYSTEMS MANAGEMENT MODE</td>
<td>Intel Core i7/i5 vPro Technology Enabled</td>
</tr>
<tr>
<td>OPERATING SYSTEM</td>
<td>Windows Server 2008 R2, Standard Edition, x64, Includes 5 CALS</td>
</tr>
<tr>
<td>HARD DRIVE CONFIGURATION</td>
<td>RAID 1 for H700, PERC 6/i, H200 or SAS 6/iR Controllers</td>
</tr>
<tr>
<td>INTERNAL CONTROLLER</td>
<td>PERC H200 Integrated RAID Controller</td>
</tr>
<tr>
<td>HARD DRIVES</td>
<td>500GB 7.2K RPM SATA 2.5-in HotPlug Hard Drive</td>
</tr>
<tr>
<td>MICROSOFT SQL SERVER</td>
<td>Microsoft®SQL Server™2008R2 Workgroup w 5 CALs, OEM, NFI, w/Media</td>
</tr>
</tbody>
</table>
D. User Interface: The BAS workstation software shall allow the creation of a custom, browser-style interface linked to the user that has logged into the workstation software. This interface shall support the creation of "hot-spots" that the user may link to view/edit any object in the system or run any object editor or configuration tool contained in the software. Furthermore, this interface must be able to be configured to become a user’s “PC Desktop” – with all the links that a user needs to run other applications. This, along with the Windows NT user security capabilities, will enable a system administrator to setup workstation accounts that not only limit the capabilities of the user within the BAS software but may also limit what a user can do on the PC and/or LAN/WAN. This might be used to ensure, for example, that the user of an alarm monitoring workstation is unable to shutdown the active alarm viewer and/or unable to load software onto the PC.

E. User Security: The software shall be designed so that each user of the software can have a unique username and password. This username/password combination shall be linked to a set of capabilities within the software, set by and editable only by, a system administrator. The sets of capabilities shall range from View only, Acknowledge alarms, Enable/disable and change values, Program, and Administer. The system shall allow the above capabilities to be applied independently to each and every class of object in the system. The system must allow a minimum of 256 users to be configured per workstation. There shall be an inactivity timer adjustable in software that automatically logs off the current operator after the timer has expired.

F. Configuration Interface:

1. The workstation software shall use a familiar Windows Explorer™-style interface for an operator or programmer to view and/or edit any object (controller, point, alarm, report, schedule, etc.) in the entire system. In addition, this interface shall present a “network map” of all controllers and their associated points, programs, graphics, alarms, and reports in an easy to understand structure. All object names shall be alphanumeric and use Windows long filename conventions. Object names shall not be required to be unique throughout the system. This allows consistency in point naming. For example, each VAV controller can have an input called Space Temperature and a setpoint called CFM Setpoint. The VAV controller name shall be unique such as VAV for LAB101. Systems requiring unique object names throughout the system will not be acceptable.

2. The configuration interface shall also include support for template objects. These template objects shall be used as building blocks for the creation of the BAS database. The types of template objects supported shall include all data point types (input, output,
string variables, setpoints, etc.), alarm algorithms, alarm notification objects, reports, graphics displays, schedules, and programs. Groups of template object types shall be able to be set up as template subsystems and systems. The template system shall prompt for data entry if necessary. The template system shall maintain a link to all “child” objects created by each template. If a user wishes to make a change to a template object, the software shall ask the user if he/she wants to update all of child objects with the change. This template system shall facilitate configuration and programming consistency and afford the user a fast and simple method to make global changes to the BAS.

G. Color Graphic Displays

1. The system shall allow for the creation of user defined, color graphic displays for the viewing of mechanical and electrical systems, or building schematics. These graphics shall contain point information from the database including any attributes associated with the point (engineering units, etc.). In addition operators shall be able to command equipment or change setpoints from a graphic through the use of the mouse. Requirements of the color graphic subsystem include:

a. SVGA, bit-mapped displays. The user shall have the ability to import AutoCAD generated picture files as background displays.

b. A built-in library of animated objects such as dampers, fans, pumps, buttons, knobs, gauges, ad graphs which can be “dropped” on a graphic through the use of a software configuration “wizard”. These objects shall enable operators to interact with the graphic displays in a manner that mimics their mechanical equivalents found on field installed control panels. Using the mouse, operators shall be able to adjust setpoints, start or stop equipment, modify PID loop parameters, or change schedules.

c. Status changes or alarm conditions must be able to be highlighted by objects changing screen location, size, color, and text, blinking or changing from one display to another.

d. Graphic panel objects shall be able to be configured with multiple “tabbed” pages allowing an operator to quickly view individual graphics of equipment, which make up a subsystem or system.

e. Ability to link graphic displays through user-defined objects; alarm testing, or the result of a mathematical expression.

f. Operators must be able to change from one graphic to another by selecting an object with a mouse - no menus will be required.

H. Alarm Management

1. The software shall be capable of accepting alarms directly from controllers, or generating alarms based on evaluation of data in controllers and comparing to limits or conditional equations configured through the software. Any alarm (regardless of its origination) will be integrated into the overall alarm management system and will appear in all standard alarm reports, be available for operator acknowledgment, and have the option for displaying graphics, or reports.

2. Alarm management features shall include:

a. A minimum of 255 alarm notification levels. Each notification level will establish a unique set of parameters for controlling alarm display, acknowledgment, keyboard annunciation, alarm printout and record keeping.

b. Automatic logging in the database of the alarm message, point name, point value, connected controller, timestamp, username and time of acknowledgement, username and time of alarm silence (soft acknowledgement)
c. Automatic printing of the alarm information or alarm report to an alarm printer or report printer.

d. Playing an audible beep or audio (wav) file on alarm initiation or return too normal.

e. Sending an email or alphanumeric page to anyone listed in a workstation’s email account address list on either the initial occurrence of an alarm and/or if the alarm is repeated because an operator has not acknowledged the alarm within a user-configurable timeframe. The ability to utilize email and alphanumeric paging of alarms shall be a standard feature of the software integrated with the operating system’s mail application interface (MAPI). No special software interfaces shall be required.

f. Individual alarms shall be able to be re-routed to a workstation or workstations at user-specified times and dates. For example, a critical high temp alarm can be configured to be routed to a Facilities Dept. workstation during normal working hours (7am-6pm, Mon-Fri) and to a Central Alarming workstation at all other times.

g. An active alarm viewer shall be included which can be customized for each user or user type to hide or display any alarm attributes.

h. The font type and color, and background color for each alarm notification level as seen in the active alarm viewer shall be customizable to allow easy identification of certain alarm types or alarm states.

i. The active alarm viewer can be configured such that an operator must type in text in an alarm entry and/or pick from a drop-down list of user actions for certain alarms. This ensures accountability (audit trail) for the response to critical alarms.

I. Scheduling

1. It shall be possible to configure and download from the workstation schedules for any of the controllers on the network.

2. Time of day schedules shall be in a calendar style and shall be programmable for a minimum of one year in advance. Each standard day of the week and user-defined day types shall be able to be associated with a color so that when the schedule is viewed it is very easy, at-a-glance, to determine the schedule for a particular day even from the yearly view. To change the schedule for a particular day, a user shall simply click on the day and then click on the day type.

3. Each schedule will appear on the screen viewable as the entire year, monthly, week and day. A simple mouse click shall allow switching between views. It shall also be possible to scroll from one month to the next and view or alter any of the schedule times.

4. Schedules will be assigned to specific controllers and stored in their local RAM memory. Any changes made at the workstation will be automatically updated to the corresponding schedule in the controller.

J. Programmer’s Environment: The programmer’s environment will include access to a superset of the same programming language supported in the controllers. Here the programmer will be able to configure application software off-line (if desired) for custom program development, write global control programs, system reports, wide area networking data collection routines, and custom alarm management software. On the same screen as the program editor, the programming environment shall include dockable debug and watch bars for program debugging and viewing updated values and point attributes during programming. In addition a wizard tool shall be available for loading programs from a library file in the program editor.

K. Saving/Reloading: The workstation software shall have an application to save and restore field controller memory files. This application shall not be limited to saving and reloading an entire controller – it must also be able to save/reload individual objects in the controller. This allows off-line debugging of control programs, for example, and then reloading of just the modified information.
L. Data Logging: The workstation software shall have the capability to easily configure groups of data points with trend logs and display the trend log data. A group of data points shall be created by drag-and-drop method of the points into a folder. The trend log data shall be displayed through a simply menu selection. This data shall be able to be saved to file and/or printed.

M. Audit Trail: The workstation software shall automatically log and timestamp every operation that a user performs at a workstation, from logging on and off a workstation to changing a point value, modifying a program, enabling/disabling an object, viewing a graphic display, running a report, modifying a schedule, etc.

N. Fault Tolerant File Server Operation:
   1. The system shall provide the option to provide fault tolerant operation in the event of the loss of the CPU, disk drives, or other hardware required to maintain the operational integrity of the system. Operational integrity includes all user interfaces, monitoring of alarm points and access points, and executing access control functions.
   2. The switchover mechanism provided shall be automatic. Should the failure be caused by hardware, and then the system shall immediately switch to the Backup computer. Should the system failure be caused by software (instruction or data), the system shall not pass the faulted code to the Backup computer, otherwise the Backup shall fail in the same manner of the Primary computer.
   3. Switchover to the Backup computer shall be initiated and effective (complete) in a manner and time frame that precludes the loss of event data, and shall be transparent to the system users, except for an advisory alarm message indicating that the switchover has occurred.
   4. When the system fails-over from the Primary to the Backup computer, no alarm or other event shall be lost, and the Backup computer shall take control of all system functions.
   5. A single component failure in the system shall not cause the entire system to fail. All system users shall be informed of any detectable component failure via an alarm event. System users shall not be logged off as a result of a system failure or switchover.
   6. The Primary computer shall provide continual indication that the Backup computer is unavailable until such time that the fault has been purged.
   7. Full screen, laptop service tools shall communicate directly to all controllers. The laptop software shall enable users to monitor both instantaneous and historical point data, modify control parameters, and enable/disable any point or program in any controller on the network.

O. Temperature Sensors
   1. All temperature devices shall use precision thermistors accurate to +/-1 degree F over a range of -30 to 230 degrees F. Space temperature sensors shall be accurate to +/-0.5 degrees F over a range of 40 to 100 degrees F.
      a. Zone Sensors- Andover Model Number: TTS-SD-LCD-1
      b. Duct Sensors- Andover TT-D Series, Veris TJ Series, or equivalent
      c. Well Sensors- Andover TT-I Series
   2. Standard space sensors shall be available in an off-white enclosure for mounting on a standard electrical box.
   3. Where manual overrides are required, the sensor housing shall feature both an optional Sliding mechanism for adjusting the space temperature setpoint, as well as a push button for selecting after hours operation.
   4. Where a local display is specified, the sensor shall incorporate either an LED or LCD display for viewing the space temperature, setpoint and other operator selectable
parameters. Using built in buttons, operators shall be able to adjust setpoints directly from the sensor.

5. Duct temperature sensors shall incorporate a thermistor bead embedded at the tip of a stainless steel tube. Probe style duct sensors are useable in air handling applications where the coil or duct area is less than 14 square feet.

6. Averaging sensors shall be employed in ducts, which are larger than 14 square feet. The averaging sensor tube must contain at least one thermistor for every 3 feet, with a minimum tube length of 12 feet.

7. Immersion sensors shall be employed for measurement of temperature in all chilled and hot water applications as well as refrigerant applications. Thermal wells shall be brass or stainless steel for non-corrosive fluids below 250 degrees F and 300 series stainless steel for all other applications.

8. A pneumatic signal shall not be allowed for sensing temperature.

P. Humidity Sensors
1. Humidity devices shall be accurate to +/- 5% at full scale for space and +/- 3% for duct and outside air applications. Provide Minco or Setra.
2. Provide a hand held field calibration tool that both reads the output of the sensor and contains a reference sensor for ongoing calibration.

Q. Pressure Sensors
1. Air pressure measurements in the range of 0 to 10” water column will be accurate to +/- 1 percent using a solid-state sensing element. Acceptable manufacturers include Setra and Dwyer.
2. Differential pressure measurements of liquids or gases shall be accurate to =/- 0.5% of range. The housing shall be Nema 4 rated. Acceptable manufacturers include Setra and Dwyer.

R. Current and KW Sensors
1. Current status switches shall be used to monitor fans, pumps, motors and electrical loads. Current switches shall be available in solid core models, and offer either a digital or an analog signal to the automation system. Acceptable manufacturer is Veris or approved equal.
2. Measurement of three-phase power shall be accomplished with a kW/kWH transducer. This device shall utilize direct current transformer inputs to calculate the instantaneous value (kW) and a pulsed output proportional to the energy usage (kWh). Provide Veris Model 6000 Power Transducer or approved equal.

S. Flow Sensors
1. Provide an insertion flowmeter for measurement of liquid; gas or steam flows in pipe sizes above 3 inches.
2. Install the flow meter on an isolation valve to permit removal without process shutdown.
3. Sensors shall be manufactured by ONICON, Badger, or approved equal.

T. Electric/Pneumatic Transducers
1. Electric to pneumatic transducers shall operate from an analog signal. E/P transducers shall be rated for 0 - 20 psi operation and accurate to 2% of full scale. E/P transducers shall have a maximum air consumption of 100 SCFM.
2. E/P transducers may be installed at the end device (damper or valve), or mounted separately in a field interface panel, or in the control panel. All transducers will be calibrated. Panel mounted transducers shall be Mamac or approved equal.
U. Electric/Pneumatic Solenoid Valves: Electric solenoid operated pneumatic valves (EP's) shall have a three-port operation: common, normally open and normally closed. They shall be rated for 50 psig when used for 25 psig or less applications, or rated for 150 psig when used for 100 psig or less applications. The coils shall be equipped with transient suppression devices to limit transients to 150 percent of the rated coil voltage.

2.05 CONTROL VALVES

A. Provide automatic control valves suitable for the specified controlled media (Hot and Chilled Water). Provide valves, which mate and are compatible with the material of the connected piping. Equip control valves with the actuators of required input power type and control signal type to accurately position the flow control element and provide sufficient force to achieve required leakage specification. Control valves to be DuraDrive or equivalent.

B. Contractor to size valve Cv so that differential pressure at rated flow is between 3 to 5 psig for Chilled Water and 2 to 3.5 psig for Hot Water.

C. Control valves shall meet the heating and cooling loads specified, and close off against the differential pressure conditions within the application. Valves should be sized to operate accurately and with stability from 10 to 100% of the maximum design flow.

D. Electric actuation should be provided on all terminal unit reheat applications.

E. The actuator shall be direct coupled over the shaft, enabling it to be mounted directly to the damper shaft without the need for connecting linkage. The actuator shall have electronic overload circuitry to prevent damage. For power-failure/safety applications, an internal mechanical, spring return mechanism shall be built into the actuator housing. Non-spring return actuators shall have an external manual gear release to allow positioning of the damper when the actuator is not powered. Actuators to be DuraDrive or equivalent.

2.06 SMOKE DETECTORS

A. Smoke detector to be furnished and wired by Division 16, installed by Division 15.—Smoke Detector – Robertshaw Model Number: 2650-450

2.07 AIRFLOW MEASURING STATIONS

A. Provide a thermal anemometer using instrument grade self heated thermistor sensors with thermistor temperature sensors.

B. The flow station shall operate over a range of 0 to 5,000 feet/min with an accuracy of +/- 2% over 500 feet/min and +/- 10 ft/min for reading less than 500 feet/min.

C. The output signal shall be linear with field selectable ranges including 0-5 VDC, 0-10VDC and 4-20 mA.

D. Furnish Ebtron Series GTx116 airflow stations or approved equal.

PART 3 - EXECUTION

3.01 CONTRACTOR RESPONSIBILITIES

A. General: The BAS system is to be furnished and installed by an Andover approved Contractor. The Contractor shall certify all work as proper and complete. Under no circumstances shall the design; scheduling, coordination, programming, training, and warranty requirements for the project are delegated to a subcontractor.
B. Access to Site: Unless notified otherwise, entrance to building is restricted. No one will be permitted to enter the building unless their names have been cleared with the Owner or the Owner’s Representative.

C. Code Compliance: All wiring shall be installed in accordance with all applicable electrical codes and will comply with equipment manufacturer’s recommendations. Should any discrepancy be found between wiring specifications in Division 15900 and Division 16, wiring requirements of Division 15900 will prevail for work specified in Division 17.

D. Cleanup: At the completion of the work, all equipment pertinent to this contract shall be checked and thoroughly cleaned, and all other areas shall be cleaned around equipment provided under this contract. Clean the exposed surfaces of tubing, hangers, and other exposed metal of grease, plastic, or other foreign materials.

3.02 WIRING, CONDUIT, TUBING AND CABLE

All wire will be copper and meet the minimum wire size and insulation class listed below:

<table>
<thead>
<tr>
<th>Wire Class</th>
<th>Wire Size</th>
<th>Isolation Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power</td>
<td>12 Gauge</td>
<td>600 Volt</td>
</tr>
<tr>
<td>Class Two</td>
<td>14 Gauge Std.</td>
<td>600 Volt</td>
</tr>
<tr>
<td>Class Two</td>
<td>18 Gauge Std.</td>
<td>300 Volt</td>
</tr>
<tr>
<td>Class Two</td>
<td>18 Gauge Std.</td>
<td>300 Volt</td>
</tr>
<tr>
<td>Communications</td>
<td>Per Mfr.</td>
<td>Per Mfr.</td>
</tr>
</tbody>
</table>

A. Power and Class One wiring may be run in the same conduit. Class Two and Three wiring and communications wiring may be run in the same conduit.

B. Where different wiring classes terminate within the same enclosure, maintain clearances and install barriers per the National Electric Code.

C. Where wiring is required to be installed in the conduit, EMT shall be used. Conduit shall be minimum 1/2 inch galvanized EMT. Setscrew fittings are acceptable for dry interior locations. Watertight compression fittings shall be used for exterior locations and interior locations subject to moisture. Provide conduit seal off fitting where exterior conduits enter the building or between areas of high temperature/moisture differential.

D. Where the space above the ceiling is a supply or return air plenum, the wiring shall be plenum rated cable. Plenum rated cable can be run without conduit above suspended ceilings. Cabling shall be installed in conduit systems in mechanical and electrical rooms.

E. Flexible metallic conduit (max. 3 feet) shall be used for connections to motors, actuators, controllers, and sensors mounted on vibration producing equipment. Liquid-tight flexible conduit shall be use in exterior locations and interior locations subject to moisture.

F. Junction boxes shall be provided at all cable splices, equipment termination, and transitions from EMT to flexible conduit. Interior dry location J-boxes shall be galvanized pressed steel, nominal four-inch square with blank cover. Exterior and damp location JH-boxes shall be cast alloy FS boxes with threaded hubs and gasketed covers.

G. Pneumatic tubing will be FR rated polyethylene instrumentation tubing, type M, hard copper tubing, or soft copper tubing. All pneumatic tubing will be sized for a maximum pressure drop of 2 PSI from the pressure-reducing valve to end device.

H. Coaxial cable shall conform to RG62 or RG59 rating. Provide plenum rated coaxial cable when running in return air plenums.
I. Fiber optic cable shall include the following sizes; 50/125, 62.5/125 or 100/140: Only glass fiber is acceptable, no plastic.

J. Fiber optic cable shall only be installed and terminated by an experienced contractor. The BAS contractor shall submit to the Engineer the name of the intended contractor of the fiber optic cable with his submittal documents.

3.03 HARDWARE INSTALLATION

A. Installation Practices for Wiring and Tubing
   1. All controllers are to be mounted vertically and per the manufacturer’s installation documentation.
   2. A true earth ground must be available in the building. Do not use a corroded or galvanized pipe, or structural steel. Conduit in finished areas will be concealed in furred spaces and wall construction. Exception; metallic surface raceway may be used in finished areas on masonry walls. All surface raceway in finished areas must be color matched to the existing finish within the limitations of standard manufactured colors.
   3. Conduit, in non-finished areas where possible, will be concealed in furred spaces, and wall construction. Exposed conduit will run parallel to or at right angles to the building structure.
   4. Wires are to be kept a minimum of three (3) inches from hot water, steam, or condensate piping.
   5. Where sensor wires leave the conduit system, they are to be protected by a plastic insert.
   6. Wire or pneumatic tubing will not be allowed to run across telephone equipment areas.
   7. All wiring running down exposed fire rated walls to controls or control panels shall be run in EMT or completely enclosed in metal raceways.
   8. All control wiring in concrete walls or floors shall run in rigid conduit.

B. Installation Practices for Field Devices
   1. Well-mounted sensors will include thermal conductive compound within the well to insure good heat transfer to the sensor.
   2. Actuators will be firmly mounted to give positive movement and linkage will be adjusted to give smooth continuous movement throughout 100 percent of the stroke.
   3. Waterline mounted sensors shall be removable without shutting down the system in which they are installed.
   4. For duct static pressure sensors, the high-pressure port shall be connected to a metal static pressure probe inserted into the duct pointing upstream. The low-pressure port shall be left open to the plenum area at the point that the high-pressure port is tapped into the ductwork.
   5. For building static pressure sensors, the high-pressure port shall be inserted into the space via a metal tube. Pipe the low-pressure port to the outside of the building.

C. Enclosures
   1. For all I/O requiring field interface devices, these devices where practical will be mounted in a field interface panel (FIP). The Contractor shall provide an enclosure, which protects the device(s) from dust, moisture, conceals integral wiring and moving parts.
   2. FIPs shall contain power supplies for sensors, interface relays and contactors, safety circuits, and I/P transducers.
3. The FIP enclosure shall be of steel construction with baked enamel finish, NEMA 1 rated with a hinged door and keyed lock. The enclosure will be sized for twenty percent spare mounting space. All locks will be keyed identically.

4. All wiring to and from the FIP will be to screw type terminals. Analog or communications wiring may use the FIP as a raceway without terminating. The use of wire nuts on control signal wires within the FIP is prohibited.

5. All outside mounted enclosures shall meet the NEMA-4 rating.

6. The tubing and wiring within all enclosures shall be run in plastic track. Wiring within controllers shall be wrapped and secured.

D. Identification

1. Identify all control wires with labeling tape or sleeves using words, letters, or numbers that can be exactly cross-referenced with as-built drawings.

2. Identify all pneumatic tubing with labeling tape or sleeves using words, letters, or numbers that can be exactly cross-referenced with as-built drawings.

3. All field enclosures, other than controllers, shall be identified with a Bakelite nameplate. The lettering shall be in white against a black or blue background.

4. Junction box covers will be marked to indicate that they are a part of the BAS system.

5. All I/O field devices (except space sensors) that are not mounted within FIP's shall be identified with nameplates.

6. All I/O field devices inside FIP's shall be labeled.

E. Location

1. The location of sensors is per mechanical and architectural drawings.

2. Space humidity or temperature sensors will be mounted away from machinery generating heat, direct light and diffuser air streams.

3. Outdoor air sensors will be mounted on the north building face directly in the outside air. Install these sensors such that the effects of heat radiated from the building or sunlight is minimized.

4. Field enclosures shall be located immediately adjacent to the controller panel(s) to which it is being interfaced.

3.04 SOFTWARE INSTALLATION

A. General: The software design and implementation is to be facilitated only by an Andover approved Contractor. The Contractor shall provide all labor necessary to install, initialize, startup and debug all system software as described in this section. This includes any operating system software or other third party software necessary for successful operation of the system.

B. Database Configuration: The Contractor will provide all labor to configure those portions of the database that are required by the point's list and sequence of operation.

C. Color Graphic Slides:

1. Unless otherwise directed by the owner, the Contractor will provide color graphic displays matching the Campus Standards for each system and floor plan.

2. For each system or floor plan, the display shall contain the associated points identified in the point list and allow for setpoint changes as required by the owner.
   a. Animations and 3D Rendering.
   b. Animations to mimic all moving devised, status and operation.
   c. Animations set to maximum performance, compatible with Version 1.81.
d. Individual slides; mechanical equipment, VAV/CAV boxes, pumps, motors, fans, dampers, thermostats, and valves.

D. Reports
1. The Contractor will configure a minimum of 6 reports for the owner as listed below:
   b. VAV Status Report.

E. Documentation
1. As built software documentation will include the following:
   a. Descriptive point lists.
   b. Application program listing.
   c. Application programs with comments.
   d. Printouts of all reports.
   e. Alarm list.
   f. Printouts of all graphics.

3.05 COMMISSIONING AND SYSTEM STARTUP

A. Point to Point Checkout: Each I/O device (both field mounted as well as those located in FIPs) shall be inspected and verified for proper installation and functionality. A checkout sheet itemizing each device shall be filled out, dated and approved by the Facilities Manager for submission to the owner's representative.

B. Controller and Workstation Checkout: A field checkout of all controllers and front-end equipment (computers, printers, modems, etc.) shall be conducted to verify proper operation of both hardware and software. A checkout sheet itemizing each device and a description of the associated tests shall be prepared and submitted to the owner or owner's representative by the completion of the project.

C. System Acceptance Testing
1. All application software will be verified and compared against the sequences of operation. Control loops will be exercised by inducing a setpoint shift of at least 10% and observing whether the system successfully returns the process variable to setpoint. Record all test results and attach to the Test Results Sheet.

2. Test each alarm in the system and validate that the system generates the appropriate alarm message, that the message appears at all prescribed destinations (workstations or printers), and that any other related actions occur as defined (i.e. graphic panels are invoked, reports are generated, etc.). Submit a Test Results Sheet to the owner.

3. Perform an operational test of each unique graphic display and report to verify that the item exists, that the appearance and content are correct, and that any special features work as intended. Submit a Test Results Sheet to the owner.

4. Perform an operational test of each third party interface that has been included as part of the automation system. Verify that all points are properly polled, that alarms have been configured, and that any associated graphics and reports have been completed. If the interface involves a file transfer over Ethernet, test any logic that controls the transmission of the file, and verify the content of the specified information.

END OF SECTION
SECTION 23 80 90

LABORATORY AIRFLOW CONTROLS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS
   A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Specification Sections, apply to this Section.
   B. “Instrumentation and Control for HVAC” section.
   C. “Laboratory Fume Hoods” section.

1.02 SUMMARY
   A. Description
      1. A laboratory airflow control system shall be furnished and installed to control the airflow into and out of laboratory rooms. The exhaust flow rate of a laboratory fume hood shall be precisely controlled to maintain a constant average face velocity into the fume hood at either a standard/in-use or standby level based on an operator being present in front of the fume hood. The laboratory control system shall vary the amount of make-up/supply air into the room to operate the laboratories at the lowest possible airflow rates necessary to maintain temperature control, achieve minimum ventilation rates, and maintain laboratory pressurization in relation to adjacent spaces (positive or negative).
   B. Section Includes:
      1. Single-duct air terminal units (venturi air valves) for laboratory supply and exhaust.
      2. Fume hood control devices.

1.03 AIRFLOW CONTROL SYSTEM DESCRIPTION
   A. Each laboratory shall have a dedicated laboratory airflow control system.
   B. The laboratory airflow control system shall employ individual average face velocity controllers that directly measure the area of the fume hood sash opening and proportionally control the hood’s exhaust airflow to maintain a constant face velocity over a minimum range of 20 to 100% of sash travel. The corresponding minimum hood exhaust flow turndown ratio shall be 5 to 1.
   C. The hood exhaust airflow control device shall respond to the fume hood sash opening by achieving 90% of its commanded value within one second of the sash reaching 90% of its final position (with no more than 5% overshoot/undershoot) of required airflow. Rate of sash movement shall be between 1.0 to 1.5 feet per second.
   D. The hood exhaust airflow control device shall be automatically switched between in-use and standby levels based on operator presence immediately in front of the hood. A presence and motion sensor shall activate the switching. The airflow control device shall achieve the required in-use commanded value in less than one second from moment of detection with no more than a 5% overshoot or undershoot.
   E. The laboratory airflow control system shall maintain specific airflow (± 5% of signal within one second of a change in duct static pressure) regardless of the magnitude of the pressure change (within 0.6" to 3.0" WC), airflow change or quantity of airflow control devices on the manifold.
F. The laboratory airflow control system shall use volumetric offset control to maintain room pressurization. The system shall maintain proper room pressurization polarity (negative or positive) regardless of any change in room/system conditions such as the raising and lowering of any or all fume hood sashes or rapid changes in duct static pressure. Systems using differential pressure measurement or velocity measurement to control room pressurization are unacceptable.

G. The laboratory airflow control system shall maintain specific airflow (± 5% of signal) with a minimum 16 to 1 turndown to insure accurate pressurization at low airflow and guarantee the maximum system diversity and energy efficiency.

1.04 PERFORMANCE REQUIREMENTS

A. Structural Performance: Hangers and supports shall withstand the effects of gravity loads and stresses within limits and under conditions described in SMACNA’s "HVAC Duct Construction Standards - Metal and Flexible".

1.05 SUBMITTALS

A. Product Data: For each type of the following products, including rated capacities, furnished specialties, sound-power ratings, and accessories.
   1. Air valves.
   2. Liners and adhesives.
   3. Sealants and gaskets.
   4. Fume hood control devices.

B. Proposed Equipment
   1. The laboratory airflow control system supplier shall provide a detailed proposal describing all elements of the laboratory control system. A schematic laboratory layout shall be provided, showing relations of these elements and a description of how they interact.
   2. Technical specification data sheets shall be provided for all proposed system components and devices.
   3. All proposed airflow control devices shall include discharge, exhaust, and radiated sound power level performance obtained from testing in accordance with ARI Standard 880.

C. Field quality-control reports.

D. Operation and Maintenance Data: For laboratory airflow control system to include emergency, operation, and maintenance manuals. In addition to items specified in Section "Operation and Maintenance Data," include the following:
   1. Instructions for resetting minimum and maximum air volumes.
   2. Instructions for adjusting software set points.

1.06 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1-2004, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-Up."

1.07 PREVENTIVE MAINTENANCE

A. The laboratory airflow control system supplier shall provide at no additional cost to the owner during and after the warranty period, five years of required preventive maintenance on all airflow sensors (e.g., pitot tube, flow cross, orifice ring, air bar, hot wire, vortex shedder, side wall
sensors, etc.), and flow transducers provided under this section. Airflow sensors shall be removed, inspected and cleaned annually during the five-year period to prevent inaccuracies due to long-term buildup from corrosion, lab tissues, wet or sticky particles, or other materials that foul the sensor. If impractical to remove the airflow sensors, the laboratory airflow control system supplier shall include in the proposal the cost of supplying and installing duct access doors, one for each sensor. The transducer shall be checked and recalibrated annually to ensure long-term accuracy. Note that auto-zero recalibration of transducers is not acceptable as a substitute for annual recalibration.

1.08 WARRANTY PERIOD

A. Warranty shall commence upon the date of shipment and extend for a period of 24 months whereupon any defects in materials or laboratory airflow control system performance shall be repaired by the supplier at no cost to the owner.

PART 2 - PRODUCTS

2.01 LABORATORY AIRFLOW CONTROL SYSTEM MANUFACTURERS

A. Acceptable Manufacturers:

1. The plans and specifications for the laboratory airflow control system are based on systems and equipment manufactured by Triatek LLC. Substitutions will not be considered for this project, the equipment of this project must integrate with the existing Triatek system in the building.

2. The laboratory airflow system provider shall be an entity that designs, develops, manufactures and sells products and services to control the environment and airflow of critical spaces using a Quality Management System registered to ISO 9001:2008.

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

1. Triatek LLC (NO substitutions allowed).

2.02 USAGE BASED CONTROL EQUIPMENT

A. For variable air volume (VAV) systems, a sash sensor shall be provided to measure the height of each vertically-moving fume hood sash. A sash sensor shall also be provided for horizontal overlapping sashes. Control systems employing only sidewall mounted velocity sensors shall be unacceptable.

B. A presence and motion sensor shall be provided to determine an operator’s presence in front of a hood by detecting the presence and/or motion of an operator, and to command the laboratory airflow control system from an in-use operating face velocity (e.g., 100 fpm) to a standby face velocity (e.g., 60 fpm) and vice versa.

1. The sensor shall define a detection zone that extends approximately 20” (50 cm) from the front of the fume hood. If the sensor does not detect presence and/or motion in its detection zone within five seconds, it shall command the system to the user adjustable standby face velocity. When the sensor detects the presence and/or motion of an operator within the detection zone, it shall command the system to the in-use face velocity within 1.0 second.

2. The sensor shall have a control circuit that adapts to its specific surroundings and automatically adjusts for inanimate objects placed within its detection zone. It shall map the area into memory and, after a period of five minutes, nullify the image of the inanimate object and return to a standby mode. Operators shall enter and leave the zone
with the unit automatically adjusting between in-use and standby modes. If the inanimate object is moved or taken out of the zone, the unit shall automatically re-map the area.

3. Wide area motion detectors (on the hood or room level) shall be unacceptable.

C. The airflow at the fume hood shall vary in a linear manner between two adjustable minimum and maximum flow set points to maintain a constant face velocity throughout this range. A minimum volume flow shall be set to assure flow through the fume hood even with the sash totally closed.

D. A fume hood monitor shall be provided to receive the sash sensor output and presence and/or motion signal. This same monitor shall generate an exhaust airflow control signal for the appropriate airflow control device in order to provide a constant average face velocity. Audible and separate visual alarms shall be provided for both flow alarm and emergency exhaust conditions.

2.03 AIRFLOW CONTROL DEVICE—GENERAL

A. The airflow control device shall be a venturi valve.


C. The airflow control device shall be pressure independent over its specified differential static pressure operating range. An integral pressure independent assembly shall respond and maintain specific airflow within one second of a change in duct static pressure irrespective of the magnitude of pressure and/or flow change or quantity of airflow controllers on a manifold system.

D. The airflow control device shall maintain accuracy within ± 5% of signal over an airflow turndown range of no less than 16 to 1. No minimum entrance or exit duct diameters shall be required to ensure accuracy and/or pressure independence.

E. The airflow control device shall be constructed of one of the following three types:

1. Class A - The airflow control device for non-corrosive airstreams such as supply and general exhaust shall be constructed of 16 gauge aluminum. The device's shaft and shaft support brackets shall be made of 316-stainless steel. The pivot arm and internal mounting link shall be made of aluminum. The pressure independent springs shall be a spring grade stainless steel. All shaft bearing surfaces shall be made of a Teflon, or polyester, or PPS (polyphenylene-sulfide) composite.

2. Sound attenuating devices used in conjunction with general exhaust or supply airflow control devices shall be constructed using 24 gauge galvanized steel or other suitable material used in standard duct construction. No sound absorptive materials of any kind shall be used.

3. Class B - The airflow control device for corrosive airstreams such as fume hoods and biosafety cabinets shall have a baked-on corrosion resistant phenolic coating. The device's shaft shall be made of 316-stainless steel with a Teflon coating. The shaft support brackets shall be made of 316-stainless steel. The pivot arm and internal mounting link shall be made of 316 or 304 stainless steel. The pressure independent springs shall be a spring grade stainless steel. The internal nuts, bolts and rivets shall be stainless steel. All shaft bearing surfaces shall be made of a Teflon or PPS (polyphenylene-sulfide) composite.

4. Class C - An airflow control device for highly corrosive airstreams shall be constructed as defined in paragraph D.2 and in addition, shall have no exposed aluminum or stainless steel components. Shaft support brackets, pivot arm, internal mounting link, and pressure independent springs shall have a baked-on corrosion resistant phenolic coating in addition to the materials defined in paragraph D.2. The internal nuts, bolts, and rivets
shall be titanium or phenolic coated stainless steel. Only devices clearly defined as "High Corrosion Resistant" on project drawings will require this construction.

F. Actuation

1. For pneumatically-actuated two-position or VAV operation, a pneumatic actuator shall be factory mounted to the valve. Loss of pneumatic main air or control power shall cause normally open valves to fail to maximum position, and normally closed valves to fail to minimum position.

2. For electrically-actuated VAV operation, a UL 916 listed electronic actuator shall be factory mounted to the valve. Loss of main power shall cause the valve to position itself in an appropriate failsafe state. Options for these failsafe states include: normally open-maximum position, normally closed-minimum position, or last position. This position shall be maintained constantly without external influence, regardless of external conditions on the valve (within product specifications).

3. Constant volume valves do not require actuators.

G. Certification

1. Each airflow control device shall be factory calibrated to the job specific airflows as detailed on the plans and specifications using NIST traceable air stations and instrumentation having a combined accuracy of no more than ± 1% of signal over the entire range of measurement. Electronic airflow control devices shall be further calibrated and their accuracy verified to ± 5% of signal at a minimum of eight different airflows across the full operating range of the device.

2. All airflow control devices shall be individually marked with device specific and factory characterization data. As a minimum, it should include: tag number, serial number, model number, characterization information (for electronic devices), and quality control inspection numbers. All information shall be stored by the manufacturer. Job related information, such as tag number, serial number and model number, shall be stored by the manufacturer for use with as-built documentation.

H. Airflow control devices that are not venturi valves, and airflow measuring devices (e.g., pitot tube, flow cross, air bar, orifice ring, vortex shedder, etc.) shall only be acceptable provided they meet all the performance and construction characteristics as stated throughout this specification and:

1. Provide the airflow control device with transducers manufactured by Rosemount, Bailey, Bristol, or Foxboro. Accuracy shall be no less than ± 0.15% of span (to equal ± 5% of signal with a 15 to 1 turndown) over the appropriate full scale range including the combined effects of nonlinearity, hysteresis, repeatability, drift over a one year period, and temperature effect. 316L stainless steel materials shall be provided for all exhaust applications. The use of 304 stainless steel materials shall be provided for all make-up air applications.

2. Provide Airflow sensors of a multi-point averaging type 304-stainless steel for all supply and general exhaust applications, 316L stainless steel for all fume hood, canopy, snorkel, and biosafety cabinet applications. Single point sensors are not acceptable.

3. Suppliers of airflow control devices or airflow measuring devices requiring minimum duct diameters shall provide revised duct layouts showing the required straight duct runs upstream and downstream of these devices. Coordination drawings reflecting these changes shall be submitted by the supplier of the laboratory airflow control system. In addition, suppliers shall include static pressure loss calculations as part of their submittals. All costs to modify the ductwork, increase fan sizes and horsepower, and all associated electrical changes shall be borne by the laboratory airflow control supplier.

2.04 EXHAUST AND SUPPLY AIRFLOW CONTROL DEVICE
A. The airflow control device shall use closed loop control to linearly regulate airflow based on a 0 to 10 volt control signal. The device shall generate a 0 to 10 volt feedback signal that is linearly proportional to its airflow.

2.05 LABORATORY OFFICE SUPPLY AND GENERAL PURPOSE AIRFLOW CONTROL DEVICE
A. The control device shall regulate flow based on a varying 0 to 10 volt electronic signal. The office supply or general-purpose devices requiring flow feedback shall generate a 0 to 10 volt feedback signal that is linearly proportional to its airflow.

2.06 CLOSED LOOP VARIABLE FREQUENCY DRIVE
A. Provide a drive in conformance with 239500 "Variable Frequency Drives". The drive shall be a high performance pulse width modulated design, which generates a sine-coded, adjustable voltage/frequency, three phase output for complete speed control of any conventional squirrel cage induction motor.
B. The device shall not induce any voltage line notching distortion back to the utility line. The device shall maintain a displacement power factor of not less than .95 throughout its speed range. Synchronism between drive frequency and motor speed shall be maintained under all conditions.
C. The drive shall automatically restart a coasting motor after a power outage of any duration without tripping or shutting down. The drive shall apply rated power to accelerate the motor to the commanded speed within 0.5 second of the reaplication of drive power or the removal of a motor fault condition.
D. The drive shall accelerate the motor rapidly, limited only by the motor’s rated torque and load.
E. An alarm circuit indicating low face velocity shall be included to electronically sense a loss of airflow via a drop in actual (not calculated) motor power or a difference between the actual and commanded motor speed. The alarm shall be enunciated through audible and visual means at the fume hood monitor.

2.07 LABORATORY CONTROL UNIT
A. A laboratory control unit shall control the supply and/or general exhaust airflow control devices to maintain proper room pressurization polarity (positive or negative). Each individual laboratory shall have a dedicated laboratory control unit.
B. The control unit shall be electronic. The inputs shall accept linear feedback signals from fume hood, canopy, snorkel, biosafety cabinet, and office supply airflow control devices. The output signals shall control supply, general exhaust/return airflow control devices and/or variable frequency drives with signals that are linearly proportional to the desired supply or exhaust airflows.
C. The control unit shall maintain a constant design offset between the sum of the room's total exhaust and make-up/supply airflows. This offset shall be field adjustable and represents the volume of air that will enter (or exit) the room from the corridor or adjacent spaces.
D. The control unit shall provide linear signals that are proportional to all airflow sources, sash sensors, and flow alarms. The signals shall be available for hard-wired connection to the facility’s direct digital control (DDC) system, or through an integrated control unit that interfaces directly into the facility’s DDC system.
E. The laboratory control unit may be either panel or valve mounted.
F. Refer to the DDC Control specification for the required input/output summary for the necessary points to be monitored and or controlled.
G. Each laboratory shall have a dedicated 120 Vac line connection to power the laboratory's airflow control system power supply.

2.08 ATTENUATOR SECTION: 0.032-INCH ALUMINUM SHEET

A. Lining: Adhesive, attached, ¼ inch thick, coated, fibrous-glass duct liner complying with ASTM C 1071, 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 SSTM E84.
   1. Cover liner with non-porous foil and perforated metal.

B. Lining: Adhesive attached, ¼ 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.

C. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2004.

2.09 HYDRONIC COILS

A. Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch, and rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 220 degrees F. Include manual air vent and drain valve.

2.10 HANGERS AND SUPPORTS

A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.

B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.

C. Steel Cables: Stainless steel complying with ASTM A 492.

D. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.

E. Air Terminal Unit Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

F. Trapeze and Riser Supports: Steel shapes and plates for units with steel casings; aluminum for units with aluminum casings.

2.11 SOURCE QUALITY CONTROL

A. Factory Tests: Test assembled air terminal units according to ARI 880.
   1. Label each air terminal unit with plan number, nominal airflow, maximum and minimum factory-set airflows, coil type, and ARI certification seal.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install air terminal units according to NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems."

B. Provide and ship fume hood control devices to the controls contractor for installation of the sash sensors, interface boxes, presence and motion sensor, and fume hood monitor on the fume hood under initial supervision of the laboratory airflow control system supplier. Reel-type sash sensors and their stainless steel cables shall be hidden from view. Sash interface boxes with interface cards shall be mounted in an accessible location.
C. Install the laboratory control unit (if panel-mounted) and transformers (as required) in an accessible location in the designated laboratory room above the fume hoods in a ceiling enclosure section.

D. Terminate and connect all cables as required.

E. Install all airflow control devices in the ductwork and shall connect all airflow control valve linkages.

F. Provide and install all reheat coils and transitions.

G. Provide and install insulation as required.

H. Provide a dedicated, single-phase 120 Vac power circuit to the laboratory control unit or power supply.

I. Install air valves level and plumb. Maintain sufficient clearance for normal service and maintenance.

3.02 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Hangers and Supports."

B. Hangers Exposed to View: Threaded rod and angle or channel supports.

C. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.03 CONNECTIONS

A. Install piping adjacent to air terminal unit to allow service and maintenance.

B. Hot-Water Piping: In addition to requirements in Section "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.

C. Connect ducts to air terminal units.

D. Make connections to air terminal units with flexible connectors.

3.04 IDENTIFICATION

A. Label each laboratory airflow control unit with plan number, nominal airflow, and maximum and minimum factory-set airflows. Comply with requirements in Section "Identification for HVAC Piping and Equipment" for equipment labels and warning signs and labels.

3.05 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

C. System start-up, checkout, programming, gateway configuration, etc. shall be provided by a factory-authorized representative of the laboratory airflow control system manufacturer and not the EMS contractor. Start-up shall include calibrating the fume hood monitor and any combination sash sensing equipment as required. Start-up shall also provide electronic verification of airflow (fume hood exhaust, supply, make-up, general exhaust, or return).

D. The balancing contractor shall be responsible for final verification and reporting of all airflows.
E. The laboratory airflow control system supplier shall furnish a minimum of 4 hours of owner training by factory trained and certified personnel. The training will provide an overview of the job specific airflow control components, verification of initial fume hood monitor calibration, general procedures for verifying airflows of air valves, and general troubleshooting procedures.

F. Operation and maintenance manuals, including as-built wiring diagrams and component lists, shall be provided for each training attendee.

G. 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.
   2. Coordinate with the commissioning authority.

H. Tests and Inspections:
   1. After installing laboratory airflow control system 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.

I. Laboratory airflow control devices will be considered defective if it does not pass tests and inspections.

J. Prepare test and inspection reports.

3.06 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.
   1. Complete installation and startup checks according to manufacturer's written instructions.
   2. Verify that inlet duct connections are as recommended by air terminal unit manufacturer to achieve proper performance.
   3. Verify that controls and control enclosure are accessible.
   4. Verify that control connections are complete.
   5. Verify that nameplate and identification tag are visible.
   6. Verify that controls respond to inputs as specified.

END OF SECTION
SECTION 23 80 95

CUSTOM ROOFTOP 100% OA AIR HANDLER

PART 1 - GENERAL

Basis of design is Energy Labs. Alternate brands shall meet or exceed performance and construction aspects as described and detailed herein. Being listed as an alternate manufacturer does not imply that the alternate manufacturer’s standard construction will be acceptable. Deviations from the base bid specification shall be clearly noted at the time of bid.

Alternates:
Scott Springfield
Hunt Air
ClimateCraft

REFERENCES
   AFBMA 9 - Load Ratings and Fatigues Life for Ball Bearings
   AFBMA 11 - Load Ratings and Fatigue Life for Roller Bearings
   AMCA 99 - Standards Handbook
   AMCA 210 - Laboratory Methods of Testing Fans for Rating Purposes
   AMCA 300 - Test Code for Sound Rating Air Moving Devices
   AMCA 301 - Method of Publishing Sound Ratings for Air Moving Devices
   AMCA 500 - Test Methods for Louver, Dampers, and Shutters
   ARI 410 - Forced-Circulation Air-Cooling and Air-Heating Coils
   ARI 430 - Central Station Air Handling Units
   ARI 435 - Application of Central Station Air Handling Units
   ARI 610 - Central System Humidifiers
   ASTM B117 – Standard Practice for Operating Salt Spray Apparatus
   ASHRAE Std. 52.2 – Method of Testing Air-Cleaning Devices for Removal Efficiency by Particle Size
   IBC – International Building Code
   NEMA MG1 - Motors and Generators
   NFPA 70 - National Electrical Code
   NFPA 90A – Standard for the Installation of Air Conditioning and Ventilating Systems
   SMACNA - HVAC Duct Construction Standards - Metal and Flexible
   UL 900 - Test Performance of Air Filter Units
   UL 1995 – Standard for Heating and Cooling Equipment

1.01 SUBMITTALS

A. Submit under provisions of General Conditions and Division 1 as applicable.

B. Shop Drawings: Indicate assembly drawings, unit dimensions, weight loading, required clearances, construction details, field connection details, electrical characteristics and connection requirements.

C. Product Data:
   1. Provide literature, which indicates dimensions, weights, capacities, ratings, fan performance, gauges and finishes of materials, electrical characteristics and connection requirements.
   2. Provide data on filter media, filter performance data, filter assembly, and filter frames.
3. Provide fan curves with specified operating point clearly plotted.
4. Submit sound power level data for the air handling unit outlet, inlet and casing radiated at rated capacity and specified pressure.
5. Submit electrical requirements for power supply including wiring diagrams for interlock and control wiring, clearly indicating factory installed and field installed wiring.
6. Applicable warranty certificates.

1.02 OPERATION AND MAINTENANCE DATA
   A. Submit under provisions of General Conditions and Division 1 as applicable.
   B. Maintenance Data: Include instructions for inspection, maintenance, lubrication, filter replacement, motor and drive replacement, adjustments, spare parts lists and wiring diagrams.
   C. Manufacturer’s Installation Instructions.

1.03 QUALIFICATIONS
   A. Manufacturer: Company specializing in the design and manufacture of the products specified in this section with a minimum of ten (10) years documented experience, and which issues complete catalog data on the total product.
   B. Each unit shall bear an ETL label, conforming to UL Standard 1995.

1.04 WARRANTY
   A. Manufacturer shall provide the complete unit with a limited parts only warranty covering the first year of operation. The warranty period shall commence on the date of first equipment startup or six months after the date of shipment, whichever shall occur first.
   B. The installing contractor shall provide labor warranty during the first year of operation.

1.05 EXTRA MATERIALS
   A. Furnish under provisions of General Conditions and Division 1 as applicable.

1.06 QUALITY ASSURANCE
   A. Conform to all information documented in approved submittal package and construction notes.
   B. Fan vibration test results shall be available for review prior to any air handling unit shipment to the jobsite.
   C. Manufacturer shall have a documented quality assurance plan for providing consistent product quality. The quality assurance plan shall include component quality check lists, random product inspections, fan balance reports, coil and piping leak test reports, electrical system test reports, etc. Copies of these reports shall be made available to the engineer upon request.

1.07 DELIVERY STORAGE AND HANDLING
   A. Deliver, store, protect and handle under the supervision of the owner and in accordance with the manufacturer’s Operation & Maintenance manuals.

PART 2 - PRODUCTS

2.01 MANUFACTURERS
   A. Basis of design is Energy Labs.
B. Alternate by Scott Springfield
C. Alternate by Hunt Air
D. Alternate by ClimateCraft

2.02 CABINET

A. General Construction
Cabinets shall be constructed in a water and airtight manner and shall have a leakage performance equal to or better than SMACNA Class 5. Units shall comply with UL1995 and NFPA90. Units shall carry the ETL label. Units shipping in multiple sections shall be designed for ease of field joining. Field joining shall be accomplished using instructions and materials supplied by the unit manufacturer, and shall be capable of providing a factory quality seal.

B. Base
Each unit shall be constructed on a base fabricated from ASTM A36 welded structural steel channel. Tubular or formed bases are not acceptable. To provide adequate strength and L/200 rigidity for uniform lifting, bases shall be sized as a function of air handling unit length as follows:

<table>
<thead>
<tr>
<th>AHU UNIT LENGTH</th>
<th>MINIMUM BASE CHANNEL SIZE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to 10’</td>
<td>4” x 1½” (5.4lbs/lin. ft.)</td>
</tr>
<tr>
<td>11’ to 20’</td>
<td>6” x 2” (8.2lbs/lin. ft.)</td>
</tr>
<tr>
<td>21’ to 30’</td>
<td>8” x 2½” (11.5lbs/lin. ft.)</td>
</tr>
<tr>
<td>31’ to 40’</td>
<td>10” x 2¾” (15.3lbs/lin. ft.)</td>
</tr>
<tr>
<td>41’ and longer</td>
<td>12” x 3” (20.7lbs/lin. ft.)</td>
</tr>
</tbody>
</table>

Heavy duty lifting lugs shall be added to the perimeter channel along the longest length of the unit to facilitate hoisting and field attachment to the building structure. After fabrication, the base frame shall be thoroughly cleaned, primed and painted with an industrial grade, high solids polyurethane paint. The paint system shall meet ASTM B117 salt spray test criteria for a minimum of 2,000 hours.

Provide a recessed roof curb angle around the unit perimeter for mounting the unit to the roof curb.

The unit floor shall be fabricated of 14-gauge G90 galvanized steel sheets. The entire floor shall be insulated with water impervious foam, minimum R14 total insulating value. Glass fiber insulation is not acceptable.

Floor sheets shall maintain a water and airtight seal and be capable of supporting a 300lb. load with maximum L/200 deflection at any floor seam. All floor openings shall include a 12 gauge galvanized steel flange around the entire perimeter duct connection. Floor openings larger than 8’x8” shall be covered with galvanized steel grating designed to support a minimum of 100lbs/sq. ft. No fastener penetrations through the floor sheets shall be acceptable. All fans, coils and major components shall be directly supported by structural steel frame members.

C. Housing

Cabinet shall utilize a modular panel construction. Exterior wall and roof panels shall feature a Class A thermal break. Wall panels shall be constructed of 20-gauge galvannealed steel exterior panels with industrial grade paint. Paint shall provide a durable finish with excellent color and gloss retention, shall meet ASTM B117 salt spray performance criteria for a minimum rating of 1,000 hours, and shall be covered by a 10 year manufacturer’s limited warranty. All panels shall be securely attached to each other, to the roof, and to the base and all seams shall be sealed to create a water and airtight assembly. Indoor units shall have matching wall and roof construction.
Wall and roof panel construction shall be 2" thick, R12.1 moisture resistant polyisocyanurate foam protected by a solid interior liner. Interior liners shall be 20-gauge, G90 bright galvanized steel. Steel exterior panels shall feature steel interior liners, and aluminum exterior panels shall feature aluminum interior liners. Air handling unit housing shall meet NFPA 90A smoke and flame spread limits.

Units with fasteners that penetrate thru the wall or roof panels and into the air tunnel will not be acceptable.

Roof mounted units shall use a standing seam, pitched roofing system that provides a positive slope for drainage. Roof panels shall feature a Class A thermal break and shall be constructed of 20-gauge galvanized steel exterior panels with industrial grade paint. Paint shall provide a durable finish with excellent color and gloss retention, shall meet ASTM B117 salt spray performance criteria for a minimum rating of 1,000 hours and shall be covered by a 10 year manufacturer's limited warranty. Interior liners shall be 20-gauge, G90 bright galvanized steel.

D. Doors

Hinged, double wall, man size access doors shall be provided in all sections requiring access for maintenance or service as indicated in the Plan documents. Door thickness, R value and exterior and interior materials shall match those of its associated section. The door frame shall be extruded aluminum. Access doors shall be fully sealed with a dual set of closed cell, replaceable neoprene gasket. Door gasket shall be installed to allow for easy removal and replacement in case of damage.

Door hinges and latches shall be adjustable, without the use of shims or special tools. Hinges shall be stainless steel or cast aluminum. Provide door detail drawings with submittal package.

Door handles shall be composite, fiber reinforced nylon equal to those by Allegis Corporation. The latch mechanism shall be a thermal break assembly which can be operated from outside or inside of the cabinet. Doors shall open against pressure or shall include a built-in safety catch to release cabinet operating pressure prior to opening the door.

Fan section door(s) shall be equipped with a switch interlocked with the fan starter to stop the fan before the access door is opened.

All outdoor mounted units shall use a rain diverter over each door frame.

2.03 INTERNAL COMPONENTS

A. Fan Assembly

1. General Requirements for All Fans

   a. Fans shall be of the size and type shown in the project Schedule and shall perform as indicated. The fan wheel diameter shall not be less than that shown on the equipment schedule. Fans shall be constructed to AMCA Standards for the Class Rating as indicated on the Equipment Schedule.

   b. Fan performance shall be based on tests run in an AMCA accredited laboratory and administered in accordance with AMCA Standards 210 and 300. Fans shall be licensed to bear the AMCA seal for air and sound performance.

   c. Fan performance shall be adjusted to reflect fans running inside the cabinet such that it reflects any affects from the unit cabinet, fan configuration or other internal components. Performance shall be based on unit tests run in an AMCA 210 and 300 accredited laboratory.

   d. Fan and motor shall be mounted on an internal, fully welded, rigid steel assembly. Each individual fan assembly shall be free-floating at all four corners on minimum 2" deflection spring isolators with earthquake restraints. The spring isolators shall be mounted to structural steel members and shall be rated for a minimum of 1G.
The fan discharge shall be isolated from the cabinet by means of a neoprene-coated flexible connection.

2. Direct Drive Fans
   a. Single or multiple, Arrangement #4 plenum fan assemblies shall be provided. Fans shall be arranged to provide even air distribution within the unit cabinet. Minimum/maximum fan quantity shall be as indicated in the project Schedule. Total fan BHP and motor HP shall not be exceeded. Scheduled motor efficiencies are considered to be the minimum allowed.
   b. Individual fan performance shall be based on tests performed in an AMCA accredited laboratory and administered in accordance with AMCA Standards 210 and 300. Individual fans shall be licensed to bear the AMCA seal for air and sound performance. Submitted fan performance shall be adjusted to reflect multiple fans running inside the cabinet and to reflect any affects from the unit cabinet and other internal components. Performance shall be based on tests run in an AMCA 210 and 300 accredited laboratory. Fans shall be minimum Class 2 construction.
   c. The fan wheel shall be aluminum with extruded aluminum airfoil blades continuously welded to the fan side plates. The fan back plane shall be bolted to a cast aluminum fan hub with keyway. Fans not using airfoil blades, or using steel construction, will not be considered. Fan inlets shall be isolated from the cabinet by means of a neoprene-coated flexible connection.
   d. Motors shall be premium efficiency to meet or exceed the requirements in EISA 2007. Motors shall be TEFC, NEMA frame, cast iron casing, ball bearing type complete with grease lubricated bearings and zerk fittings for field lubrication. Motors shall have a NEMA Class F insulation rating with Class B temperature rise, and have a 1.15 service factor.
   e. Fan and motor shall be mounted on an internal, fully welded, rigid steel assembly with each individual assembly free-floating on minimum 2” deflection spring isolators with earthquake restraints. Thrust restraints shall be provided. Units with fans that are not individually spring isolated will not be considered.
   f. Each fan shall be mounted into its final intended assembly, including intended isolation, and balanced to ISO Standard BV5. (A factory certified test report, with a vibration signature for each fan, shall be made available to the engineer and owner at time of unit shipment.) Balance procedures where the fan & motor assemblies are balanced on a test fixture, and not in point of use, will not be accepted.
   g. Each motor shall be provided with a shaft grounding device that will bleed potential induced motor shaft voltage to ground.

B. Coils
   1. Coils shall be rated in accordance with AHRI Standard 410 and licensed to bear the AHRI certification seal.
   2. All cooling coil sections shall include drain pans constructed from 16-gauge, type 304 stainless steel. Galvanized steel drain pans will not be considered. Drain pans shall be insulated with a minimum R14 of spray foam insulation to prevent condensation under the pan. Drain pans shall be sized such that the entire coil, including headers and return bends, are contained within the drain pan. Downstream drain pan extension shall be no less than as indicated on the plan drawings. Drain pans must slope in two directions so that there is no standing water in the pan. A stainless steel condensate connection shall be provided on one side of the unit, located as shown on the plan drawings. Coils shall be supported on 10 gauge stainless steel members to prevent immersion of the coil in condensate and to allow for periodic inspection and cleaning of the drain pan.
3. Intermediate condensate drain pans shall be furnished on all stacked coil arrangements and single coils greater than 48" finned height. There shall never be more than a 48" vertical separation between drain pans. Pans shall be sloped, 16-gauge, type (304) stainless steel and shall drain to the main pan through copper downsputs.

4. All water coils shall be of the high efficiency, plate fin, extended surface type. Tubes shall be 5/8" OD seamless copper with a 0.020" minimum wall thickness. ½" diameter tube coils will not be considered.

5. Coils shall have individually replaceable return bends with a minimum wall thickness that matches the performance of the specified coil tube thickness. Coils incorporating a "hairpin" type design with "thinned" tube thickness at the bend are not acceptable. Tubes shall be expanded into the fin collars to provide a permanent mechanical bond.

6. The coil secondary surface shall be formed of 0.008 aluminum fins spaced not closer than 12 fins per inch with integral spacing collars that cover the tube surface. Headers shall be seamless copper tube, outside of the airstream. Coil connections shall be copper MPT. Supply and return connections shall be extended to the exterior of the air handling unit. Connection exit locations shall be sealed airtight at the factory.

7. All coils shall utilize counter flow circuiting with connections left or right hand as shown on the drawings. The use of internal restrictive devices to obtain turbulent flow will not be accepted.

8. Cooling coil casings shall be minimum 16-gauge, type 304 stainless steel with double-formed 1-1/4" stacking flanges and 3/4" flanges on the side plates. Heating coil casings shall be 16-gauge galvanized steel. Coil tube sheets shall have extruded holes to prevent raw edges of tube sheets cutting into the copper tubes during thermal expansion of the tubes. Straight punched tube holes with raw sheet metal edges are not acceptable. Reinforcing shall be furnished so that the unsupported fin length is not over 60".

9. All water coils shall have a working pressure rating of 250psig and shall be factory tested under water at 350psig. Headers are to be located inside the cabinet casing with only the pipe connections extending through the casing. All sides of the coils shall be carefully blanked off to ensure all air passes through the coil.

C. Filters

1. Complete filter sections shall be integral to the air-handling unit. Filter frames shall be arranged for upstream loading as shown on the drawings. Filter frames shall be 16 Ga. galvanized steel and shall include factory applied gasket. Frames shall be installed with vertical stiffeners to provide a rigid assembly. All filter clips shall be provided by the air handling unit manufacturer. Clips shall be capable of use without a tool. All filter frames shall be 12"x24" or 24"x24" in size.

2. Each filter rack shall come complete with a factory installed pressure gauge, complete with static pressure taps, hardware and fittings. Combination filter racks with pre and final filters shall have dual gauges, one to indicate the air pressure drop across the pre-filter and one to indicate final filter pressure drop.

3. Medium efficiency filters shall be 2" thick rigid, disposable pleated media type, rated MERV 8 per ASHRAE Standard 52.2. Filters shall be UL900 (Class 2).

4. High efficiency filters shall be 12" thick rigid, low APD disposable cartridge type, rated (MERV 13) per ASHRAE Standard 52.2. Upstream of the high efficiency filter, in the same rack, shall be a 2" thick MERV 8 pre-filter. Filters shall be UL900 Class 2.

D. Dampers

1. Dampers shall be supplied with ultra low leak extruded 6063T5 aluminum airfoil blades. Blades shall be supplied with dual durometer, Santoprene™, bulb type edge seals and stainless steel arc end seals. Edge seals shall be backed by the damper blade to assure
a positive seal in the closed position. Dampers shall be provided with nylon bearings within extruded openings.

2. Damper leakage shall not exceed 6 CFM/ft² at 5.0° of static pressure. Leakage rating shall be determined by testing performed in accordance with AMCA Standard 500, figure 5.5, and tests shall have been performed by an independent testing laboratory.

3. 100% outdoor air section dampers shall be opposed blade type. Dampers shall be sized for not greater than 1200 fpm face velocity based upon gross damper area. Furnish full height, 24" wide access doors for damper and linkage service.

E. OSA intake Louvers

1. All intake and exhaust openings shall include factory provided and installed weather louvers. Louvers shall use stationary horizontal blades contained in a weather resistant frame designed to shed all runoff from the louver blades. Louver assemblies shall be constructed of 18-gauge galvanized steel. A 1/2" galvanized steel wire mesh bird screen shall be provided with all louver assemblies. Louvers shall be tested and rated per AMCA Standard 500. All louvers shall be selected at a free area velocity that yields no measurable water penetration as defined by AMCA Standard 500.

F. Electrical Power Service

1. Fan motors shall be factory wired to a motor control center with flexible conduit of adequate length so that it will not affect vibration isolation. Motor control center shall include motor overload protection, short circuit protection, manual disconnecting means and a power distribution block.

2. Provide single source power panels (SSPP) that are constructed to N.E.C. regulations and carry a U.L. 508 listing. Panels shall be NEMA 3R and shall have door for direct access to the electrical components. One panel shall be provided for a single power connection to the unit. Panels shall have a Short Circuit Capacity Rating (SCCR) of 25,000amps.

3. Each panel shall include an externally operated non-fused main disconnect switch. Panels directly servicing unit fan motors shall include fan VFD.

4. Wiring shall be clearly labeled to allow for ease of final field connections, and shall be run in EMT conduit. Raceways are not acceptable.

5. The air handling unit manufacturer, for the purpose of sole source responsibility, shall manufacture all electrical panel assemblies supplied for the air handlers. The air handling unit manufacturer shall be a U.L. 508 listed panel shop.

G. Lights

1. Provide factory installed marine type light fixtures in each air handling unit section serviced by a door. Cabinets >14' in width shall have two fixtures per section. Fixtures to be factory wired to a single toggle switch located on the unit exterior at the supply fan section door. A 15 amp GFCI convenience outlet shall be mounted with the light switch. The electrical contractor shall bring a separate 120/60/1 power service to operate the GFCI & lighting circuit. Lamps to be mini-fluorescent.

H. Variable Frequency Drive

1. ABB Variable frequency drives (VFD) shall be provided as shown on the Schedule. Provide startup by a factory authorized startup technician of the drive manufacturer.

2. All VFDs and their associated options shall be UL listed, and shall comply with the applicable requirements of the latest standards of ANSI, NEMA, National Electric Code (NEC), NEPU-70, IEEE 519-1992, FCC Part 15 Subpart J, and CE96.

3. VFDs mounted in a NEMA 12 enclosure shall be UL™ listed for plenum mounting.
4. The variable frequency drive(s) shall be flush mounted in a NEMA 3R ventilated control panel. Drives shall ship factory mounted.
5. The VFD shall be provided with BACnet communication that will allow direct connection from the VFD to the BAS.

I. Roof Curb
1. Perimeter roof curbs shall be bolted constructed made from a minimum 10 gauge, G-90 galvanized steel. Curbs shall be flat with an 12" height, as indicated on the Schedule. All required fasteners, wood nailing strips and gasket shall be provided. Gasket shall be a weather resistant closed cell EPDM. Insulation shall be provided in the field by others.

2.04 UNIT TESTING AND QUALITY CONTROL
A. Equipment Qualification
1. Prior to unit shipment, the following qualifications shall be performed and documented:
a. All fans shall be balanced and factory run tested to ensure design integrity.
b. All bearings shall be provided with a full complement of grease.
c. All factory piping shall be leak tested to ensure integrity.
d. All electrical circuits shall be tested to ensure correct operation.

B. Warranty and Start-Up Service
1. A manufacturer trained service engineer shall provide factory start-up supervision for each air-handling unit. Physical connections and start-up services are to be performed by the installing contractor.
2. Manufacturer shall provide with each unit complete Installation, Operation & Maintenance manuals at time of shipment.
3. Manufacturer shall provide a one (1) year limited parts only warranty. Warranty terms and conditions are to be included in the project submittal.

PART 3 - EXECUTION
A. Delivery, Storage, And Handling
1. Deliver, store, protect and handle products under the supervision of the owner’s representative and per the manufacturer’s Installation, Operation & Maintenance Instructions. Store in a clean dry place and protect from weather and construction traffic. Handle carefully to avoid damage to components, enclosures and finish.

B. Environmental Requirements
1. Do not operate units for any purpose, temporary or permanent, until ductwork is clean, filters are in place, bearings are lubricated, and the fan(s) has been test run under observation

C. Installation
1. Assemble and install in strict accordance with manufacturer’s Operation & Maintenance Instructions, shop drawings and contract documents.
2. Verify all components, accessories and appurtenances are on site.
3. Align, level, bolt in place and grout.
4. Install in conformance with ARI 435.

END OF SECTION
SECTION 23 95 00

VARIABLE FREQUENCY DRIVES

PART 1 - GENERAL

1.01 DESCRIPTION

A. This specification is to cover a complete Variable Frequency motor Drive (VFD) consisting of a pulse width modulated (PWM) inverter designed for use on a standard NEMA Design B induction motor.

B. The drive manufacturer shall supply the drive and all necessary controls as herein specified. The manufacturer shall have been engaged in the production of this type of equipment for a minimum of twenty years. VFD’s that are manufactured by a third party and “brand labeled” shall not be acceptable.

1.02 QUALITY ASSURANCE

A. Referenced Standards:
   1. Institute of Electrical and Electronic Engineers (IEEE)
   2. Underwriters laboratories
      a. UL508C
   3. National Electrical Manufacturer’s Association (NEMA)
      a. ICS 7.0, AC Adjustable Speed Drives
   4. IEC 16800 Parts 1 and 2
   6. NEMA MG1 part 31

B. Qualifications:
   1. VFDs and options shall be UL listed as a complete assembly. VFD’s that require the customer to supply external fuses for the VFD to be UL listed are not acceptable. VFDs with requiring additional branch circuit protection are not acceptable. The base VFD shall be UL listed for 100 KAIC without the need for input fuses.
   2. CE Mark – The VFD shall conform to the European Union ElectroMagnetic Compatibility directive, a requirement for CE marking. The VFD shall meet product standard EN 61800-3 for the First Environment restricted level.
   3. Acceptable Manufacturers
      a. ABB ACH Series or Danfoss VLT HVAC series
      b. Alternates to the above manufacturers must be owner and engineer approved 2 weeks prior to bid date. Approval does not relieve supplier of specification requirements.
      c. VFDs that are manufactured by a third party and “brand labeled” shall not be acceptable.
1.03 SUBMITTALS

A. Submittals shall include the following information:
   a. Outline dimensions, conduit entry locations and weight.
   2. Customer connection and power wiring diagrams.
   3. Complete technical product description include a complete list of options provided. Any portions of the specifications not complied with must be clearly indicated or the supplier and contractor shall be liable to provide all components required to meet the specification.
   4. Compliance to IEEE 519 – harmonic analysis for particular jobsite including total harmonic voltage distortion and total harmonic current distortion (THD).
      a. The VFD manufacturer shall provide calculations, specific to this installation, showing total harmonic voltage distortion is less than 5% with the project submittal. Input filters shall be sized and provided as required by the VFD manufacturer to ensure compliance with IEEE standard 519. All VFD’s shall include a minimum of 5% impedance reactors, no exceptions.
      b. Harmonic analysis shall be forwarded to the engineer for review before VFD’s are supplied to the job site. VFD’s are not to be commissioned until this harmonic analysis is approved by the EOR and Owner.

PART 2 - PRODUCTS

2.01 VARIABLE FREQUENCY DRIVES

A. The VFD package as specified herein shall be enclosed in a UL Type 12 or 3R listed enclosure, (NEMA only rated enclosures are not acceptable) completely assembled and tested by the manufacturer in an ISO9001 facility. The VFD tolerated voltage window shall allow the VFD to operate from a line of +30% nominal, and -35% nominal voltage as a minimum.
   1. Environmental operating conditions: 0-45C continuous through 125 HP @ 460 volt, through 60 HP @ 208 volt. Altitude 0 to 3300 feet above sea level, up to 95% humidity, non-condensing.
   2. Enclosure shall be rated UL type 1 or 12 as shown on the schedule and shall be UL listed as a plenum rated VFD. VFD’s without these ratings are not acceptable.

B. All VFDs shall have the following features:
   1. All VFDs shall have the same customer interface, including digital display, and keypad, regardless of horsepower rating. The keypad shall be removable, capable of remote mounting and allow for uploading and downloading of parameter settings as an aid for start-up of multiple VFDs.
   2. The keypad shall include Hand-Off-Auto selections and manual speed control. There shall be fault reset and “Help” buttons on the keypad. The Help button shall include “online” assistance for programming and troubleshooting.
   3. There shall be a built-in real-time clock in the VFD viewable at the keypad. The clock shall have a battery back up with 10 years minimum life span or be able automatically synchronize with the BAS controls system time clock in cases of lost and restored power. The clock shall be used to date and time stamp faults and record operating parameters at the time of fault. If the battery fails, the VFD shall automatically revert to hours of operation since initial power up. The clock shall also be programmable to control start/stop functions, constant speeds, PID parameter sets and output relays. The VFD shall have a digital input that allows an override to the time clock (when in the off mode) for a programmable time frame. There shall be four (4) separate, independent timer
functions that have both weekday and weekend settings. Capacitor backup is not acceptable.

4. The VFD shall be capable of starting into a coasting load (forward or reverse) up to full speed and accelerate or decelerate to setpoint without safety tripping or component damage (flying start).

5. The overload rating of the drive shall be 110% of its normal duty current rating for 1 minute every 10 minutes, 130% overload for 2 seconds. The minimum FLA rating shall meet or exceed the values in the NEC/UL table 430-150 for 4-pole motors.

6. The VFD shall have 5% impedance reactors to reduce the harmonics to the power line and to add protection from AC line transients. The 5% impedance may be from dual (positive and negative DC bus) reactors, or 5% AC line reactors. VFD's with only one DC reactor shall add 5% AC line reactors. VFDs which have 5% dual DC link reactors only up to 50 HP shall add 5% AC line reactors to each drive 60 HP and larger.

7. The VFD shall include a coordinated AC transient protection system consisting of 4-120 joule rated MOV's (phase to phase and phase to ground), a capacitor clamp, and 5% impedance reactors.

8. The VFD shall provide a programmable proof of flow form c relay output (broken belt / broken coupling). The drive shall be programmable to signal this condition via a keypad warning, relay output and/or over the serial communications bus. Relay outputs shall include programmable time delays that will allow for drive acceleration from zero speed without signaling a false underload condition.

9. All pump VFDs shall have built-in Advanced Pump Control features, including “No flow” detection, “End of Pump Curve” detection, “Sensor Placement Compensation”, and “Dry Pump” detection. All of these functions shall be able to alarm or stop the pump with such negative pump condition.

C. All VFDs to have the following adjustments:

1. Three (3) programmable critical frequency lockout ranges to prevent the VFD from operating the load continuously at an unstable speed.

2. Four (minimum of 2) PID Setpoint controllers shall be standard in the drive, allowing pressure or flow signals to be connected to the VFD, using the microprocessor in the VFD for the closed loop control. The VFD shall have 250 ma of 24 VDC auxiliary power and be capable of loop powering a transmitter supplied by others. There shall be two parameter sets for the first PID that allow the sets to be switched via a digital input, serial communications or from the keypad for night setback, summer/winter setpoints, etc. There shall be an independent, second PID loop that can utilize the second analog input and modulate one of the analog outputs to maintain setpoint of an independent process (ie. valves, dampers, etc.). All setpoints, process variables, etc. to be accessible from the serial communication network.

3. Two (2) programmable analog inputs shall accept current or voltage signals.

4. Two (2) programmable analog outputs (minimum of one if only one is needed) (0-20ma or 4-20 ma). The outputs may be programmed to output proportional to Frequency, Motor Speed, Output Voltage, Output Current, Motor Torque, Motor Power (kW), DC Bus voltage, Active Reference, and other data.

5. Six (6) programmable digital inputs.

6. Three (3) programmable digital Form-C relay outputs (minimum of 2 if only 2 are needed). The relays shall include programmable on and off delay times and adjustable hysteresis. The relays shall be rated for maximum switching current 8 amps at 24 VDC and 0.4 A at 250 VAC; Maximum voltage 300 VDC and 250 VAC; continuous current rating 2 amps RMS. Outputs shall be true form C type contacts; open collector outputs are not acceptable.
7. Run permissive circuit - There shall be a run permissive circuit for damper or valve control in both drive and bypass mode. Regardless of the source of a run command (keypad, time-clock control, or serial communications) the VFD shall provide a dry contact closure that will signal the damper to open (VFD motor does not operate). When the damper is fully open, a normally open dry contact (end-switch) shall close. The closed end-switch is wired to a VFD digital input and allows motor operation. Two separate safety interlock inputs shall be provided. When either safety is opened, the motor shall be commanded to coast to stop, and the damper shall be commanded to close.

8. Two independently adjustable accel and decel ramps with 1 – 1800 seconds adjustable time ramps.

9. The VFD shall include a motor flux optimization circuit that will automatically reduce applied motor voltage to the motor to optimize energy consumption and audible motor noise.

10. The VFD shall include a carrier frequency control circuit that reduces the carrier frequency based on actual VFD temperature that allows higher carrier frequency without derating the VFD or operating at high carrier frequency only at low speeds.

11. The VFD shall include two levels of password protection against parameter changes. A log of parameter changes shall be maintained in the drive, either the last 10 changes or all changes since drive commissioning.

D. The Keypad shall include a backlight LCD display. The display shall be in complete English words for programming and fault diagnostics (LED and alpha-numeric codes are not acceptable). All VFD faults shall be displayed in English words.

E. All applicable operating values shall be capable of being displayed in engineering (user) units. A minimum of three operating values from the list below shall be capable of being displayed at all times. The display shall be in complete English words (alpha-numeric codes are not acceptable):

1. Output Frequency
2. Motor Speed (RPM, %, or Engineering units)
3. Motor Current
4. Drive Temperature
5. DC Bus Voltage
6. Output Voltage

F. The VFD shall include a fireman's override input. Upon receipt of a contact closure from the fireman's control station, the VFD shall operate in one of two modes: 1) Operate at a programmed predetermined fixed speed or operate in a specific fireman's override PID algorithm that automatically adjusts motor speed based on override setpoint and feedback. The Fireman's Override mode shall override all other inputs (analog/digital, serial communication, and all keypad commands), except customer defined safety run interlock, and force the motor to run in one of the two modes above. "Override Mode" shall be displayed on the keypad. Upon removal of the override signal, the VFD shall resume normal operation.

G. Serial Communications

1. The VFD shall have an RS-485 port as standard. The standard protocols shall be Modbus, BACnet, Johnson Controls N2 bus, and Siemens Building Technologies FLN. Each individual drive shall have the protocol in the base VFD. The use of third party gateways and multiplexers is not acceptable. All protocols shall be "certified" by the governing authority (ie BTL Listing for BacNet). Use of non-certified protocols is not allowed.
2. A USB port shall be available for use with Windows-based software to be used for VFD programming, data logging, trouble-shooting, and program upload and download.

3. The BACnet connection shall be an RS485, MSTP interface operating at 9.6, 19.2, 38.4, or 76.8 Kbps. The connection shall be tested by the BACnet Testing Labs (BTL) and be BTL Listed. The BACnet interface shall conform to the BACnet standard device type of an Applications Specific Controller (B-ASC). The interface shall support all BIBBs defined by the BACnet standard profile for a B-ASC including, but not limited to:
   a. Data Sharing – Read Property – B.
   b. Data Sharing – Write Property – B.
   e. Device Management – Communication Control – B.
   f. Device time clock synchronization

4. Serial communication capabilities shall include, but not be limited to; run-stop control, speed set adjustment, proportional/integral/derivative PID control adjustments, current limit, accel/decel time adjustments, and lock and unlock the keypad. The drive shall have the capability of allowing the DDC to monitor feedback such as process variable feedback, output speed / frequency, current (in amps), % torque, power (kW), kilowatt hours (resettable), operating hours (resettable), and drive temperature. The DDC shall also be capable of monitoring the VFD relay output status, digital input status, and all analog input and analog output values. “Pass thru I/O” All diagnostic warning and fault information shall be transmitted over the serial communications bus. Remote VFD fault reset shall be possible.

H. EMI / RFI filters. All VFD’s shall include EMI/RFI filters. The VFD shall comply standard EN 61800-3 for the First Environment, restricted level with up to 100’ of motor cables. No Exceptions. Certified test lab test reports shall be provided with the submittals

I. All VFD’s (minimally to 60 HP) shall be protected from input and output power mis-wiring. The VFD shall sense this condition and display an alarm on the keypad. The VFD shall not be damaged by this condition.

J. Optional Features – Optional features to be furnished and mounted by the drive manufacturer. All optional features shall be UL Listed by the drive manufacturer as a complete assembly and carry a UL508 label. The bypass enclosure door and VFD enclosure must be interlocked such that input power is turned off before either enclosure can be opened. The VFD and Bypass as a package shall have a UL listed short circuit rating of 100,000 amps and shall be indicated on the data label.

K. A complete factory wired and tested bypass system consisting of an output contactor and bypass contactor, service (isolation) switch and VFD input fuses are required. Bypass designs, which have no VFD only fuses, or that incorporate fuses common to both the VFD and the bypass will not be accepted

L. Door interlocked, padlockable circuit breaker or main disconnect that will disconnect all input power from the drive and all internally mounted options.

M. Bypass shall be electronically or electro-mechanically controlled.

N. Bypass Controller

O. The following operators shall be provided:
   1. Bypass Hand-Off-Auto
   2. Drive mode selector and light
   3. Bypass mode selector and light
4. Bypass fault reset

5. Bypass LCD display, 2 lines, for programming and status / fault / warning indications, or VFD display showing total bypass functionality of all aspects.
   a. Motor protection from single phase power conditions - The Bypass system must be able to detect a single phase input power condition while running in bypass, disengage the motor in a controlled fashion, and give a single phase input power indication. Bypass systems not incorporating single phase protection in Bypass mode are not acceptable.
   b. The system (VFD and Bypass) tolerated voltage window shall allow the system to operate from a line of +30\%, -35\% nominal voltage as a minimum. The system shall incorporate circuitry that will allow the drive or bypass contactor to remain "sealed in" over this voltage tolerance at a minimum.
   c. The Bypass system shall NOT depend on the VFD for bypass operation. The bypass shall be completely functional in both Hand and Automatic modes even if the VFD has been removed from the enclosure for repair / replacement.
   d. Serial communications - the bypass and VFD shall be capable of being monitored and/or controlled via serial communications. Provide communications protocols for ModBus; Johnson Controls N2; Siemens Building Technologies FLN (P1) and BacNet.
   e. BACnet Serial communication bypass capabilities shall include, but not be limited to; bypass run-stop control; the ability to force the unit to bypass; and the ability to lock and unlock the keypad. The bypass shall have the capability of allowing the DDC to monitor feedback such as, bypass current (in amps), bypass kilowatt hours (resettable), bypass operating hours (resettable), and bypass logic board temperature. The DDC shall also be capable of monitoring the bypass relays output status, and all digital input status. "Pass thru I/O" All bypass diagnostic warning and fault information shall be transmitted over the serial communications bus. Remote bypass fault reset shall be possible. The following additional bypass status indications and settings shall be transmitted over the serial communications bus – keypad "Hand" or "Auto" selected, and bypass selected. The DDC system shall also be able to monitor if the motor is running under load in both VFD and bypass (proof of flow) in the VFD mode over serial communications or Form C relay output. A minimum of 40 field parameters shall be capable of being monitored in the bypass mode.
   f. Run permissive circuit - There shall be a run permissive circuit for damper or valve control. Regardless of the source of a run command (keypad, time-clock control, or serial communications) the VFD and bypass shall provide a dry contact closure that will signal the damper to open (VFD motor does not operate). When the damper is fully open, a normally open dry contact (end-switch) shall close. The closed end-switch is wired to a VFD system input and allows motor operation. Two separate safety interlock inputs shall be provided. When either safety is opened, the motor shall be commanded to coast to stop, and the damper shall be commanded to close.
   g. The bypass control shall monitor the status of the VFD and bypass contactors and indicate when there is a welded contactor contact or open contactor coil. This failed contactor operation shall be indicated on the Bypass LCD display as well as over the serial communications protocol.
   h. The bypass control shall include a programmable time delay for bypass start and keypad indication that this time delay is in process. This will allow VAV boxes to be driven open before the motor operates at full speed in the bypass mode. The time delay shall be field programmable from 0 – 120 seconds.
i. The bypass control shall be programmable for manual or automatic transfer to bypass. The user shall be able to select via keypad programming which drive faults will generate an automatic transfer to bypass and which faults require a manual transfer to bypass.

j. There shall be an adjustable motor current sensing circuit for the bypass and VFD mode to provide proof of flow indication. The condition shall be indicated on the keypad display, transmitted over the building automation protocol and on a relay output contact closure.

k. The bypass controller shall have six programmable digital inputs, and five programmable form C relay outputs.

l. The relay outputs from the bypass shall programmable for any of the following indications.
   1) System started
   2) System running
   3) Bypass override enabled
   4) Drive fault
   5) Bypass fault
   6) Bypass H-O-A position
   7) Motor proof of flow (broken belt)
   8) Overload
   9) Bypass selected
   10) Bypass run
   11) System started (damper opening)
   12) Bypass alarm
   13) Over temperature

m. The digital inputs for the system shall accept 24VAC or 24VDC. The bypass shall incorporate internally sourced power supply and not require an external control power source. The bypass power board shall supply 250 ma of 24 VDC for use by others to power external devices.

n. Customer Interlock Terminal Strip – provide a separate terminal strip for connection of freeze, fire, smoke contacts, and external start command. All external safety interlocks shall remain fully functional whether the system is in VFD or Bypass mode. The remote start/stop contact shall operate in VFD and bypass modes. The terminal strip shall allow for independent connection of up to four (4) unique safety inputs.

o. The user shall be able to select the text to be displayed on the keypad when the safety opens. Example text display indications include “Firestat”, “Freezstat”, “Over pressure” and “Low pressure”. The user shall also be able to determine which of the four (4) safety contacts is open over the serial communications connection.

p. Class 10, 20, or 30 (selectable) electronic motor overload protection shall be included.
PART 3 - EXECUTION

3.01 INSTALLATION
   A. Installation shall be the responsibility of the air handler manufacturer. The manufacturer shall install the drive in accordance with the requirements of the VFD manufacturer’s installation manual.

3.02 START-UP
   A. Certified factory start-up shall be provided for each drive by a factory certified service center. A certified start-up form shall be filled out for each drive with a copy provided to the owner, and a copy kept on file at the manufacturer.

3.03 PRODUCT SUPPORT
   A. Factory trained application engineering and service personnel that are thoroughly familiar with the VFD products offered shall be locally available at both the specifying and installation locations. A toll free 24/365 technical support line shall be available.
   B. A computer based training CD or 8-hour professionally generated video (VCR format) shall be provided to the owner at the time of project closeout. The training shall include installation, programming and operation of the VFD, bypass and serial communication.

3.04 WARRANTY
   A. Warranty shall be 24 months from the date of certified start-up, not to exceed 30 months from the date of shipment. The warranty shall include all parts, labor, travel time and expenses.
   B. All VFD components shall be designed and built for the life of the VFD – no “maintenance parts” shall cause scheduled replacement of fans or capacitors.

END OF SECTION
SECTION 26 01 00
BASIC ELECTRICAL REQUIREMENTS

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. The requirements of the General Conditions and Division 1, General Requirements, apply to
the work specified in this section.

1.2 DESCRIPTION OF WORK

A. Related Work in Other Sections, but not limited to the following:
1. Motors, motor controls and low voltage conduit and control wiring that are an integral part
   of equipment assemblies and heating and ventilation controls.
2. Painting of exposed electrical work.
3. Plumbing controls and low voltage wiring.

B. Work Included in Contract
1. Grounding and bonding per NEC.
2. Disconnect and remove existing electrical conduit and wiring for power, lighting and low
   voltage systems and provide new as shown on plans.
3. Provide and install new panelboard and transformer as shown on plans.
4. Provide and install new data/telephone outlets as shown on plans and connect to existing
   building MDF.
5. Replace existing lighting with new with new Title 24 compliant controls.
6. Provide complete telephone/data system per District standards as shown on drawings
   and specified under Division 27.
7. Provide wiring and hookup of all electrical equipment specified under other specification
   sections, such as technology systems, mechanical and plumbing equipment.
8. Provide and install a new complete addressable fire alarm system per District standards
   as detailed on drawings and specifications and specified under Division 27 and connect to
   existing fire alarm system.

1.3 CODES AND STANDARDS

A. In addition to Codes and Standards - Division 1, the following shall apply to this Division:
   National Electrical Code with California amendments
   U.L. Electrical Construction Materials List
   Codes, rules and regulations as specified hereinafter
   Local city and county agencies

1.4 SUBMITTALS

A. Submittals shall be made in conformance with the General Conditions. The list shall include,
for each item, the manufacturer, manufacturer's catalog number, type of class, the rating,
capacity, size, etc. Submittals shall include:
1. Light Fixtures
2. Circuit Breakers
3. Conduit & Fittings
4. Boxes & Covers
5. Fuses
6. Wire & Cable
7. Wiring Devices
8. Disconnect Switches
9. Data/Telephone Systems
10. Fire Alarm System

B. Shop Drawings: Submit for approval, detailed construction drawings for each item of fabricated equipment required for the electrical installation. All drawings shall be to scale, fully dimensioned, and provide sufficient detail to clearly indicate the arrangement of the equipment and its component parts. Construction of the equipment shown shall be revised to comply with the drawings and specifications as required by the Architect after review of the shop drawings, and the drawings submitted when requested by the Architect. Shop drawings shall be submitted for the following:

1. Lighting Controls
2. Data/Telephone Systems
3. Fire Alarm System

C. Substitution: Provide substitutions as outlined.

1.5 SUPERVISION OF ELECTRICAL WORK

A. Contractor shall personally, or through an authorized and competent representative, constantly supervise the work from beginning to completion and final acceptance. So far as possible, keep same foreman and workmen throughout the project duration. Work shall be subject to inspection and approval by Architect. Promptly furnish related information when so requested by Architect.

1.6 EQUIPMENT AND SYSTEMS IDENTIFICATION

A. General: All panels, terminal cabinets, etc., shall be labeled as to identification and use. In general, equipment shall be identified in accordance with drawings. Identification tags, signs, labels and markers shall comply with OSHA and ANSI requirements.

B. Nameplates: All equipment, terminal cabinets, panels and systems shall be identified by laminated, engraved plastic, white on black plates permanently attached to the equipment. Voltage and phase shall be listed on these plates.

C. All terminal cabinets to have terminal strips and all wiring in terminal cabinets shall be tagged.

D. Directories: Provide for power circuits, typewritten, neatly arranged in numerical order, and permanently fixed inside all new and existing panels.

E. Provide lamedoid label on all receptacle and switch covers indicating complete circuit number.

F. Provide lamedoid label on all blank cover plates indicating circuit number or low voltage system (i.e. future data, intrusion, etc.).

G. Provide lamedoid label on all fire alarm device covers indicating complete device number.

H. Provide service description etched on cover of all underground pull boxes.
1.7 OPERATING INSTRUCTIONS ON-SITE

A. At time of occupancy, arrange for manufacturer's representatives to instruct building operating and maintenance personnel in use of any equipment requiring operating and maintenance. Arrange for all personnel to be instructed at one time. Pay all costs for such service (minimum of 4 hours).

1.8 ADJACENT WORK

A. Coordinate work and complete with others in furnishing and placing this work.

B. Work to approved shop drawings for work by others and to field measurements as necessary to properly fit the work.

C. Project adjacent work as necessary; adjacent construction or exposed surfaces or surfaces damaged by use of materials or operations under this Section shall be repaired or replaced as directed by Architect.

1.9 DRAWINGS

A. The electrical drawings, which constitute an integral part of this contract, shall serve as the working drawings. They indicate diagrammatically the general layout of the complete electrical system, including the arrangement of feeders, circuits, panelboards, service equipment, and other work. Field verifications of scale dimensions taken from the drawings are directed since actual field locations, distances and elevations will be governed by actual field conditions. Review architectural, structural, mechanical and plumbing drawings and adjust work to conform to all conditions indicated thereon. Discrepancies shown on different plans or between plans and actual field conditions, or between plans and specifications, shall promptly be brought to the attention of the Architect for a decision.

1.10 COORDINATION AND COOPERATION

A. Drawings and specifications are both supplementary and complementary. Taken together, they are intended to define complete working installations of the systems represented, in accordance with approved practice in the trade, and in conformity with all applicable requirements of local jurisdictional offices and officers and codes and enforcing bodies.

B. It shall be presumed that any bid offered under this Division of the Specifications is based on a careful examination of the job site, and of the plans and specifications; that the person(s) or firm(s) awarded a contract hereunder is/are experienced and qualified in the type of work represented; that every effort has been made to prepare complete, accurate and correct plans and specifications; and that reasonable diligence will be exercised in planning and scheduling the work to anticipate conflicts and/or detect errors or omissions. All such shall be immediately reported, and proper resolution agreed on between concerned parties before the work affected is performed. If due to lack of diligence, or to incompetence, failure to anticipate such problems shall not create a valid claim for extra costs or charges.

C. Requirements of other trades, of utility companies, and of fire departments, protective services, communication systems, or other facilities of a utility nature, shall be determined prior to installation of systems, equipment, devices or materials affected by or dependent on such requirements.

D. Unapproved deviations or changes based on a presumption of error or code violation, or work not suitable for its intended function, may not be accepted.
E. Nothing herein shall act to prevent or discourage the contractor from suggesting or discussing possible changes in the work where such might be beneficial to the contractor or the owner, or might facilitate the work of this or other trades.

F. Any work resulting in a claim for a change in the contract price must be approved and fully documented.

1.11 VISIT TO SITE

A. Visit the project site, take requisite measurements, and verify exact location of buildings, utilities, and other facilities, and obtain such other information as is necessary for an intelligent bid. No allowance will subsequently be made by the Architect or Owner for any error or omission on the part of the bidder in this connection.

1.12 RECORD DRAWINGS

A. Record of Job Progress: Keep an accurate dimensional record of the "as-built" locations and of all work; all as required. This record shall be kept up-to-date on blueline prints as the job progresses and shall be available for inspection at all times. It shall be reviewed by inspector prior to each monthly application for payment.

B. Record of Installation: Refer to Supplementary General Conditions.

C. Include on "as-built" drawings:
   1. Routing of all buried or concealed electrical feeders and conduits.

D. Upon completion of the work, a completed set of as-built reproducible vellums and electronic file (ACAD 2010) on Cd/DVD disk(s) shall be delivered to the Architect.

1.13 GUARANTEE

A. All work shall be guaranteed for a minimum period of one year from either the official date of completion or from the date of acceptance by the Owner, whichever is the later date. The guarantee period for certain items shall be longer, as indicated in the specification for those items.

B. Should any trouble develop during the guarantee time due to defective material, faulty workmanship, or non-compliance with plans, specifications, codes or directions of the Owner, Architect, Engineer or Inspector, the Contractor shall furnish all necessary labor and materials to correct the trouble without additional charges.

END OF SECTION
SECTION 26 05 00

MATERIALS AND METHODS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:
   1. Electrical identification.
   2. Concrete equipment bases.
   3. Electrical demolition.
   4. Cutting and patching for electrical construction.

1.2 SUBMITTALS

A. Product Data: For utility company electricity-metering components.

B. Shop Drawings: Dimensioned plans and sections or elevation layouts and single-line diagram of electricity-metering component assemblies specific to this Project.

1.3 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. Comply with NFPA 70.

1.4 COORDINATION

A. Coordinate chases, slots, inserts, sleeves, and openings for electrical supports, raceways, and cable with general construction work.

B. Sequence, coordinate, and integrate installing electrical materials and equipment for efficient flow of the Work. Coordinate installing large equipment that requires positioning before closing in the building.

C. Coordinate location of access panels and doors for electrical items that are concealed by finished surfaces.

D. Where electrical identification devices are applied to field-finished surfaces, coordinate installation of identification devices with completion of finished surface.

PART 2 - PRODUCTS

2.1 SUPPORTING DEVICES

A. Material: Cold-formed steel, with corrosion-resistant coating.

B. Metal Items for Use Outdoors or in Damp Locations: Hot-dip galvanized steel.

C. Slotted-Steel Channel: Flange edges turned toward web, and 9/16-inch- diameter slotted holes at a maximum of 2 inches o.c., in webs. Strength rating to suit structural loading.
D. Slotted Channel Fittings and Accessories: Recommended by the manufacturer for use with the type and size of channel with which used.
   1. Materials: Same as channels and angles, except metal items may be stainless steel.

E. Raceway and Cable Supports: Manufactured clevis hangers, riser clamps, straps, threaded C-clamps with retainers, ceiling trapeze hangers, wall brackets, and spring-steel clamps or click-type hangers.

F. Pipe Sleeves: ASTM A 53, Type E, Grade A, Schedule 40, galvanized steel, plain ends.

G. Cable Supports for Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug for nonarmored electrical cables in riser conduits. Plugs have number and size of conductor gripping holes as required to suit individual risers. Body constructed of malleable-iron casting with hot-dip galvanized finish.

H. Expansion Anchors: Carbon-steel wedge or sleeve type.

I. Toggle Bolts: All-steel springhead type.


2.2 ELECTRICAL IDENTIFICATION

A. Identification Device Colors: Use those prescribed by ANSI A13.1, NFPA 70, and these Specifications.

B. Colored Adhesive Marking Tape for Raceways, Wires, and Cables: Self-adhesive vinyl tape, not less than 1 inch wide by 3 mils thick.

C. Tape Markers for Conductors: Vinyl or vinyl-cloth, self-adhesive, wraparound type with preprinted numbers and letters.

D. Color-Coding Cable Ties: Type 6/6 nylon, self-locking type. Colors to suit coding scheme.

E. Underground Warning Tape: Permanent, bright-colored, continuous-printed, vinyl tape compounded for permanent direct-burial service, and with the following features:
   1. Not less than 6 inches wide by 4 mils thick.
   2. Embedded continuous metallic strip or core.
   3. Printed legend that indicates type of underground line.

F. Engraved-Plastic Labels, Signs, and Instruction Plates: Engraving stock, melamine plastic laminate punched or drilled for mechanical fasteners 1/16-inch minimum thickness for signs up to 20 sq. in. and 1/8-inch minimum thickness for larger sizes. Engraved legend in black letters on white background.

G. Warning and Caution Signs: Preprinted; comply with 29 CFR 1910.145, Chapter XVII. Colors, legend, and size appropriate to each application.
   1. Interior Units: Aluminum, baked-enamel-finish, punched or drilled for mechanical fasteners.
   2. Exterior Units: Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate with 0.0396-inch, galvanized-steel backing. 1/4-inch grommets in corners for mounting.

H. Fasteners for Nameplates and Signs: Self-tapping, stainless-steel screws or No. 10/32 stainless-steel machine screws with nuts and flat and lock washers.

2.3 CONCRETE BASES
A. Concrete Forms and Reinforcement Materials: As specified in Division 3 Section "Cast-in-Place Concrete."

B. Concrete: 3000-psi, 28-day compressive strength.

2.5 CONCRETE BOXES

A. Concrete Boxes: Pre-cast reinforced, size and type as shown; Christy, Brooks or approved equal. All underground boxes shall be provided with traffic grade, spring loaded, bolt-down, steel cover and McCain or equivalent vandal proof insert.

PART 3 - EXECUTION

3.1 ELECTRICAL EQUIPMENT INSTALLATION

A. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom.

B. Materials and Components: Install level, plumb, and parallel and perpendicular to other building systems and components, unless otherwise indicated.

C. Equipment: Install to facilitate service, maintenance, and repair or replacement of components. Connect for ease of disconnecting, with minimum interference with other installations.

D. Right of Way: Give to raceways and piping systems installed at a required slope.

3.2 ELECTRICAL SUPPORTING DEVICE APPLICATION

A. Damp Locations and Outdoors: Hot-dip galvanized materials or nonmetallic, slotted channel system components.

B. Dry Locations: Steel materials.

C. Strength of Supports: Adequate to carry present and future loads, times a safety factor of at least four with, 200-lb minimum design load for each support element.

3.3 SUPPORT INSTALLATION

A. Support parallel runs of horizontal raceways together on trapeze- or bracket-type hangers.

B. Size supports for multiple raceway or cable runs so capacity can be increased by a 25 percent minimum in the future.

C. Support individual horizontal single raceways with separate, malleable-iron pipe hangers or clamps except use spring-steel fasteners for 1-1/2-inch and smaller single raceways above suspended ceilings and for fastening raceways to slotted channel and angle supports.

D. Install sleeves for cable and raceway penetrations of concrete slabs and walls unless core-drilled holes are used. Install sleeves for cable and raceway penetrations of masonry and fire-rated gypsum walls and of all other fire-rated floor and wall assemblies. Install sleeves during erection of concrete and masonry walls.

E. Secure electrical items and their supports to building structure, using the following methods unless other fastening methods are indicated:
   1. Wood: Wood screws or screw-type nails.
2. Gypsum Board: Toggle bolts. Seal around sleeves with joint compound, both sides of wall.
3. Masonry: Toggle bolts on hollow block and expansion bolts on solid block. Seal around sleeves with mortar, both sides of wall.
4. New Concrete: Concrete inserts with machine screws and bolts.
5. Existing Concrete: Expansion bolts.
   a. Comply with AWS D1.1 for field welding.
7. Light Steel Framing: Sheet metal screws.
10. Fasteners: Select so load applied to each fastener does not exceed 25 percent of its proof-test load.

3.4 IDENTIFICATION MATERIALS AND DEVICES

A. Install at locations for most convenient viewing without interference with operation and maintenance of equipment.

B. Coordinate names, abbreviations, colors, and other designations used for electrical identification with corresponding designations indicated in the Contract Documents or required by codes and standards. Use consistent designations throughout Project.

C. Self-Adhesive Identification Products: Clean surfaces before applying.

D. Tag and label circuits designated to be extended in the future. Identify source and circuit numbers in each cabinet, pull and junction box, and outlet box. Color-coding may be used for voltage and phase identification.

E. Install continuous underground plastic markers during trench backfilling, for exterior underground power, control, signal, and communication lines located directly above power and communication lines. Locate 6 to 8 inches below finished grade. If width of multiple lines installed in a common trench or concrete envelope does not exceed 16 inches, overall, use a single line marker.

F. Install warning, caution, and instruction signs where required to comply with 29 CFR 1910.145, Chapter XVII, and where needed to ensure safe operation and maintenance of electrical systems and of items to which they connect. Indoors install engraved plastic-laminated instruction signs with approved legend where instructions are needed for system or equipment operation. Install metal-backed butyrate signs for outdoor items.

G. Install, where applicable, engraved-laminated emergency-operating signs with white letters on red background with minimum 3/8-inch-high lettering for emergency instructions on power transfer, load shedding, and other emergency operations.

H. Provide service description etched on cover of all underground pull boxes.

3.5 FIRESTOPPING

A. Apply firestopping to cable and raceway sleeves and other penetrations of fire-rated floor and wall assemblies to restore original undisturbed fire-resistance ratings of assemblies. Firestopping installation is specified in Division 7 Section "Through-Penetration Firestop Systems."

3.6 CONCRETE BASES
A. Construct concrete bases of dimensions indicated, but not less than 4 inches larger, in both directions, than supported unit. Follow supported equipment manufacturer's anchorage recommendations and setting templates for anchor-bolt and tie locations, unless otherwise indicated.

3.7 DEMOLITION

A. Protect existing electrical equipment and installations indicated to remain. If damaged or disturbed in the course of the Work, remove damaged portions and install new products of equal capacity, quality, and functionality.

B. Accessible Work: Remove exposed electrical equipment and installations, indicated to be demolished, in their entirety.

C. Abandoned Work: Cut and remove buried raceway and wiring, indicated to be abandoned in place, 2 inches below the surface of adjacent construction. Cap raceways and patch surface to match existing finish.

D. Remove, store, clean, reinstall, reconnect, and make operational components indicated for relocation.

3.8 CUTTING AND PATCHING

A. Cut, channel, chase, and drill floors, walls, partitions, ceilings, and other surfaces required to permit electrical installations. Perform cutting by skilled mechanics of trades involved.

B. Repair, refinish and touch up disturbed finish materials and other surfaces to match adjacent undisturbed surfaces.

END OF SECTION
SECTION 26 05 19

CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes building wires and cables and associated connectors, splices, and terminations for wiring systems rated 600 V and less.

1.2 SUBMITTALS

A. Field quality-control test reports.

1.3 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. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 CONDUCTORS AND CABLES

A. Manufacturers:

   1. Alcan Aluminum Corporation; Alcan Cable Div.
   3. General Cable Corporation.
   4. Senator Wire & Cable Company.
   5. Southwire Company.

B. Refer to Part 3 "Conductor and Insulation Applications" Article for insulation type, cable construction, and ratings.

C. Conductor Material: Copper complying with NEMA WC 5 or 7; solid conductor for No. 10 AWG and smaller, stranded for No. 8 AWG and larger.

D. Conductor Insulation Types: Type THW, THHN-THWN or XHHW complying with NEMA WC 5 or 7.

2.3 CONNECTORS AND SPLICES

A. Manufacturers:

   1. AMP Incorporated/Tyco International.
   2. Hubbell/Anderson.
   3. O-Z/Gedney; EGS Electrical Group LLC.
   4. 3M Company; Electrical Products Division.
PART 3 - EXECUTION

3.1 CONDUCTOR AND INSULATION APPLICATIONS

A. Service Entrance: Type THHN-THWN, single conductors in raceway.

B. Exposed Feeders: Type THHN-THWN, single conductors in raceway.

C. Feeders Concealed in Ceilings, Walls, and Partitions: Type THHN-THWN, single conductors in raceway.

D. Feeders Concealed in Concrete, below Slabs-on-Grade, and in Crawlspace: Type THHN-THWN, single conductors in raceway.

E. Exposed Branch Circuits, including in Crawlspace: Type THHN-THWN, single conductors in raceway.

F. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN-THWN, single conductors in raceway.

G. Branch Circuits Concealed in Concrete and below Slabs-on-Grade: Type THHN-THWN, single conductors in raceway.


I. Fire Alarm Circuits: Type THHN-THWN, in raceway.

J. Class 1 Control Circuits: Type THHN-THWN, in raceway.

K. Class 2 Control Circuits: Type THHN-THWN, in raceway.

3.2 INSTALLATION

A. Conceal cables in finished walls, ceilings, and floors, unless otherwise indicated.

B. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

C. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.

D. Install exposed feeders parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.

E. Support cables according to Division 26.

F. Seal around cables penetrating fire-rated elements according to Section "Through-Penetration Firestop Systems."

G. Identify and color-code conductors and cables according to Division 26 Section "Basic Electrical Materials and Methods."
H. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.

I. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches of slack.

3.3 FIELD QUALITY CONTROL

A. Testing: Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Section 7.3.1. Certify compliance with test parameters.

B. Test Reports: Prepare a written report to record the following:
   1. Test procedures used.
   2. Test results that comply with requirements.
   3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

END OF SECTION
SECTION 26 05 26
GROUNDING AND BONDING

PART 1 - GENERAL

1.1 SUMMARY
A. This Section includes grounding of electrical systems and equipment. Requirements specified in this Section may be supplemented by requirements of other Sections.

1.2 SUBMITTALS
A. Product Data: For ground rods.
B. Field quality-control test reports.

1.3 QUALITY ASSURANCE
A. Electrical Components, Devices, and Accessories: Listed and labeled under UL 467 as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

PART 2 - PRODUCTS

2.1 MANUFACTURERS
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Boggs, Inc.
2. Copperweld Corp.
3. Dossert Corp.
5. Galvan Industries, Inc.
8. Hearty Brothers Lightning Protection Co.
9. ILSCO.
12. Lightning Master Corp.
13. Lyncle XIT Grounding.
15. Robbins Lightning, Inc.
17. Superior Grounding Systems, Inc.
18. Thomas & Betts, Electrical.

2.2 GROUNDING CONDUCTORS
A. For insulated conductors, comply with Division 26 Section "Conductors and Cables."
B. Equipment Grounding Conductors: Insulated with green-colored insulation.
C. Isolated Ground Conductors: Insulated with green-colored insulation with yellow stripe. On feeders with isolated ground, use colored tape, alternating bands of green and yellow tape to provide a minimum of three bands of green and two bands of yellow.

D. Grounding Electrode Conductors: Stranded cable.

E. Underground Conductors: Bare, tinned, stranded, unless otherwise indicated.

F. Bare, Solid-Copper Conductors: ASTM B 3.

G. Assembly of Bare, Stranded-Copper Conductors: ASTM B 8.

H. Bare, Tinned-Copper Conductors: ASTM B 33.

I. Copper Bonding Conductor: No. 4 or No. 6 AWG, stranded copper conductor.

J. Copper Bonding Jumper: Bare copper tape, braided bare copper conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

K. Tinned-Copper Bonding Jumper: Tinned-copper tape, braided copper conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

L. Grounding Bus: Bare, annealed copper bars of rectangular cross section, with insulated spacer.

M. Connectors: Comply with IEEE 837 and UL 467; listed for use for specific types, sizes, and combinations of conductors and connected items. Exothermic-welded type, in kit form, selected per manufacturer's written instructions.

2.3 GROUNDING ELECTRODES

A. Ground Rods: Copper-clad steel.
   1. Size: 3/4 inches in diameter by 120 inches long.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Use only copper conductors for both insulated and bare grounding conductors in direct contact with earth, concrete, masonry, crushed stone, and similar materials.

B. In raceways, use insulated equipment grounding conductors.

C. Exothermic-Welded Connections: Use for connections to structural steel and for underground connections.

D. Grounding Bus: Install in electrical and telephone equipment rooms, in rooms housing service equipment, and elsewhere as indicated.
   1. Use insulated spacer; space 1 inch from wall and support from wall 6 inches above finished floor, unless otherwise indicated.
   2. At doors, route the bus up to the top of the door frame, across the top of the doorway, and down to the indicated height above the floor.

E. Underground Grounding Conductors: Use copper conductor, No. 2/0 AWG minimum. Bury at least 24 inches below grade or bury 12 inches above duct bank when installed as part of the duct bank.
F. Equipment Grounding Conductors: Comply with NFPA 70, Article 250, for types, sizes, and quantities of equipment grounding conductors, unless specific types, larger sizes, or more conductors than required by NFPA 70 are indicated.
   1. Install insulated equipment grounding conductors in feeders.
   2. Isolated Grounding Receptacle Circuits: Install an insulated equipment grounding conductor connected to the receptacle grounding terminal. Isolate grounding conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service, unless otherwise indicated.
   3. Nonmetallic Raceways: Install an equipment grounding conductor in nonmetallic raceways unless they are designated for telephone or data cables.
   4. Air-Duct Equipment Circuits: Install an insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners and heaters. Bond conductor to each unit and to air duct.
   5. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install an insulated equipment grounding conductor to each electric water heater, heat-tracing, and antifrost heating cable. Bond conductor to heater units, piping, connected equipment, and components.
   6. Signal and Communication Systems: For telephone, alarm, voice and data, and other communication systems, provide insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location and per Division 27.
      a. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a grounding bus per Division 27.
      b. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.
   7. Metal Poles Supporting Outdoor Lighting Fixtures: Provide a grounding electrode in addition to installing an insulated equipment grounding conductor with supply branch-circuit conductors.

G. Ground Rods: Install at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes.
   1. Drive ground rods until tops are 2 inches below finished floor or final grade, unless otherwise indicated.
   2. Interconnect ground rods with grounding electrode conductors. Use exothermic welds, except as otherwise indicated. Make connections without exposing steel or damaging copper coating.

H. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

I. Bonding Straps and Jumpers: Install so vibration by equipment mounted on vibration isolation hangers or supports is not transmitted to rigidly mounted equipment. Use exothermic-welded connectors for outdoor locations, unless a disconnect-type connection is required; then, use a bolted clamp. Bond straps directly to the basic structure taking care not to penetrate any adjacent parts. Install straps only in locations accessible for maintenance.

J. Metal Water Service Pipe: Provide insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes by grounding clamp connectors. Where a dielectric main water fitting is installed, connect grounding conductor to street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
K. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with grounding clamp connectors.

L. Bond each aboveground portion of gas piping system upstream from equipment shutoff valve.

M. Connections: Make connections so galvanic action or electrolysis possibility is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.
   1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer to order of galvanic series.
   2. Make connections with clean, bare metal at points of contact.
   5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.
   6. Exothermic-Welded Connections: Comply with manufacturer's written instructions. Welds that are puffed up or that show convex surfaces indicating improper cleaning are not acceptable.
   7. Equipment Grounding Conductor Terminations: For No. 8 AWG and larger, use pressure-type grounding lugs. No. 10 AWG and smaller grounding conductors may be terminated with winged pressure-type connectors.
   8. Noncontact Metal Raceway Terminations: If metallic raceways terminate at metal housings without mechanical and electrical connection to housing, terminate each conduit with a grounding bushing. Connect grounding bushings with a bare grounding conductor to grounding bus or terminal in housing. Bond electrically noncontinuous conduits at entrances and exits with grounding bushings and bare grounding conductors, unless otherwise indicated.
   9. Tighten screws and bolts for grounding and bonding 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.
   10. Compression-Type Connections: Use hydraulic compression tools to provide correct circumferential pressure for compression connectors. Use tools and dies recommended by connector manufacturer. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed on grounding conductor.
   11. Moisture Protection: If insulated grounding conductors are connected to ground rods or grounding buses, insulate entire area of connection and seal against moisture penetration of insulation and cable.

N. Manholes and Handholes: Install a driven ground rod close to wall and set rod depth so 4 inches will extend above finished floor. If necessary, install ground rod before manhole is placed and provide a No. 1/0 AWG bare, tinned-copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive tape or heat-shrunk insulating sleeve from 2 inches above to 6 inches below concrete. Seal floor opening with waterproof, nonshrink grout.

O. Connections to Manhole Components: Connect exposed-metal parts, such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with No. 4 AWG minimum, stranded, hard-drawn copper conductor. Train conductors level or plumb around corners and fasten to manhole walls. Connect to cable armor and cable shields as recommended by manufacturer of splicing and termination kits.
3.2 FIELD QUALITY CONTROL

A. Testing: Perform the following field quality-control testing:
   1. After installing grounding system but before permanent electrical circuitry has been energized, test for compliance with requirements.
   2. Test completed grounding system at each location where a maximum ground-resistance level is indicated and at service disconnect enclosure grounding terminal. Measure ground resistance not less than two full days after the last trace of precipitation, and without the soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance. Perform tests by the fall-of-potential method according to IEEE 81.
   3. Provide drawings locating each ground rod, ground rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results. Nominal maximum values are as follows:
      a. Equipment Rated 500 kVA and Less: 10 ohms.
      b. Equipment Rated 500 to 1000 kVA: 5 ohms.
      c. Equipment Rated More Than 1000 kVA: 3 ohms.
      e. Manhole Grounds: 10 ohms.

END OF SECTION
SECTION 26 05 29

SEISMIC FOR ELECTRICAL

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes seismic restraints and other earthquake-damage-reduction measures for electrical components. It applies to and complements optional seismic-restraint requirements in the various electrical component Sections of these Specifications.

1.2 DEFINITIONS

A. Seismic Restraint: A fixed device (a seismic brace, an anchor bolt or stud, or a fastening assembly) used to prevent vertical or horizontal movement, or both vertical and horizontal movement, of an electrical system component during an earthquake.

B. Mobile Structural Element: A part of the building structure such as a slab, floor structure, roof structure, or wall that may move independently of other structural elements during an earthquake.

1.3 SUBMITTALS

A. Product Data: Illustrate and indicate types, styles, materials, strength, fastening provisions, and finish for each type and size of seismic-restraint component used. Include documentation of evaluation and approval of components by agencies acceptable to authorities having jurisdiction.

B. Shop Drawings: For components, physical arrangements, and installation details not defined by Drawings. Indicate materials and show details and layouts.

C. Pre-approval and Evaluation Documentation: By an agency approved by authorities having jurisdiction, showing maximum ratings of restraints.

D. Qualification data.

E. Field quality-control test reports.

1.4 QUALITY ASSURANCE

A. Comply with seismic-restraint requirements in California Building Code, unless requirements in this Section are more stringent.

B. Testing Agency Qualifications: An independent testing and inspection agency, acceptable to authorities having jurisdiction, with the experience and capability to conduct the inspection indicated.

1.5 PROJECT CONDITIONS

A. Project Seismic Zone and Zone Factor as Defined in CBC.

1.6 COORDINATION
A. Coordinate layout and installation of seismic bracing with building structure, architectural features, and mechanical, fire-protection, electrical, and other building systems.

B. Coordinate concrete bases with building structural system.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Amber/Booth Company, Inc.
   2. B-Line Systems, Inc.
   3. Erica, Inc.
   4. GS Metals Corp.
   5. Loos & Company, Inc.
   6. Mason Industries, Inc.
   7. Powerstrut.
   8. Thomas & Betts Corp.

2.2 MATERIALS

A. Use the following materials for restraints:
   1. Indoor Dry Locations: Steel, zinc plated.
   2. Outdoors and Damp Locations: Galvanized steel.

2.3 ANCHORAGE AND STRUCTURAL ATTACHMENT COMPONENTS

A. Strength: Defined in reports by ICBO Evaluation Service or another agency acceptable to authorities having jurisdiction.
   1. Structural Safety Factor: Strength in tension and shear of components shall be at least twice the maximum seismic forces for which they are required to be designed.

B. Concrete and Masonry Anchor Bolts and Studs: Steel-expansion wedge type.

C. Concrete Inserts: Steel-channel type.

D. Through Bolts: Structural type, hex head, high strength. Comply with ASTM A 325.

E. Welding Lugs: Comply with MSS SP-69, Type 57.

F. Beam Clamps for Steel Beams and Joists: Double sided. Single-sided type is not acceptable.

G. Bushings for Floor-Mounted Equipment Anchors: Neoprene units designed for seismically rated rigid equipment mountings, and matched to the type and size of anchor bolts and studs used.

H. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for seismically rated rigid equipment mountings, and matched to the type and size of attachment devices used.

2.4 SEISMIC-BRACING COMPONENTS
A. Slotted Steel Channel: 1-5/8-by-1-5/8-inch cross section, formed from 0.1046-inch thick steel, with 9/16-by-7/8-inch slots at a maximum of 2 inches o.c. in webs, and flange edges turned toward web.
   1. Materials for Channel: ASTM A 570, GR 33.
   3. Fittings and Accessories: Products of the same manufacturer as channels and designed for use with that product.
   4. Finish: Baked, rust-inhibiting, acrylic-enamel paint applied after cleaning and phosphate treatment, unless otherwise indicated.

B. Channel-Type Bracing Assemblies: Slotted steel channel, with adjustable hinged steel brackets and bolts.

C. Hanger Rod Stiffeners: Slotted steel channels, installed vertically, with internally bolted connections to hanger rod.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install seismic restraints according to applicable codes and regulations and as approved by authorities having jurisdiction, unless more stringent requirements are indicated.

B. Install structural attachments as follows:
   1. Use bolted connections with steel brackets, slotted channel, and slotted-channel fittings to spread structural loads and reduce stresses.
   2. Attachments to New Concrete: Bolt to channel-type concrete inserts or use expansion anchors.
   3. Attachments to Existing Concrete: Use expansion anchors.
   4. Holes for Expansion Anchors in Concrete: Drill at locations and to depths that avoid reinforcing bars.
   5. Attachments to Solid Concrete Masonry Unit Walls: Use expansion anchors.
   6. Attachments to Hollow Walls: Bolt to slotted steel channels fastened to wall with expansion anchors.
   7. Attachments to Wood Structural Members: Install bolts through members.
   8. Attachments to Steel: Bolt to clamps on flanges of beams or on upper truss chords of bar joists.

C. Install electrical equipment anchorage as follows:
   1. Anchor panelboards, motor-control centers, motor controls, switchboards, transformers, fused power-circuit devices, control, and distribution units as follows:
      a. Anchor equipment rigidly to a single mobile structural element or to a concrete base that is structurally tied to a single mobile structural element.
      b. Size concrete bases so expansion anchors will be a minimum of 10 bolt diameters from the edge of the concrete base.
      c. Bushings for Floor-Mounted Equipment Anchors: Install to allow for resilient media between anchor bolt or stud and mounting hole in concrete.
      d. Anchor Bolt Bushing Assemblies for Wall-Mounted Equipment: Install to allow for resilient media where equipment or equipment-mounting channels are attached to wall.
      e. Torque bolts and nuts on studs to values recommended by equipment manufacturer.

D. Install seismic bracing as follows:
   1. Install bracing according to spacings and strengths indicated by approved analysis.
   2. Expansion and Contraction: Install to allow for thermal movement of braced components.
3. Attachment to Structure: If specific attachment is not indicated, anchor bracing to the structure at flanges of beams, upper truss chords of bar joists, or at concrete members.

E. Accommodation of Differential Seismic Motion: Make flexible connections in raceways, cables, wireway, cable trays, and busway where they cross expansion- and seismic-control joints, where adjacent sections or branches are supported by different structural elements, and where they terminate at electrical equipment anchored to a different mobile structural element from the one supporting them.

3.2 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing and inspection agency to inspect seismic-control installation for compliance with indicated requirements.

B. Testing Agency: Engage a qualified testing and inspection agency to inspect seismic-control installation for compliance with indicated requirements.

C. Reinspection: Correct deficiencies and verify by reinspection that work complies with requirements.

D. Provide written report of tests and inspections.

END OF SECTION
SECTION 26 13 00
RACEWAYS AND BOXES

PART 1 - GENERAL

1.1 SUMMARY
   A. This Section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.

1.2 SUBMITTALS
   A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets indicated.

1.3 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. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 MANUFACTURERS
   A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
      1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 METAL CONDUIT AND TUBING
   A. Manufacturers:
      1. AFC Cable Systems, Inc.
      2. Alflex Inc.
      3. Anamet Electrical, Inc.; Anaconda Metal Hose.
      4. Electri-Flex Co.
      5. Grinnell Co./Tyco International; Allied Tube and Conduit Div.
      6. LTV Steel Tubular Products Company.
      7. Manhattan/CDT/Cole-Flex.
      8. O-Z Gedney; Unit of General Signal.
      9. Wheatland Tube Co.

   B. Rigid Steel Conduit: ANSI C80.1.
   C. Aluminum Rigid Conduit: ANSI C80.5.
   D. IMC: ANSI C80.6.
   E. EMT and Fittings: ANSI C80.3.
      1. Fittings: Compression type.
   F. FMC: Aluminum.
   G. LFMC: Flexible steel conduit with PVC jacket.
H. Fittings: NEMA FB 1; compatible with conduit and tubing materials.

2.3 NONMETALLIC CONDUIT AND TUBING

A. Manufacturers:
2. Anamet Electrical, Inc.; Anaconda Metal Hose.
3. Arno Corp.
4. Cantex Inc.
7. ElecSYS, Inc.
8. Electri-Flex Co.
9. Lamson & Sessions; Carlon Electrical Products.
10. Manhattan/CDT/Cole-Flex.
11. RACO; Division of Hubbell, Inc.
12. Spiralduct, Inc./AFC Cable Systems, Inc.

B. RNC: NEMA TC 2, Schedule 40 and Schedule 80 PVC.

C. RNC Fittings: NEMA TC 3; match to conduit or tubing type and material.

2.4 SURFACE RACEWAYS

A. Surface Metal Raceways: Galvanized steel with snap-on covers. Finish with manufacturer's standard prime coating.
1. Manufacturers:
   a. Airey-Thompson Sentinel Lighting; Wiremold Company (The).
   b. Thomas & Betts Corporation.
   d. Wiremold Company (The); Electrical Sales Division.

B. Surface Nonmetallic Raceways: Two-piece construction, manufactured of rigid PVC compound with matte texture and manufacturer's standard color.
1. Manufacturers:
   b. Enduro Composite Systems.
   c. Hubbell, Inc.; Wiring Device Division.
   d. Lamson & Sessions; Carlon Electrical Products.
   e. Panduit Corp.
   g. Wiremold Company (The); Electrical Sales Division.

C. Types, sizes, and channels as indicated and required for each application, with fittings that match and mate with raceways.

2.5 BOXES, ENCLOSURES, AND CABINETS

A. Manufacturers:
1. Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.
2. Emerson/General Signal; Appleton Electric Company.
3. Erickson Electrical Equipment Co.
6. O-Z/Gedney; Unit of General Signal.
7. RACO; Division of Hubbell, Inc.

B. Sheet Metal Outlet and Device Boxes: NEMA OS 1.
C. Cast-Metal Outlet and Device Boxes: NEMA FB 1, Type FD, with gasketed cover.
D. Nonmetallic Outlet and Device Boxes: NEMA OS 2.
E. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
F. Cast-Metal Pull and Junction Boxes: NEMA FB 1, cast aluminum with gasketed cover.
G. Hinged-Cover Enclosures: NEMA 250, Type 1, with continuous hinge cover and flush latch.
   1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.

H. Cabinets: NEMA 250, Type 1, galvanized steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel. Hinged door in front cover with flush latch and concealed hinge. Key latch to match panelboards. Include metal barriers to separate wiring of different systems and voltage and include accessory feet where required for freestanding equipment.

I. Concrete Boxes: Pre-cast reinforced, size and type as shown; Christy, Brooks or approved equal. All underground boxes shall be provided with traffic grade, spring loaded, bolt-down, steel cover.

2.6 FACTORY FINISHES

A. Finish: For raceway, enclosure, or cabinet components provide manufacturer's standard prime-coat finish ready for field painting.

2.7 FIRESTOPPING FOR LOW VOLTAGE SLEEVES

A. Firestop Pillows: STI SpecSeal® Brand re-enterable, non-curing, mineral fiber core encapsulated on six sides with intumescent coating contained in a flame retardant poly bag, the following products are acceptable:
B. Fire Rated Cable Pathways: STI EZ-PATH™ Brand device modules comprised of steel raceway with intumescent foam pads allowing 0 to 100 percent cable fill, the following products are acceptable:
   1. Specified Technologies Inc. (STI) EZ-PATH™ Fire Rated Pathway.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

A. Outdoors:
   1. Exposed: Rigid steel or IMC.
   2. Concealed: Rigid steel or IMC.
   3. Underground, Single Run: RNC.
   4. Underground, Grouped: RNC.
   5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
   6. Boxes and Enclosures: NEMA 250, Type 3R.
   8. Backfill materials per civil site requirements.
B. Indoors:
   1. Exposed: EMT.
   2. Concealed: EMT.
   3. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC; except use LFMC in damp or wet locations.
   4. Damp or Wet Locations: Rigid steel conduit.
   5. Boxes and Enclosures: NEMA 250, Type 1, except as follows:
      a. Damp or Wet Locations: NEMA 250, Type 4, stainless steel.

C. Minimum Raceway Size: 3/4-inch trade size.

D. Raceway Fittings: Compatible with raceways and suitable for use and location.
   1. Intermediate Steel Conduit: Use threaded rigid steel conduit fittings, unless otherwise indicated.
   2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings approved for use with that material. Patch all nicks and scrapes in PVC coating after installing conduits.
   3. For Outdoor Use – conduit hub, NEMA 4 for conduit connection/terminating to cabinet/panel/boxes.
   4. All connectors to be steel. Die cast connectors are not acceptable.

E. Do not install aluminum conduits embedded in or in contact with concrete.

3.2 INSTALLATION

A. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.

B. Complete raceway installation before starting conductor installation.

C. Support raceways as specified in Division 26 Section "Basic Electrical Materials and Methods."

D. Install temporary closures to prevent foreign matter from entering raceways.

E. Protect stub-ups from damage where conduits rise through floor slabs. Arrange so curved portions of bends are not visible above finished slab.

F. Make bends and offsets so ID is not reduced. Keep legs of bends in same plane and keep straight legs of offsets parallel, unless otherwise indicated.

G. Conceal conduit and EMT within finished walls, ceilings, and floors, unless otherwise indicated.
   1. Install concealed raceways with a minimum of bends in shortest practical distance, considering type of building construction and obstructions, unless otherwise indicated.

H. Raceways Embedded in Slabs: Install in middle 1/3 of slab thickness where practical and leave at least 2 inches of concrete cover.
   1. Secure raceways to reinforcing rods to prevent sagging or shifting during concrete placement.
   2. Space raceways laterally to prevent voids in concrete.
   3. Run conduit larger than 1-inch trade size parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support.
   4. Change from nonmetallic tubing to Schedule 80 nonmetallic conduit, rigid steel conduit, or IMC before rising above floor.

I. Install exposed raceways parallel or at right angles to nearby surfaces or structural members and follow surface contours as much as possible.
1. Run parallel or banked raceways together on common supports.
2. Make parallel bends in parallel or banked runs. Use factory elbows only where elbows can be installed parallel; otherwise, provide field bends for parallel raceways.

J. Join raceways with fittings designed and approved for that purpose and make joints tight.
1. Use insulating bushings to protect conductors on all raceways 2" and larger.

K. Tighten set screws of threadless fittings with suitable tools.

L. Terminations:
1. Where raceways are terminated with locknuts and bushings, align raceways to enter squarely and install locknuts with dished part against box. Use two locknuts, one inside and one outside box.
2. Where raceways are terminated with threaded hubs, screw raceways or fittings tightly into hub so end bears against wire protection shoulder. Where chase nipples are used, align raceways so coupling is square to box; tighten chase nipple so no threads are exposed.

M. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire.

N. Telephone and Signal System Raceways, 2-Inch Trade Size and Smaller: In addition to above requirements, install raceways in maximum lengths of 150 feet and with a maximum of two 90-degree bends or equivalent. Separate lengths with pull or junction boxes where necessary to comply with these requirements.

O. Install raceway sealing fittings at suitable, approved, and accessible locations and fill them with UL-listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points:
1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
2. Where otherwise required by NFPA 70.

P. Stub-up Connections: Extend conduits through concrete floor for connection to freestanding equipment. Install with an adjustable top or coupling threaded inside for plugs set flush with finished floor. Extend conductors to equipment with rigid steel conduit; FMC may be used 6 inches above the floor. Install screwdriver-operated, threaded plugs flush with floor for future equipment connections.

Q. Flexible Connections: Use maximum of 72 inches of flexible conduit for recessed and semi-recessed lighting fixtures; for equipment subject to vibration, noise transmission, or movement; and for all motors. Use LFMC in damp or wet locations. Install separate ground conductor across flexible connections.

R. Surface Raceways: Install a separate, green, ground conductor in raceways from junction box supplying raceways to receptacle or fixture ground terminals.

S. Set floor boxes level and flush with finished floor surface.

T. Install hinged-cover enclosures and cabinets plumb. Support at each corner.

3.3 PROTECTION

A. Provide final protection and maintain conditions that ensure coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.
1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
2. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION
SECTION 26 24 20

PANELBOARDS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes distribution panelboards and lighting and appliance branch-circuit panelboards.

1.2 SUBMITTALS

A. Product Data: For each type of panelboard, overcurrent protective device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: For each panelboard and related equipment.
   1. Dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings. Include the following:
      a. Enclosure types and details for types other than NEMA 250, Type 1.
      b. Bus configuration, current, and voltage ratings.
      c. Short-circuit current rating of panelboards and overcurrent protective devices.
      d. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
   2. Wiring Diagrams: Power, signal, and control wiring.
   3. Field quality-control test reports.
   4. Operation and maintenance data.

1.3 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. Comply with NEMA PB 1.

C. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Panelboards, Overcurrent Protective Devices, Controllers, Contactors, and Accessories:
      a. Square D is preferred manufacturer.
      c. Siemens Energy & Automation, Inc.

2.2 MANUFACTURED UNITS

A. Enclosures: Flush- and surface-mounted cabinets. NEMA PB 1, Type 1.
   1. Rated for environmental conditions at installed location.
      a. Outdoor Locations: NEMA 250, Type 3R.
c. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
2. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box.

B. Phase and Ground Buses: Hard-drawn copper, 98 percent conductivity.

C. Conductor Connectors: Suitable for use with conductor material.
1. Ground Lugs and Bus Configured Terminators: Compression type.

D. Service Equipment Label: UL labeled for use as service equipment for panelboards with main service disconnect switches.

E. Future Devices: Mounting brackets, bus connections, and necessary appurtenances required for future installation of devices. Provide 20% space in all panelboards

F. Panelboard Short-Circuit Rating:
1. Fully rated to interrupt symmetrical short-circuit current available at terminals.

2.3 DISTRIBUTION PANELBOARDS

A. Doors: Secured with vault-type latch with tumbler lock; keyed alike. Omit for fused-switch panelboards.

B. Main Overcurrent Protective Devices: Circuit breaker.

C. Branch Overcurrent Protective Devices:
1. For Circuit-Breaker Frame Sizes 125 A and Smaller: Bolt-on circuit breakers.
2. For Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers; plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.

2.4 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

A. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units. No tie-handle allowed for multi-pole breakers.

B. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.

2.5 OVERCURRENT PROTECTIVE DEVICES

A. Molded-Case Circuit Breaker: UL 489, with interrupting capacity to meet available fault currents.
2. GFCl Circuit Breakers: Single- and two-pole configurations with 30-mA trip sensitivity.
3. Molded-Case Circuit-Breaker Features and Accessories: Standard frame sizes, trip ratings, and number of poles.
   a. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
   b. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HACR for heating, air-conditioning, and refrigerating equipment.
   c. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 55 percent of rated voltage.
2.6 ACCESSORY COMPONENTS AND FEATURES

A. Furnish accessory set including tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

B. Fungus Proofing: Permanent fungicidal treatment for panelboard interior, including overcurrent protective devices and other components for all NEMA 3R panelboards.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install panelboards and accessories according to NEMA PB 1.1.

B. Comply with mounting and anchoring requirements specified in Division 26 Section "Seismic Controls for Electrical Work."

C. Mount top of trim 74 inches above finished floor, unless otherwise indicated.

D. Mount plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish.

E. Install overcurrent protective devices and controllers.
   1. Set field-adjustable switches and circuit-breaker trip ranges.

F. Install filler plates in unused spaces.

G. Stub four 1-inch empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future.

H. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 26 Section "Basic Electrical Materials and Methods."

I. Panelboard Nameplates: Label each panelboard with engraved metal or laminated-plastic nameplate mounted with corrosion-resistant screws.

J. Ground equipment according to Division 26 Section "Grounding and Bonding."

K. Connect wiring according to Division 26 Section "Conductors and Cables."

3.2 FIELD QUALITY CONTROL

A. Prepare for acceptance tests as follows:
   1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
   2. Test continuity of each circuit.

B. Perform the following field tests and inspections and prepare test reports:
   1. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Section 7.5 for switches and Section 7.6 for molded-case circuit breakers. 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.

END OF SECTION
SECTION 26 27 00

DRY-TYPE TRANSFORMERS (600 V AND LESS)

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following types of dry-type transformers rated 600 V and less, with capacities up to 1000 kVA:
   1. Distribution transformers.
   2. Control and signal transformers.

1.2 SUBMITTALS

A. Product Data: For each product indicated.
B. Shop Drawings: Wiring and connection diagrams.
C. Output Settings Reports: Record of tap adjustments specified in Part 3.

1.3 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. Comply with IEEE C 57.12.91.

C. Energy-Efficient Transformers Rated 15 kVA and Larger: Certified as meeting NEMA TP 1, Class 1 efficiency levels when tested according to NEMA TP 2. Transformers shall be EPA Energy Star® compliant and bear the Energy Star® label.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Temporary Heating: Apply temporary heat according to manufacturer's written instructions within the enclosure of each ventilated-type unit, throughout periods during which equipment is not energized and when transformer is not in a space that is continuously under normal control of temperature and humidity.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Acme Electric Corporation; Power Distribution Products Division.
3. Federal Pacific Transformer Company; Division of Electro-Mechanical Corp.
4. GE Electrical Distribution & Control.
5. Siemens Energy & Automation, Inc.
6. Square D/Groupe Schneider NA.

2.2 MATERIALS
A. Description: Factory-assembled and -tested, air-cooled units for 60-Hz service.
B. Cores: Grain-oriented, non-aging silicon steel.
C. Coils: Continuous windings without splices, except for taps.
   1. Internal Coil Connections: Brazed or pressure type.

2.3 DISTRIBUTION TRANSFORMERS
A. Comply with NEMA ST 20, and list and label as complying with UL 1561.
B. Provide transformers that are internally braced to withstand seismic forces specified in Division 16 Section "Seismic Controls for Electrical Work."
C. Cores: One leg per phase.
D. Enclosure:
   1. Ventilated, NEMA 250, Type 2 (indoor)
   2. Ventilated, raintight, NEMA 250, Type 3R (for exterior at secured areas)
   3. Totally enclosed, nonventilated, with lifting eyes, NEMA 250, type suitable for outdoor use (for exterior at public accessible locations)
   4. Core and coil shall be encapsulated within resin compound, sealing out moisture and air.
E. Insulation Class: 220 deg C, UL-component-recognized insulation system with a maximum of 150 deg C rise above 40 deg C ambient temperature.
F. Taps for Transformers Smaller Than 3 kVA: None.
G. Taps for Transformers 7.5 to 24 kVA: Two 5 percent taps below rated voltage.
H. Taps for Transformers 25 kVA and Larger: Two 2.5 percent taps above and four 2.5 percent taps below normal full capacity.
I. Wall Brackets: Manufacturer's standard brackets.
J. Sound levels shall be warranted by the manufacturer not to exceed the following: 1515 to 50KVA - 45dB; 51 to 150kVA - 50dB; 151 to 300kVA - 55dB; 301 to 500kVA - 60dB; 501 to 700kVA - 62dB; 701 to 1000kVA - 64dB

TRANSFORMERS
26 27 00 - 2
K. Transformers shall be low loss type with minimum efficiencies per NEMA TP1 when operated at 35% of full load capacity. Efficiency shall be tested in accordance with NEMA TP2.

<table>
<thead>
<tr>
<th>Single Phase</th>
<th></th>
<th>Three Phase</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>KVA</td>
<td>Efficiency</td>
<td>KVA</td>
<td>Efficiency</td>
</tr>
<tr>
<td>15</td>
<td>97.7%</td>
<td>15</td>
<td>97.0%</td>
</tr>
<tr>
<td>25</td>
<td>98.0%</td>
<td>30</td>
<td>97.5%</td>
</tr>
<tr>
<td>37.5</td>
<td>98.2%</td>
<td>45</td>
<td>97.7%</td>
</tr>
<tr>
<td>50</td>
<td>98.3%</td>
<td>75</td>
<td>98.0%</td>
</tr>
<tr>
<td>75</td>
<td>98.5%</td>
<td>112.5</td>
<td>98.2%</td>
</tr>
<tr>
<td>100</td>
<td>98.6%</td>
<td>150</td>
<td>98.3%</td>
</tr>
<tr>
<td>167</td>
<td>98.7%</td>
<td>225</td>
<td>98.5%</td>
</tr>
<tr>
<td>250</td>
<td>98.8%</td>
<td>300</td>
<td>98.6%</td>
</tr>
<tr>
<td>333</td>
<td>98.9%</td>
<td>500</td>
<td>98.7%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>750</td>
<td>98.8%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1000</td>
<td>98.9%</td>
</tr>
</tbody>
</table>

2.4 CONTROL AND SIGNAL TRANSFORMERS

A. Description: Self-cooled, two-winding dry type, rated for continuous duty, complying with NEMA ST 1, and listed and labeled as complying with UL 506.

B. Ratings: Continuous duty. If rating is not indicated, provide at least 50 percent spare capacity above connected peak load.

2.5 SOURCE QUALITY CONTROL

A. Test and inspect transformers according to IEEE C57.12.91.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install wall-mounting transformers level and plumb with wall brackets fabricated by transformer manufacturer.

B. Install floor-mounting transformers level on concrete bases.

3.2 CONNECTIONS

A. Ground equipment according to Division 26 Section "Grounding and Bonding."

B. Connect wiring according to Division 26 Section "Conductors and Cables."

3.3 ADJUSTING
A. Record transformer secondary voltage at each unit for at least 48 hours of typical occupancy period. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 10 percent and not being lower than nameplate voltage minus 5 percent. Submit recording and tap settings as test results.

B. Output Settings Report: Prepare a written report recording output voltages and tap settings.

END OF SECTION
SECTION 26 27 26

WIRING DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:
   1. Single and duplex receptacles, ground-fault circuit interrupters.
   3. Device wall plates.
   4. Floor service outlets, poke-through assemblies and multioutlet assemblies.

1.2 SUBMITTALS

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

B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.

C. Samples: One for each type of device and wall plate specified, in each color specified.

1.3 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. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Wiring Devices:
      b. Eagle Electric Manufacturing Co., Inc.
      c. Hubbell Incorporated; Wiring Device-Kellems.
      d. Leviton Mfg. Company Inc.
      e. Pass & Seymour/Legrand; Wiring Devices Div.
   2. Multioutlet Assemblies:
      a. Hubbell Incorporated; Wiring Device-Kellems.
      b. Wiremold Company (The).
   3. Poke-Through, Floor Service Outlets and Telephone/Power Poles:
      a. Hubbell Incorporated; Wiring Device-Kellems.
      b. Pass & Seymour/Legrand; Wiring Devices Div.
      c. Square D/Groupe Schneider NA.
      d. Thomas & Betts Corporation.
      e. Wiremold Company (The).
2.2 RECEPTACLES
A. Straight-Blade and Locking Receptacles: Heavy-Duty grade.
B. Straight-Blade Receptacles: Hospital grade.
C. GFCI Receptacles: Straight blade, non-feed-through type, Hospital or Heavy-Duty grade, with integral NEMA WD 6, Configuration 5-20R duplex receptacle; complying with UL 498 and UL 943. Design units for installation in a 2-3/4-inch deep outlet box without an adapter.

2.3 SWITCHES
B. Snap Switches: Heavy-Duty grade, quiet type.
C. Combination Switch and Receptacle: Both devices in a single gang unit with plaster ears and removable tab connector that permit separate or common feed connection.
   2. Receptacle: NEMA WD 6, Configuration 5-20R.
D. Dimmer Switches: Modular, full-wave, solid-state units with integral, quiet on/off switches and audible frequency and EMI/RFI filters.
   1. Control: Continuously adjustable slider; with single-pole or three-way switching to suit connections.
   2. Incandescent Lamp Dimmers: Modular, 120 V, 60 Hz with continuously adjustable rotary knob, toggle switch, or slider; single pole with soft tap or other quiet switch; EMI/RFI filter to eliminate interference; and 5-inch wire connecting leads.
   3. Fluorescent Lamp Dimmer Switches: Modular; compatible with dimmer ballasts; trim potentiometer to adjust low-end dimming; dimmer-ballast combination capable of consistent dimming with low end not greater than 20 percent of full brightness.

2.4 WALL PLATES
A. Single and combination types to match corresponding wiring devices.
   1. Plate-Securing Screws: Metal with head color to match plate finish.
   2. Material for Finished Spaces:
      a. 0.035-inch thick, satin-finished stainless steel.
   4. Material for Wet Locations: Cast aluminum with spring-loaded, lockable, lift cover, and listed and labeled for use in "wet locations."

2.5 FLOOR SERVICE FITTINGS
A. Type: Modular, flush-type, dual-service units suitable for wiring method used.
B. Compartments: Barrier separates power from voice and data communication cabling.
C. Service Plate: Rectangular, solid brass with satin finish.
D. Power Receptacle: NEMA WD 6, Configuration 5-20R, gray finish, unless otherwise indicated.
E. Voice and Data Communication Outlet: See telecommunication specifications for requirements.
F. Wiremold RFB4-4DB series complete with brackets, devices, corresponding covers and hardware.
2.6 POKE-THROUGH ASSEMBLIES

A. Description: Factory-fabricated and -wired assembly of below-floor junction box with multichanneled, through-floor raceway/firestop unit and detachable matching floor service outlet assembly.
   1. Service Outlet Assembly: Flush type with two simplex receptacles and space for two RJ-45 jacks.
   2. Size: Selected to fit nominal 4-inch cored holes in floor and matched to floor thickness.
   3. Fire Rating: Unit is listed and labeled for fire rating of floor-ceiling assembly.
   4. Closure Plug: Arranged to close unused 4-inch cored openings and reestablish fire rating of floor.
   5. Wiring Raceways and Compartments: For a minimum of four No. 12 AWG conductors; and a minimum of four, 4-pair, Category 6 voice and data communication cables.

2.7 MULTIOUTLET ASSEMBLIES

A. Components of Assemblies: Products from a single manufacturer designed for use as a complete, matching assembly of raceways and receptacles.

B. Raceway Material: PVC.

C. Wire: No. 12 AWG.

2.8 FINISHES

A. Color:
   1. Wiring Devices Connected to Normal Power System: As selected by Architect, unless otherwise indicated or required by NFPA 70.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install devices and assemblies level, plumb, and square with building lines.

B. Install wall dimmers to achieve indicated rating after derating for ganging.

C. Install unshared neutral conductors on line and load side of dimmers.

D. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical, and with grounding terminal of receptacles on bottom. Group adjacent switches under single, multi-gang wall plates.

E. Remove wall plates and protect devices and assemblies during painting.

F. Adjust locations of floor service outlets to suit arrangement of partitions and furnishings.

3.2 IDENTIFICATION

A. Comply with Division 26 Section "Basic Electrical Materials and Methods."
   1. Receptacles: Identify panelboard and circuit number from which served. Use hot stamped or engraved machine printing with black-filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.
   2. Submit same for approval.
3.3 CONNECTIONS

A. Ground equipment according to Division 26 Section "Grounding and Bonding."

B. Connect wiring according to Division 26 Section "Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections:
   1. After installing wiring devices and after electrical circuitry has been energized, test for proper polarity, ground continuity, and compliance with requirements.
   2. Test GFCI operation with both local and remote fault simulations according to manufacturer’s written instructions.

B. Remove malfunctioning units, replace with new units, and retest as specified above.

END OF SECTION
SECTION 26 28 16

ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following individually mounted, enclosed switches and circuit breakers:
   1. Fusible switches.
   2. Nonfusible switches.
   4. Enclosures.

1.2 SUBMITTALS

A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated.

B. Field quality-control test reports.

C. Operation and maintenance data.

1.3 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. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 FUSIBLE AND NONFUSIBLE SWITCHES

A. Manufacturers:
   1. Eaton Corporation; Cutler-Hammer Products.
   2. General Electric Co.; Electrical Distribution & Control Division.
   4. Square D/Group Schneider.

B. Fusible Switch, 600 A and Smaller: NEMA KS 1, Type GD, with clips or bolt pads to accommodate specified fuses, lockable handle with capability to accept two padlocks, and interlocked with cover in closed position.

C. Nonfusible Switch, 600 A and Smaller: NEMA KS 1, Type GD, lockable handle with capability to accept two padlocks, and interlocked with cover in closed position.
D. Accessories:
1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded, and bonded; and labeled for copper and aluminum neutral conductors.
3. Auxiliary Contact Kit: Auxiliary set of contacts arranged to open before switch blades open (required for all disconnects located downstream of Variable frequency Drives)

2.3 MOLDED-CASE CIRCUIT BREAKERS AND SWITCHES

A. Manufacturers:
1. Eaton Corporation; Cutler-Hammer Products.
2. General Electric Co.; Electrical Distribution & Control Division.
4. Square D/Group Schneider.

B. Molded-Case Circuit Breaker: NEMA AB 1, with interrupting capacity to meet available fault currents.
3. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller and let-through ratings less than NEMA FU 1, RK-5.

C. Molded-Case Circuit-Breaker Features and Accessories:
1. Standard frame sizes, trip ratings, and number of poles.
2. Lugs: Mechanical style suitable for number, size, trip ratings, and conductor material.
3. Application Listing: Type SWD for switching fluorescent lighting loads; Type HACR for heating, air-conditioning, and refrigerating equipment.
4. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 55 percent of rated voltage.

2.4 ENCLOSURES

A. NEMA AB 1 and NEMA KS 1 to meet environmental conditions of installed location.
1. Outdoor Locations: NEMA 250, Type 3R.
3. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Coordinate size and location of concrete bases. Verify structural requirements with structural engineer.

B. Concrete base is specified in Division 26 Section "Basic Electrical Materials and Methods," and concrete materials and installation requirements are specified.

C. Comply with applicable portions of NEC A 1, NEMA PB 1.1, and NEMA PB 2.1 for installation of enclosed switches and circuit breakers.
D. Mount individual wall-mounting switches and circuit breakers with tops at uniform height, unless otherwise indicated. Anchor floor-mounting switches to concrete base.

E. Comply with mounting and anchoring requirements specified in Division 26 Section “Seismic Controls for Electrical Work.”

F. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

G. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 26 Section "Basic Electrical Materials and Methods."

3.2 FIELD QUALITY CONTROL

A. Prepare for acceptance testing as follows:
   1. Inspect mechanical and electrical connections.
   2. Verify switch and relay type and labeling verification.
   3. Verify rating of installed fuses.

B. Perform the following field tests and inspections and prepare test reports:
   1. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Section 7.5 for switches and Section 7.6 for molded-case circuit breakers. 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.

END OF SECTION
SECTION 26 51 00

PART 1 - GENERAL

INTERIOR LIGHTING

1.1 SUMMARY

A. This Section includes the following:
   1. Interior lighting fixtures with lamps and ballasts.
   2. Lighting fixtures mounted on exterior building surfaces.
   3. Emergency lighting units.
   4. Exit signs.
   5. Accessories, including fluorescent fixture dimmers, occupancy sensors and lighting fixture retrofitting.

1.2 SUBMITTALS

A. Product Data: For each type of lighting fixture scheduled, arranged in order of fixture designation. Include data on features, accessories, and finishes. Clearly identify ballast(s) and lamp(s) for each lighting fixture.

B. Operation and maintenance data.

1.3 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. Comply with NFPA 70.

C. NFPA 101 Compliance: Comply with visibility and luminance requirements for exit signs.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
   1. Products: Subject to compliance with requirements, provide one of the products specified.

2.2 FIXTURES AND COMPONENTS, GENERAL

A. Air-Handling Fluorescent Fixtures: For use with plenum ceiling for air return and heat extraction and for attaching an air-diffuser-boot assembly specified in Division 15 Section "Diffusers, Registers, and Grilles."
   1. Air Supply Units: Slots in one or both side trims join with air-diffuser-boot assemblies.
   2. Heat Removal Units: Air path leads through lamp cavity.
   3. Combination Heat Removal and Air Supply Unit: Heat is removed through lamp cavity at both ends of the fixture door with air supply same as for air supply units.
   4. Dampers: Operable from outside fixture for control of return-air volume.
   5. Static Fixtures: Air supply slots are blanked off, and fixture appearance matches active units.
2.3 LIGHTING FIXTURES

A. Fixture: See drawings.

2.4 LAMP BALLASTS

A. Description: Include the following features, unless otherwise indicated:
1. Designed for type and quantity of lamps indicated at full light output except for emergency lamps powered by in-fixture battery-packs.
2. Externally fused with slow-blow type rated between 2.65 and 3.0 times the line current.
3. Warranted for 5 years to include replacement ballasts and labor cost, plus lamp warranty for at least 2 years for lamps used with ballast.

B. LED lamps shall include following features:
1. L.E.D. 3000K/3500K - Philips, CREE or approved equal.
2. Comply with NEMA C82.11.
3. Normal Light Output (NLO) BF 0.87.
4. Sound Rating: A.
5. Total harmonic distortion rating of less than 20 percent according to NEMA C82.11.
6. Transient Voltage Protection: IEEE C62.41, Category A.
7. Listed class P automatic reset thermal protection.
8. Lamp Current Crest Factor: Less than 1.7

C. Ballasts for dimmer-controlled fixtures shall comply with general and fixture-related requirements above for electronic ballasts and the following features:
1. Dimming Range: 100 to 5 percent of rated lamp lumens.
2. Ballast Input Watts: Can be reduced to 20 percent of normal.
3. Compatibility: Certified by manufacturer for use with specific dimming system indicated.

2.5 EXIT SIGNS

A. General: Comply with UL 924; for sign colors and lettering size, comply with authorities having jurisdiction.

B. Internally Lighted Signs:
1. Lamps for AC Operation: Light-emitting diodes, 70,000 hours minimum of rated lamp life.

C. Self-Powered Exit Signs (Battery Type): Integral automatic charger in a self-contained power pack.
1. Battery: Sealed, maintenance-free, nickel-cadmium type with special warranty.
2. Charger: Fully automatic, solid-state type with sealed transfer relay.
3. Operation: Relay automatically energizes lamp from battery when circuit voltage drops to 80 percent of nominal voltage or below. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.

2.6 EMERGENCY LIGHTING UNITS

A. General: Self-contained units complying with UL 924.
1. Battery: Sealed, maintenance-free, lead-acid type with minimum 10-year nominal life and special warranty.
2. Charger: Fully automatic, solid-state type with sealed transfer relay.
3. Operation: Relay automatically turns lamp on when power supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
4. Wire Guard: Where indicated, heavy-chrome-plated wire guard protects lamp heads or fixtures.
5. Integral Time-Delay Relay: Holds unit on for fixed interval when power is restored after an outage; time delay permits high-intensity-discharge lamps to restrike and develop adequate output.
2.7 EMERGENCY LIGHTING FIXTURES

A. Internal Type: Self-contained, modular, battery-inverter unit factory mounted within fixture body. Comply with UL 924.
   1. Emergency Connection: Operate one lamp continuously. Connect unswitched circuit to battery-inverter unit and switched circuit to fixture ballast.
   2. Night Light Connection: Operate one lamp continuously.
   3. Test Switch and Light-Emitting-Diode Indicator Light: Visible and accessible without opening fixture or entering ceiling space.
   4. Battery: Sealed, maintenance-free, nickel-cadmium type with minimum seven-year nominal life.
   5. Charger: Fully automatic, solid-state, constant-current type.
   6. 

2.8 LED LAMPS

A. L.E.D. 3500K - Philips, CREE or approved equal.

2.9 FIXTURE SUPPORT COMPONENTS

A. Comply with Division 26 Section "Basic Electrical Materials and Methods" for channel- and angle-iron supports and nonmetallic channel and angle supports.

B. Single-Stem Hangers: 1/2-Inch.

C. Twin-Stem Hangers: Two, 1/2-inch steel tubes with single canopy designed to mount a single fixture. Finish same as fixture.


E. Wires For Humid Spaces: ASTM A 580/A 580M, Composition 302 or 304, annealed stainless steel, 12 gage.

F. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.

G. Hook Hangers: Integrated assembly matched to fixture and line voltage and equipped with threaded attachment, cord, and locking-type plug.

2.10 LIGHTING CONTROL DEVICES

A. Dimming Ballast Controls: Sliding-handle type with on/off control; compatible with ballast and having light output and energy input over the full dimming range.

B. Light Level Sensor: Detect changes in ambient lighting level and provide dimming range of 20 to 100 percent in response to change.
   2. Adjustable Ambient Detection Range: 10 to 100 fc minimum

C. Occupancy Sensors: Adjustable sensitivity and off delay time range of 5 to 15 minutes.
   1. Device Color:
   2. Occupancy detection indicator.
   3. Ultrasonic Sensors: Crystal controlled with circuitry that causes no detection interference between adjacent sensors.
   4. Infrared Sensors: With daylight filter and lens to afford coverage applicable to space to be controlled.
5. Combination Sensors: Ultrasonic and infrared sensors combined.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Fixtures: Set level, plumb, and square with ceilings and walls. Install lamps in each fixture.

B. Support for Fixtures in or on Grid-Type Suspended Ceilings: Use grid for support.
   1. Install a minimum of four ceiling support system rods or wires for each fixture. Locate not more than 6 inches from fixture corners.
   2. Support Clips: Fasten to fixtures and to ceiling grid members at or near each fixture corner with clips that are UL listed for the application.
   3. Fixtures of Sizes Less Than Ceiling Grid: Install as indicated on reflected ceiling plans or center in acoustical panel, and support fixtures independently with at least two 3/4-inch metal channels spanning and secured to ceiling tees.
   4. Install at least two independent support rods or wires from structure to a tab on lighting fixture. Wire or rod shall have breaking strength of the weight of fixture at a safety factor of 3.

C. Suspended Fixture Support: As follows:
   1. Pendants and Rods: Where longer than 48 inches, brace to limit swinging. Pendant fixtures shall be free to swing a minimum of 45 degrees from the vertical in all directions without contacting any obstructions. Otherwise, seismic restraints are required.
   3. Continuous Rows: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of fixture chassis, including one at each end.

D. Air-Handling Fixtures: Install with dampers closed and ready for adjustment.

E. Adjust aimable fixtures to provide required light intensities.

F. Occupancy sensor and daylighting sensor placement review by factory representative is required before installing sensors.

G. 3.2 COMMISSIONING

H. All electrical power and lighting controls will be commissioned per the requirements of Section 01 91 13, Commissioning Requirements. Contractor is to provide a factory representative to start-up, test and commission all lighting controls.

END OF SECTION
SECTION 27 01 00

GENERAL TECHNOLOGY REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. The provisions of the General Conditions, Supplementary Conditions, and the Sections included under Division 1 and 2, General Requirements, are included as a part of this section as though bound herein.

1. DRAWINGS

a. The Drawings prepared for this Project are an outline to show where apparatus must go in order to harmonize with the building and installations of the various trades. Work must be installed in accordance with the drawings insofar as possible. Drawings shall be carefully checked during the course of bidding and construction. If discrepancies, errors, or omissions are discovered prior to or during the construction phase, notify the Owner's Agent immediately for interpretation or correction. Take necessary measurements and be responsible for same, including clearances for equipment that is to be furnished. The Owner shall reserve the right to make minor location changes of equipment where such adjustments are deemed desirable from an appearance or operational standpoint. Such changes will be anticipated sufficiently in advance to avoid extra work or unduly delayed progress on the Project.

1.2 SUMMARY

A. RELATED SECTIONS

1. The requirements of this Section supplement the General Conditions and shall apply to Work for Sections listed under Division 27 – TECHNOLOGY.

B. PERFORMANCE

1. Provide the labor, materials, equipment, appliances, services and transportation, and perform the operations in connection with the construction and installation of the Work. Work shall be as herein specified and as denoted on the accompanying Drawings.

1.3 DEFINITIONS

A. PRECEDENCE

1. Precedence of project documents shall be as follows:

a. In the event of a discrepancy between the specifications and drawings, whichever is more stringent or calls for the highest quantity or quality of materials has precedence.

B. OMISSIONS

1. The omission of express reference to any parts necessary for, or reasonably incidental to, a complete installation shall not be construed as a release from providing such parts.

C. ANCILLARY AND ACCESSORY ITEMS
1. No exclusion from, or limitations in, the language used in the drawings or specifications shall be interpreted as meaning that the accessories necessary to complete any required system or item of equipment are to be omitted.

D. DRAWINGS

1. The drawings of necessity utilize symbols and schematic diagrams to indicate various items of work. Neither of these have any dimensional significance nor do they delineate every item required for the intended installations. The work shall be installed in accordance with the intent diagrammatically expressed on the drawings and described in these specifications. No interpretation shall be made from the limitations of symbols and diagrams that any elements necessary for complete work are excluded.

E. ORDINANCES

1. All work shall conform to all federal, state, and local ordinances and building official requirements.

F. BUILDING CODES AND STANDARDS

1. All work shall conform to all state and local building codes and the following:
   a. National Electrical Code (NEC)
   b. National Fire Protection Association (NFPA)
   2. Telecommunications Industry Association (TIA):
      a. ANSI/TIA-568-C.0, “Generic Telecommunications Cabling for Customer Premises”
      b. ANSI/TIA-568-C.1, “Commercial Building Telecommunications Cabling Standards - Part 1 General Requirements”
      c. ANSI/TIA-568-C.2, “Balanced Twisted Pair Telecommunications Cabling and Components”
      e. ANSI/TIA-569-B, “Commercial Building Standard for Telecommunications Pathways and Spaces”
      f. ANSI/TIA/EIA-598-B, “Optical Fiber Cable Color Coding”
      g. ANSI/TIA-606-B, “Administration Standard for Telecommunications Infrastructure”
      h. ANSI-TIA-607-B, “Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises”

G. UL LISTING

1. All material and equipment shall be listed, labeled, or certified by Underwriter’s Laboratories, Inc., where such standards have been established.

H. FCC APPROVAL

1. The system shall be approved for direct interconnection to the utility services under Part 68 of FCC rules and regulations. Those systems that are not FCC approved or utilize an
intermediary device for connection will not be considered. Provide FCC registration number of system being proposed with submittals.

I. SUBMITTALS

1. Provide complete shop drawings and submittals for all systems specified within 30 days of notice of award or actual award of contract which ever occurs first. The Architect/Consultant will review and return submittals and shop drawings within fourteen (14) days. Failure to obtain submittal approval within sixty (60) days of contract award, where the delay is due to the poor performance of the contractor, may be cause for cancellation of the contract without penalty of the Owner.

2. Where applicable, the Contractor will submit the greatest quantity of submittal copies noted herein or in the General or Supplemental Conditions of the project documents. If not noted elsewhere within the project documents, the Contractor will submit a minimum of five (5) sets of submittals and shop drawings.

3. The Contractor should not consider the Consultant or Owner’s review of submittals to be exhaustive or complete in every detail. Approval of submittals, including substitutions, indicates only the acceptance of intent to comply with general design or method of construction and quality as specified. The functional requirements, operations, arrangements, and quantities must comply with the contract documents unless changes are specifically approved in writing. Submittal approval does not relieve the Contractor of responsibility for errors in dimensions, details, sizes, fire, etc., or coordinating items with actual building conditions. Contractor’s responsibility for error and omissions in submittals is not relieved by the Consultant or Owner review of submittals.

4. Submittals and shop drawings will be provided in a single package, multiple partial submittals are not acceptable.

5. Submittals which, in the Consultant’s opinion, are incomplete deviate significantly from the requirements of the Project Specifications, or contain numerous errors will be returned without review for rework and are to be re-submitted.

6. If submittals and/or drawings are rejected, or approved with noted changes and resubmittal required, the Contractor will correct the documents as required and resubmit within fourteen (14) days.

7. The Contractor will not fabricate products, begin work, or submit invoices for the scope of work defined in the project documents until return of submittals and shop drawings with Consultant acceptance.

J. SCALED DRAWINGS (Shop Drawings)

1. Each drawing shall have a descriptive title and all subparts of each drawing shall be completely described. All drawings shall have the name of the project, Owner’s name and address, consultant, and electronics contractor in the title block.

2. Cabinets
   a. Provide complete scaled elevation drawings of all equipment racks with equipment identification number. Each drawing shall show all equipment with its manufacturer, model number, and specific room location. If other Contractor(s) are providing
equipment in the room, this Contractor will coordinate the layout of the room with the 
other Contractor(s).

b. Provide complete scaled floor plan drawings of all rooms where equipment racks or 
cabinets are located with location and orientation of every rack or cabinet shown. 
Provide dimensional relation of each piece of equipment to other pieces of equipment, 
room walls, and ceiling.

3. Backboards

a. Provide complete scaled elevation drawings of all backboards with equipment 
designations and locations. Provide dimensional relation of each piece of equipment 
to other pieces of equipment. If other Contractor(s) are providing equipment on the 
backboard, this Contractor will coordinate the layout of equipment on the backboard 
with the other Contractor(s).

4. Primary Cable Paths and Device Locations

a. Provide complete scaled drawings detailing projected primary cable paths and 
locations of all equipment such as control panels, plug panels, video monitors, video 
projectors, equipment racks, speakers, etc... in quantities noted in the general 
requirements. These drawings will be utilized for "as-built" submittals with cable 
numbers noted at the end of the project.

5. Assembly, Supports, and Panel/Plate Layout

a. Provide diagrammatic representation of all assemblies, i.e. monitor mount assembly, 
projector mount assembly, and connector panel and/or plate layout. Identify the 
components that make up the assembly or are used on the panel/plate. For connector 
panel or plate, indicate identification location and methodology.

6. One-Line System Diagram

a. Provide one-wire drawings of all racks, consoles, control panels, and custom 
assemblies, etc. in quantities noted in the general requirements. Each drawing shall 
delineate circuit numbers for all cables and terminal connections. Provide typical wiring 
termination for all devices.

K. MANUFACTURERS PRODUCT DATA

1. Manufacturer Cut Sheets

a. Provide complete sets of a project material list with manufacturer specification sheets 
for each manufactured device utilized within the system in quantities noted in the 
general requirements. The Owners Agent will use these sets in determining that all 
products listed are being supplied as required.

2. Samples

a. Provide samples of the following:

1) Any plastic or custom metal panels.
2) All paint finishes of cabinets or custom assemblies. (These may be manufacturer
cuts sheets indicating the various colors and finishes available).

3) Equipment identification tag material, labeling method, and numbering method

4) Cable labeling material, labeling method, and numbering method

5) Faceplate and modules of selected color for approval by Owner/architect

6) Faceplate labeling material, labeling method, and numbering method.

L. SCHEDULE

1. The Consultant has been retained by the Owner to provide inspection services throughout
the duration of the project. Those services include:

   a. Inspection of technology rough-in methodologies (cable installation and support
      methods, component support methodologies.)

   b. Inspection of cable, face plate, and cabinet termination and labeling methodologies.

   c. Review of Verification Test Reports.

   d. Attend and Witness Final Acceptance Test (Proof of Performance Tests).

   e. Verify Contractor provision of training requirements.

2. The Contractor is required to provide a projected schedule of activities for the Consultant
to plan site visits. The Contractor is responsible to notify the Consultant of any changes in
their activity schedule due to change in the overall construction schedule or Contractor
schedule. Provide dates for the following:

   a. Date upon which 10% of the project cable is expected to be installed.

   b. Date upon which 10% of system supports are expected to be installed.

   c. Date upon which 10% of cable and plates are terminated and labeled.

   d. Date of Verification Test Report completion.

   e. Date of expected Final Acceptance Testing.

   f. Dates of expected Systems Training.

1.4 QUALITY ASSURANCE

A. MANUFACTURER QUALIFICATIONS

1. Five continuous years, minimum, design and manufacture of the materials and equip-
ment specified herein.
2. Manufacturer(s) of products and equipment specified herein shall demonstrate that they have a quality assurance program in place to assure that the specifications are met. Include in the program, at a minimum, provisions for:

   a. Incoming inspection of raw materials.

   b. In-process inspection and final inspection of the cable product.

   c. Calibration procedures of test equipment to be used in the qualifications of the product.

   d. Recall procedures in the event that out of calibration equipment is identified.

3. Conform to government standards on quality assurance for applications within these specifications.

B. CONTRACTOR QUALIFICATIONS:

1. A current, active, and valid and C7 or C10 California State Contractors License

2. Manufacturer certification for the specified cabling system, including the ability to provide a 25-year extended warranty for the structured cabling system.

3. Five, minimum, continuous years of experience.

4. Five, minimum, completed projects similar to scope and cost.

5. Evidence of technicians qualified for the work.

C. MATERIALS

1. Materials, support hardware, equipment, parts comprising units, etc., shall be new, unused, without defects and of current manufacturer, materials.

2. Use specified products and applications, unless otherwise submitted and approved in writing.

D. REGULATORY REQUIREMENTS

1. Work and materials shall conform to the latest rules of National Board of Fire Underwriters wherever such standards have been established and shall conform to the regulations of the State Fire Marshal, OSHA and the codes of the governing local municipalities. Work under Division 27 shall confirm to the most stringent of the applicable codes.

2. Provide the quality identified within these specifications and drawings when codes, standards, regulations, etc. allow Work of lesser quality or extent. The contract documents address the minimum requirements for construction.

E. DRAWINGS

1. Follow the general layout shown on the drawings except where other work may conflict with the drawings.
2. Drawings for the work within this division are essentially diagrammatic within the constraints of the symbology applied.

3. The drawings do not fully represent the entire installation. Drawings indicate the general route for pathways and cables, and show general locations of outlets. The drawings might not expressly show every conduit, sleeve, hanger, etc., but a complete system is required.

PART 2 - PRODUCTS

2.1 DEVICE LOCATIONS

A. Locate all apparatus requiring adjustments, cleaning, or similar attention so it will be accessible for such attention. Equipment racks shall be positioned to permit full access for operation and service.

2.2 SUPPORTS

A. Provide and install brackets, braces, and supports as required. Minimum fastening and/or support safety factor shall be at least three (3). Design shall be to the approval of the Owner.

2.3 PAINTING

A. All supporting structures and enclosures supplied by the contractor not having a standard factory paint finish shall be painted in a manner approved by the Owner.

2.4 PAINT COLOR

A. Provide, as may be required, custom color and/or finish for any equipment or materials supplied which are exposed to public view. Color and finish of all such equipment or materials shall be submitted to the Architect for approval. This does exclude equipment or materials where standard colors and finishes are specified herein, unless otherwise noted.

2.5 BLANK AND CUSTOM PANELS

A. Finish of blank panels and/or custom assembly panels utilized for termination and/or interconnection as part of this system shall be stainless steel.

B. In addition, provide blank plastic panels finished in matte (or satin) black to close off all spaces around the source equipment in the distribution room racks. These panels shall have cutouts that provide access to the source machine and its controls. Match each panel to the device it is covering in the racks. Submit a sample of the plastic with finish to the Consultant for approval.

2.6 MARKINGS

A. Switches, connectors, jacks, receptacles, outlets, cables and cable terminations shall be logically and permanently marked in a manner approved by the Owner. Custom panel nomenclature shall be engraved, etched, or screened. Marking for these items are purposely detailed in the drawings to ensure consistency and clarity. Verify any changes in working type size, and/or placement with the Owner prior to marking. Mount on the custom rack panels as described above a designation of each source machine, which correlates to the system architecture. Submit a sample layout for Consultant approval.

2.7 ENVIRONMENT
A. The equipment specified herein is designed to operate in environments of normal humidity, dust, and temperature. Protect equipment and related wiring where extreme environmental conditions can occur.

2.8 REFERENCE STANDARDS

A. NOTE: Educational facilities are unique facilities and do not specifically conform to the TIA/EIA standard, they are not commercial buildings that must flex with each new tenant. The Owner will deviate from the standard to enhance the instructional impact of the technology implementation. Deviations will be noted below:

1. Quantity of drops in a given space.
2. Quantity of drops within a single communications box.
3. Use of a collapsed backbone data system architecture.
4. Deletion of wiring closets (IDF).
5. Fiber cable direct to the classroom.
6. No patch panels in classrooms containing hub units.
7. When wiring closets (IDF) are used, room size requirements are not strictly adhered to.

B. Where practices noted within this specification do not adhere strictly to the TIA/EIA standards, The Owner has done so for a specific purpose related to educational facilities. For those areas deviating from the standard, this contractor will not be liable for complying with the TIA/EIA standards.

C. The standard references for the layout and construction of the system shall be the current version of:

1. GENERAL, (Includes Copper and Fiber)
   a. TIA/EIA-568 - Commercial Building Standard for Telecommunications Wiring
   b. TIA/EIA-569 - Commercial Building Standard for Telecommunications Pathways and Spaces.
   c. TIA/EIA-606 - Administrative Standard for the Telecommunications Infrastructure of Commercial Buildings.
   d. TIA/EIA-607 - Commercial Building Grounding/Bonding Requirements.
   f. ANSI - American National Standards Institute
   g. UL Listed - Underwriter's Laboratories Listed
   h. UL Certified - Underwriter's Laboratories LAN Cable Certification Program.
i. NEMA - National Electrical Manufacture’s Association.

2. AUDIO
   a. Handbook for Sound Engineers
   b. The New Audio Cyclopedia (Howard W. Sams, Indianapolis, Indiana 1987)

3. VIDEO
   a. National Association of Broadcasters
   b. Engineers Handbook

4. ADDITIONAL: FIBER OPTICS
   a. Refer to the fiber optic cable manufacturers design guide:
      1) i.e. SIECOR
      2) Siecor Universal Transport System (UTS)
      3) Design Guide, Siecor Corp.
      4) Brochure #CC-110
      5) Also refer to the following standards committees:
      6) ANSI: Proposed Fiber Distributed Data Interface (FDDI) Physical Media Documents
      7) Institute of Electrical & Electronic Engineers (IEEE) 802.8
      8) Electronic Industries Association (EIA) Committees:
      9) TR4 1.8.1: Working Group on Commercial & Industrial Building Wiring Standard
      10) FO-6: Fiber Optic Committee
      11) FO-6.7: Fiber Optic Cable Sub Committee
      12) FO-2: Fiber Optic Systems Committee
      13) Insulated Cable Engineers Association Inc. (ICEA)
      14) WG 596: Fiber Optic Premises Distribution Cable
      16) DO9.18, TG-12: Task Group on Fiber Optics
PART 3 - EXECUTION

3.1 INSTALLATION

A. GENERAL

1. Perform this work in accordance with acknowledged industry and professional standards and practices, existing building conditions, and as specified herein. Provide and install all materials, devices, components, and equipment for complete, operational systems.

2. Maintain a competent supervisor and supporting technical personnel, acceptable to the Architect, during the entire installation. Change of the supervisor during the project shall not be acceptable without prior written approval from the Owner and the Owner's Agent.

3. Coordinate all efforts with those of related trades. In the event of any conflicts, delayed or improper preparatory work by others, notify the Owner's Agent. The Owner's Agent's decision will be binding. Verify all field conditions.

3.2 ELECTRICAL DISTRIBUTION

A. Provide distribution of electrical power within the equipment racks with a minimum of one spare AC receptacle for each four in use per branch circuit or a minimum of two spare AC receptacles per branch circuit, whichever is greater. Power will be made available in each area. Where applicable, coordinate extension of those circuits by the District.

3.3 BOXES

A. MOUNTING

1. With the exception of portable equipment, all boxes, conduits, cabinets, equipment and related wiring shall be held firmly in place and the mounting shall be plumb and square. All boxes shall be rigidly and securely mounted to building structure. All boxes shall be installed so that wiring contained in them is accessible. Install blanking devices or threaded plugs in all unused holes.

B. WIRING

1. Wiring groups and circuits shall be isolated as indicated herein. Common pull or junction boxes shall be avoided. Where deemed necessary and approved, they shall be barrier.

C. CLEANING

1. Clean all box interiors thoroughly before installing plates, panels, or covers.

3.4 WIRING METHODS & PRACTICES

A. SUPERVISION

1. Installation of all audio, video, control, and/or fiber cable to be provided under this scope of work is by this contractor. Supervision to include, but not be limited to ensuring proper:

   a. Pulling Tensions

   b. Quantities
c. Types

d. Lengths

e. Routing

f. Wire Group Separation

g. Identification

B. IDENTIFICATION

1. All wires shall be permanently identified at each wire end utilizing a self-laminating wire or cable marker comprised of a white label with black lettering and clear over laminate area, in a manner approved by the Owner's Agent.

2. All faceplates will be permanently identified with engraved plastic laminate or metallized polyester identification labels.

C. TERMINAL BLOCKS

1. All terminal block connections shall be readily accessible. Not more than one wire connected to one terminal. Spare terminal blocks, equivalent to 10% of those in actual use shall be provided.

D. SPLICING

1. Splicing of cables is not permitted between terminations.

E. PULLING CABLE

1. Do not pull wire or cable through any box fitting or enclosure where change of raceway alignment or direction occurs; do not bend conductors to less than recommended radius. Employ temporary guides, sheaves, rollers, and other necessary items to protect cables from excess tension, abrasion, or damaging bending during installation. Care shall be taken not to bend, crush or kink cables.

F. CABLE MANAGEMENT

1. Building Locations

   a. Comb straight and form in a neat and orderly manner all conductors in large junction boxes and cable support bridle rings or other types of open top support systems, providing circuit and conductor identification. Tie wraps are only to be used for cable management, not support. Arrange as required using tie wraps of appropriate size and type, (plenum rated as required). Limit spacing between ties to six inches and provide circuit and conductor identification at least once in each enclosure.

2. Equipment Cabinets or Racks

   a. Comb straight and form in a neat and orderly manner all conductors located within equipment cabinets, located in the head end room or remote locations, and wiring harnesses in the head end room. Tie as required using Velcro cable ties of appropriate type and size.
G. SERVICE LOOPS

1. Provide ample service loops at each termination and/or per drawings so that plates, panels, and equipment can be dismounted for service and inspection. Provide the following as a minimum:

   a. Outlet box: Eighteen (18) inches from wall surface to jack.

   b. Termination panel: Four (4) inches behind termination panel from last cable tie to jack.

   c. Fiber terminations: Eighteen (18) inches of service loop coiled and stored in junction box (refer to NEC for proper sizing of junction boxes and pull boxes). Take care not to exceed bend radius of fiber per recommended telecommunications standards.

H. NON-CABLE TRAY INSTALLATION

1. All cable installations which are not supported by a cable tray or conduit system and where educational technology system cables are allowed to be placed loosely in the ceiling must follow the TIA/EIA standard methodology as noted in TIA/EIA 569 - Part 4.6 Ceiling Pathways. Specifically, sections 4.6.1 General, 4.6.2 Design Guidelines, and 4.6.5 Cable Support. Those sections are paraphrased herein (the contractor will be familiar with the specifics of these sections and install their cables in accordance with the standard or as noted herein).

2. The installation of all education technology cabling, regardless of type and separation requirements, from the head end room to various zones throughout the facility will use common pathway routes.

3. Inaccessible ceiling areas, such as lock-in ceiling tiles, drywall or plaster, will not be used as distribution pathways. Should the contractor find inaccessible ceiling areas as the only available pathway, the contractor will notify the Owner’s Agent immediately for direction prior to proceeding with the cable installation.

4. Accessible ceiling areas must have adequate and suitable space available for the distribution layout (minimum of three inches clear vertical space between ceiling tiles and distribution wiring and pathway).

5. The design shall provide a suitable means and method for supporting cables and wires from the head end room (and/or telecommunications closet) to the area being served. The cable will not be laid directly on the ceiling tiles or rail. The Owner allows the use of "Caddy - Multifunction Clip" (as manufactured by ERICO or other equivalent manufacturer) installed on the ceiling support wire at a minimum height of eighteen inches above the tile and utilizing the appropriate D-ring or bridle ring for the installation of cable within a single zone.

6. Cable support will be provided through the use of open-top cable supports located on 48-60 inch centers. Where large quantities of cables (50-75) are bunched together in the ceiling at a congested area, the contractor will use multiple open-top cable supports or a special support designed to carry the additional weight.

7. A single classroom or suite of offices (with an area not exceeding 1200 square) feet will be considered a single telecommunication zone. Instructional spaces which exceed the 1200 square foot limit must be brought to the attention of the Owner’s Agent for review and
approval as a single zone. Loose cables from each zone to the telecommunications closet or headend room will be grouped and tied.

I. WIRING HARNESSES

1. All wires and cables used in assembling custom panels and equipment racks shall be formed into harnesses, tied with Velcro tie wraps and supported in accordance with accepted engineering practice.

2. Harnessed cables shall be combed straight. Each cable that breaks out from a harness for termination shall be provided with an ample service loop.

3. Harnessed cables shall be formed in either a vertical or horizontal relationship to equipment, controls, components, or terminations.

J. FIBER OPTIC CABLE

1. All cable shall be installed and terminated in accordance with the manufacturer’s recommended procedures. All cables shall be continuous between terminals with no splicing. All cables will be terminated with SC type connectors and terminated into their respective classroom terminals and central racks.

3.5 GROUNDING

A. GROUNDING PROCEDURE

1. The system wiring will conform to the following procedures:
   a. ITEM PROCEDURE
   b. Equipment AC Ground Pins Connect to AC ground.
   c. Equipment Chassis Connect to AC ground and/or rack frames
   d. Rack Frames Connect to AC ground. Use insulated bushings for all conduit connections.
   e. Shielded Cable Between
   f. AC powered equipment: Connect to ground at one end only.
   g. Unbalanced Equipment: Float chassis from rack.
   h. Conduit/Back Boxes: Isolate system wiring, including AC power, from all conduits and permanent backboxes.
   i. AC Ground: Green wire (grounding conductor) system shall be isolated from all other facility grounds. Connects at one point to earth.

B. METALLIC CONDUIT & ENCLOSURES

1. All metallic conduit, boxes, and enclosures shall be permanently and effectively grounded in accordance with the National Electrical Code. Metallic enclosures containing active equipment shall be grounded with due regard for minimization of electrical noise.

GENERAL TECHNOLOGY REQUIREMENTS
27 01 00 - 13
3.6 EQUIPMENT RACKS

A. GENERAL

1. The equipment racks shall be vented and considered as custom assemblies and shall be assembled, wired, and tested in a properly equipped shop maintained by the contractor. Assembly of racks on site will not be permitted.

B. EQUIPMENT LOCATION

1. Placement of equipment in equipment racks is for maximum operator convenience. Verify any changes in placement prior to assembly with the Owners Agent. All system components and related wiring will be located with due regard for the minimization of induced electromagnetic and electrostatic noise, for the minimization of wiring length, proper ventilation, and to provide reasonable safety and convenience for the operator. Fans shall be provided if required for proper ventilation. All cabling to the racks shall be ceiling access and within enclosures extending from the racks into the ceiling area.

C. RACK INSTALLATION

1. Racks shall be installed plumb and square without twists in the frames or variations in level between adjacent racks.

D. IDENTIFICATION

1. All terminal blocks, rack mounted equipment, and active slots of card frame systems shall be clearly and logically labeled in a manner acceptable to the Owner as to their function, circuit, or system as appropriate. Labeling on manufactured equipment shall be engraved plastic laminate with white lettering on black background or dark background. Handwritten identification is not permitted. The contractor may substitute metallized polyester permanent identification labels with black printing on silver, white, or another light color background for the phenolic labels above.

3.7 CABLE TEST METHODOLOGY

A. TEST DOCUMENTATION

1. Upon substantial completion of the data network and interfacing of the Owner supplied equipment, test every data port for the functional requirements as listed in previously. Document, on a contractor generated form, the compliance of every port and the testing individual will initialize the results of each location. Submit a written report detailing the results of initial adjustments and verification tests including all relevant drawings, charts, and photographs.

B. FIELD TEST REQUIREMENTS FOR A BALANCED TWISTED-PAIR CABLING SYSTEM

1. Every cabling link in the installation shall be tested in accordance with the Telecommunications Industry Association (TIA) standard ANSI/TIA/EIA-568-B.2-1 (June 2002) Section 11.2: “100-Ohm twisted-pair transmission performance and field test requirements”.

2. The installed twisted-pair horizontal links shall be tested from the IDF in the telecommunications room to the telecommunication wall outlet in the work area against the
"Permanent Link" performance limits specification as defined in ANSI/TIA/EIA-568-B.2-1 (June 2002).

3. 100% of the installed cabling links must be tested and must pass the requirements of the standards mentioned in subsection 1 above and as further detailed in Section 27 16 00. Any failing link must be diagnosed and corrected. The corrective action shall be followed with a new test to prove that the corrected link meets the performance requirements. The final and passing result of the tests for all links shall be provided in the test results documentation as described below.

4. Trained technicians who have successfully attended an appropriate training program and have obtained a certificate as proof thereof shall execute the tests. Appropriate training programs include but are not limited to installation certification programs provided by BICSI or the ACP (Association of Cabling Professionals).

5. The test equipment (tester) shall comply with or exceed the accuracy requirements for enhanced level II (Level II-E) field testers as defined in TIA-568-B: Annex I: Section I.4. The tester including the appropriate interface adapter must meet the specified accuracy requirements. The accuracy requirements for the permanent link test configuration (baseline accuracy plus adapter contribution) are specified in Table I.4 of Annex I of TIA/EIA-568-B.2. (Table I.5 in this TIA document specifies the accuracy requirements for the Channel configuration.)

6. The tester shall be within the calibration period recommended by the vendor in order to achieve the vendor-specified measurement accuracy.

7. The tester interface adapters must be of high quality and the cable shall not show any twisting or kinking resulting from coiling and storing of the tester interface adapters. In order to deliver optimum accuracy preference is given to a permanent link interface adapter for the tester that can be calibrated to extend the reference plane of the Return Loss measurement to the permanent link interface. The contractor shall provide proof that the interface has been calibrated within the period recommended by the vendor. To ensure that normal handling on the job does not cause measurable Return Loss change, the adapter cord cable shall not be of twisted-pair construction. The Fluke DSP-LIA101S permanent link adapter available for the DSP-4000 Series CableAnalyzer™ is an example of a tester interface that fully complies with this requirement.

8. The Pass or Fail condition for the link-under-test is determined by the results of the required individual tests (detailed in Section 27 16 00). Any Fail or Fail* result yields a Fail for the link-under-test. In order to achieve an overall Pass condition, the results for each individual test parameter must Pass or Pass*.

9. A Pass or Fail result for each parameter is determined by comparing the measured values with the specified test limits for that parameter. The test result of a parameter shall be marked with an asterisk (*) when the result is closer to the test limit than the accuracy of the field tester. The field tester manufacturer must provide documentation as an aid to interpret results marked with asterisks. (Reference TIA-568-B: Annex I: Section I.2.2)

10. A representative of the end-user shall be invited to witness field testing. The representative shall be notified of the start date of the testing phase 5 business days before testing commences.

11. A representative of the end-user will select a random sample of 10% of the installed links. The representative (or his authorized delegate) shall test these randomly selected links.
and the results are to be stored in accordance with the prescriptions in Section 27 16 00. The results obtained shall be compared to the data provided by the installation contractor. If more than 2% of the sample results differ in terms of the pass/fail determination, the installation contractor under supervision of the end-user representative shall repeat 100% testing and the cost shall be borne by the installation contractor.

C. BALANCED TWISTED-PAIR CABLE SYSTEM PERFORMANCE TEST PARAMETERS

1. The test parameters for Cat 6 are defined in ANSI/TIA/EIA standard 568-B.2-1 "Parameters to be reported". The test of each Cat 6 link shall contain all of the following parameters as detailed below. In order to pass the link test all measurements (at each frequency in the range from 1MHz through 250MHz) must meet or exceed the limit value determined in the above-mentioned Cat 6 standard.

   a. Wire Map [as defined in TIA/EIA-568-B.2-1] Wire Map shall report Pass if the wiring of each wire-pair from end to end is determined to be correct. The Wire Map results shall include the continuity of the shield connection if present.

   b. Length [as defined in TIA/EIA-568-B.2-1]

   c. The field tester shall be capable of measuring length of all pairs of a permanent link or channel based on the propagation delay measurement and the average value for NVP. The physical length of the link shall be calculated using the pair with the shortest electrical delay. This length figure shall be reported and shall be used for making the Pass/Fail decision. The Pass/Fail criteria are based on the maximum length allowed for the permanent link configuration (90 meters – 295 ft) or the channel (100 meters – 328 ft) plus 10% to allow for the variation and uncertainty of NVP.

   d. Insertion Loss (Attenuation) [as defined in TIA/EIA-568-B.2-1] Insertion Loss is a measure of signal loss in the permanent link or channel. The term 'Attenuation' has been used to designate "insertion loss". Insertion Loss shall be tested from 1 MHz through 250 MHz in maximum step size of 1 MHz. It is preferred to measure attenuation at the same frequency intervals as NEXT Loss in order to provide a more accurate calculation of the Attenuation-to-Crosstalk Ratio (ACR) parameter. Minimum test results documentation (summary results): Identify the worst wire pair (1 of 4 possible). The test results for the worst wire pair must show the highest attenuation value measured (worst case), the frequency at which this worst case value occurs, and the test limit value at this frequency.

   e. NEXT Loss, pair-to-pair [as defined in TIA/EIA-568-B.2-1] Pair-to-pair near-end crosstalk loss (abbreviated as NEXT Loss) shall be tested for each wire pair combination from each end of the link (a total of 12 pair combinations). This parameter is to be measured from 1MHz through 250MHz. NEXT Loss measures the crosstalk disturbance on a wire pair at the end from which the disturbance signal is transmitted (near-end) on the disturbing pair. The maximum step size for NEXT Loss measurements shall not exceed the maximum step size defined in the standards as shown in Table 1, column 2. A smaller step size more accurately identifies worst case margin conditions (see summary results, below).
Table 1

<table>
<thead>
<tr>
<th>Frequency Range (MHz)</th>
<th>Maximum size (MHz)</th>
<th>Step</th>
<th>Fluke DSP-4000 Fluke DSP-4100</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 – 31.25</td>
<td>0.15</td>
<td>0.10</td>
<td></td>
</tr>
<tr>
<td>31.26 – 100</td>
<td>0.25</td>
<td>0.20</td>
<td></td>
</tr>
</tbody>
</table>

Minimum test results documentation (summary results): Identify the wire pair combination that exhibits the worst case NEXT margin (1) and the wire pair combination that exhibits the worst value of NEXT (worst case). NEXT is to be measured from each end of the link-under-test. These wire pair combinations must be identified for the tests performed from each end. Each reported case shall include the frequency at which it occurs as well as the test limit value at this frequency.

f. PSNEXT Loss [as defined in TIA/EIA-568-B.2-1] Power Sum NEXT Loss shall be evaluated and reported for each wire pair from both ends of the link-under-test (a total of 8 results). PSNEXT Loss captures the combined near-end crosstalk effect (statistical) on a wire pair when all other pairs actively transmit signals. Like NEXT this test parameter must be evaluated from 1MHz through 250MHz and the step size may not exceed the maximum step size defined in the standards as shown in Table 1, column 2.

g. Minimum test results documentation (summary results): Identify the wire pair that exhibits the worst case margin and the wire pair that exhibits the worst value for PSNEXT. These wire pairs must be identified for the tests performed from each end. Each reported case shall include the frequency at which it occurs as well as the test limit value at this frequency.

h. ELFEXT Loss, pair-to-pair [as defined in TIA/EIA-568-B.2-1] Pair-to-pair FEXT Loss shall be measured for each wire-pair combination from both ends of the link-under-test. FEXT Loss measures the unwanted signal coupling (crosstalk disturbance) on a wire pair at the opposite end (far-end) from which the transmitter emits the disturbing signal on the disturbing pair. FEXT is measured to compute ELFEXT Loss that must be evaluated and reported in the test results. ELFEXT measures the relative strength of the far-end crosstalk disturbance relative to the attenuated signal that arrives at the end of the link. This test yields 24 wire-pair combinations. ELFEXT is to be measured from 1MHz through 250MHz and the maximum step size for FEXT Loss measurements shall not exceed the maximum step size defined in the standards as shown in Table 1, column 2. Minimum test results documentation (summary results): Identify the wire pair combination that exhibits the worst case margin and the wire pair combination that exhibits the worst value for ELFEXT. These wire pairs must be identified for the tests performed from each end. Each reported case shall include the frequency at which it occurs as well as the test limit value at this frequency.

i. PSELFEXT Loss [as defined in TIA/EIA-568-B.2-1] Power Sum ELFEXT is a calculated parameter that combines the effect of the FEXT disturbance from three wire pairs on the fourth one. This test yields 8 wire-pair combinations. Each wire-pair is
evaluated from 1MHz through 250MHz in frequency increments that do not exceed the maximum step size defined in the standards as shown in Table 1, column 2. Minimum test results documentation (summary results): Identify the wire pair that exhibits the worst case margin and the wire pair that exhibits the worst value for PSELFEXT. These wire pairs must be identified for the tests performed from each end. Each reported case shall include the frequency at which it occurs as well as the test limit value at this frequency.

j. Return Loss [as defined in TIA/EIA-568-B.2-1] Return Loss (RL) measures the total energy reflected on each wire pair. Return Loss is to be measured from both ends of the link-under-test for each wire pair. This parameter is also to be measured from 1 through 100 MHz in frequency increments that do not exceed the maximum step size defined in the standards as shown in Table 1, column 2. Minimum test results documentation (summary results): Identify the wire pair that exhibits the worst case margin and the wire pair that exhibits the worst value for Return Loss. These wire pairs must be identified for the tests performed from each end. Each reported case shall include the frequency at which it occurs as well as the test limit value at this frequency.

k. ACR (Attenuation to crosstalk ratio) ACR provides an indication of bandwidth for the two wire-pair network applications. ACR is a computed parameter that is analogous to ELFEXT and expresses the signal to noise ratio for a two wire-pair system. This calculation yields 12 combinations – six from each end of the link. Minimum test results documentation (summary results): Identify the wire pair combination that exhibits the worst case margin and the wire pair combination that exhibits the worst value for ACR. These wire pair combinations must be identified for the tests performed from each end. Each reported case shall include the frequency at which it occurs as well as the test limit value at this frequency.

l. PSACR
The Power Sum version of ACR is based on PSNEXT and takes into account the combined NEXT disturbance of all adjacent wire pairs on each individual pair. This calculation yields 8 combinations – one for each wire pair from both ends of the link. Minimum test results documentation (summary results): Identify the wire pair that exhibits the worst case margin and the wire pair that exhibits the worst value for PSACR. These wire pairs must be identified for the tests performed from each end. Each reported case shall include the frequency at which it occurs as well as the test limit value at this frequency.

m. Propagation Delay [as defined in TIA/EIA-568-B.2-1] Propagation delay is the time required for the signal to travel from one of the link to the other. This measurement is to be performed for each of the four wire pairs. Minimum test results documentation (summary results): Identify the wire pair with the worst case propagation delay. The report shall include the propagation delay value measured as well as the test limit value.

n. Delay Skew [as defined in TIA/EIA-568-B.1; Section 11.2.4.11] This parameter shows the difference in propagation delay between the four wire pairs. The pair with the shortest propagation delay is the reference pair with a delay skew value of zero. Minimum test results documentation (summary results): Identify the wire pair with the worst case propagation delay (the longest propagation delay). The report shall include the delay skew value measured as well as the test limit value.

D. BALANCED TWISTED-PAIR CABLING SYSTEM TEST RESULT DOCUMENTATION

GENERAL TECHNOLOGY REQUIREMENTS
27 01 00 - 18
1. The test results information for each link shall be recorded in the memory of the field tester upon completion of the test.

2. The test results records saved by the tester shall be transferred into a Windows™-based database utility that allows for the maintenance, inspection and archiving of these test records. A guarantee must be made that the measurement results are transferred to the PC unaltered, i.e., “as saved in the tester” at the end of each test and that these results cannot be modified at a later time. Superior protection in this regard is offered by testers that transfer the numeric measurement data from the tester to the PC in a non-printable format such as the Fluke DSP-4000 Series CableAnalyzer™.

3. The database for the completed job shall be stored and delivered on CD-ROM including the software tools required to view, inspect, and print any selection of test reports.

4. A paper copy of the test results shall be provided that lists all the links that have been tested with the following summary information.
   a. The identification of the link in accordance with the naming convention defined in the overall system documentation:
   b. The overall Pass/Fail evaluation of the link-under-test including the NEXT Headroom (overall worst case) number.
   c. The date and time the test results were saved in the memory of the tester.

5. General Information to be provided in the electronic data base with the test results information for each link:
   a. The identification of the customer site as specified by the end-user.
   b. The identification of the link in accordance with the naming convention defined in the overall system documentation.
   c. The overall Pass/Fail evaluation of the link-under-test.
   d. The name of the standard selected to execute the stored test results.
   e. The cable type and the value of NVP used for length calculations.
   f. The date and time the test results were saved in the memory of the tester.
   g. The brand name, model and serial number of the tester.
   h. The identification of the tester interface.
   i. The revision of the tester software and the revision of the test standards database in the tester.
   j. The test results information must contain information on each of the required test parameters that are listed in Section 27 16 00 and as further detailed below under paragraph 6.

6. The detailed test results data to be provided in the electronic database for each tested link must contain the following information:
a. For each of the frequency-dependent test parameters, the minimum test results documentation shall be stored for each wire-pair or wire-pair combination as observed from each end of the link. The minimum test results documentation for each test parameter shall be in compliance with the information described herein.

1) Length: Identify the wire-pair with the shortest electrical length, the value of the length rounded to the nearest 0.5 m [optional: foot] and the test limit value

2) Propagation delay: Identify the pair with the shortest propagation delay, the value measured in nanoseconds (ns) and the test limit value

3) Delay Skew: Identify the pair with the largest value for delay skew, the value calculated in nanoseconds (ns) and the test limit value

4) Insertion Loss (Attenuation): Minimum test results documentation as explained in Section 27 16 00 for the wire pair with the worst insertion loss

5) Return Loss: Minimum test results documentation as explained in Section 27 16 00. Identify as detected from each end of the link, the wire pair that exhibits the worst case margin and the wire pair with the worst RL. Each reported case shall include the frequency at which it occurs as well as the test limit value at this frequency.

6) NEXT, ELFEXT, ACR: Minimum test results documentation as explained in Section 27 16 00. Identify as measured from each end of the link, the wire pair combination that exhibits the worst case margin and the wire pair combination that delivers the worst case value. Each reported case shall include the frequency at which it occurs as well as the test limit value at this frequency.

7) PSNEXT, PSELFEXT, and PSACR: Minimum test results documentation as explained in Section 27 16 00. Identify as detected from each end of the link, the wire pair that exhibits the worst case margin and the wire pair with the worst value. Each reported case shall include the frequency at which it occurs as well as the test limit value at this frequency.

8) Link length, propagation delay, and delay skew shall be reported for each wire pair as well as the test limit for each of these parameters.

E. FIBER DISTRIBUTION SYSTEM VERIFICATION TESTS

1. Every fiber optic cabling link in the installation shall be tested in accordance with the field test specifications defined by the CENELEC (Comité Européen de Normalisation Electrotechnique) standard ISO/IEC 11801, TIA/EIA T568B.3 or by the appropriate network application standard(s) whichever is more demanding.

2. ISO/IEC 11801 defines the passive cabling network, to include cable, connectors, and splices (if present), between two optical fiber patch panels (connecting hardware). A typical horizontal link segment is from the telecommunications outlet/connector to the horizontal cross-connect. A building backbone cabling subsystem extends from building distributor(s) to the floor distributor(s). The test shall include the representative connector performance at the connecting hardware associated with the mating of patch cords. The test does not, however, include the performance of the connector at the interface with the test equipment.
3. 100% of the installed cabling links must be tested and must pass the requirements of the standards mentioned in E.1 above and as further detailed in Section 27 16 00. Any failing link must be documented, diagnosed and corrected. The corrective action shall be followed with a new test to prove that the corrected link meets the performance requirements. The final and passing result of the tests for all links shall be provided in the test results documentation.

4. Trained technicians who have successfully attended an appropriate training program and have obtained a certificate as proof thereof shall execute the tests. These certificates may have been issued by any of the following organizations or an equivalent organization:
   
a. the manufacturer of the fiber optic cable and/or the fiber optic connectors
   
b. the manufacturer of the test equipment used for the field certification
   
c. Training organizations authorized by BICSI (Building Industry Consulting Services International with headquarters in Tampa, Florida), Btec or City & Guilds.

5. The test equipment shall comprise optical power source and meter equipment in accordance with IEC 61280-4-1 (for multimode optical fibers) and IEC 61280-4-2 (for single mode optical fibers). The type of optical source and launch condition shall correspond with one of the categories defined in IEC 61280-4-1 (for multimode optical fibers) and IEC 61280-4-2 (for single mode optical fibers). The cable interface adapters consist of a number of test cords mating in accordance with IEC 61280-4-1 (for multimode optical fibers) and IEC 61280-4-2 (for single mode optical fibers). It is recommended to use a mandrel wrap and, where appropriate, cladding mode stripping techniques in order to maximize measurement repeatability. These should be established within the test cord. The mandrel used should be in accordance with IEC 61300-3-34 (5x15 mm for 50/125 μm optical fiber).

6. The test equipment shall be within the calibration period recommended by the manufacturer in order to achieve the manufacturer-specified measurement accuracy. This period is normally 12 months.

7. The fiber optic launch cables and adapters must be of high quality and the cables shall not show excessive wear resulting from repetitive coiling and storing of the test equipment interface adapters. No index matching gel shall be used.

8. The Pass or Fail condition for the link-under-test is determined by the results of the required individual tests.

9. A Pass or Fail result for each parameter is determined by comparing the measured values with the specified test limits for that parameter.

10. A representative of the end-user shall be invited to witness field testing. The representative shall be notified of the start date of the testing phase five (5) business days before testing commences.

11. A representative of the end-user will select a random sample of 10% of the installed links. The representative (or his authorized delegate) shall test these randomly selected links and the results are to be stored in accordance with the prescriptions in Section 27 16 00. The results obtained shall be compared to the data provided by the installation contractor. If more than 2% of the sample results differ in terms of the pass/fail determination, the
installation contractor under supervision of the end-user representative shall repeat 100% testing and the cost shall be borne by the installation contractor.

F. FIBER DISTRIBUTION SYSTEM PERFORMANCE TEST PARAMETERS

1. ISO/IEC 11801 prescribes the single performance parameter for field testing of fiber optic links as link attenuation (alternative and equivalent term: insertion loss), when installing components compliant with this standard.

2. The link attenuation shall be calculated in accordance to the specifications within ISO/IEC 11801. These specifications are representative of the following formulas.

\[ \text{Link Attenuation} = \text{Cable Attn} + \text{Connector Attn} + \text{Splice Attn} \]
\[ \text{Cable Attn (dB)} = \text{Attenuation Coefficient (dB/km)} \times \text{Length (km)} \]

The values for the Attenuation Coefficient are listed in the table below:

<table>
<thead>
<tr>
<th>Type of Optical Fiber</th>
<th>Wavelength (nm)</th>
<th>Attenuation_Coefficient (dB/km)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multimode 50/125 μm</td>
<td>850</td>
<td>3.5</td>
</tr>
<tr>
<td></td>
<td>1300</td>
<td>1.5</td>
</tr>
<tr>
<td>Single-mode</td>
<td>1310</td>
<td>1.0</td>
</tr>
<tr>
<td></td>
<td>1550</td>
<td>1.0</td>
</tr>
</tbody>
</table>

\[ \text{Connector Attn (dB)} = \text{number of connector pairs} \times \text{connector loss (dB)} \]
\[ \text{Maximum allowable connector loss} = 0.75 \text{ dB} \]
\[ \text{Splice Attn (dB)} = \text{number of splices (S)} \times \text{splice loss (dB)} \]
\[ \text{Maximum allowable splice loss} = 0.3 \text{ dB} \]

3. Link attenuation does not include any active devices or passive devices other than cable, connectors, and splices, i.e. link attenuation does not include such devices as optical bypass switches, couplers, repeaters, or optical amplifiers.

4. Test equipment such as the Fluke DSP-FTA410S for multimode using LEDs, the DSP-FTA440S for gigabit Ethernet multimode using VCSELs, or the DSP-FTA430S for singlemode using lasers that measures the link length and automatically calculates the link loss based on the above formulas is preferred.

5. The above link test limits attenuation are based on the use of the One Reference Jumper Method specified by Method 1 of IEC 61280-4-1 for multimode and Method 1 of EN 61280-4-2 for singlemode (or the equivalent method explained in Fluke Networks application note “Loss Testing of Premises Fiber Optic Links” (Lit # 1560065)). The user shall follow the procedures established by these standards or application notes to accurately conduct performance testing.

6. The horizontal link (multimode): acceptable link attenuation for a multimode horizontal optical fiber cabling system is based on the maximum 90 m distance. The horizontal link should be tested at 850 nm and 1300 nm in one direction in accordance with Method 1 of IEC 61280-4-1, One Reference Jumper or Fluke Networks application note “Loss Testing of Premises Fiber Optic Links” (Lit # 1560065).
7. The backbone link (multimode) shall be tested in one direction at both operating wavelengths to account for attenuation deltas associated with wavelength.

8. Multimode backbone links shall be tested at 850 nm and 1300 nm in accordance with Method 1 of IEC 61280-4-1.

9. Because backbone length and the potential number of splices vary depending upon site conditions, the link attenuation equation shall be used to determine limit (acceptance) values.

10. Single-mode backbone links shall be tested at 1310 nm and 1550 nm in accordance with IEC 61280-4-2, One Reference Jumper or the equivalent method outlined in Fluke Networks application note “Loss Testing of Premises Fiber Optic Links” (Lit # 1560065).

11. All single-mode links shall be certified with test tools using laser light sources at 1310 nm and 1550 nm (See Note below).

   a. NOTE:

      1) Links destined to be used with network applications that use laser light sources (underfilled launch conditions) shall be tested with test equipment based on laser light sources categorized by a Coupled Power Ratio (CPR) of Category 2, Underfilled, per IEC 60825-2. This rule should be followed for cabling systems to support Gigabit Ethernet. Gigabit Ethernet only specifies laser light sources. Field test equipment based on LED (light emitting diode) light sources is a Category 1 device per IEC 60825-2 and typically yields high attenuation results.

      2) For Gigabit Ethernet compliant certification (IEEE STD 802.3Z application), use test equipment such as the Fluke DSP-FTA440S which uses a VCSEL (Vertical cavity surface emitting laser) at 850 nm (compliant with 1000BASE-SX) and an FP laser at 1310 nm (compliant with 1000BASE-LX).

G. FIBER DISTRIBUTION SYSTEM PERFORMANCE TEST PARAMETERS TEST RESULT DOCUMENTATION

1. The test result information for each link shall be recorded in the memory of the field test equipment upon completion of the test.

2. The test result records saved by the test equipment shall be transferred into a Windows™ based database utility that allows for the maintenance, inspection and archiving of these test records.

3. A guarantee must be made that these results are transferred to the PC unaltered, i.e., “as saved in the test equipment” at the end of each test.

4. The popular ‘csv’ format (comma separated value format) does not provide adequate protection and shall not be acceptable.

5. The database for the completed job – including twisted-pair copper cabling links if applicable shall be stored and delivered on CD-ROM; this CD-ROM shall include the software tools required to view, inspect, and print any selection of test reports.

6. A paper copy of the test results shall be provided that lists all the links that have been tested with the following summary information:

   GENERAL TECHNOLOGY REQUIREMENTS
   27 01 00 - 23
a. The identification of the link in accordance with the naming convention defined in the overall system documentation.

b. The overall Pass/Fail evaluation of the link-under-test including the Attenuation worst case margin (margin is defined as the difference between the measured value and the test limit value).

c. The date and time the test results were saved in the memory of the test equipment.

7. General Information to be provided in the electronic data base containing the test result information for each link:

a. The identification of the customer site as specified by the end-user.

b. The overall Pass/Fail evaluation of the link-under-test. The name of the standard selected to execute the stored test results.

c. The cable type and the value of the 'index of refraction' used for length calculations.

d. The date and time the test results were saved in the memory of the test equipment.

e. The brand name, model and serial number of the test equipment.

f. The revision of the test equipment software and the revision of the test standards database in the test equipment.

8. The detailed test results data to be provided in the electronic database for each tested optical fiber must contain the following information:

a. The identification of the link/fiber in accordance with the naming convention defined in the overall system documentation.

b. The attenuation measured at each wavelength, the test limit calculated for the corresponding wavelength and the margin (difference between the measured attenuation and the test limit value).

c. The link length shall be reported for each optical fiber for which the test limit was calculated based on the formulas previously shown.

d. All fiber optic cable shall be factory tested on a reel basis with performance data for each cable supplied to the contractor and to the Owner. Tests shall be conducted utilizing an OTDR (Optical Time Domain Reflectometer) at 850nm and 1300 nm with the attenuation in dB/km recorded for each fiber.

3.8 VERIFICATION TEST REPORT

A. Submit a written report detailing the results of initial adjustments and verification tests including all relevant drawings, charts, and photographs. This report will be completed and submitted for review at least five (5) days prior to acceptance testing.

3.9 ACCEPTANCE TESTING

A. The Acceptance Testing and provision of testing equipment will be the responsibility of and performed by the Contractor in the presence of the Owner, Architect, or the Owner’s
representative. Coordinate this period so that free access, work lighting, electrical is available on the site. See the acceptance testing requirements in each subsection of Division 26 work.

B. Should the contractor schedule an Acceptance Test and the system or components are not ready for or fail Acceptance Testing, the contractor will pay for all subsequent trips and man-hours required for the consultant to properly document specification conformance by the contractor. The Owner will have the right to reduce pay requests or final application of payment to the contractor in an amount equal to the travel costs and man-hours expended by the Consultant and charged to the contractor. The Owner would then pay the Consultant from the funds with held from the contractor.

C. Upon witness of the Acceptance Testing and the determination, in the Consultant’s opinion, that the Contractor has falsified the Verification Test Reports, the Owner has the right to hire an Independent Testing Agency to provide outside verification of the results. Falsification of the test results is defined as cables shown as testing correctly in the Verification Report fail during the Acceptance Testing. (The Contractor has the right to hire an Independent Testing Agency approved by the Consultant and the Owner directly.) Furthermore, the Owner will have the right to reduce pay requests or final application of payment to the Contractor in an amount equal to the travel costs and man-hours expended by the Independent Testing Agency and Consultant and charged to the contractor. The Owner would then pay the Independent Testing Agency and Consultant from the funds with held from the contractor.

3.10 SYSTEM DOCUMENTATION

A. Prior to final acceptance tests, the Contractor shall submit to the Owner three copies of an operating and maintenance manual for the system that has been installed. These manuals will be used during the final acceptance testing of the system. Each manual will contain the following information:

1. As-built project drawings. Provide three copies.
2. Manufacturer Operation and Maintenance manuals. Provide three copies.
3. Where applicable, single line diagrams showing levels throughout system and impedances. Provide three copies.
4. Copies of Training materials. Provide three copies
5. Verification and Acceptance Test Reports. Provide three copies

END OF SECTION
SECTION 27 16 50

DATA NETWORKING

PART 1 – GENERAL

1.1 SECTION INCLUDES

A. General Requirements

B. Scope: Data, Telephone/Voice

C. Industry Guidelines and Standards

D. Submittals

1.2 GENERAL REQUIREMENTS

A. Manufacturer: The term "manufacturer" shall be defined as the company, or group of companies, that actually produces the products meeting the requirements of Section 2 of this document. The manufacturer shall have a minimum of seven (7) years experience in manufacturing products of this type and shall be ISO 9001 Certified.

B. Contractor: The term "contractor" shall be defined as the company, or group of companies, that actually installs the product. The contractor selected to provide the installation of this system shall be certified by the manufacturer in all aspects of design, installation and testing of the products described herein.

1. The contractor shall hold a valid State of California C-7 Or C-10 Contractor’s license, shall have completed at least ten (10) projects of equal scope, shall have been in business of furnishing and installing systems of this scope and magnitude for at lest three (3) years and capable of being bonded to assure the Owner’s Project Manager of performance and satisfactory service during the guarantee period.

2. The contractor shall hold all other licenses required by the legally constituted authorities having jurisdiction over the work.

3. All work shall be performed under the supervision of a company accredited by the manufacturer and such accreditation must be presented.

4. The contractor shall be a manufacturer’s authorized distributor and warranty station for the equipment offered and shall maintain a fully equipped service organization capable of furnishing adequate repair service to the equipment. The contractor shall maintain a spare set of all major parts for the system at all times.

5. The contractor selected for this Project must adhere to the engineering, installation and testing procedures and utilize the authorized manufacturer components and distribution channels in provisioning this Project.

6. The contractor shall own and maintain tools and equipment necessary for successful installation and testing of optical and Category 6a metallic premise distribution systems and have personnel who are adequately trained in the use of such tools and equipment.

7. All of the equipment in this specification shall be furnished and installed by the Authorized Factory Distributor of the equipment. The Contractor shall furnish a letter from the
manufacturer of all major equipment, which certifies that the installing contractor is the Authorized Distributor and that the equipment has been installed according to factory intended practices. The Contractor shall furnish a written guarantee from the manufacturer that they will have a service representative assigned to this area for the life of the equipment.

8. All communication system supplied shall be listed by Underwriter’s Laboratories under UL Standard 1459. A copy of the UL listing card for the proposed system shall be included with the contractor’s submittal.

C. Responsible Person for Contractor: Submit name of the individual authorized to receive construction change documents, and who is responsible for informing others in Contractor’s employ or subcontractors of changes in the Work.

1.3 SCOPE OF WORK

A. DATA: The work shall include, but not be limited to the following objectives:

1. Install new patch panel in existing IDF as required to accommodate new data drops. New patch panel to match existing. Provide all hardware and supports as required. Contractor shall coordinate closely with District for required time to complete connection.

2. Only virgin materials shall be used in the construction of cabling.

3. Installation of a new Category 6a UTP in rooms as required by the drawings or the scope of work. Category 6a terminations will be EIA/TIA standard 568B wiring configuration into RJ45 workstation data jacks (all jacks shall be orange in color for data and all cables shall be yellow in color for data). All cables shall be installed with service loops at ground boxes and MDF/IDF/CIDF locations only.

4. Furnish and install as required at each IDF a data cabinet, fiber patch panel, copper patch panel, UPS, and wire management hardware as required by the drawings or the scope of work.

5. Mount and install Switches as required by the drawings or the scope of work. Contractor shall notify the District in writing two weeks prior to the expected installation date of switches. Equipment shall be installed within Data Cabinets (provided by the contractor). Data Cabinets will be dual access and fully enclosed (See Materials List)

6. Testing of cables and connections to insure a complete and operable end-to-end data connection using EIA/TIA TSB-67 testing guidelines at level II accuracy for Category 6a, and EIA/TIA 455a for fiber.

7. All terminations into patch panel for connection to Switches using contractor supplied patch cords/station cables. For each data cable installed, the contractor shall supply one (1) 3’ Category 6a patch cord for the patch panel location. In addition, the contractor shall supply 50% of 7’ station cords and 50% of 10’ station cords of the total number of data jacks installed. Station cords shall be delivered as directed by computer services in boxes clearly labeled with School name, quantity and size of station cords. Contractor to install patch cords from patch-panel to switches.

8. Set up a complete wire management system at each IDF, this includes wire management organizer(s). Contractor shall provide one horizontal wire manager for each new Category 6a patch panel and one horizontal wire manager for each switch installed.

9. Warranty:

DATA NETWORKING
27 16 50 - 2
a. Contractor shall warrant the installation and that all approved cabling components meet or exceed the requirements of TIA/EIA-568A, TIA/EIA-568A-A5, and ISO/IEC 11801.

b. Contractor will provide a minimum of a fifteen (15) year written warranty from the manufacturer(s) for both UTP basic link and fiber optic cable systems. This may require the contractor to certify their installers to the manufacturer’s guidelines before the project begins.

c. The permanent link cabling system shall be warranted for a period of at least 25 years.

d. The contractor will provide a two (2) year written warranty covering workmanship and materials in compliance with District specifications. All repairs shall be made at no cost to District during the warranty period.

e. Contractor will provide to the District warranty information covering parts and materials used by the contractor.

f. Upon hookup of system and system start-up by District, if system troubles should indicate problems with the cables or terminations, it shall be the responsibility of the cable installation contractor to repair any such problems free of charge to the District. The contractor shall start this repair work within a 48 hour period of time from initial notification by District.

B. TELEPHONE/VOICE: The work shall include but not be limited to the following objectives:

1. Only virgin materials shall be used in the construction of cabling.

2. Backbone feeder cables shall be Category 6a, size and number of pairs as indicated in drawings and Scope of Work documents. All pairs are to be terminated on 66m, 50 blocks and 89B standoffs.

3. All 66 blocks shall be mounted on blue-boards located in or near data cabinets.

4. Each 66-block shall have a minimum of a mushroom block and mushrooms installed per drawing details.

5. Installation of new Category 6a UTP in rooms as indicated on the drawings. Category 6a terminations will be EIA/TIA standard 568B wiring configuration into RJ45 workstation jacks (all telephone wire and jacks shall be blue in color). All cables shall be installed with service loops at ground boxes and MDF/IDF/CIDF locations only.

6. Testing of cables and connections to insure a complete and operable end-to-end data connection using EIA/TIA TSB-67 testing guidelines at level II accuracy for Category 6a.

C. INDUSTRY GUIDELINES AND STANDARDS

1. When Contract Documents differ from governing codes, furnish and install larger size or higher standards called for without extra charge. Notify the District Representative of any discrepancies prior to commencement of construction. Obtain written clarification prior to proceeding with work.

2. Fiber optic cable, electrical cable, wire and connectors shall be installed as indicated, in accordance with the manufacturer’s written instructions, the applicable requirements of NEC
and the National Electrical Contractors Association's "Standard of Installation", and in accordance with recognized industry practices to ensure that products serve the intended functions.

3. The National Fire Code (NFPA), National Electrical Code (NEC), California Electrical Code (CEC), California Building Code and Local Codes will be followed.

4. Applicable Standards

   a) National Electrical Code (NEC), 2002 or most recent edition.

   b) ANSI/TIA/EIA-568-B -- Commercial Building Telecommunications Cabling Standard
      ANSI/TIA/EIA-568-A-1 -- Propagation Delay and Delay Skew Specifications for 100 ohm 4-pair Cable.

   c) ANSI/TIA/EIA-568-A-2 - Commercial Building Standards Updates

   d) ANSI/TIA/EIA-569-A -- Commercial Building Standard for Telecommunications
      Pathways and Spaces.

   e) ANSI/TIA/EIA-606 -- The Administration Standard for the Telecommunications
      Infrastructure of Commercial Buildings.

   f) ANSI/TIA/EIA-607 -- Commercial Building Grounding and Bonding Requirements for
      Telecommunications.

   g) ANSI/TIA/EIA TSB-67 -- Transmission Performance Specifications for Field-testing of
      Unshielded Twisted-Pair Cabling Systems.

   h) ANSI/TIA/EIA TSB-75 -- Additional Horizontal Cabling Practices for Open Offices.

   i) BICSI -- Telecommunications Distribution Methods Manual.


   k) IEEE 802.3 "Carrier Sense Multiple Access with Collision Detection".

   l) IEEE 802.3ab "Gigabit Ethernet transmission over unshielded twisted pair (UTP)"

   m) IEEE 802.z "1000Base-SX transmission over multi-mode fiber and 1000Base-LX
      transmission over single-mode fiber


   o) UL Cable Certification Program.

   p) ANSI X3T9.5 Requirements for UTP at 100 Mbps.

      Specifications for Unshielded Twisted-Pair Cables.

      Transmission Specifications for Unshielded Twisted-Pair Connecting Hardware.

   s) TIA/EIA-607 Commercial Building Grounding and Bonding Requirements for
Telecommunications.

  t) EIA/TIA-455-61 FOTP-61 Measurement of Fiber or Cable Attenuation Using an OTDR.
  w) ANSI/ICEA S-87-640-2000, Fiber Optic Outside Plant Communications Cable.

1.4 SUBMITTALS

  A. Pre-construction material submittals

      1. Whenever in the Contract Documents any materials, products, processes or articles are indicated or specified by the name brand of the manufacturer, or by patent or proprietary names, such specifications shall be deemed to be a measure of quality and utility or a standard, and shall be deemed to be followed by the words, "or equal". It is the intent of this article to comply with Public Contract Code Section 3400.

  B. Proposed Product Substitutions

      1. All proposed product substitutions shall be requested as per Section 01630 Product Substitution Procedures.

1.5 LOW VOLTAGE ENCLOSURES AND PATHWAYS

  A. Single channel surface raceway will be Wiremold 2300 or 2900 series or larger depending on fill ratio, as directed by Architect. All fittings made for an intended purpose of installation by the manufacturer shall be included as part of this material.

  B. Multi channel surface raceway will be Wiremold 5400, 5500 series depending on fill ratio, as directed by Architect. All fittings made for an intended purpose of installation by the manufacturer shall be included as part of this material.

  C. Mounting hardware and anchors recommended by the Manufacturer of any material that shall be mounted to the building or structure.

      1. Sheetrock/drywall/wall board: Easy Anchor, toggle bolt, other spread type anchor with load distribution, or approved equal.

      2. Concrete/cinder block/solid masonry: expanding compression type lag, expanding compression type bolt, expanding compression type all tread with nuts, or approved equal.
3. Tile/Stucco/hollow masonry: toggle bolts or approved equal.

4. Wood: lags, wood screws, or approved equal.

5. Metal: clamp, or approved equal.

D. Surface Mount Boxes will be Wiremold 2944 Extra Deep Device Box.

E. Cover plates will be Panduit with four ports (minimum). Blanks will be used to cover any unused ports.

F. Wall mounted phone plates will be Hubbell multi-jack faceplate (p/n BR630DWP) and jacks.

G. Wiremold 5500 faceplates shall be 5507FRJ, Color to match existing or new installed raceway.

H. Wall mounted cabinets shall be either a Hubbell (RE4X with Sound Dampening Kit REKS) or the Chatsworth Cube-iT Plus cabinets 24"Hx24"Wx24"D (p/n 11840-224) or 36"Hx24"Wx24"D (p/n 11840-236) with solid door and vents, computer white in color. (NOTE: Size and type of cabinet will be specified by the District depending on need). Extra package of Phillips mounting screws to be provided with cabinet.

I. Floor mounted cabinets will be Chatsworth Enhanced Steel frame cabinets (p/n 16141-701)

J. Wall mount racks shall be Chatsworth stacker swing-gate rack, minimum of 24" deep, 24" tall (p/n 13602-725), or 36" tall (p/n 13604-725), or approved equal.

K. Floor mount racks shall be Chatsworth 19"W x 7'H standard equipment rack (p/n 55053-503) with Quantity 4 Panduit vertical wire managers (p/n WMPVHC46) and appropriate ladder racking with mounting hardware for structural support.

L. Definitions:

1. A rack is defined as a sideless, bottomless, topless open-rammed support structure for equipment. A rack may be mounted to a wall, ceiling, or to a floor depending on type, size, and District requirements.

2. A cabinet is defined as an enclosed equipment support structure with opening front and rear. A cabinet may be mounted to a wall, or to a floor depending on type, size, and District requirements.

3. All cabinets and swing able racks must be able to open fully with no cable tension, or obstructions.

M. Nomenclature:

1. CIDF cabinets are classroom cabinets /racks specified for mounting within classrooms or offices. Typically a Chatsworth (24Hx24Wx24D) or a Hubbell RE4X (42Hx24.2Wx10D)

2. IDF cabinets are cabinets/racks specified for intermediate distribution frames, typically at the head of a wing and feed one or more classrooms. Typically a Chatsworth (36Hx24Wx24D or 48Hx24Wx24D).

3. MDF cabinets are cabinets/racks specified for main distribution frames. Typically 84" high.
4. All equipment shall be mounted with Phillips screws, unless otherwise specified.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

A. Panduit cabling system

B. Superior-Essex cabling system

2.2 HORIZONTAL CABLE – CAT6A PLENUM (CMP) RATED

A. Application: Suitable for indoor installation, within ceiling space in primary and secondary pathways.

B. Conductors:
   1. Insulated Conductors: 23 AWG solid copper, fully insulated with a flame retardant thermoplastic material (material = FEP, or equivalent).

C. Cable Sheath:
   1. Outer Jacket: seamless outer jacket (material = LS-PVC, or similar) applied to and completely cover the internal components (twisted pairs).
   2. Flame Rating: NEC (Article 800) rated as CMP, and UL listed as such.

D. Electrical Performance: Meet or exceed TIA/EIA-568-C.2, ISO 11801 Class E Edition 2.1, and IEEE Std. 802.3an channel requirements for supporting 10GBASE-T.

E. Manufacturer:

   1. Panduit
      a. #PUP6XC04GR-U; CAT6A 4 pair UTP cable “10Gig”, CMP, green

   2. Superior Essex
      a. #6H-272-5B; CAT6A 4 pair UTP cable “10Gain XP”, CMP, green

2.3 TERMINATION APPARATUS – MODULAR PATCH PANEL, CAT6A RATED

A. Application: Panels shall be suitable for installation within a telecommunication room (TR) for the termination of the horizontal cables specified herein. Panels shall be horizontally oriented for a rack-mounted configuration. Panels shall be capable of supporting, organizing, labeling and patching/ crossconnecting between the horizontal termination field and the equipment termination field.

B. Modular patch panel shall have 110-type termination, and shall be compatible with the specified horizontal cables both electrically and physically. Modular patch panels shall match the existing product manufacturer and type, where available.
C. Mechanical Performance: Each port shall be an 8-position modular jack, compliant to ANSI/TIA-568-C.2 (2.5.7).

D. Electrical Performance: Each port shall meet or exceed TIA/EIA-568-C.2 6.8 and ISO/IEC 11801 requirements for CAT6A UTP cabling through the cable termination and patch cord connection.

E. Manufacturer:

1. Panduit
   a. # DP486X88TGY; CAT6A modular patch panel “DP6 10Gig”, flat, 48 ports
   b. # DPA486X88TGY; CAT6A modular patch panel “DP6 10Gig”, angled, 48 ports

2. Or equal

2.4 MODULAR CONNECTOR / 8-POSITION JACK – CAT6A RATED

A. Application: Modular connectors (jacks) for termination of 4-pair UTP cables; modular connectors shall be compatible with the 4-pair cables specified herein this section both electrically and physically. Modular connectors shall match the existing product manufacturer, type, and color, where available.

B. Mechanical Performance: Modular jacks shall be 8-position, compliant to ANSI/TIA-568-C.2.

C. Electrical Performance: Each jack shall meet or exceed TIA/EIA-568-C.2 and ISO/IEC 11801 requirements for CAT6A UTP cabling.

D. Manufacturer:

1. Panduit
   a. #CJ6X88TGWHT; CAT6A 8-position jack “Mini-Com” series “TX6 10Gig”, White (voice)
   b. #CJ6X88TGBU; CAT6A 8-position jack “Mini-Com” series “TX6 10Gig”, Blue (data)
   c. #CJ6X88TGBL; CAT6A 8-position jack “Mini-Com” series “TX6 10Gig”, Black (security)
   d. #CJ6X88TGG; CAT6A 8-position jack “Mini-Com” series “TX6 10Gig”, Green (wireless)
   e. #CJ6X88TGRD; CAT6A 8-position jack “Mini-Com” series “TX6 10Gig”, Red (emergency notification)

2.5 WORK AREA OUTLETS
A. Faceplates for Standard Flush-Mount Outlets

1. Application: Faceplates shall be suitable for indoor installation for standard 1-gang and 2-gang flush-mount devices. Faceplates shall match the existing product manufacturer, type, and color, where available.

2. Faceplates shall have 1, 4, or 10 ports, and shall include required accessories, such as icons, blank inserts, label windows and labels.

3. Color: White

4. Manufacturer:
   a. Panduit
      1) #CFPE4WHY; faceplate, “Executive Series” series, 1-gang, horizontal, 4 ports, white
      2) #CFPE10WH-2GY; faceplate, “Executive Series” series, 2-gang, horizontal, 10 ports, white

B. Faceplate for Wall Phone Outlets

1. Application: Faceplates shall be suitable for indoor installation for standard 1-gang flushmount device equipped with one opening for a keystone jack and two mounting studs for standard wall-mount telephones.

2. Faceplates shall include required accessories, such as icons, blank inserts, label windows and labels.

3. Color: Stainless steel

4. Manufacturer:

5. Panduit
   1) #KWPY; wall phone faceplate, stainless steel, recessed port

C. Bezel Adapters

1. Adapters fully compatible with Wiremold’s “Open Systems” devices and Panduit Mini-Com connectors.

2. Manufacturer:
   a. Panduit
      1) #CHI2MEI-X; bezel adapter, 2 port, accepts Mini-Com connectors

3. Adapters fully compatible with Wiremold’s “Ortronics Systems” devices and Panduit MiniCom connectors.

4. Manufacturer:
a. Panduit

1) #CH02ME1-X; bezel adapter, 2 port, accepts Mini-Com connectors

2.6 LABELS

A. Labels shall be machine printable with a laser printer, ink jet printer, thermal transfer printer, or hand-held printer.

B. Labels for Horizontal Cables

1. Adhesive backed labels and self-laminating feature.

2. Fit the horizontal cables listed above (i.e., shall fully wrap around the cable’s jacket).

3. Size: 2”x.05” printable area, minimum

4. Color: white

5. Manufacturer:

a. Panduit

1) #S100X150YAJ; labels for cable diameters 0.16”-0.32”, white, desktop printer

    (laser or ink jet)

b. Or equal

2.7 MISCELLANEOUS COMPONENTS

A. Hook and Loop Cable Ties

1. Width: .75”.

2. Color: Hook and loop cable ties the same color as the cable to which it is being applied.

3. Manufacturers:

a. Panduit “Tak-Ty” series hook and loop cable ties

b. Panduit

1) #HLS-15R-0; black, 15’ roll, cut to length.

c. Or Equal

PART 3 – EXECUTION

3.1 GENERAL REQUIREMENTS

A. The wiring of the system shall be executed in accordance with the drawings and the equipment manufacturer’s wiring diagrams. Should any variations in these requirements occur, the contractor...
shall notify the Owner’s Representative before making any changes. It shall be the responsibility of the manufacturer-authorized distributor of the approved equipment to install the equipment and guarantee the system to operate as per plans and specifications.

B. Furnish all conductors, equipment plugs, terminal strips, etc., and labor to install a complete and operable system.

C. Splices of conductors in underground pull boxes are not permitted.

D. The labor employed by the contractor shall be regularly employed in the installation and repair of communication systems and shall be acceptable to the Owner’s Representative to engage in the installation and service of this system.

E. The contractor shall thoroughly clean all equipment and materials. All exposed parts of the equipment, cabinets, and other equipment shall be left in a clean condition, unblemished and free of all dirt, dust, smudges, spots, fingerprints, etc. The contractor shall remove all debris and rubbish occasioned by the electronic systems work from the site. The contractor shall thoroughly clean all buildings of any dirt, debris, rubbish, marks, etc., caused by the performance of this work.

F. The system must meet all local and other prevailing codes.

G. All cabling installations shall be performed by qualified technicians.

H. All cabling shall be splice free.

I. In order to ensure the least amount of cable untwisting, it is required that all cables shall be stripped using a special tool.

J. The use of lubricants (i.e. Yellow 77) to facilitate the installation of cables in conduits is highly discouraged. If such a lubricant must be used, the contractor shall verify the acceptability of the lubricant to be used with the cable manufacturer, prior to using such a lubricant. Lubricants that harden after installation are not allowed.

K. Under no circumstance are “channel locks” or other pliers to be used.

L. Plenum rated cable may be run exposed above ceilings, provided the cabling is supported independent of other utilities such as conduits, pipes, and the ceiling support systems. The cable shall not be laid directly on the ceiling panels. The use of cable ties shall be done in accordance with the cable manufacturer’s requirements. The cable jacket composition must meet local and all other prevailing fire and safety codes.

M. All firewalls penetrated by structured cabling shall be sealed by use of a non-permanent fire blanket or other method in compliance with the current edition of national Fire Protection Association (NFPA) and the National Electric Code (NEC) or other prevailing code. The contractor must not use concrete or other non-removable substance for fire stopping on cable trays, wire ways or conduits.

N. Site Cleaning. Throughout the progress of the plant construction, the contractor shall keep the working area free from debris of all types and remove from the premises all rubbish resulting from any work done by Contractor. On a daily basis and at the completion of its work the Contractor shall, to the extent possible, leave the premises in a clean and finished condition.

O. Conduits. All backbone cabling will run through dedicated conduits. All new conduits will be supplied with a pull string. Contractor shall supply pull string and pull rope for the installation of all cables in existing conduits. For all conduits left with available capacity, Contractor shall replace...
pull strings with ¼-inch pull rope during the course of his work. Contractor must seal all conduits with an approved sealing compound.

P. Cabling and Termination Identifications. All new cabling shall be of the type specified herein. Any conflicts between cabling types specified and code or design requirements shall be submitted to Owner’s Representative for review and final disposition. All cabling shall be neatly laced, dressed and adequately supported. Cabling must be concealed to the fullest extent possible. In addition, a numbering and marking scheme must be used to identify all cable and cabling terminations. All cables, regardless of length, shall be marked and/or numbered at both ends. Marking codes and methodologies shall correspond to the instructions in this specification.

Q. Seismic Requirements. Contractor will install all equipment racks, equipment cabinet enclosures, cable runways, etc. according to the local, state and/or federal code. Contractor will notify Owner’s Representative of such requirements and shall provide such bracing as required.

R. Safety Requirements. Contractor will utilize appropriate personnel and display warning signs, signals, flags and/or barricades at the work site to ensure adherence to safety regulations and as prudence requires.

S. Owner or Owner’s Representative may view work or testing in progress.

3.2 CABLE ROUTING

A. The cables will be routed to their respective Main Distribution Frame (MDF), Intermediate Distribution Frame (IDF), or Classroom Intermediate Distribution Frame (CIDF) or to service drop utilizing the shortest path possible.

B. Cable shall not be exposed at any point in the cable path. Contractor is to use appropriate pathway for the situation (i.e. inside wall, conduit, or non-metallic surface raceway). EXCEPTION: In MDF ROOM ONLY cables may be exposed and routed in contractor supplied D-rings every 4 feet.

C. Cables shall be protected and sleeved with a conduit in locations where cables need to pass through walls, floors, or hard ceilings. Contractor shall install threaded IMC or rigid conduit with large fender washers, lock rings, and screw on protective bushings on both ends. The fire rating of the wall must be maintained during and after installation.

D. At solid wall location such as plaster, brick, concrete, cinder block, tile, reinforced concrete, Contractor will provide and install surface mounted non-metallic raceways or equivalent. The use of different series raceways is required at locations where cable fill capacities are exceeded.

E. Terminations on block walls will be accomplished with District approved surface mount boxes.

F. Cables will be run vertically inside the wall and into the ceiling space. Terminations on stud walls will be accomplished with cut-in type electrical boxes with a 1" conduit (flex or EMT) extended from the box within the wall to ceiling access space.

G. Service loops:

1. Fiber:
   a. Shall be a minimum of 10’ at all MDF, IDF and CIDF locations.
   b. Shall be a minimum of 6’ at all ground box locations that allow for the minimum bend radius specified by the manufacturer.

2. Category 6a (Data and Voice) and CATV/Broadband
   a. Shall be a minimum of 6’ at all MDF, IDF and CIDF locations.
b. Shall be a minimum of 6’ at all ground box locations that allow for the minimum bend radius specified by the manufacturer.

3. Category 6a Voice Feeder Cables
   a. Shall be routed around the perimeter of the backboard in which it is terminated on.
   b. All ground boxes shall have a minimum of 6’ service loop.

H. Cables shall be run in corridors wherever possible in order to avoid furniture and work areas so that access to the cables in unencumbered.

I. The cables are to be as accessible as possible, placed above all other items in the ceiling, including ducts and supports.

J. Do not use pulling means, including fish tape, cable or rope, which can damage the Wiremold raceway.

K. Use pulling compound or lubricant that will not deteriorate cable or conduit.

L. Pulling compound shall be a water base pulling lubricant that will not deteriorate cable or conduit.

M. Cables shall not be pulled across sharp edges. If sharp edges are present a small sleeve, insuliner or grommet shall be installed to protect the cable.

N. Cables shall be pulled free of sharp bends or kinks.

O. Cables shall not be forced or jammed between metal parts, assemblies, etc.

P. Cables shall not be pulled across access doors and pull box covers. Access to all equipment and systems shall be maintained.

Q. Manufacturer’s specifications for pulling stress and minimum bend radius shall not be exceeded on any cable.

R. Do not use staples or drive rings.

3.2 CABLE INSTALLATION PARAMETERS

A. Cable Installation and Routing

1. Cable runs shall have continuous sheath continuity, homogenous in nature. Splices are not permitted anywhere.

2. Place cables within designated pathways, such as conduit, cable tray, basketway, etc. Do not fasten (such as with hook and loop cable ties) or attach cables to other building infrastructure (such as ducts, pipes, conduits, etc), other systems (such as ceiling support wires, wall studs, etc), or to the outside of conduits, cable trays, or other non-approved pathway systems. Use of cable hangers for primary support of cabling requires approval by the Owner.

3. Place and suspend cables and conductors during installation and termination in a manner to protect them from physical interference or damage. Place cables with no kinks, twists, or impact damage to the sheath. Replace cables damaged during installation or termination at no additional cost.
4. No cable length shall exceed 85 meters (279 ft) from the termination point in the TR to the termination point at the work area (permanent link).

5. Route cables at 90-degree angles, allowing for bending radius, along corridors for ease of access.

6. Do not exceed manufacturer's limits for pulling tension.

7. Do not use cable-pulling compounds for indoor installations.

8. Maintain a minimum bend radius of 6 times the cable diameter during and after installation.

9. Route cables under building infrastructure (such as ducts, pipes, conduits, etc); Do not route cables over building infrastructure. The installation shall result in easy accessibility to the cables in the future.

10. Place cables 6", minimum, away from power sources to reduce interference from EMI.

11. Place a pull string along with cables where run in pathways and spare capacity in the pathway remains. Tie off ends of the pull string (to prevent the string from falling into the conduit).

12. Neatly dress and organize cables using designated cable routing facilities, and fasten to support devices via approved ties.

13. When exiting the primary pathway (cable tray) to the work area, exit via the top of the pathway. Secure the cables to the pathway using an approved hook and loop cable tie.

14. Provide 2-4 feet, minimum, sheathed cable slack – length not to exceed permanent link maximum length requirement. Place the slack within ceiling space neatly on a cable hanger.

15. Routing to Type “A8” Student Desk
   a. Route cables from primary pathway (cable tray) through conduit to outlet.
   b. Provide appropriate length patch cable to serve desk location as shown on drawings.

B. Cable Routing and Dressing within the TR

1. Place cables within the overhead cable support and, when routing vertically, fasten the cables onto wall-mounted vertical cable support every 24 inches on-center using hook and loop cable ties.

2. At the rack bay, route cables into the back of the vertical management sections (do not route cables into the front as this space is reserved for patch cords only). Divide the cables equally between both sides of an equipment rack such that a cable does not travel past the midpoint of the rack prior to termination. Dress and cut cables to length required to reach the designated termination point with no excess cable and slack left in the horizontal cable manager, vertical cable manager, and overhead cable support.
3. Provide 15 feet of slack within the TR, minimum, sheathed cable slack – length not to exceed permanent link maximum length requirement. Place the slack in the overhead cable support.

C. Termination in the TR

1. Provide termination apparatus and accessories required for a complete installation. Install and assemble termination apparatus, accessories and associated management apparatus according to the manufacturer’s instructions.

2. Properly strain relieve cables to and at termination points per manufacturer’s instructions.

3. Terminate cables and twisted pairs in accordance with manufacturer's latest installation requirements and ANSI/TIA-568-C.0 standard installation practices. Terminate cable pairs onto the termination apparatus. Terminate twisted pairs compliant to ANSI/TIA-568-C.0 and wired per 1.04 System Description.

4. Modular Patch Panels and Horizontal Management Panels

   a. Provide quantity of modular patch panels to support termination of cables served from respective TR. Provide quantity of horizontal management panels based on the quantity of patch panels.

   b. Install and assemble modular patch panels and horizontal management panels according to the manufacturer's instructions.

   c. Install the patch panels and the horizontal management panels as shown on the contract drawings. If configuration is not shown, install the patch panels in association with the horizontal management panels such that a management panel is mounted above and below given patch panel.

5. Termination Sequence

   a. Terminate voice and data cables on separate patch panels.

   b. Terminate the cables in sequential order using the link’s identifier starting at the top left and completing a panel before moving to the next panel below. Link identifier shall be based on the campus room numbers.

D. Termination at the Work Areas

1. Provide device components, connectors, and accessories required for a complete installation. Install and assemble connectors, jacks, adapters, termination apparatus, accessories and associated management apparatus according to the manufacturer’s instructions.

2. Provide six inches, minimum, sheathed cable slack behind each workstation outlet faceplate. Coil the slack cable inside the raceway, within the wall, or in the junction box (if used), per the cabling manufacturer's installation standards.

3. Type "A" Wall-Mount Faceplates

   a. Install devices at heights shown on the contract drawings.
b. Mount faceplates plumb, square, and at the same level as adjacent device faceplates.

c. Patch gaps around faceplates so that faceplate covers the entire opening.

d. Surface mount outlets and conduit where walls are existing.

4. Type "B" Furniture-Serving Faceplates

   a. Coordinate installation of faceplate adapters with the architect and Owner.

   b. Mount outlets at +6" above table top.

   c. Surface mount outlets and conduit where walls are existing.

5. Terminate cables and twisted pairs in accordance with manufacturer's latest installation requirements and ANSI/TIA-568-C.0 standard installation practices. Terminate twisted pairs compliant to ANSI/TIA-568-C.0 and wired per 1.04 System Description.

E. Perform post-installation testing as described in the Telecommunication Testing specification (refer to Section 270811). Replace terminations and connectors not passing the required media test.

F. Patching and Crossconnecting

   1. Patch cords and crossconnects are Owner-provided.

3.4 LABELING AND IDENTIFICATION

A. General Requirements

   1. Labeling, identifier assignment, and label colors shall conform to ANSI/TIA/EIA-606-A Administration Standard and as approved by the Owner or Owner's Representative before installation.

   2. Permanent labels with machine-generated text (hand written labels will not be accepted).

B. Label Formats

   1. Horizontal Cable Labels

      a. Text Attributes: Black, 1/8" high, minimum, or #12 font size.

      b. Install labels on both ends of cables no more than 4" from the edge of the cable jacket. Install labels such that they are visible by a technician from a normal stance.

   2. Patch Panel Labels
a. Use modular patch panel labels included in the product packaging. Request approval by the Engineer for other labels.

b. Use a label color for the respective field type, per TIA/EIA-606.

c. Text Attributes: Black, 3/32" high, minimum, or #10 font size.

3. Termination Block Labels

   a. Use labels included in the product packaging. Any deviation from this requirement must be approved in writing by the Owner or Owner’s Representative.

   b. Use a label color for the respective field type, per TIA/EIA-606-A.

   c. Text Attributes: Black, 3/32" high, minimum, or #10 font size.

4. Outlet Labels

   a. Use outlet labels included in the product packaging. Any deviation from this requirement must be approved in writing by the Owner or Owner’s Representative.

   b. Label Background: White.

   c. Text Attributes: Black, 1/8" high, minimum, or #12 font size.

   d. Install label in the top label window. Leave the bottom label window blank.

C. Identifier Assignment

1. General: Separate label fields of the identifier with a hyphen.

2. Horizontal Cables

   a. First field: the originating room identifier (campus room number); for example: “241”.

   b. Second field: the destination room number (campus room number); for example: “236”.

   c. Third field: the outlet number within the destination room; for example: “4”.

   d. Fourth field: the cable’s intended service type followed by a unique sequential number; for example: “V1” (voice, cable #1) or “D2” (data, cable #2).

   e. Example: “241-236-1-V1”

3. Outlets

   a. First field: the originating room identifier (campus room number); for example: “241”.

   b. Second field: the destination room number (campus room number); for example: “236”.

DATA NETWORKING 27 16 50 - 17
c. Third field: the outlet number within the destination room; for example: “1”.

d. Example: “241-236-1”

4. Individual Ports at the Outlets

a. First field: the cable’s intended service type followed by a unique sequential number; for example: “V1” (voice, cable #1) or “D2” (data, cable #2).

5. Individual Ports at Patch Panels

a. First field: the destination room number; for example: “236”.

b. Second field: the outlet number within the destination room; for example: “1”

c. Third field: the cable’s intended service type – for example: “D” (data), and a unique sequential number – for example: “2”.

d. Example: “236-1-D2”

3.5 TESTING OF THE CABLE PLANT

A. Contractor is responsible for supplying all of the required test equipment used to conduct acceptance tests.

B. District reserves the right to be present during any or all of testing.

C. All cabling not tested strictly in accordance with these procedures shall be re-tested at no additional cost to the District.

D. 100% of the installed cabling must be tested. All tests must pass acceptance.

E. Test equipment shall be fully charged prior to each day’s testing.

F. Test reports must be submitted in hardcopy or electronic format. Hand-written test reports are not acceptable.

G. Hardcopy reports are to be submitted in labeled 3 ring binders with an attached affidavit verifying passing execution of all tests. For large installations electronic reports with hardcopy summaries are preferred. Hardcopy summary reports shall contain the following information on each row of the report: circuit ID, test specification used, length, date of test, and pass/fail result.

H. Electronic reports are to be submitted on CD format. If proprietary software is used, CD shall contain any necessary software required to view test results. If the results are delivered in a standard format like Excel, Access, CSV files, etc. then software to read these files are not provided. Electronic reports must be accompanied by a Certificate signed by an authorized representative of the Contractor warranting the truth and accuracy of the electronic report. Certificate must reference traceable circuit numbers that match the electronic record.

I. Test reports shall include the following information for each cabling element tested:

1. Wire map results that indicate the cabling has no shorts, opens, miswires, split, reversed,
or crossed pairs, and end to end connectivity is achieved.

2. For Category 6a cabling: Attenuation, NEXT, PSNEXT, Return Loss, ELFEXT, and PSELFEXT data that indicate the worst case result, the frequency at which it occurs, the limit at that point, and the margin. These tests shall be performed in a swept frequency manner from 1 MHz to highest relevant frequency, using a swept frequency interval that is consistent with TIA and ISO requirements. Information shall be provided for all pairs or pair combinations and in both directions when required by the appropriate standards. Any individual test that fails the relevant performance specification shall be marked as a FAIL.

3. Length (in meters), propagation delay, and delay skew relative to the relevant limit. Any individual test that fails the relevant performance specification shall be marked as a FAIL.

4. Cable manufacturer, cable model number/type, and NVP

5. Tester manufacturer, model, serial number, hardware version, and software version

6. Circuit ID number and project name

7. Auto-test specification used

8. Overall pass/fail indication

9. Date of test

10. Test reports shall be submitted within 7 business days of completion of testing.

3.6 TEST EQUIPMENT

A. Test equipment used under this contract shall be from manufacturers that have a minimum of 5 years experience in producing field test equipment. Manufacturers must be ISO 9001 certified.

B. All test tools of a given type shall be from the same manufacturer, and have compatible electronic results output.

C. Test adapter cables must be approved by the manufacturer of the test equipment. Adapters from other sources are not acceptable.

D. Baseline accuracy of the test equipment must exceed TIA Level III, as indicated by independent laboratory testing.

E. Test equipment must be capable of certifying Category 6a and 6 links.

F. Test equipment must have a dynamic range of at least 100 dB to minimize measurement uncertainty.

G. Test equipment must be capable of storing full frequency sweep data for all tests and printing color graphical reports for all swept measurements.

H. Test equipment must include S-Band time domain diagnostics for NEXT and return loss (TDNX and TDRL) for accurate and efficient troubleshooting.

I. Test equipment must be capable of running individual NEXT, return loss, etc measurements in addition to auto-tests. Individual tests increase productivity when diagnosing faults.
J. Test equipment must include a library of cable types, sorted by major manufacturer.

K. Test equipment must store at least 1000 Category 6a or 6 auto-tests in internal memory.

L. Test equipment must be able to internally group auto-tests and cables in project folders for good records management.

M. Test equipment must include DSP technology for support of advanced measurements.

N. Test equipment must make swept frequency measurements in compliance with TIA standards.

O. The measurement reference plane of the test equipment shall start immediately at the output of the test equipment interface connector. There shall not be a time domain dead zone of any distance that excludes any part of the link from the measurement.

3.7 MDF>IDF>CIDF INSTALLATION PARAMETERS

A. UTP cabling shall conform to a 6 foot separation requirement from main power panels, Switch gear and/or starter motors adjacent to the IDF and termination locations.

B. All data, voice and communications racks and cabinets shall be anchored in accordance with manufacturer specifications and drawn details, to walls and floors and grounded to building ground grid (not to water pipes, etc.). Individual or new ground points are acceptable.

C. All floor mounted racks and cabinets shall have ladder racking from top of rack or cabinet to nearest wall as directed by consultant.

D. Wall mounted racks and cabinets.

1. Backboards shall be made of fire retardant or treated materials. Outside backboards shall be mounted squarely cut, with sanded edges, void free and painted. Backboards made from particle or pressed board materials are not acceptable. Backboards shall be a minimum size of ¾” thick x 36” wide x the height of the rack or cabinet. Backboard shall be painted with white fire-retardant paint.

2. Inside backboards shall be mounted squarely cut, with sanded edges and void free. Inside backboard shall match the inside dimensions of the installed cabinet. Inside backboard shall be a minimum thickness of ¾”.

3. All new racks and cabinets shall be securely mounted to wall studs in accordance with manufacturer specifications and drawn details.

E. All new and existing racks and cabinets shall have a dedicated 110V/AC double duplex outlet installed per specification section 16100, California Electrical Codes, and drawing details.

3.8 DOCUMENTATION AND DRAWINGS

A. As a pre-requisite for the acceptance of the work, the Contractor shall provide all of the following information. The Contractor shall prepare and provide 2 copies of a complete Cable Book as documentation. This cable book shall consist of the following:

   1. Title of Project
2. Index page detailing the following sections
3. Site plans (as-built drawings)
4. Drawings shall be professionally drafted (to scale, within a border similar to design drawings) and reproducible. Hand written drawings are not acceptable.
5. The drawings shall depict, at a minimum, the following conditions:
   a. The exact MDF/IDF/CIDF locations
   b. Size and routing of backbone cable from each IDF to the MDF.
   c. Station locations and their exact labeling ID(s) which shall match the physical label at the device.
   d. New pathways, conduit, ground boxes, junction boxes, raceway, power poles and floor monuments.
   e. Any other new conditions.
6. Contractor shall provide 3 sets of as-built drawings, one of which shall be reproducible.
7. In addition to the hard copy requirements, the as-buils, one of which shall be generated on Visio, and supplied to District. Media shall be recordable CD.
8. The Contractor shall submit as-built drawings and media no later than 30 days after the installation date.
9. Price list and contact information for emergency service work.
B. Fiber backbone test results
   1. In sequential order by IDF number
C. Data station cable test results
   1. In sequential order by IDF and then drop number.
D. Voice feeder test results.
   1. In sequential order by IDF number.
   2. Station/Feeder connectivity spread sheet (8-1/2" x 11" hard copy and electronic file, Microsoft Excel format).
E. Voice station cable test results.
   1. In sequential order by IDF number.
   2. Station/Feeder connectivity spread sheet (8-1/2" x 11" hard copy and electronic file, Microsoft Excel format).
F. Warranty certificates and documentation.
3.9 WARRANTY AND SUPPORT SERVICE
A. The warranty shall commence from the date of final written acceptance by the Owner.
B. All conditions for obtaining the manufacturer's Performance Warranty shall be the sole responsibility of the contractor.

c. The contractor shall maintain a competent service organization and shall, if requested, submit a service maintenance agreement to the owner after the end of the guarantee period.

D. A typewritten notice shall be posted at the equipment rack that shall indicate the firm, address and telephone number to call when service is necessary. The notice shall be mounted in a neatly finished metal frame with a clear plastic window and securely attached to the inside of the door.

E. Extended Product Warranty and Application Assurance:

1. The 25 Year Extended Product Warranty shall ensure against product defects, that all approved cabling components exceed the specifications of TIA/EIA 568A and ISO/IEC IS 11801, exceed the attenuation and NEXT requirements of TIA/EIA TSB 67 and ISO/IEC IS 11801 for cabling links/channels, that the installation will exceed the loss and bandwidth requirements of TIA/EIA TSB 67 and ISO/IEC IS 11801 for fiber links/channels, for a twenty (20) year period. The warranty shall apply to all passive SCS components. The 20 Year Extended Product Warranty shall cover the replacement or repair of defective product(s) and labor for the replacement or repair of such defective product(s) for a twenty (20) year period.

2. The 25 Year Application Assurance shall cover the failure of the wiring system to support the application which it was designed to support, as well as additional application(s) introduced in the future, up to 1000 Mbps parallel transmission schemes, by recognized standards or user forums that use the TIA/EIA-568A or ISO/IEC IS 11801 component and link/channel specifications for cabling, for a twenty (20) year period.

3. Upon successful completion of the installation and subsequent inspection, the Owner's Project Manager shall be provided with a numbered certificate, from the manufacturing company, registering the installation.

F. One-Year Maintenance Service shall be provided as follows:

1. Emergency Response: Contractor must respond by utilizing remote diagnostics capabilities (as applicable) within thirty minutes of notification. If necessary, Contractor must dispatch at least one certified technician for arrival on-site within two hours of notification.

2. Non-Emergency Response: Contractor shall respond by utilizing remote diagnostics capabilities and or cause dispatch of at least one certified technician for arrival on-site within one business day of notification.

3. Definition of "Emergency": For maintenance purposes, "emergency" shall be defined as one or more of the following conditions:

   a. Defects of any riser pairs and/or components involving at least ten percent (10%) of any riser cable’s capacity.
   b. Defects of station cable pairs and/or components involving at least ten percent (10%) of any department or group of voice and/or data stations.
   c. Defects significantly impairing any single attendant console.
   d. Defects of any fiber optic cable and/or components involving at least ten percent (10%) of any departments or groups fiber-based systems and/or stations.
   e. Any pre-defined failure as submitted by Owner and agreed to by Contractor.

G. Contractor shall provide extra service upon request on a 24 hour-a-day, 365 day-a-Year basis. Pricing for such service shall be described in the "Cable Book" Documentation.
3.10 FINAL ACCEPTANCE

A. The Owner or Owner's representative may visit the site during the installation of the system to ensure that correct installation practices are being followed.

B. The Owner or Owner's representative will conduct a final job review once the contractor has finished the job. The review will take place within one week after the contractor notifies the owner.

C. Two copies of all certification data and drawings for all identifications shall be provided to the Owner before the Owner's review.

D. The Owner or Owner's representative will review the installation and certification data prior to the system acceptance.

E. The Owner or Owner's representative may test some of the systems features to ensure that the certification data is correct. If a substantial discrepancy is found, the Owner reserves the right to have an independent consultant perform a certification of the entire system. If such a procedure is undertaken, the cost of the testing will be billed back to the contractor.

F. In the event that repairs or adjustments are necessary, the contractor shall make these repairs at his own expense. All repairs shall be completed within 10 days from the time they are discovered.

END OF SECTION
SECTION 16900

FIRE ALARM SYSTEM

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Furnish and install Fire Alarm System including all wiring and connections and other materials as shown on Plans and specified herein. It is the intent that a complete operating system conforming to all applicable codes be installed and that any power supplies, relays, resistors, cards, modules, programming, or other items required to achieve this end result shall be furnished whether or not such item or items are specified herein.

B. The wiring shall be per system manufacturer’s requirements. The cable shall be approved for fire alarm systems, UL rated, and run in conduit. Provide sleeves through walls and floor and seal with fire-stop material.

C. Fire alarm system shall tie into existing campus Siemens Network System. System shall be programmed so that any new or existing device in any new or existing building shall alarm the Science Building only and notify the main panel and call to monitoring company. The features and capacities described in this specification are required as a minimum for this project and shall be furnished by The Siemens Industry office in Hayward California. Other suppliers or outlets are not acceptable.

D. Update existing graphic annunciator to include all existing buildings.

E. Fire alarm work must be contracted through Siemens Hayward branch office. Other outlets will not be acceptable.

1.2 GENERAL REQUIREMENTS

A. Code Requirements: System and all its components to meet requirements for local alarm system of National Fire Protection Association Standard 72 with California Amendments found in CBC, Americans with Disabilities Act (ADA), and Article 760, California Electrical Code, and to be approved by Division of the State Architect for use as school fire alarm system.

B. System Requirements: All of various equipment components to be complete with all appurtenant accessories required to provide specified facilities and perform specified functions throughout presently planned construction and space; and provisions for expanding system to provide same facilities, and perform same functions in all future planned construction, inducing space and mountings in control panels and terminal cabinets.

C. Instructions And Manuals:

1. Equipment supplier of systems to demonstrate operation of system to satisfaction of Owner and furnish Owner three (3) wiring schematics for all items of equipment, installation instructions, and details of all routine maintenance and servicing which must be given system by Owner (refer to Section 16010).

2. Manuals to be provided in substantial fiberboard covers, with title page, list of
contents, and conspicuous label on cover and shall be delivered to District. Submit copy to Architect for approval before delivering to Owner.

D. Fire Alarm Certification: Written certification on the form found in NFPA 72 shall be submitted by the Contractor to Architect (with copies to Electrical Engineer and DSA) stating for himself and the equipment manufacturer that component parts are as LISTED AND APPROVED BY State Fire Marshal, that the installation conforms in all respects to requirements as set forth in the California Electrical Code, that acceptance testing has been performed in the presence of the Inspector of Record (IOR), and the certificate signed by the IOR.

E. Installation of the fire alarm system and equipment shall not be started until submittals, including State Fire Marshal listing numbers for each component of the system, have been submitted to and approved by the Architect.

F. Submittals: Furnish catalog data, shop drawings, one-line diagrams, and scaled plan drawings. Building plans shall be 1/8"=1'0", and site plans shall be no smaller than 1"=40'. Minimum text height shall be 3/32" high. Contractor shall also submit name of firm he proposes to do work under this Section, addresses, phone numbers, and name of firm's contact, for approval. Such firms shall be factory authorized representatives of the equipment specified, who shall furnish all equipment, make all connections to same, and place the systems in operation. Such firms shall have offices and service departments within a 100 mile radius of project and shall have been in business of this type for at least five years. Also, refer to requirement for shop drawings, substitutions, materials, and submittals in Section 16010, Electrical. Two submittal reviews will be made by the Architect's representative. Subsequent reviews will be charged to the Contractor. A rejection of a submittal or review of a partially presented submittal constitutes one submittal review.

1. Fire alarm system design and products have been reviewed and approved by DSA. Alterations to design and/or substitutions proposed by the contractor shall require the following to be included with the fire alarm submittal:

a. Riser diagram.

b. Point-to-point diagram.

c. Mounting detail showing elevations of wall mounted devices.

d. List of system components, equipment, and devices, including manufacturer's model number(s) and California State Fire Marshal listing numbers.

e. Copies of manufacturer's specification sheets for equipment and devices indicated.

f. Voltage drop calculations — include the following information for the worst case:

1) Point-to-Point or ohms law calculations.

2) Zone used in calculations.

3) Voltage drop percent (not to exceed manufacturer's requirement(s).
Note: If voltage drop exceeds 10%, indicate manufacturer's listed operating voltage ranges(s) for equipment and devices.

g. Battery type(s), amp hours, and load calculations – include the following information:

1) Normal Operation: 100% of applicable devices for 24 hours = control panel amps plus list of amps per device which draw power from the panel during standby power condition – i.e.:
   a) Zone modules.
   b) Detectors.
   c) Other devices (identify).

   (Note: These specifications require standby power for 72 hours. The specified duration shall be used in calcs.)

2) Alarm Condition: 100% of applicable devices for 5 minutes = control panel amps plus list of amps per device which draw power from the panel during alarm condition — i.e.:
   a) Zone modules.
   b) Signal modules.
   c) Detectors.
   d) Signal devices
   e) Annunciator.
   f) Other devices (identify).

3) Normal Operation + Alarm Condition:
   a) Total amp hours required.
   b) Total amp hours provided.

G. Record Drawings: Refer to General Conditions. Final inspection will not be made until drawings are received and approved. Record Drawings shall include “As-Built” one-line and wiring diagrams, with terminations identified, wire color coding schedule, pullbox locations, and conduit routing plans.

H. Guarantee:

1. One firm to assume full responsibility for performance on all work of this section. Guarantee all equipment against defects in material and workmanship for three (3) years, and provide on-the-premises service during normal working hours for one year, at no cost to purchaser if trouble is not caused by misuse, abuse, or accident, or at current labor rates if so caused. Provide manufacturer's written three-year guarantee for equipment and parts.

2. Service shall normally be available within 24 hours from service department of authorized distributor of manufacturer by factory trained servicemen.

3. On-the-premises service at other than normal working hours to also be available, but labor charges for such calls to be paid by purchaser at current labor rates.
I. Product Delivery, Storage and Handling:
   1. Ship equipment in original packages to prevent damage or entry of foreign matter. All handling shall be in accordance with manufacturer's recommendations. Provide protective covering during construction.
   2. Replace, at no expense to Owner, equipment or material damaged during storage or installation as directed by the Architect.

PART 2 - DETAIL REQUIREMENTS AND PRODUCTS

2.1 SYSTEM OPERATION

A. Activation of any manual station, water flow switch, or automatic detector shall cause the sounding of all signals. In addition to sounding local alarm signals, operation of manual stations, water flow switch, or automatic detectors shall activate a relay for telephone leased line reporting to remote location via digital communicator. Digital communicator shall report alarm and trouble conditions. Telephone company leased lines shall be arranged by the Owner.

B. The system shall be electrically supervised against open circuits and grounds on the wiring to the alarm-initiating devices. An open or ground in the system shall cause a trouble signal to sound continuously until the system is restored to normal or until the signal is silenced by means of a cut-off switch. When the cut-off switch is thrown to the "off" position, a white pilot light shall be illuminated to show that the trouble signal is off. When the system is restored to normal operation, the trouble signal shall sound again and shall be silenced only by restoring the cut-off switch to its normal position, thereby also extinguishing the pilot light. Open and grounded circuits in the system shall not cause the sounding of false alarms. System shall be capable of initiating fire drill signal from master location. Fire drill signal shall not activate relay for remote reporting facilities.

2.2 STANDARD PRODUCTS

A. Equipment and accessories furnished under the terms of these specifications shall be the standard products of a single manufacturer. All equipment shall be listed by U.L. and State Fire Marshal. Specifications are based on District standards.

B. Manual Stations: Administrative manual and manual alarm-initiating devices shall be for semi-flush mounting, double action, open circuit manual stations located as shown on plans with addressable module. Each manual station shall have its own address.

C. Fire Alarm Control Panel: Existing control unit is Siemens MXL. Opening main door shall expose all components for inspection or adjustment without further dismantling of the cabinet, control units, or wiring. All electrical components shall be modular.
   1. Provide audible trouble signal.
   2. Main source system shall operate on a 120 volt, 60-cycle, AC power unit.
   3. Auxiliary Source: Batteries shall be provided to operate the system under supervisory conditions for up to 72 hours after a power failure. Provide separate enclosure similar to control unit construction, if required.
4. Control panel shall provide addressable and hardwired monitoring and control. The unit shall be programmable to meet user needs and code requirements. A backlit 80 character liquid crystal display shall be provided to display condition status.

5. Control panel shall include modules for addressable initiation loops as required by the Drawings with a minimum of (2) spare addressable loops.

6. Control Panel shall include modules for alarm indicating appliance circuits necessary for devices provided in this project plus two (2) spare circuits and space for two (2) future circuits. Alarm circuits shall be field programmable to provide steady or "temporal pattern" alarm tones and it shall be possible to have both occur simultaneously on different circuits.

D. Heat Detectors (Addressable): Shall be rate-of-rise type with test switch and tamperproof base.

E. Duct Detectors: Shall be addressable photoelectric or ionization type. Coordinate requirements with mechanical plans.

F. Smoke Detectors: Shall be addressable photoelectric type with test switch, LED status indicator, and tamperproof locking base.

G. Addressable Modules: Shall provide an address for a group of normally open initiating devices.
   2. Output Module: TRI-R.

H. Audible/Visual Devices: All fire alarm devices shall be U.L. listed and meet ADA requirements. All devices shall have a red finish. All fire alarm audible devices shall have the same basic sound and pattern and shall be ANSI S3.41.
   1. Fire Alarm Horns: Shall be semi-flush mounted with wall trim plate. Horns installed at exterior locations shall be provided with cast weatherproof boxes. All exposed parts of horn, boxes, and plates shall be finished with red enamel. Horns shall be Wheelock. Set horns at 99dBA.
   2. Combination Horn/Visual Alarm Indicating Devices: Shall be semi-flush mounted, high intensity Xenon flasher type with candela (cd) output specified on drawings. Wheelock as shown on plans. Set horn dBA at 99 and minihorn dBA at 90.
   3. Visual Fire Alarm Indicating Devices: Shall be semi-flush mounted, high intensity Xenon flasher type with candela (cd) output specified on drawings. Wheelock as shown on plans.

I. Digital Communicator: Existing.

J. Signal Extender Panel: Shall provide a minimum of four notification appliance circuits. Wheelock PS-8. Provide with 7.0Ah batteries.

K. Electromagnetic door holders shall be recessed.
PART 3 - EXECUTION

3.1 REQUIREMENTS

A. System shall be complete and operational in every respect.

B. Provide certification of testing by local fire district.

C. Label all zone cables at devices and junction boxes using E-Z Marker labels. Label all conduits leaving the fire alarm equipment in Administration Building with zone and circuit numbers with black ink. Label inside cover of device with zone and circuit number.

D. Provide red laminate labels engraved with white letters indicating type of fire alarm main equipment i.e. "FATC-T", "RPS-T", etc.

E. Fire alarm contractor shall provide services for alerting service technicians 24 hours-7 days a week-365 days of the year.

F. Fire alarm contractor shall have a minimum of five years experience in installing fire alarm systems and shall show evidence of experience.

3.2 TEST AND REPORTS

A. System test shall be performed only by an individual who has attended a manufacturer's training school for installation and testing the system as described above and shall provide evidence of certification from manufacturer. Testing of the system shall be performed with the test instruments as required by the manufacturer; testing by means other than the manufacturer's procedures will not be acceptable unless agreed to by the Owner, specifying engineer, and the manufacturer.

B. Upon completion of the installation to the existing fire alarm system, a satisfactory test of the entire system shall be made in the presence of the enforcing agencies.

Reports Shall Include, But Not Be Limited To:

1. A complete list of equipment/devices installed.

2. Indications that all equipment/devices are properly installed and functions and conforms with these Specifications.

3. Test of all individual zones and devices.

4. List of serial numbers, locations by zone and device number, and model number for each detector installed.

5. List method of testing and smoke detectors.

6. Technician's name, company and date.

7. Complete Record Drawings of wiring and conduits.

8. Detailed catalog data on all installed components.
9. Copy of the test reports described above.

10. Sixty days prior to expiration of warranty, Contractor shall retest entire system as described above, and submit a test report of findings. All items covered by warranty shall be corrected immediately. Warranty remains in effect until 100% of defective items are corrected by Contractor.

11. Upon completion of the installation of fire alarm equipment, the electrical contractor shall provide to the architect, a signed written statement substantially in the form as follows:

THE UNDERSIGNED HAVING BEEN ENGAGED AS THE ELECTRICAL CONTRACTOR ON (Project Name) CONFIRMS THAT THE FIRE ALARM EQUIPMENT WAS INSTALLED IN ACCORDANCE WITH WIRING DIAGRAMS, INSTRUCTIONS AND DIRECTIONS PROVIDED TO US BY THE MANUFACTURER.

END OF SECTION