

# PROJECT MANUAL

FOR

**RANCHO CAMPANA HIGH SCHOOL**  
OXNARD UNION HIGH SCHOOL DISTRICT

**New HVAC System**

Prepared by:

**FLEWELLING & MOODY**  
architecture    planning    interiors

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Project No. 2841.100

August 8, 2019

**NEW HVAC SYSTEM AT  
RANCHO CAMPANA HIGH SCHOOL  
OXNARD UNION HIGH SCHOOL DISTRICT  
F&M 2841.0100**

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**END OF DIRECTORY**

# PROJECT MANUAL

## RANCHO CAMPANA HIGH SCHOOL NEW HVAC SYSTEM for OXNARD UNION HIGH SCHOOL DISTRICT Oxnard, California

Prepared by  
FLEWELLING & MOODY ARCHITECTS  
815 Colorado Blvd.  
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August 7, 2019



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**PROJECT MANUAL**  
**TABLE OF CONTENTS**

**DIVISION 0 - BIDDING/CONTRACT REQUIREMENTS**

00 00 00	Cover Page
00 00 02	Project Directory
00 00 05	Signature Sheet
00 00 10	Table of Contents

**DIVISION 1 - GENERAL REQUIREMENTS**

01 10 00	Summary of Work
01 10 30	Project Procedures
01 10 45	Cutting and Patching
01 10 60	Regulatory Requirements
01 31 00	Project Management and Coordination
01 33 00	Submittal Procedures
01 42 00	References
01 43 00	Quality Control
01 45 29	Testing and Inspection
01 50 00	Temporary Facilities and Controls
01 58 13	Temporary Project Signage
01 60 20	Storage and Protection
01 77 00	Closeout Procedures
01 77 01	Project Closeout
01 77 20	Project Record Documents
01 77 40	Warranties
01 78 23	Operation and Maintenance Manuals
01 91 13	General Commissioning Requirements

**DIVISION 2 – EXISTING CONDITIONS**

02 41 19	Demolition
----------	------------

**DIVISION 3 – CONCRETE**

03 30 00	Cast-In-Place Concrete
----------	------------------------

**DIVISION 4 – MASONRY**

04 22 00	Concrete Unit Masonry (CMU)
----------	-----------------------------

**DIVISION 5 – METALS**

05 12 00	Structural Steel
05 40 00	Light Gauge Steel Framing System
05 50 00	Metal Fabrications
05 55 00	Miscellaneous Metals

**DIVISION 6 – WOOD AND PLASTICS**

NOT USED

**DIVISION 7 - THERMAL AND MOISTURE PROTECTION**

07 19 00 Water Repellent Coating  
07 60 00 Sheet Metal Flashing and Trim  
07 92 00 Joint Sealants

**DIVISION 8 - DOORS AND WINDOWS**

NOT USED

**DIVISION 9 - FINISHES**

09 24 00 Portland Cement Plaster  
09 29 00 Gypsum Board  
09 51 13 Acoustical Tile Ceilings  
09 90 00 Painting

**DIVISION 10 - SPECIALTIES**

NOT USED

**DIVISION 11 – EQUIPMENT**

NOT USED

**DIVISION 12 – FURNISHINGS**

12 49 20 Motor Operated Shade System

**DIVISION 14 – CONVEYING SYSTEMS**

NOT USED

**DIVISION 21 – SPRINKLER SYSTEM**

NOT USED

**DIVISION 22 – PLUMBING**

22 05 00 Common Work Results for Plumbing  
22 05 13 Basic Plumbing Materials and Methods  
22 05 53 Plumbing Identification  
22 07 00 Plumbing Insulation  
22 10 00 Plumbing

**DIVISION 23 – MECHANICAL**

23 05 00	Common Work Results for HVAC
23 05 13	Common Motor Requirements for HVAC Equipment
23 05 29	Hangers and Supports for HVAC Piping and Equipment
23 05 48	Vibration and Seismic Controls for HVAC Piping and Equipment
23 05 53	Identification for HVAC Piping and Equipment
23 05 93	Testing, Adjusting, and Balancing for HVAC
23 07 00	HVAC Insulation
23 08 13	Environmental Controls EMS Commissioning
23 09 23	Environmental Controls Energy Management System
23 20 13	HVAC Piping
23 20 16	Underground HVAC Piping
23 25 00	HVAC Water Treatment
23 31 13	Metal Ducts
23 33 00	Air Duct Accessories
23 34 23	HVAC Power Ventilators
23 37 13	Diffusers, Registers, and Grilles
23 41 00	Particulate Air Filtration
23 70 00	Air Handling Units
23 80 00	Heating, Ventilating Air Conditioning Equipment
23 82 41	Multistack

**DIVISION 26 – ELECTRICAL**

26 05 00	Common Work Results for Electrical
26 05 13	Basic Electrical Materials and Methods
26 05 19	Low Voltage Wires (600 Volt AC)
26 05 26	Grounding and Bonding
26 05 33	Raceways, Boxes, Fittings and Supports

**DIVISION 27 – LOW VOLTAGE**

NOT USED

**DIVISION 28 – FIRE ALARM**

28 31 00	Fire Detection and Alarm
----------	--------------------------

**DIVISION 31 – EARTHWORK**

31 10 00	Site Clearing
----------	---------------

**DIVISION 32 – EXTERIOR IMPROVEMENTS**

32 13 13	Site Concrete
32 31 13	Site Metal Fabrications

**DIVISION 33 – UTILITIES**

NOT USED

**END OF TABLE OF CONTENTS**

**SECTION 01 10 01  
SUMMARY OF WORK**

**PART 1 - GENERAL**

1.1 SUMMARY

A. Section includes:

1. Project information.
2. Work covered by Contract Documents.
3. Work under separate contracts.
4. Access to site.
5. Coordination with occupants.
6. Work restrictions.
7. Specification and drawing conventions.

B. Related Section:

1. Division 01 50 00 Section "Temporary Facilities & Controls" for limitations and procedures governing temporary use of Owner's facilities.

1.2 PROJECT INFORMATION

A. Project Identification: Rancho Campana High School

1. Project Location: 4235 Mar Vista Dr, Camarillo, CA 93010.

B. Owner: Oxnard Union High School District

1. Owner's Representative: Poul Hanson, Bond Project Manager.

C. Architect: Flewelling & Moody.

1.3 WORK COVERED BY CONTRACT DOCUMENTS

A. The Work of the Project is defined by the Contract Documents and consists of the following:

1. New HVAC system for Buildings A, C1, C2, C3, D, and E.
2. New exterior enclosures for the new HVAC system – Total of 5 enclosures.
3. Exterior underground piping installation and routing.

4. Exterior hardscape, landscape, and existing utilities modifications as required for the new enclosure construction and pipe installation and routing.
5. Interior building modifications as required for the new HVAC system components.
6. New shading system at existing skylight wells.

#### 1.4 WORK UNDER SEPARATE CONTRACTS

- A. General: Cooperate fully with separate contractors so work on those contracts may be carried out smoothly, without interfering with or delaying work under this Contract or other contracts. Coordinate the Work of this Contract with work performed under separate contracts.

#### 1.5 ACCESS TO SITE

- A. General: Contractor shall have full use of Project site for construction operations during construction period. Contractor's use of Project site is limited only by Owner's right to perform work or to retain other contractors on portions of Project.
- B. Use of Site: Limit use of Project site to areas within the Contract limits indicated. Do not disturb portions of Project site beyond areas in which the Work is indicated.

1. Limits: Limit site disturbance, including earthwork and clearing of vegetation, to 40 feet (12.2 m) beyond building perimeter; 10 feet (3 m) beyond surface walkways, patios, surface parking, and utilities less than 12 inches (300 mm) in diameter; 15 feet (4.5 m) beyond primary roadway curbs and main utility branch trenches; and 25 feet (7.6 m) beyond constructed areas with permeable surfaces (such as pervious paving areas, storm water detention facilities, and playing fields) that require additional staging areas in order to limit compaction in the constructed area.
2. Driveways, Walkways and Entrances: Keep driveways loading areas, and entrances serving premises clear and available to Owner, Owner's employees, and emergency vehicles at all times. Do not use these areas for parking or storage of materials.
  - a. Schedule deliveries to minimize use of driveways and entrances by construction operations.
  - b. Schedule deliveries to minimize space and time requirements for storage of materials and equipment on-site.

#### 1.6 COORDINATION WITH OCCUPANTS

- A. Partial Owner Occupancy: Owner will not occupy the premises during entire construction period. Adjacent site is residential area. Cooperate with Owner during construction operations to minimize conflicts and facilitate Owner usage. Perform the Work so as not to interfere with Owner's operations. Maintain existing exits unless otherwise indicated.

1. Maintain access to existing walkways, corridors, and other adjacent occupied or used facilities. Do not close or obstruct walkways, corridors, or other occupied or used facilities without written permission from Owner and authorities having jurisdiction.
  2. Provide not less than 72 hours' notice to Owner of activities that will affect Owner's operations.
- B. Owner Limited Occupancy of Completed Areas of Construction: Owner reserves the right to occupy and to place and install equipment in completed portions of the Work, prior to Substantial Completion of the Work, provided such occupancy does not interfere with completion of the Work. Such placement of equipment and limited occupancy shall not constitute acceptance of the total Work.
1. Architect will prepare a Certificate of Substantial Completion for each specific portion of the Work to be occupied prior to Owner acceptance of the completed Work.
  2. Obtain a Certificate of Occupancy from authorities having jurisdiction before limited Owner occupancy.
  3. Before limited Owner occupancy, mechanical and electrical systems shall be fully operational, and required tests and inspections shall be successfully completed. On occupancy, Owner will operate and maintain mechanical and electrical systems serving occupied portions of Work.
  4. On occupancy, Owner will assume responsibility for maintenance and custodial service for occupied portions of Work.

## 1.7 WORK RESTRICTIONS

- A. Work Restrictions, General: Comply with restrictions on construction operations.
1. Comply with limitations on use of public streets and other requirements of authorities having jurisdiction.
- B. On-Site Work Hours: Limit work in the existing building to normal business working hours as regulated by the City of Camarillo.
- C. Existing Utility Interruptions: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after providing temporary utility services according to requirements indicated:
1. Notify Owner not less than two days in advance of proposed utility interruptions.
  2. Obtain Owner's written permission before proceeding with utility interruptions.
- D. Noise, Vibration, and Odors: Coordinate operations that may result in high levels of noise and vibration, odors, or other disruption to Owner occupancy with Owner.
1. Notify Owner not less than two days in advance of proposed disruptive operations.
  2. Obtain Owner's written permission before proceeding with disruptive operations.

- E. Nonsmoking Building: Smoking is not permitted within the building or within 25 feet (8 m) of entrances, operable windows, or outdoor air intakes.
- F. Controlled Substances: Use of tobacco products and other controlled substances on the Project site is not permitted.

## 1.8 SPECIFICATION AND DRAWING CONVENTIONS

- A. Specification Content: The Specifications use certain conventions for the style of language and the intended meaning of certain terms, words, and phrases when used in particular situations. These conventions are as follows:
  - 1. Imperative mood and streamlined language are generally used in the Specifications. The words "shall," "shall be," or "shall comply with," depending on the context, are implied where a colon (:) is used within a sentence or phrase.
  - 2. Specification requirements are to be performed by Contractor unless specifically stated otherwise.
- B. Division 1 General Requirements: Requirements of Sections in Division 1 apply to the Work of all Sections in the Specifications.
- C. Drawing Coordination: Requirements for materials and products identified on the Drawings are described in detail in the Specifications. One or more of the following are used on the Drawings to identify materials and products:
  - 1. Terminology: Materials and products are identified by the typical generic terms used in the individual Specifications Sections.
  - 2. Abbreviations: Materials and products are identified by abbreviations published as part of the U.S. National CAD Standard and scheduled on Drawings.
  - 3. Keynoting: Materials and products are identified by reference keynotes referencing Specification Section numbers found in this Project Manual.

### **PART 2 - PRODUCTS (Not Used)**

### **PART 3 - EXECUTION (Not Used)**

END OF SECTION

**SECTION 01 10 30  
PROJECT PROCEDURES**

**PART 1 – GENERAL**

1.1 DESCRIPTION

- A. Work included: This section establishes special project procedures regarding
  - 1. Documents and bid procedures;
  - 2. Protection of existing facilities;
  - 3. Limits of work and storage areas;
  - 4. Construction controls;
  - 5. Coordination;

1.2 QUALITY ASSURANCE

- A. Perform all work in strict accordance with pertinent requirements of these Specifications and, in the event no such requirements are determined, in conformance with the Architect's written direction.

1.3 SUBMITTALS

- A. None required.

**PART 2 – PRODUCTS**

2.1 GENERAL

- A. It is the intent of these Specifications and other Contract Documents to provide a complete workable design in all parts; any equipment shown or specified shall be furnished and installed with all accessories, controls, power, and full connections as may be necessary to assure safe and proper installation and operation.

2.2 PRECEDENCE

- A. The Contract and each of the Contract Documents are complementary and they shall be interpreted so that what is called for in any one shall be as binding as if called for in all.
- B. If there is a conflict between these Technical Specifications and any remaining portion of the bid, the provisions requiring the most expensive or elaborate method of work, materials, or equipment shall control. Items in direct conflict, discovered during the bid, should be brought to the attention of the Architect for clarification, by written Addenda. If clarification and/or Addenda is unable to be issued, the bidders shall bid the more expensive of the conflicting items/conditions; this provision shall govern the entire scope of this contract. Following Award of Bid, should the District elect to utilize the cheaper or less elaborate condition, a credit change Order shall be issued. Refer to related information in the General and Special Conditions. Contractor shall secure written permission from Architect before proceeding with work affected by omission or discrepancies in the Contract.

- C. Separate sections of this Specification are arranged only for convenience of Contractor, and nothing stated herein should be misconstrued as suggesting jurisdiction over items of work by any different building trades.
- D. When Agreement is signed, the Contractor will be given copies of the Architect's electronic bid plans to make one (1) set of reproducible prints and one (1) set of as-built electronic CD, the cost to be funded by the Bidder's General Conditions. All drawing print sets required by the awarded firm, subcontractors and suppliers shall be included. This print set and electronic CD set will also be used for the "as-built" drawings as referenced in Section 01 77 20, Project Record Documents. A complete As-Built submission shall consist of the prints and the electronic CD.

### **PART 3 – EXECUTION**

#### **3.1 CARE OF PRESENT BUILDINGS AND GROUNDS**

- A. Contractor shall be held responsible, so far as his operations are concerned, for the care and preservation of the adjacent premises, utilities, walks, streets and co-terminus property. Any parts of them injured, damaged, or disturbed because of his work shall be repaired, replaced, or cleaned, at Contractor's expense, to the satisfaction of District Representative. Prior to commencement of the Work, the Contractor or his designated representative shall jointly review the site as a part of the Pre-Construction Conference.
- B. Any such facilities as existing roads, curbing, utility poles, or underground utility lines damaged by Contractor in execution of this Contract shall be restored to former condition by Contractor at no change in the Contract price to satisfaction of District.
- C. Contractor shall take all precautions and care to preserve and protect all trees and shrubs in the right-of-ways and on the property. No tree or trees shall be cut or felled without specific permission in writing from the Architect. Trees cut without explicit instructions do so shall be replaced at the expense of the Contractor.
- D. No pruning of trees is to be done except by specified instructions of the District. Soil within the spread of the tree branches shall not be disturbed. Advance notice shall be given to the District if roots of a diameter greater than 1" must be cut.
- E. Contractor shall record and submit to District for verification any damage prior to commencement of work. Any damage not recorded and verified by District is the responsibility of the Contractor to correct.

#### **3.2 LIMITS OF WORK AND STORAGE AREAS**

- A. Submit for District's approval a site utilization plan for construction. Plans shall indicate limits of work, storage areas, and truck routes.

#### **3.3 CONSTRUCTION CONTROLS**

- A. Dust palliation: In addition to cleanup provisions of the Specifications, Contractor shall take appropriate steps during and throughout term of the Project to prevent airborne dust due to work under this Contract. Water shall be applied to settle and prevent dust, particularly during excavation and moving of materials. No chemical palliatives shall be used without permission of the District.

- B. Noise control: Noise from job equipment shall be kept to a minimum by adequate mufflers and other means as approved by District, Architect.
- C. Interruptions of existing services shall be held to minimum and shall be made only at such times as the District directs. Approval of the District shall be requested at least 3 days in advance of desired interruption time. **Contractor shall be responsible for full Utility service to be maintained at all times to the adjacent buildings.**

### 3.4 SPECIAL COORDINATION REQUIREMENT

- A. It is possible that the District might have various projects under different contracts in progress simultaneously in areas adjacent to, or coincident with, areas involved in the Project.
- B. Contractor shall be responsible to coordinate the work with that of other contractors' work to allow access to sites and to avoid rework and damages to new work.
- C. Contractor shall submit a detailed critical-path schedule for District's approval before beginning work and shall make such changes in this schedule as required by District in order to assure smooth and proper execution of all works.

### 3.5 VERIFICATION OF EXISTING UTILITIES

- A. Prior to constructing any new underground utility the Contractor shall expose and verify all existing underground facilities that may conflict with the new utility, to ensure accuracy of the information shown on the Drawings.

### 3.6 HAZARDOUS MATERIALS

- A. Should asbestos, PCB or other hazardous materials be encountered in any area, immediately stop all work in that area and notify the District's representative; the District will remove all hazardous material, clean the area, and have it certified as safe by a Certified Industrial Hygienist before work under this contract may proceed in that area. A time extension will be granted for delay caused by this cleanup.
- B. Non-Specified asbestos removal from buildings shall be done under separate contract by the District.

### 3.7 ADDENDA AND CHANGE ORDER

- A. Changes in the Plans and Specifications shall be made by Addenda and Construction Change Directives (CCDs) approved by the Division of the State Architect. Minor modifications, as determined by the District, may be made to the Plans and Specifications in writing accompanied with the Architect's signature without the processing of a formal Change Order.

### 3.8 ACCESS PANELS

- A. Access panels are referenced in separate sections for different trades (mechanical, plumbing, electrical). It shall be the responsibility of the individual trades to provide the access panels (sized accordingly) required for their installations. Coordinate exact location with Construction Manager prior to installation.

### 3.9 FIRESAFETY DURING DEMOLITION

- A. Demolition of buildings shall be in accordance with Section 8706 and, where applicable, Sections 8704 and 8705 of the California Fire Code, most recent addition.
- B. Suitable fire hose, shall be maintained at the demolition site. Such hose shall be connected to an approved source of water and shall not impede fire department use of hydrants.
- C. Demolition operations involving cutting and welding shall be in accordance with Section 4907, C.F.C.
- D. Combustible waste material, trash and rubbish shall not be burned at the demolition site, unless approved. Accumulations of such material shall be removed from the site as often as necessary to minimize the hazards therefrom.
- D. When required by the District, for building demolition which is hazardous in nature, qualified personnel shall be provided to serve as on-site fire watch. The sole duty of fire watch personnel shall be to watch for the occurrence of fire.

### 3.10 FIRE SAFETY DURING CONSTRUCTION

- A. Buildings under construction shall be in accordance with Section 8704 of the California Fire Code, most recent edition.
- B. Fire department access roads shall be established and maintained in accordance with Section 902, C.F.C.
- C. Water mains and hydrants shall be installed and operational in accordance with Section 903.
- D. During the construction of a building and until the permanent fire-extinguishing system has been installed and is in service, fire protection shall be provided in accordance with Section 8704, C.F.C.
- E. Fire extinguishers shall be provided for the buildings under construction. The number and type of extinguishers and the type of extinguisher shall be suitable for the type of fire associated with the hazards present.
- F. Combustible Debris. Combustible debris shall not be accumulated within buildings. Combustible debris, rubbish and waste material shall be removed from building as often as practical. Combustible debris, waste material and trash shall not be burned on the site unless approved.
- G. Internal-combustion-powered construction equipment shall be used in accordance with the following:
  - 1. Equipment shall be located so that exhausts do not discharge against combustible material.
  - 2. When possible, exhausts shall be piped to the outside of the building.
  - 3. Equipment shall not be refueled while in operation.
  - 4. Fuel for equipment shall be stored in an approved area outside of the building.
- H. Temporary heating devices shall located away from combustible materials, and attended and maintained by competent personnel.

- I. Smoking shall be prohibited. A suitable number and type of NO SMOKING signs shall be posted.
- J. Cutting and welding operations shall be in accordance with Article 49, C.F.C.
- K. The use of torched or flame-producing devices for the sweating of pipe joints shall be in accordance with Section 1109.3.2, C.F.C.
- M. The storage, use and handling of flammable liquids shall be in accordance with Article 79. Ventilation shall be provided for operation utilizing the application of materials containing flammable solvents.
- N. Open-flame devices and other sources of ignition shall not be located in areas where flammable materials are being used.
- O. Asphalt and tar kettles shall be located and operated in accordance with Section 1105, C.F.C.
- P. Temporary electrical wiring shall be in accordance with Section 8503, C.F.C.
- Q. When required by the chief, access to buildings for the purpose of fire-fighting shall be provided. Construction material shall not block access to buildings, hydrants or fire appliances.
- R. Telephone facilities shall be provided at the construction site for the purpose of emergency notification of the fire department. The street address of the construction site shall be posted adjacent to the telephone together with the fire department telephone number.
- S. A fire-protection plan shall be established by the Shell, Electrical and HVAC Contractors for each school site

### 3.11 REQUESTS FOR INFORMATION AND OTHER OFFICIAL CONTRACT CORRESPONDENCE

- A. Requests for Information (and/or Clarification) (hereinafter referred to as "RFI's") submitted by the Contractor to the District shall contain the following:
  - 1. Sequential RFI number.
  - 2. Date.
  - 3. Project Title and Information.
  - 4. Statement whether sent via facsimile only and/or hard copy to follow. It is acceptable to send a facsimile copy only; it is acceptable for the District to send a facsimile response only.
  - 5. Addressed to the District.
  - 6. Plan Sheet Reference and/or Spec. Section Reference including additional detail as required, such as column grid reference, or Part/Paragraph section of the Specification.
  - 7. Bold Reference citing the "Description of the Scope in Question" such as: "Ceiling Height in Classroom B123, Duct Clearances".

8. A complete, concise question regarding the issue. Note: If sketches, or other documentation, are attached, a reference shall be provided alluding to these attachments. If the RFI is originated from a subcontractor, this shall be noted.
  9. The date the answer is needed by so as not to impact schedule.  
Note: The Contractor shall allow a minimum of 5 working days for each RFI.
  10. If a "yes" answer, or some such similar answer, would impact the contract schedule, this shall be noted.
  11. If there is a potential cost/credit impact to the District's answer, this shall be noted. Failure to notify the Architect at the time of the RFI may waive the Contractor's rights to such future claim.
  12. The signature of the Contractor or Contractor's superintendent.
  13. An area with printed lines for the District's response.
  14. A space for the Project Manager's signature and date.
  15. The Contractor's field office facsimile number printed on the RFI.
- B. The Contractor shall not submit more than six (6) RFI's in any one day, or more than twenty-four (24) RFI's in any one working week. It shall be the Contractor's responsibility to study the plans and specifications, in conjunction with his subcontractors, far enough in advance to submit the RFI's so as to not have an adverse impact upon the project sequencing or schedule.
- C. The Construction Manager (or General Contractor) shall be responsible for the distribution of all RFI's, once they have been answered by the Architect, in an appropriate and final manner, to all applicable trade contractors. The Architect shall make initial distribution to the District, Inspector of Record, Construction Manager (or General Contractor), as well as to her own consultants and engineers.
- D. The Construction Manager (or General Contractor) shall maintain an RFI log, and distribute the log, showing current status at each project meeting. The Construction Manager (or General Contractor) shall maintain a bound file of all the RFI's, with the District's response, including all applicable attachments, in the job trailer at all times during the project.
1. When applicable, all Contractors shall attach an RFI response to the Master Project Construction Set, at the appropriate location in the plans and/or specifications, if the answer affects, revises, or provides necessary clarification to the construction issue in question.
- E. Proposal Requests: When the Contractor has notified the Construction Manager (or General Contractor) that the response is generating either a potential cost or credit to the contract, the Construction Manager (or General Contractor) shall issue a proposal request to the Architect and District, and copy all applicable parties.
1. When the costs and/or credits have been submitted properly for the work in question, and have been reviewed by the Architect and District, and the cost(s) and/or credits have been agreed upon, the Construction Manager (or General Contractor) will then assign the item to the next change order in the billing cycle.
- F. Frivolous RFI's: The RFI format shall not be used for the following:

1. A method for getting the Architect and Consultants to perform the Contractor's duties of properly reviewing and coordinating the plans and specifications. The Contractor is asked to use discretion in submitting RFI's; simple questions can be solved by teleconference with the Architect, or bringing up questions at the weekly meetings. The Architect will work with the Contractor in defining what constitutes the difference.
  2. The method for getting the District to answer a subcontractor's question that normally is part of the trade bid Contractor's responsibility.
  3. A method for attempting to create additional cost to the contract where no additional cost is due.
  4. A method for luring to District into providing an answer clearly different than the documents require.
  5. In the event that the Contractor is deemed to be abusing the RFI process, the District reserves the right to "back-charge" the contract, per standard hourly rates, as a credit in dollars to be applied to contract extra costs.
- G. Status of District's Responses to RFI's: The Architect's written response, when applicable, shall be incorporated into the contract as the most current ruling or interpretation of the plans and specifications.
- H. CCDs: "Construction Change Directives" issued by the Architect, whether or not generated by an RFI, shall become official contract correspondence and incorporated into the contract. If necessary, and subject to the agreement of all parties, CCD issues may lead into a Proposal Request and Change Order.

END OF SECTION

**SECTION 01 10 45  
CUTTING AND PATCHING**

**PART 1 – GENERAL**

1.1 SUMMARY

- A. This Section establishes general requirements pertaining to cutting (including excavating), fitting, and patching of the Work required to:
  - 1. Make the several parts fit properly;
  - 2. Uncover work to provide for installing, inspecting, or both, of ill-timed work.
  - 3. Remove and replace work not conforming to requirements of the Contract Documents.
  - 4. Remove and replace defective work.
- B. Related work:
  - 1. Documents affecting work of this Section include, but are not necessarily limited to, General Conditions, Supplementary Conditions, and Sections in Division 1 of these Specifications.
  - 2. In addition to other requirements specified, upon the District's request uncover work to provide for inspection by the District of covered work, and remove samples of installed materials for testing.
  - 3. Do not cut or alter work performed under separate contracts without the District's written permission.

1.2 SUBMITTALS

- A. Request for District's consent:
  - 1. Prior to cutting which affects structural safety, submit written request to the Project Manager for permission to proceed with cutting.
  - 2. Should conditions of the Work, or Schedule, indicate a required change of materials or methods for cutting and patching, notify District Project Manager and secure written permission and the required Change Order prior to proceeding.
- B. Notices to District Project Manager:
  - 1. Prior to cutting and patching performed pursuant to the District's instructions, submit cost estimate to District Project Manager. Secure the Project Manager's approval of the cost estimates and type of reimbursement before proceeding with cutting and patching.
  - 2. Submit written notice to District Project Manager designating the time the Work will be uncovered, to provide for the District's observation.

### 1.3 QUALITY ASSURANCE

- A. Use adequate numbers of skilled workmen thoroughly trained and experienced in the necessary crafts and completely familiar with the specified requirements and methods needed for proper performance of the work of this Section.

## **PART 2 – PRODUCTS**

### 2.1 MATERIALS

- A. For replacement of items removed, use materials complying with pertinent Sections of these Specifications.

### 2.2 PAYMENT FOR COSTS

- A. The Owner will reimburse the Contractor for cutting and patching performed pursuant to a written Change Order, after claim for such reimbursement is submitted by the Contractor. Perform other cutting and patching needed to comply with the Contract Documents at no additional cost to the Owner.

## **PART 3 – EXECUTION**

### 3.1 SURFACE CONDITIONS

- A. Inspection:
  - 1. Inspect existing conditions, including elements subject to movement or damage during cutting, excavating, patching, and backfilling.
  - 2. After uncovering the work, inspect conditions affecting installation of new work.
- B. Discrepancies:
  - 1. If uncovered conditions are not as anticipated, immediately notify the Architect and secure needed directions.
  - 2. Do not proceed until unsatisfactory conditions are corrected.

### 3.2 PREPARATION PRIOR TO CUTTING

- A. Provide required protection including, but not necessarily limited to, shoring, bracing, and support to maintain structural integrity of the Work.

### 3.3 PERFORMANCE

- A. Perform required excavating and backfilling as required under pertinent other Sections of these Specifications and OSHA standards for such work.
  - 1. Perform cutting and demolition by methods which will prevent damage to other portions of the Work and provide proper surfaces to receive installation of repair and new work.

2. Perform fitting and adjusting of products to provide finished installation complying with the specified tolerances and finishes.
3. Typically chip back existing adjoining plaster surfaces to expose the lath and building paper to permit proper lapping on new infill materials.

END OF SECTION

**SECTION 01 10 60  
REGULATORY REQUIREMENTS**

**PART 1 – GENERAL**

1.1 SECTION INCLUDES:

- A. This Section sets forth certain codes and standards and relevant requirements applicable to the work required under this contract.

1.2 STATUTORY AND JURISDICTIONAL REGULATIONS

- A. State of California Code of Regulation and Amendments:
  - 1. Title 24 – Industrial Relations; Safety Orders.
  - 2. Current Federal ADA Guidelines
  - 3. 2016 Building Standards Administrative Code, Title 24 C.C.R.
  - 4. 2016 California Building Code (CBC), Title 24 C.C.R.; (2015 International Building Code of the International Code Council, with California Amendments)
  - 5. 2016 California Electrical Code (CEC), Title 24 C.C.R.; (2014 National Electrical Code of the National Fire Protection Association, NFPA with 2013 California Amendments)
  - 6. 2016 California Mechanical Code (CMC), Title 24 C.C.R.; (2015 International Mechanical Code with 2013 California Amendments)
  - 7. 2016 California Plumbing Code (CPC), Title 24 C.C.R.; (2015 International Plumbing Code with 2013 California Amendments)
  - 8. 2016 Energy Code (CEC), Title 24 C.C.R.
  - 9. 2016 California Historical Building Code, Title 24, C.C.R
  - 10. 2016 California Fire Code (CFC), Title 24, C.C.R. (2015 International Fire Code of the International Code Council with 2013 California Amendments)
  - 11. 2016 California Existing Building Code, Title 24 C.C.R (2015 International Existing Building Code of the International Code Council with 2013 California Amendments)
  - 12. 2016 California Green Building Standards Code (CalGreen) Title 24, C.C.R
  - 13. 2016 California Referenced Standards Code, Title 24, C.C.R.
  - 14. 2016 California Public Safety, State Fire Marshal Regulations, Title 19, C.C.R.

B. List of Applicable NFPA Standards:

1. NFPA 253 Critical Radiant Flux of Floor Covering Systems 2015 Edition
2. NFPA 2001 Clean Agent Fire extinguishing Systems 2015 Edition
3. Reference code section for NFPA Standards – CBC (SFM) 3504.1
4. NFPA 13 Automatic Sprinkler Systems 2016 Edition
5. NFPA 14 Standpipe Systems 2013 Edition
6. NFPA 24 Private Fire Mains 2016 Edition
7. NFPA 25 Standard for Inspection, Testing & Maintenance of Water Based Fire Protection System 2016 Edition
8. NFPA 72 National Fire Alarm Code (California Amended) 2016 Edition (Note see UL Standard 1971 for “Visual Devices”)
9. NFPA 80 Fire Door & Windows 2016 Edition
10. NFPA 105 Smoke & Draft Control Door Assemblies 2016 Edition
11. NFPA 20 Stationary Pumps 2016 Edition
12. NFPA 17 Dry Chemical Extinguishing Systems 2013 Edition
13. NFPA 17a Wet Chemical Systems 2013 Edition

C. Construction Safety

1. Statutory and jurisdictional requirements as applicable to temporary work, including California Construction Safety Orders.
2. Associated General Contractors of America, Inc., Manual of Accident Prevention.
3. OSHA, Occupational Safety and Health Agencies requirements.

1.3 GENERAL STANDARDS FOR WORK AND MATERIALS

- A. Work or materials specified by reference to a number, symbol or title of a specific standard - - such as ASTM, U.L., F.S., or other standards - - shall comply with requirements thereof, except as limited to type, class, grade or modifications shown or specified.
- B. Referenced standards shall have full force and effect as though printed herein and are not repeated for reasons that manufacturers and Contractors are assumed to be familiar with requirements governing or applicable to their work. Upon request, Architect will furnish information as to where copies may be obtained.

- C. Material or trade associations, societies, or other bodies regularly publishing standards most widely used under these documents are listed herein together with reference symbols.
- D. Individual standards are referred to under Technical Sections by said reference symbol followed by designation number.

A.A.	The Aluminum Association
AASHO	American Association of the State Highway and Transportation Officials
ACI	American Concrete Institution
AGA	American Gas Association
AISC	American Institute for Steel Construction
ANSI	American National Standards Institute
ASHRAE	American Society of Heating, Refrigeration and Air Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society of Testing and Materials
AWS	American Welding Society
AWWA	American Water Works Association
CS	Commercial Standards, U.S. Department of commerce
FGMA	Flat Gas Marketing Society
FML	Factory Mutual Laboratories
F.S.	Federal Specifications
GA	Gypsum Association
IEEE	Institute of Electrical and Electronic Engineers
MFMA	Maple Flooring Manufacturer's Association
M.S.	Military Specifications U.S. GSA
NAAMM	National Association of Architectural Metal Manufacturers
NBS	National Bureau of Standards
NEMA	National Electrical Manufacturer's Association
NFPA	National Fire Protection Association
PCA	Portland Cement Association
PS	Product Standard, U.S. Department of Commerce
RIS	Redwood Inspection Service
SDI	Steel Door Inspections
SMANCA	Sheet Metal and Air Conditioning Contractor's National Association
TCA	Tile Council of America
UL	Underwriter's Laboratories, Inc.
WCLIB	West Coast Lumber Inspection Bureau
WIC	Wood Work Institute of California
WWPA	Western Wood Products Association

E. Book of Standards

1. State of California, Business and Transportation Agency, Department of Transportation.
  - a. CALIFORNIA STANDARD SPECIFICATIONS: Standard Specifications, January 1988, specific parts referred to by Section number.
  - b. CALIFORNIA TEST METHOD: Methods and Research Dept., Materials manual, 1988; specific tests referred to by California number.

2. APWA Standard Specifications: American Public Works Association, No. California Chapter, Standard Specifications for Public Works Construction, 2000 Edition; specific parts referred to by APWA Section number 3 U.L.; Underwriters' Laboratories Inc.; Buildings Materials List, 2001 or latest edition; and others regularly published; specific parts referred to by U.L. Classification Title and number.

#### 1.4 FIRE RATED WORK OR MATERIAL

- A. Applicable to materials, construction or fabrication specified or required to have limited fire hazard characteristics.
- B. Materials or assemblies shall be tested and classified per applicable ASTM Test Methods; or comparable scientific testing establishing like valuations, under sponsorship of manufacturer and conducted by U.L. or other established testing agency regularly performing tests of a type required.
  1. Testing standards, methods and procedures shall be subject to approval by California State Fire Marshall having jurisdiction.
  2. Flame spread of materials used, when installed under the conditions shown or specified, shall not exceed characteristic values specified.
  3. Compliance shall be substantiated by written certificate, labeling or both as specified.
- C. Wood: Refer to Division 6.
- D. Electrical: Refer to division 26.
- E. ASTM Tests not otherwise identified shall be listed under ASTM publication titled 2000 Annual Book of ASTM Standards, Section 00 under section of subject index, and under subject headings Fire Tests, and Flammability Tests.

#### 1.5 MANUFACTURER'S STANDARDS

- A. Applicable to type of items and products.
- B. Instructions not otherwise shown or specified shall be those of producer, as applicable, covering:
  1. Primary materials, auxiliary materials and accessories.
  2. Conditions of handling and for storage and protection.
  3. Preparation of backup surfaces.
  4. Installation, cleaning and maintenance procedures.
- C. Publications of procedures shall apply as particularly referred to, otherwise as regularly provided by producer, and shall include generalized installation publications or instructions.

**PART 2 – PRODUCTS (Not Applicable)**

**PART 3 – EXECUTION (Not Applicable)**

END OF SECTION

**SECTION 01 31 00  
PROJECT MANAGEMENT AND COORDINATION**

**PART 1 - GENERAL**

1.1 SUMMARY

- A. Section includes administrative provisions for coordinating construction operations on Project including, but not limited to, the following:
  - 1. Coordination drawings.
  - 2. Requests for Information (RFIs).
  - 3. Project meetings.

1.2 DEFINITIONS

- A. RFI: Request from Owner, Architect, or Contractor seeking information from each other during construction.

1.3 COORDINATION

- A. Coordination: Coordinate construction operations included in different Sections of the Specifications to ensure efficient and orderly installation of each part of the Work. Coordinate construction operations, included in different Sections that depend on each other for proper installation, connection, and operation.
  - 1. Schedule construction operations in sequence required obtaining the best results where installation of one part of the Work depends on installation of other components, before or after its own installation.
  - 2. Coordinate installation of different components to ensure maximum performance and accessibility for required maintenance, service, and repair.
  - 3. Make adequate provisions to accommodate items scheduled for later installation.
- B. Prepare memoranda for distribution to each party involved, outlining special procedures required for coordination. Include such items as required notices, reports, and list of attendees at meetings.
  - 1. Prepare similar memoranda for Owner and separate contractors if coordination of their Work is required.
- C. Administrative Procedures: Coordinate scheduling and timing of required administrative procedures with other construction activities to avoid conflicts and to ensure orderly progress of the Work. Such administrative activities include, but are not limited to, the following:

1. Preparation of Contractor's construction schedule.
2. Preparation of the schedule of values.
3. Installation and removal of temporary facilities and controls.
4. Delivery and processing of submittals.
5. Progress meetings.
6. Pre-installation conferences.
7. Project closeout activities.
8. Startup and adjustment of systems.
9. Project closeout activities.

#### 1.4 COORDINATION DRAWINGS

- A. Coordination Drawings, General: Prepare coordination drawings in accordance with requirements in individual Sections, where installation is not completely shown on Shop Drawings, where limited space availability necessitates coordination, or if coordination is required to facilitate integration of products and materials fabricated or installed by more than one entity.
1. Content: Project-specific information, drawn accurately to a scale large enough to indicate and resolve conflicts. Do not base coordination drawings on standard printed data. Include the following information, as applicable:
    - a. Indicate functional and spatial relationships of components of architectural, structural, civil, mechanical, and electrical systems.
    - b. Indicate dimensions shown on the Drawings. Specifically note dimensions that appear to be in conflict with submitted equipment and minimum clearance requirements. Provide alternate sketches to Architect indicating proposed resolution of such conflicts. Minor dimension changes and difficult installations will not be considered changes to the Contract.
- B. Coordination Drawing Organization: Organize coordination drawings as follows:
1. Floor Plans and Reflected Ceiling Plans: Show architectural and structural elements, and mechanical, plumbing, fire protection, fire alarm, and electrical Work. Show locations of visible ceiling-mounted devices relative to acoustical ceiling grid.
  2. Plenum Space: Indicate sub-framing for support of ceiling and wall systems, mechanical and electrical equipment, and related Work. Locate components within ceiling plenum to accommodate layout of light fixtures indicated on Drawings.
  3. Mechanical Rooms: Provide coordination drawings for mechanical rooms showing plans and elevations of mechanical, plumbing, fire protection, fire alarm, and electrical equipment.

4. Structural Penetrations: Indicate penetrations and openings required for all disciplines.
5. Slab Edge and Embedded Items: Indicate slab edge locations and sizes and locations of embedded items for metal fabrications, sleeves, anchor bolts, bearing plates, angles, door floor closers, slab depressions for floor finishes, curbs and housekeeping pads, and similar items.
6. Review: Architect will review coordination drawings to confirm that the Work is being coordinated, but not for the details of the coordination, which are the Contractor's responsibility.

#### 1.5 REQUESTS FOR INFORMATION (RFIs)

- A. General: Immediately on discovery of the need for additional information or interpretation of the Contract Documents, Contractor shall prepare and submit an RFI in the form specified.
  1. Architect will return RFIs submitted to Architect by other entities controlled by Contractor with no response.
  2. Coordinate and submit RFIs in a prompt manner so as to avoid delays in Contractor's work or work of subcontractors.
- B. Content of the RFI: Include a detailed, legible description of item needing information or interpretation and the following:
  1. Project name.
  2. Project number.
  3. Date.
  4. Name of Contractor.
  5. Name of Architect.
  6. RFI number, numbered sequentially.
  7. RFI subject.
  8. Specification Section number and title and related paragraphs, as appropriate.
  9. Drawing number and detail references, as appropriate.
  10. Field dimensions and conditions, as appropriate.
  11. Contractor's suggested resolution. If Contractor's solution(s) impacts the Contract Time or the Contract Sum, Contractor shall state impact in the RFI.
  12. Contractor's signature.
  13. Attachments: Include sketches, descriptions, measurements, photos, Product Data, Shop Drawings, coordination drawings, and other information necessary to fully describe items needing interpretation.

- C. RFI Forms: AIA Document G716 or Software-generated form with substantially the same content as indicated above, acceptable to Architect.
- D. Architect's Action: Architect will review each RFI, determine action required, and respond. Allow seven working days for Architect's response for each RFI. RFIs received by Architect after 1:00 p.m. will be considered as received the following working day.
1. The following RFIs will be returned without action:
    - a. Requests for approval of submittals.
    - b. Requests for approval of substitutions.
    - c. Requests for coordination information already indicated in the Contract Documents.
    - d. Requests for adjustments in the Contract Time or the Contract Sum.
    - e. Requests for interpretation of Architect's actions on submittals.
    - f. Incomplete RFIs or inaccurately prepared RFIs.
  2. Architect's action may include a request for additional information, in which case Architect's time for response will date from time of receipt of additional information.
  3. Architect's action on RFIs that may result in a change to the Contract Time or the Contract Sum may be eligible for Contractor to submit Change Proposal according to Division 1 Section "Contract Modification Procedures."
    - a. If Contractor believes the RFI response warrants change in the Contract Time or the Contract Sum, notify Architect and Owner's Project Manager in writing within **10** days of receipt of the RFI response.
- E. On receipt of Architect's action, update the RFI log and immediately distribute the RFI response to affected parties. Review response and notify Architect and Owner's Project Manager within seven days if Contractor disagrees with response.
- F. RFI Log: Prepare, maintain, and submit a tabular log of RFIs organized by the RFI number. Submit log weekly.
1. Project name.
  2. Name and address of Contractor.
  3. Name and address of Architect.
  4. RFI number including RFIs that were dropped and not submitted.
  5. RFI description.
  6. Date the RFI was submitted.
  7. Date Architect's response was received.

8. Identification of related Minor Change in the Work, Construction Change Directive, and Proposal Request, as appropriate.
9. Identification of related Field Order, Work Change Directive, and Proposal Request, as appropriate.

## 1.6 PROJECT MEETINGS

- A. General: Architect will schedule and conduct meetings and conferences at Project site, unless otherwise indicated.
  1. Attendees: Inform participants and others involved, and individuals whose presence is required, of date and time of each meeting. Notify Owner and Architect of scheduled meeting dates and times.
  2. Agenda: Prepare the meeting agenda. Distribute the agenda to all invited attendees.
  3. Minutes: Entity responsible for conducting meeting will record significant discussions and agreements achieved. Distribute the meeting minutes to everyone concerned, including Owner, and Architect, within three days of the meeting.
- B. Preconstruction Conference: Architect will schedule and conduct a preconstruction conference before starting construction, at a time convenient to Owner and Architect, but no later than **15** days after execution of the Agreement.
  1. Attendees: Authorized representatives of Owner, Architect, Contractor and its superintendent. Participants at the conference shall be familiar with Project and authorized to conclude matters relating to the Work.
  2. Agenda: Discuss items of significance that could affect progress, including the following:
    - a. Tentative construction schedule.
    - b. Applicable Phasing.
    - c. Critical work sequencing and long-lead items.
    - d. Designation of key personnel and their duties.
    - e. Procedures for processing field decisions and Change Orders.
    - f. Procedures for processing RFIs.
    - g. Procedures for testing and inspection.
    - h. Procedures for processing Applications for Payment.
    - i. Distribution of the Contract Documents.
    - j. Procedures for processing Submittals.
    - k. Sustainable design requirements.

- l. Preparation of record documents.
  - m. Use of the premises and existing building.
  - n. Work restrictions.
  - o. Working hours.
  - p. Owner's occupancy requirements.
  - q. Responsibility for temporary facilities and controls.
  - r. Procedures for moisture and mold control.
  - s. Procedures for disruptions and shutdowns.
  - t. Construction waste management and recycling.
  - u. Parking availability.
  - v. Office, work, and storage areas.
  - w. Equipment deliveries and priorities.
  - x. First aid.
  - y. Security.
  - z. Progress cleaning.
3. Minutes: Entity responsible for conducting meeting will record and distribute meeting minutes.
- C. Preinstallation Conferences: Conduct a preinstallation conference at Project site before each construction activity that requires coordination with other construction.
- 1. Attendees: Installer and representatives of manufacturers and fabricators involved in or affected by the installation and its coordination or integration with other materials and installations that have preceded or will follow, shall attend the meeting. Advise Architect, and Owner's Project Manager, of scheduled meeting dates.
  - 2. Agenda: Review progress of other construction activities and preparations for the particular activity under consideration, including requirements for the following:
    - a. Contract Documents.
    - b. Options.
    - c. Related RFIs.
    - d. Related Change Orders.
    - e. Purchases.
    - f. Deliveries.

- g. Submittals.
  - h. Review of mockups.
  - i. Possible conflicts.
  - j. Compatibility problems.
  - k. Time schedules.
  - l. Weather limitations.
  - m. Manufacturer's written recommendations.
  - n. Warranty requirements.
  - o. Compatibility of materials.
  - p. Acceptability of substrates.
  - q. Temporary facilities and controls.
  - r. Space and access limitations.
  - s. Regulations of authorities having jurisdiction.
  - t. Testing and inspecting requirements.
  - u. Installation procedures.
  - v. Coordination with other work.
  - w. Required performance results.
  - x. Protection of adjacent work.
  - y. Protection of construction and personnel.
3. Record significant conference discussions, agreements, and disagreements, including required corrective measures and actions.
  4. Reporting: Distribute minutes of the meeting to each party present and to other parties requiring information.
  5. Do not proceed with installation if the conference cannot be successfully concluded. Initiate whatever actions are necessary to resolve impediments to performance of the Work and reconvene the conference at earliest feasible date.
- D. Progress Meetings: Architect will conduct progress meetings at agreed upon scheduled intervals.
1. Attendees: Representative of Owner, Architect and Contractor. All participants at the meeting shall be familiar with Project and authorized to conclude matters relating to the Work.

2. Agenda: Review and correct or approve minutes of previous progress meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to status of Project.
  - a. Contractor's Construction Schedule: Review progress since the last meeting. Determine whether each activity is on time, ahead of schedule, or behind schedule, in relation to Contractor's construction schedule. Determine how construction behind schedule will be expedited; secure commitments from parties involved to do so. Discuss whether schedule revisions are required to ensure that current and subsequent activities will be completed within the Contract Time.
    - 1) Review schedule for next period.
  - b. Review present and future needs of each entity present, including the following:
    - 1) Interface requirements.
    - 2) Sequence of operations.
    - 3) Status of submittals.
    - 4) Deliveries.
    - 5) Off-site fabrication.
    - 6) Access.
    - 7) Site utilization.
    - 8) Temporary facilities and controls.
    - 9) Progress cleaning.
    - 10) Quality and work standards.
    - 11) Status of correction of deficient items.
    - 12) Field observations.
    - 13) Status of RFIs.
    - 14) Status of proposal requests.
    - 15) Pending changes.
    - 16) Status of Change Orders.
    - 17) Pending claims and disputes.
    - 18) Documentation of information for payment requests.

3. Minutes: Entity responsible for conducting the meeting will record and distribute the meeting minutes to each party present and to parties requiring information.
  - a. Schedule Updating: Revise Contractor's construction schedule after each progress meeting where revisions to the schedule have been made or recognized. Issue revised schedule concurrently with the report of each meeting.

**PART 2 - PRODUCTS (Not Used)**

**PART 3 - EXECUTION (Not Used)**

END OF SECTION

**SECTION 01 33 00  
SUBMITTAL PROCEDURES**

**PART 1 - GENERAL**

1.1 SUMMARY

- A. Section includes requirements for the submittal schedule and administrative and procedural requirements for submitting Shop Drawings, Product Data, Samples, and other submittals.
- B. Related Sections:
  - 1. Division 1 Section "Operation and Maintenance Manuals" for submitting operation and maintenance manuals.
  - 2. Division 1 Section "General Commissioning Requirements" for submitting video recordings of demonstration of equipment and training of Owner's personnel.

1.2 DEFINITIONS

- A. Action Submittals: Written and graphic information and physical samples that require Architect's responsive action.
- B. Informational Submittals: Written and graphic information and physical samples that do not require Architect's responsive action. Submittals may be rejected for not complying with requirements.

1.3 ACTION SUBMITTALS

- A. Submittal Schedule: Submit a schedule of submittals, arranged in chronological order by dates required by construction schedule. Include time required for review, ordering, manufacturing, fabrication, and delivery when establishing dates. Include additional time required for making corrections or modifications to submittals noted by the Architect and additional time for handling and reviewing submittals required by those corrections.

1.4 SUBMITTAL ADMINISTRATIVE REQUIREMENTS

- A. All submittals to be provided by Contractor within 15 days of award of bid.
- B. Architect's Digital Data Files: Electronic copies of CAD Drawings of the Contract Drawings will **not** be provided by Architect for Contractor's use in preparing submittals.
- C. Coordination: Coordinate preparation and processing of submittals with performance of construction activities.
  - 1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals, and related activities that requires sequential activity.

2. Coordinate transmittal of different types of submittals for related parts of the Work so processing will not be delayed because of need to review submittals concurrently for coordination.
    - a. Architect reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.
- D. Processing Time: Allow time for submittal review, including time for resubmittals, as follows. Time for review shall commence on Architect's receipt of submittal. No extension of the Contract Time will be authorized because of failure to transmit submittals enough in advance of the Work to permit processing, including resubmittals.
1. Initial Review: Allow 18 days for initial review of each submittal. Allow additional time if coordination with subsequent submittals is required. Architect will advise Contractor when a submittal being processed must be delayed for coordination.
  2. Intermediate Review: If intermediate submittal is necessary, process it in same manner as initial submittal.
  3. Resubmittal Review: Allow 15 days for review of each resubmittal.
  4. DSA Deferred Approval: In addition to the review periods indicated above allow 90 days for DSA review and approval.
- E. Identification and Information: Place a permanent label or title block on each paper copy submittal item for identification.
1. Indicate name of firm or entity that prepared each submittal on label or title block.
  2. Provide a space approximately 6 by 8 inches (150 by 200 mm) on label or beside title block to record Contractor's review and approval markings and action taken by Architect.
  3. Include the following information for processing and recording action taken:
    - a. Project name.
    - b. Date.
    - c. Name of Architect.
    - d. Name of Construction Manager.
    - e. Name of Contractor.
    - f. Name of subcontractor.
    - g. Name of supplier.
    - h. Name of manufacturer.
    - i. Submittal number or other unique identifier, including revision identifier.
      - 1) Submittal number shall use Specification Section number followed by a decimal point and then a sequential number (e.g., 06 10 00.01).

Resubmittals shall include an alphabetic suffix after another decimal point (e.g., 06 10 00.01.A).

- j. Number and title of appropriate Specification Section.
  - k. Drawing number and detail references, as appropriate Location(s) where product is to be installed, as appropriate.
  - l. Other necessary identification.
- F. Identification and Information: Identify and incorporate information in each electronic submittal file as follows:
- 1. Assemble complete submittal package into a single indexed file with links enabling navigation to each item.
  - 2. Name file with submittal number or other unique identifier, including revision identifier.
    - a. File name shall use project identifier and Specification Section number followed by a decimal point and then a sequential number (e.g., LNHS-06 10 00.01). Resubmittals shall include an alphabetic suffix after another decimal point (e.g., LNHS-06 10 00.01.A).
  - 3. Provide means for insertion to permanently record Contractor's review and approval markings and action taken by Architect.
  - 4. Include the following information on an inserted cover sheet:
    - a. Project name.
    - b. Date.
    - c. Name and address of Architect.
    - d. Name of Construction Manager.
    - e. Name of Contractor.
    - f. Name of firm or entity that prepared submittal.
    - g. Name of subcontractor.
    - h. Name of supplier.
    - i. Name of manufacturer.
    - j. Number and title of appropriate Specification Section.
    - k. Drawing number and detail references, as appropriate.
    - l. Location(s) where product is to be installed, as appropriate.
    - m. Related physical samples submitted directly.
    - n. Other necessary identification.

- G. Options: Identify options requiring selection by the Architect.
- H. Deviations: Identify deviations from the Contract Documents on submittals.
- I. Additional Paper Copies: Unless additional copies are required for final submittal, and unless Architect observes noncompliance with provisions in the Contract Documents, initial submittal may serve as final submittal.
  - 1. Submit one copy of submittal to concurrent reviewer in addition to specified number of copies to Architect.
- J. Transmittal: Assemble each submittal individually and appropriately for transmittal and handling. Transmit each submittal using a transmittal form. Architect will return submittals, without review, received from sources other than Contractor.
  - 1. On an attached separate sheet, prepared on Contractor's letterhead, record relevant information, requests for data, revisions other than those requested by Architect on previous submittals, and deviations from requirements in the Contract Documents, including minor variations and limitations. Include same identification information as related submittal.
- K. Resubmittals: Make resubmittals in same form and number of copies as initial submittal.
  - 1. Note date and content of previous submittal.
  - 2. Note date and content of revision in label or title block and clearly indicate extent of revision.
  - 3. Resubmit submittals until they are marked with approval notation from Architect's action stamp.
- L. Distribution: Furnish copies of final submittals to manufacturers, subcontractors, suppliers, fabricators, installers, and authorities having jurisdiction, and others as necessary for performance of construction activities. Show distribution on transmittal forms.
- M. Use for Construction: Use only final submittals that are marked with approval notation from Architect's action stamp.

## **PART 2 - PRODUCTS**

### **2.1 SUBMITTAL PROCEDURES**

- A. General Submittal Procedure Requirements:
  - 1. Action Submittals: Submit Six paper copies of each submittal, unless otherwise indicated. Architect through owner's project manager will return at least two copies.
  - 2. Informational Submittals: Submit Four paper copies of each submittal, unless otherwise indicated. Architect and owner's project manager will not return copies.
  - 3. Closeout Submittals and Maintenance Material Submittals: Comply with requirements specified in Division 1 Section "Closeout Procedures."

4. Certificates and Certifications Submittals: Provide a statement that includes signature of entity responsible for preparing certification. Certificates and certifications shall be signed by an officer or other individual authorized to sign documents on behalf of that entity.
    - a. Provide a digital signature with digital certificate on electronically submitted certificates and certifications where indicated.
    - b. Provide a notarized statement on original paper copy certificates and certifications where indicated.
  5. Test and Inspection Reports Submittals: Comply with requirements specified in Division 1 Section "Quality Requirements."
- B. Product Data: Collect information into a single submittal for each element of construction and type of product or equipment.
1. If information must be specially prepared for submittal because standard published data are not suitable for use, submit as Shop Drawings, not as Product Data.
  2. Mark each copy of each submittal to show which products and options are applicable.
  3. Include the following information, as applicable:
    - a. Manufacturer's catalog cuts.
    - b. Manufacturer's product specifications.
    - c. Standard color charts.
    - d. Statement of compliance with specified referenced standards.
    - e. Testing by recognized testing agency.
    - f. Application of testing agency labels and seals.
    - g. Notation of coordination requirements.
    - h. Availability and delivery time information.
  4. For equipment, include the following in addition to the above, as applicable:
    - a. Wiring diagrams showing factory-installed wiring.
    - b. Printed performance curves.
    - c. Operational range diagrams.
    - d. Clearances required to other construction, if not indicated on accompanying Shop Drawings.
  5. Submit Product Data before or concurrent with Samples.

6. Submit Product Data in the following format:
  - a. Six paper copies of Product Data, unless otherwise indicated. Architect, through owner's project manager, will return two copies.
  
- C. Shop Drawings: Prepare Project-specific information, drawn accurately to scale. Do not base Shop Drawings on reproductions of the Contract Documents or standard printed data.
  1. Preparation: Fully illustrate requirements in the Contract Documents. Include the following information, as applicable:
    - a. Identification of products.
    - b. Schedules.
    - c. Compliance with specified standards.
    - d. Notation of coordination requirements.
    - e. Notation of dimensions established by field measurement.
    - f. Relationship and attachment to adjoining construction clearly indicated.
    - g. Seal and signature of professional engineer if specified.
  2. Sheet Size: Except for templates, patterns, and similar full-size drawings, submit Shop Drawings on sheets at least 8-1/2 by 11 inches (215 by 280 mm) but no larger than 30 by 42 inches (750 by 1067 mm)].
  
- D. Samples: Submit Samples for review of kind, color, pattern, and texture for a check of these characteristics with other elements and for a comparison of these characteristics between submittal and actual component as delivered and installed.
  1. Transmit Samples that contain multiple, related components such as accessories together in one submittal package.
  2. Identification: Attach label on unexposed side of Samples that includes the following:
    - a. Generic description of Sample.
    - b. Product name and name of manufacturer.
    - c. Sample source.
    - d. Number and title of applicable Specification Section.
  3. Disposition: Maintain sets of approved Samples at Project site, available for quality-control comparisons throughout the course of construction activity. Sample sets may be used to determine final acceptance of construction associated with each set.
    - a. Samples that may be incorporated into the Work are indicated in individual Specification Sections. Such Samples must be in an undamaged condition at time of use.
    - b. Samples not incorporated into the Work, or otherwise designated as Owner's property, are the property of Contractor.
  4. Samples for Initial Selection: Submit manufacturer's color charts consisting of units or sections of units showing the full range of colors, textures, and patterns available.
    - a. Number of Samples: Submit four full set(s) of available choices where color, pattern, texture, or similar characteristics are required to be selected from manufacturer's product line. Architect, through Owner's Project Manager, will return one submittal with options selected.

5. Samples for Verification: Submit full-size units or Samples of size indicated, prepared from same material to be used for the Work, cured and finished in manner specified, and physically identical with material or product proposed for use, and that show full range of color and texture variations expected. Samples include, but are not limited to, the following: partial sections of manufactured or fabricated components; small cuts or containers of materials; complete units of repetitively used materials; swatches showing color, texture, and pattern; color range sets; and components used for independent testing and inspection.
  - a. Number of Samples: Submit four sets of Samples. Architect and Owner will retain two Sample sets; remainder will be returned.
    - 1) If variation in color, pattern, texture, or other characteristic is inherent in material or product represented by a Sample, submit at least three sets of paired units that show approximate limits of variations.
- E. Contractor's Construction Schedule: Comply with requirements specified in Division 1 Section "Project Record Documents."
- F. Application for Payment: Comply with requirements specified in Division 1 Section "Payment Procedures."
- G. Schedule of Values: Comply with requirements specified in Division 1 Section "Payment Procedures."
- H. Coordination Drawings: Comply with requirements specified in Division 1 Section "Project Management and Coordination."
- I. Qualification Data: Prepare written information that demonstrates capabilities and experience of firm or person. Include lists of completed projects with project names and addresses, contact information of architects and owners, and other information specified.
- J. Welding Certificates: Prepare written certification that welding procedures and personnel comply with requirements in the Contract Documents. Submit record of Welding Procedure Specification and Procedure Qualification Record on American Welding Society (AWS) forms. Include names of firms and personnel certified.
- K. Installer Certificates: Submit written statements on manufacturer's letterhead certifying that Installer complies with requirements in the Contract Documents and, where required, is authorized by manufacturer for this specific Project.
- L. Manufacturer Certificates: Submit written statements on manufacturer's letterhead certifying that manufacturer complies with requirements in the Contract Documents. Include evidence of manufacturing experience where required.
- M. Product Certificates: Submit written statements on manufacturer's letterhead certifying that product complies with requirements in the Contract Documents.
- N. Material Certificates: Submit written statements on manufacturer's letterhead certifying that material complies with requirements in the Contract Documents.
- O. Material Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting test results of material for compliance with requirements in the Contract Documents.

- P. Product Test Reports: Submit written reports indicating current product produced by manufacturer complies with requirements in the Contract Documents. Base reports on evaluation of tests performed by manufacturer and witnessed by a qualified testing agency, or on comprehensive tests performed by a qualified testing agency.
- Q. Research Reports: Submit written evidence, from a model code organization acceptable to authorities having jurisdiction, that product complies with building code in effect for Project.
- R. Schedule of Tests and Inspections: Comply with requirements specified in Division 1 Section "Quality Controls."
- S. Preconstruction Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of tests performed before installation of product, for compliance with performance requirements in the Contract Documents.
- T. Compatibility Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of compatibility tests performed before installation of product. Include written recommendations for primers and substrate preparation needed for adhesion.
- U. Field Test Reports: Submit reports indicating and interpreting results of field tests performed either during installation of product or after product is installed in its final location, for compliance with requirements in the Contract Documents.
- V. Maintenance Data: Comply with requirements specified in Division 1 Section "Operation and Maintenance Manuals."
- W. Design Data: Prepare and submit written and graphic information, including, but not limited to, performance and design criteria, list of applicable codes and regulations, and calculations. Include list of assumptions and other performance and design criteria and a summary of loads. Include load diagrams if applicable. Provide name and version of software, if any, used for calculations. Include page numbers.

## 2.2 DELEGATED-DESIGN SERVICES

- A. Performance and Design Criteria: Where professional design services or certifications by a design professional are specifically required of Contractor by the Contract Documents, provide products and systems complying with specific performance and design criteria indicated.
  - 1. If criteria indicated are not sufficient to perform services or certification required, submit a written request for additional information to Architect.
- B. Delegated-Design Services Certification: In addition to Shop Drawings, Product Data, and other required submittals, submit digitally-signed PDF electronic file and three paper copies of certificate, signed and sealed by the responsible design professional, for each product and system specifically assigned to Contractor to be designed or certified by a design professional.
  - 1. Indicate that products and systems comply with performance and design criteria in the Contract Documents. Include list of codes, loads, and other factors used in performing these services.

## **PART 3 - EXECUTION**

### **3.1 CONTRACTOR'S REVIEW**

- A. Action and Informational Submittals: Review each submittal and check for coordination with other Work of the Contract and for compliance with the Contract Documents. Note corrections and field dimensions. Mark with approval stamp before submitting to Architect.
- B. Project Closeout and Maintenance/Material Submittals: Refer to requirements in Division 1 Section "Project Closeout."
- C. Approval Stamp: Stamp each submittal with a uniform, approval stamp. Include Project name and location, submittal number, Specification Section title and number, name of reviewer, date of Contractor's approval, and statement certifying that submittal has been reviewed, checked, and approved for compliance with the Contract Documents.

### **3.2 ARCHITECT'S ACTION**

- A. General: Architect will not review submittals that do not bear Contractor's approval stamp and will return them without action.
- B. Action Submittals: Architect will review each submittal, make marks to indicate corrections or modifications required, and return it. Architect will stamp each submittal with an action stamp and will mark stamp appropriately to indicate action.
- C. Informational Submittals: Architect will review each submittal and will not return it, or will return it if it does not comply with requirements. Architect will forward each submittal to appropriate party.
- D. Incomplete submittals are not acceptable, will be considered nonresponsive, and will be returned without review.
- E. Submittals not required by the Contract Documents may not be reviewed and may be discarded.

END OF SECTION

**SECTION 01 42 00  
REFERENCES**

**PART 1 - GENERAL**

1.1 DEFINITIONS

- A. General: Basic Contract definitions are included in the Conditions of the Contract.
- B. "Approved": When used to convey Architect's action on Contractor's submittals, applications, and requests, "approved" is limited to Architect's duties and responsibilities as stated in the Conditions of the Contract.
- C. "Directed": A command or instruction by Architect. Other terms including "requested," "authorized," "selected," "required," and "permitted" have the same meaning as "directed."
- D. "Indicated": Requirements expressed by graphic representations or in written form on Drawings, in Specifications, and in other Contract Documents. Other terms including "shown," "noted," "scheduled," and "specified" have the same meaning as "indicated."
- E. "Regulations": Laws, ordinances, statutes, and lawful orders issued by authorities having jurisdiction, and rules, conventions, and agreements within the construction industry that control performance of the Work.
- F. "Furnish": Supply and deliver to Project site, ready for unloading, unpacking, assembly, installation, and similar operations.
- G. "Install": Operations at Project site including unloading, temporarily storing, unpacking, assembling, erecting, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations.
- H. "Provide": Furnish and install, complete and ready for the intended use.
- I. "Project Site": Space available for performing construction activities. The extent of Project site is shown on Drawings and may or may not be identical with the description of the land on which Project is to be built.

1.2 INDUSTRY STANDARDS

- A. Applicability of Standards: Unless the Contract Documents include more stringent requirements, applicable construction industry standards have the same force and effect as if bound or copied directly into the Contract Documents to the extent referenced. Such standards are made a part of the Contract Documents by reference.
- B. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.
- C. Copies of Standards: Each entity engaged in construction on Project should be familiar with industry standards applicable to its construction activity. Copies of applicable standards are not bound with the Contract Documents.

1. Where copies of standards are needed to perform a required construction activity, obtain copies directly from publication source.

### 1.3 ABBREVIATIONS AND ACRONYMS

- A. Industry Organizations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities indicated in Thomson Gale's "Encyclopedia of Associations" or in Columbia Books' "National Trade & Professional Associations of the U.S."
- B. Industry Organizations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list.

AA	Aluminum Association, Inc. (The)
AAADM	American Association of Automatic Door Manufacturers
AABC	Associated Air Balance Council
AAMA	American Architectural Manufacturers Association
AASHTO	American Association of State Highway and Transportation Officials
AATCC	American Association of Textile Chemists and Colorists
ABAA	Air Barrier Association of America
ABMA	American Bearing Manufacturers Association
ACI	American Concrete Institute
ACPA	American Concrete Pipe Association
AEIC	Association of Edison Illuminating Companies, Inc. (The)
AF&PA	American Forest & Paper Association
AGA	American Gas Association
AGC	Associated General Contractors of America (The)
AHA	American Hardboard Association (Now part of CPA)
AHAM	Association of Home Appliance Manufacturers
AI	Asphalt Institute
AIA	American Institute of Architects (The)
AISC	American Institute of Steel Construction
AISI	American Iron and Steel Institute

AITC	American Institute of Timber Construction
ALCA	Associated Landscape Contractors of America (Now PLANET - Professional Landcare Network)
ALSC	American Lumber Standard Committee, Incorporated
AMCA	Air Movement and Control Association International, Inc.
ANSI	American National Standards Institute
AOSA	Association of Official Seed Analysts, Inc.
APA	Architectural Precast Association
APA	APA - The Engineered Wood Association
APA EWS	APA - The Engineered Wood Association; Engineered Wood Systems (See APA - The Engineered Wood Association)
API	American Petroleum Institute
ARI	Air-Conditioning & Refrigeration Institute
ARMA	Asphalt Roofing Manufacturers Association
ASCE	American Society of Civil Engineers
ASCE/SEI	American Society of Civil Engineers/Structural Engineering Institute (See ASCE)
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers
ASME	ASME International (American Society of Mechanical Engineers International)
ASSE	American Society of Sanitary Engineering
ASTM	ASTM International (American Society for Testing and Materials International)
AWCI	Association of the Wall and Ceiling Industry
AWCMA	American Window Covering Manufacturers Association (Now WCMA)
AWI	Architectural Woodwork Institute
AWPA	American Wood Protection Association (Formerly: American Wood Preservers' Association)
AWS	American Welding Society
AWWA	American Water Works Association

BHMA	Builders Hardware Manufacturers Association
BIA	Brick Industry Association (The)
BICSI	BICSI, Inc.
BIFMA	BIFMA International (Business and Institutional Furniture Manufacturer's Association International)
BISSC	Baking Industry Sanitation Standards Committee
BWF	Badminton World Federation (Formerly: IBF - International Badminton Federation)
CCC	Carpet Cushion Council
CDA	Copper Development Association
CEA	Canadian Electricity Association
CEA	Consumer Electronics Association
CFFA	Chemical Fabrics & Film Association, Inc.
CGA	Compressed Gas Association
CIMA	Cellulose Insulation Manufacturers Association
CISCA	Ceilings & Interior Systems Construction Association
CISPI	Cast Iron Soil Pipe Institute
CLFMI	Chain Link Fence Manufacturers Institute
CRRC	Cool Roof Rating Council
CPA	Composite Panel Association
CPPA	Corrugated Polyethylene Pipe Association
CRI	Carpet and Rug Institute (The)
CRSI	Concrete Reinforcing Steel Institute
CSA	Canadian Standards Association
CSA	CSA International (Formerly: IAS - International Approval Services)
CSI	Cast Stone Institute
CSI	Construction Specifications Institute (The)
CSSB	Cedar Shake & Shingle Bureau

CTI	Cooling Technology Institute (Formerly: Cooling Tower Institute)
DHI	Door and Hardware Institute
EIA	Electronic Industries Alliance
EIMA	EIFS Industry Members Association
EJCDC	Engineers Joint Contract Documents Committee
EJMA	Expansion Joint Manufacturers Association, Inc.
ESD	ESD Association (Electrostatic Discharge Association)
ETL SEMCO	Intertek ETL SEMCO (Formerly: ITS - Intertek Testing Service NA)
FIBA	Federation Internationale de Basketball (The International Basketball Federation)
FIVB	Federation Internationale de Volleyball (The International Volleyball Federation)
FM Approvals	FM Approvals LLC
FM Global	FM Global (Formerly: FMG - FM Global)
FMRC	Factory Mutual Research (Now FM Global)
FRSA	Florida Roofing, Sheet Metal & Air Conditioning Contractors Association, Inc.
FSA	Fluid Sealing Association
FSC	Forest Stewardship Council
GA	Gypsum Association
GANA	Glass Association of North America
GRI	(Part of GSI)
GS	Green Seal
GSI	Geosynthetic Institute
HI	Hydraulic Institute
HI	Hydronics Institute
HMMA	Hollow Metal Manufacturers Association (Part of NAAMM)

HPVA	Hardwood Plywood & Veneer Association
HPW	H. P. White Laboratory, Inc.
IAS	International Approval Services (Now CSA International)
IBF	International Badminton Federation (Now BWF)
ICEA	Insulated Cable Engineers Association, Inc.
ICRI	International Concrete Repair Institute, Inc.
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers, Inc. (The)
IESNA	Illuminating Engineering Society of North America
IEST	Institute of Environmental Sciences and Technology
IGCC	Insulating Glass Certification Council
IGMA	Insulating Glass Manufacturers Alliance
ILI	Indiana Limestone Institute of America, Inc.
ISO	International Organization for Standardization Available from ANSI
ISSFA	International Solid Surface Fabricators Association
ITS	Intertek Testing Service NA (Now ETL SEMCO)
ITU	International Telecommunication Union
KCMA	Kitchen Cabinet Manufacturers Association
LMA	Laminating Materials Association (Now part of CPA)
LPI	Lightning Protection Institute
MBMA	Metal Building Manufacturers Association
MFMA	Maple Flooring Manufacturers Association, Inc.
MFMA	Metal Framing Manufacturers Association, Inc.
MH	Material Handling (Now MHIA)

MHIA	Material Handling Industry of America
MIA	Marble Institute of America
MPI	Master Painters Institute
MSS	Manufacturers Standardization Society of The Valve and Fittings Industry Inc.
NAAMM	National Association of Architectural Metal Manufacturers
NACE	NACE International (National Association of Corrosion Engineers International)
NADCA	National Air Duct Cleaners Association
NAGWS	National Association for Girls and Women in Sport
NAIMA	North American Insulation Manufacturers Association
NBGQA	National Building Granite Quarries Association, Inc.
NCAA	National Collegiate Athletic Association (The)
NCMA	National Concrete Masonry Association
NCPI	National Clay Pipe Institute
NCTA	National Cable & Telecommunications Association
NEBB	National Environmental Balancing Bureau
NECA	National Electrical Contractors Association
NeLMA	Northeastern Lumber Manufacturers' Association
NEMA	National Electrical Manufacturers Association
NETA	InterNational Electrical Testing Association
NFHS	National Federation of State High School Associations
NFPA	NFPA (National Fire Protection Association)
NFRC	National Fenestration Rating Council
NGA	National Glass Association
NHLA	National Hardwood Lumber Association
NLGA	National Lumber Grades Authority
NOFMA	NOFMA: The Wood Flooring Manufacturers Association (Formerly: National Oak Flooring Manufacturers Association)

NOMMA	National Ornamental & Miscellaneous Metals Association
NRCA	National Roofing Contractors Association
NRMCA	National Ready Mixed Concrete Association
NSF	NSF International (National Sanitation Foundation International)
NSSGA	National Stone, Sand & Gravel Association
NTMA	National Terrazzo & Mosaic Association, Inc. (The)
NTRMA	National Tile Roofing Manufacturers Association (Now TRI)
NWWDA	National Wood Window and Door Association (Now WDMA)
OPL	Omega Point Laboratories, Inc. (Now ITS)
PCI	Precast/Prestressed Concrete Institute
PDCA	Painting & Decorating Contractors of America
PDI	Plumbing & Drainage Institute
PGI	PVC Geomembrane Institute
PLANET	Professional Landcare Network (Formerly: ACLA - Associated Landscape Contractors of America)
PTI	Post-Tensioning Institute
RCSC	Research Council on Structural Connections
RFCI	Resilient Floor Covering Institute
RIS	Redwood Inspection Service
SAE	SAE International
SDI	Steel Deck Institute
SDI	Steel Door Institute
SEFA	Scientific Equipment and Furniture Association
SEI/ASCE	Structural Engineering Institute/American Society of Civil Engineers (See ASCE)
SGCC	Safety Glazing Certification Council
SIA	Security Industry Association

SIGMA	Sealed Insulating Glass Manufacturers Association (Now IGMA)
SJI	Steel Joist Institute
SMA	Screen Manufacturers Association
SMACNA	Sheet Metal and Air Conditioning Contractors' National Association
SMPTE	Society of Motion Picture and Television Engineers
SPFA	Spray Polyurethane Foam Alliance (Formerly: SPI/SPFD - The Society of the Plastics Industry, Inc.; Spray Polyurethane Foam Division)
SPIB	Southern Pine Inspection Bureau (The)
SPRI	Single Ply Roofing Industry
SSINA	Specialty Steel Industry of North America
SSPC	SSPC: The Society for Protective Coatings
STI	Steel Tank Institute
SWI	Steel Window Institute
SWRI	Sealant, Waterproofing, & Restoration Institute
TCA	Tile Council of America, Inc. (Now TCNA)
TCNA	Tile Council of North America, Inc.
TIA/EIA	Telecommunications Industry Association/Electronic Industries Alliance
TMS	The Masonry Society
TPI	Truss Plate Institute, Inc.
TPI	Turfgrass Producers International
TRI	Tile Roofing Institute
UL	Underwriters Laboratories Inc.
UNI	Uni-Bell PVC Pipe Association
USAV	USA Volleyball
USGBC	U.S. Green Building Council
USITT	United States Institute for Theatre Technology, Inc.

WASTEC	Waste Equipment Technology Association
WCLIB	West Coast Lumber Inspection Bureau
WCMA	Window Covering Manufacturers Association
WCSC	Window Covering Safety Council (Formerly: WCMA - Window Covering Manufacturers Association)
WDMA	Window & Door Manufacturers Association (Formerly: NWWDA - National Wood Window and Door Association)
WI	Woodwork Institute (Formerly: WIC - Woodwork Institute of California)
WIC	Woodwork Institute of California (Now WI)
WMMPA	Wood Moulding & Millwork Producers Association
WSRCA	Western States Roofing Contractors Association
WWPA	Western Wood Products Association

C. Code Agencies: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list.

IAPMO	International Association of Plumbing and Mechanical Officials
ICC	International Code Council
ICC-ES	ICC Evaluation Service, Inc.
UBC	Uniform Building Code (See ICC)

D. Federal Government Agencies: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list. Names, telephone numbers, and Web sites are subject to change and are believed to be accurate and up-to-date as of the date of the Contract Documents.

CE	Army Corps of Engineers
CPSC	Consumer Product Safety Commission
DOC	Department of Commerce
DOD	Department of Defense
DOE	Department of Energy
EPA	Environmental Protection Agency
FAA	Federal Aviation Administration

FCC	Federal Communications Commission
FDA	Food and Drug Administration
GSA	General Services Administration
HUD	Department of Housing and Urban Development
LBL	Lawrence Berkeley National Laboratory
NCHRP	National Cooperative Highway Research Program (See TRB)
NIST	National Institute of Standards and Technology
OSHA	Occupational Safety & Health Administration
PBS	Public Buildings Service (See GSA)
PHS	Office of Public Health and Science
RUS	Rural Utilities Service (See USDA)
SD	State Department
TRB	Transportation Research Board
USDA	Department of Agriculture
USPS	Postal Service

E. Standards and Regulations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the standards and regulations in the following list. Names, telephone numbers, and Web sites are subject to change and are believed to be accurate and up-to-date as of the date of the Contract Documents.

ADAAG	Americans with Disabilities Act (ADA) Architectural Barriers Act (ABA) Accessibility Guidelines for Buildings and Facilities Available from U.S. Access Board
CFR	Code of Federal Regulations Available from Government Printing Office
DOD	Department of Defense Military Specifications and Standards Available from Department of Defense Single Stock Point
DSCC	Defense Supply Center Columbus (See FS)
FED-STD	Federal Standard (See FS)

- FS Federal Specification  
Available from Department of Defense Single Stock Point  
  
Available from Defense Standardization Program  
  
Available from General Services Administration  
  
Available from National Institute of Building Sciences
- FTMS Federal Test Method Standard  
(See FS)
- MIL (See MILSPEC)
- MIL-STD (See MILSPEC)
- MILSPEC Military Specification and Standards  
Available from Department of Defense Single Stock Point
- UFAS Uniform Federal Accessibility Standards  
Available from Access Board

F. State Government Agencies: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list. Names, telephone numbers, and Web sites are subject to change and are believed to be accurate and up-to-date as of the date of the Contract Documents.

- CBHF State of California, Department of Consumer Affairs Bureau of Home Furnishings and Thermal Insulation
- CCR California Code of Regulations
- CPUC California Public Utilities Commission
- TFS Texas Forest Service  
Forest Resource Development

**PART 2 - PRODUCTS (Not Used)**

**PART 3 - EXECUTION (Not Used)**

END OF SECTION

**SECTION 01 43 00  
QUALITY CONTROL**

**PART 1 - GENERAL**

1.1 SUMMARY

- A. Section includes administrative and procedural requirements for quality assurance and quality control.
- B. Testing and inspecting services are required to verify compliance with requirements specified or indicated. These services do not relieve Contractor of responsibility for compliance with the Contract Document requirements.
  - 1. Specified tests, inspections, and related actions do not limit Contractor's other quality-assurance and -control procedures that facilitate compliance with the Contract Document requirements.
  - 2. Requirements for Contractor to provide quality-assurance and -control services required by Architect, Owner, or authorities having jurisdiction are not limited by provisions of this Section.
- C. Related Sections:
  - 1. Divisions 2 through 33 Sections for specific test and inspection requirements.

1.2 DEFINITIONS

- A. Quality-Assurance Services: Activities, actions, and procedures performed before and during execution of the Work to guard against defects and deficiencies and substantiate that proposed construction will comply with requirements.
- B. Quality-Control Services: Tests, inspections, procedures, and related actions during and after execution of the Work to evaluate that actual products incorporated into the Work and completed construction comply with requirements. Services do not include contract enforcement activities performed by Architect.
- C. Mockups: Full size physical assemblies that are constructed on-site. Mockups are constructed to verify selections made under sample submittals; to demonstrate aesthetic effects and, where indicated, qualities of materials and execution; to review coordination, testing, or operation; to show interface between dissimilar materials; and to demonstrate compliance with specified installation tolerances. Mockups are not Samples. Unless otherwise indicated, approved mockups establish the standard by which the Work will be judged.
- D. Preconstruction Testing: Tests and inspections performed specifically for the Project before products and materials are incorporated into the Work to verify performance or compliance with specified criteria.
- E. Product Testing: Tests and inspections that are performed by a testing agency qualified to conduct product testing and acceptable to authorities having jurisdiction, to establish product performance and compliance with specified requirements.

- F. Source Quality-Control Testing: Tests and inspections that are performed at the source, i.e., plant, mill, factory, or shop.
- G. Field Quality-Control Testing: Tests and inspections that are performed on-site for installation of the Work and for completed Work.
- H. Testing Agency: An entity engaged to perform specific tests, inspections, or both. Testing laboratory shall mean the same as testing agency.
- I. Installer/Applicator/Erector: Contractor or another entity engaged by Contractor as an employee, Subcontractor, or Sub-subcontractor, to perform a particular construction operation, including installation, erection, application, and similar operations.
  - 1. Use of trade-specific terminology in referring to a trade or entity does not require that certain construction activities be performed by accredited or unionized individuals, or that requirements specified apply exclusively to specific trade or trades.
- J. Experienced: When used with an entity or individual, "experienced" means having successfully completed a minimum of **five** previous projects similar in nature, size, and extent to this Project; being familiar with special requirements indicated; and having complied with requirements of authorities having jurisdiction.

### 1.3 CONFLICTING REQUIREMENTS

- A. Referenced Standards: If compliance with two or more standards is specified and the standards establish different or conflicting requirements for minimum quantities or quality levels, comply with the most stringent requirement. Refer conflicting requirements that are different, but apparently equal, to Architect for a decision before proceeding.
- B. Minimum Quantity or Quality Levels: The quantity or quality level shown or specified shall be the minimum provided or performed. The actual installation may comply exactly with the minimum quantity or quality specified, or it may exceed the minimum within reasonable limits. To comply with these requirements, indicated numeric values are minimum or maximum, as appropriate, for the context of requirements. Refer uncertainties to Architect for a decision before proceeding.

### 1.4 INFORMATIONAL SUBMITTALS

- A. Contractor's Statement of Responsibility: When required by authorities having jurisdiction, submit copy of written statement of responsibility sent to authorities having jurisdiction before starting work on the following systems.
  - 1. Seismic-force resisting system, designated seismic system, or component listed in the designated seismic system quality assurance plan prepared by the Architect.
  - 2. Main wind-force resisting system or a wind-resisting component listed in the wind-force-resisting system quality assurance plan prepared by the Architect.
- B. Testing Agency Qualifications: For testing agencies specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include proof of qualifications in the form of a recent report on the inspection of the testing agency by a recognized authority.

## 1.5 REPORTS AND DOCUMENTS

- A. Test and Inspection Reports: Prepare and submit certified written reports specified in other Sections. Include the following:
1. Date of issue.
  2. Project title and number.
  3. Name, address, and telephone number of testing agency.
  4. Dates and locations of samples and tests or inspections.
  5. Names of individuals making tests and inspections.
  6. Description of the Work and test and inspection method.
  7. Identification of product and Specification Section.
  8. Complete test or inspection data.
  9. Test and inspection results and an interpretation of test results.
  10. Record of temperature and weather conditions at time of sample taking and testing and inspecting.
  11. Comments or professional opinion on whether tested or inspected Work complies with the Contract Document requirements.
  12. Name and signature of laboratory inspector.
  13. Recommendations on retesting and reinspecting.
- B. Manufacturer's Field Reports: Prepare written information documenting tests and inspections specified in other Sections. Include the following:
1. Name, address, and telephone number of representative making report.
  2. Statement on condition of substrates and their acceptability for installation of product.
  3. Summary of installation procedures being followed, whether they comply with requirements and, if not, what corrective action was taken.
  4. Results of operational and other tests and a statement of whether observed performance complies with requirements.
  5. Other required items indicated in individual Specification Sections.
- C. Permits, Licenses, and Certificates: For Owner's records, submit copies of permits, licenses, certifications, inspection reports, releases, jurisdictional settlements, notices, receipts for fee payments, judgments, correspondence, records, and similar documents, established for compliance with standards and regulations bearing on performance of the Work.

## 1.6 QUALITY ASSURANCE

- A. General: Qualifications paragraphs in this article establish the minimum qualification levels required; individual Specification Sections specify additional requirements.
- B. Manufacturer Qualifications: A firm experienced in manufacturing products or systems similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.
- C. Fabricator Qualifications: A firm experienced in producing products similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.
- D. Installer Qualifications: A firm or individual experienced in installing, erecting, or assembling work similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful in-service performance.
- E. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of the system, assembly, or product that are similar to those indicated for this Project in material, design, and extent.
- F. Specialists: Certain Specification Sections require that specific construction activities shall be performed by entities who are recognized experts in those operations. Specialists shall satisfy qualification requirements indicated and shall be engaged for the activities indicated.
  - 1. Requirements of authorities having jurisdiction shall supersede requirements for specialists.
- G. Testing Agency Qualifications: An independent agency with the experience and capability to conduct testing and inspecting indicated, as documented according to **ASTM E 329**; and with additional qualifications specified in individual Sections; and where required by authorities having jurisdiction, that is acceptable to authorities.
- H. Manufacturer's Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to observe and inspect installation of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.
- I. Preconstruction Testing: Where testing agency is indicated to perform preconstruction testing for compliance with specified requirements for performance and test methods, comply with the following:
  - 1. Contractor responsibilities include the following:
    - a. Provide test specimens representative of proposed products and construction.
    - b. Submit specimens in a timely manner with sufficient time for testing and analyzing results to prevent delaying the Work.
    - c. When testing is complete, remove test specimens, assemblies, mockups; do not reuse products on Project.

2. Testing Agency Responsibilities: Submit a certified written report of each test, inspection, and similar quality-assurance service to Architect, with copy to Contractor. Interpret tests and inspections and state in each report whether tested and inspected work complies with or deviates from the Contract Documents.
- J. Mockups: Before installing portions of the Work requiring mockups, build mockups for each form of construction and finish required to comply with the following requirements, using materials indicated for the completed Work:
1. Build mockups in location and of size indicated or, if not indicated, as directed by Architect.
  2. Notify Architect **seven** days in advance of dates and times when mockups will be constructed.
  3. Demonstrate the proposed range of aesthetic effects and workmanship.
  4. Obtain Architect's approval of mockups before starting work, fabrication, or construction.
    - a. Allow **seven** days for initial review and each re-review of each mockup.
  5. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
  6. Demolish and remove mockups when directed, unless otherwise indicated.

#### 1.7 QUALITY CONTROL

- A. Owner Responsibilities: Where quality-control services are indicated as Owner's responsibility, Owner will engage a qualified testing agency to perform these services.
1. Owner will furnish Contractor with names, addresses, and telephone numbers of testing agencies engaged and a description of types of testing and inspecting they are engaged to perform.
  2. Costs for retesting and reinspecting construction that replaces or is necessitated by work that failed to comply with the Contract Documents will be charged to Contractor, **and the Contract Sum will be adjusted by Change Order.**
- B. Contractor Responsibilities: Tests and inspections not explicitly assigned to Owner are Contractor's responsibility. Perform additional quality-control activities required to verify that the Work complies with requirements, whether specified or not.
1. Where services are indicated as Contractor's responsibility, engage a qualified testing agency to perform these quality-control services.
    - a. Contractor shall not employ same entity engaged by Owner, unless agreed to in writing by Owner.
  2. Notify testing agencies at least **48** hours in advance of time when Work that requires testing or inspecting will be performed.
  3. Where quality-control services are indicated as Contractor's responsibility, submit a certified written report, in duplicate, of each quality-control service.

4. Testing and inspecting requested by Contractor and not required by the Contract Documents are Contractor's responsibility.
  5. Submit additional copies of each written report directly to authorities having jurisdiction, when they so direct.
- C. **Manufacturer's Field Services:** Where indicated, engage a manufacturer's representative to observe and inspect the Work. Manufacturer's representative's services include examination of substrates and conditions, verification of materials, inspection of completed portions of the Work, and submittal of written reports.
- D. **Retesting/Reinspecting:** Regardless of whether original tests or inspections were Contractor's responsibility, provide quality-control services, including retesting and reinspecting, for construction that replaced Work that failed to comply with the Contract Documents.
- E. **Testing Agency Responsibilities:** Cooperate with Architect and Contractor in performance of duties. Provide qualified personnel to perform required tests and inspections.
1. Notify Architect and Contractor promptly of irregularities or deficiencies observed in the Work during performance of its services.
  2. Determine the location from which test samples will be taken and in which in-situ tests are conducted.
  3. Conduct and interpret tests and inspections and state in each report whether tested and inspected work complies with or deviates from requirements.
  4. Submit a certified written report, in duplicate, of each test, inspection, and similar quality-control service through Contractor.
  5. Do not release, revoke, alter, or increase the Contract Document requirements or approve or accept any portion of the Work.
  6. Do not perform any duties of Contractor.
- F. **Associated Services:** Cooperate with agencies performing required tests, inspections, and similar quality-control services, and provide reasonable auxiliary services as requested. Notify agency sufficiently in advance of operations to permit assignment of personnel. Provide the following:
1. Access to the Work.
  2. Incidental labor and facilities necessary to facilitate tests and inspections.
  3. Adequate quantities of representative samples of materials that require testing and inspecting. Assist agency in obtaining samples.
  4. Facilities for storage and field curing of test samples.
  5. Delivery of samples to testing agencies.
  6. Preliminary design mix proposed for use for material mixes that require control by testing agency.

7. Security and protection for samples and for testing and inspecting equipment at Project site.
- G. Coordination: Coordinate sequence of activities to accommodate required quality-assurance and -control services with a minimum of delay and to avoid necessity of removing and replacing construction to accommodate testing and inspecting.
  1. Schedule times for tests, inspections, obtaining samples, and similar activities.

## 1.8 SPECIAL TESTS AND INSPECTIONS

- A. Special Tests and Inspections: **Owner will engage** a qualified **testing agency** and/or **special inspector** to conduct special tests and inspections required by authorities having jurisdiction as the responsibility of Owner, **as indicated in Statement of Special Inspections attached to this Section**, and as follows:
- B. Special Tests and Inspections: Conducted by a qualified **testing agency** or **special inspector** as required by authorities having jurisdiction, as indicated in individual Specification Sections, and as follows:
  1. Verifying that manufacturer maintains detailed fabrication and quality-control procedures and reviewing the completeness and adequacy of those procedures to perform the Work.
  2. Notifying Architect and Contractor promptly of irregularities and deficiencies observed in the Work during performance of its services.
  3. Submitting a certified written report of each test, inspection, and similar quality-control service to Architect with copy to Contractor and to authorities having jurisdiction.
  4. Submitting a final report of special tests and inspections at Substantial Completion, which includes a list of unresolved deficiencies.
  5. Interpreting tests and inspections and stating in each report whether tested and inspected work complies with or deviates from the Contract Documents.
  6. Retesting and reinspecting corrected work.

## **PART 2 - PRODUCTS (Not Used)**

## **PART 3 - EXECUTION**

### 3.1 REPAIR AND PROTECTION

- A. General: On completion of testing, inspecting, sample taking, and similar services, repair damaged construction and restore substrates and finishes.
  1. Provide materials and comply with installation requirements specified in other Specification Sections or matching existing substrates and finishes. Restore patched areas and extend restoration into adjoining areas with durable seams that are as invisible

as possible. Comply with the Contract Document requirements for cutting and patching in Division 1 Section "Execution Requirements."

- B. Protect construction exposed by or for quality-control service activities.
- C. Repair and protection are Contractor's responsibility, regardless of the assignment of responsibility for quality-control services.

END OF SECTION

**SECTION 01 45 29  
TESTING AND INSPECTION**

**1.01 SUMMARY**

- A. Section Includes: Cooperate with the Owner's selected testing agency, the Project Inspector, and others responsible for testing and inspecting the Work, and assist the Owner by coordinating such testing and inspecting services as specified in this Section and/or elsewhere in the Contract Documents including the attached Division of State Architect Structural Tests and Inspections sheet (enclosed).
- B. Related Work Specified Elsewhere:
  - 1. Requirements for testing may be required in other Sections of these Specifications.
  - 2. Where no testing requirements are specified or required by reference standards or authorities having jurisdiction, the Owner may require such testing to be performed under current pertinent standards for testing. Payment for such testing will be made as described herein.
- C. Work Not Included:
  - 1. The Owner will select a pre-qualified independent testing laboratory and Inspector as approved by the Division of the State Architect, Office of Regulation Services.
  - 2. The Owner will pay for initial services of the testing laboratory as further described hereinafter.

**1.02 QUALITY ASSURANCE**

- A. The Owner will select an independent testing laboratory to conduct the tests. Selection of the material required to be tested shall be by the laboratory or the Owner's representative and not by the Contractor.
- B. Qualifications of Testing Laboratory: The testing laboratory shall be qualified to the Owner's acceptance in accordance with ASTM E 329. The testing laboratory shall be qualified by the Division of State Architect in accordance with Interpretation of Regulation No. 1R1-1.
- C. Codes and Standards: Testing, when required, will be in accordance with pertinent codes and regulations and with selected standards of the American Society for Testing and Materials and other organizations or agencies which publish recognized codes, standards, or tests. Refer to Article 3.04 – Required Testing of this Section.
- D. The project specifications shall be in accordance with the provisions of the Standard Specifications for Public Works Construction (SSPWC) 2018 Edition.

**1.03 TEST REPORT DISTRIBUTION**

- A. Promptly process and distribute required copies of test reports and related instructions to ensure necessary retesting and/or replacement of materials with the least possible delay in progress of the Work.

- B. One copy of test reports shall be forwarded to the Division of the State Architect by the testing agency. Such reports shall include tests made, regardless of whether such tests indicate that the material is satisfactory or unsatisfactory. Samples taken but not tested shall also be reported. Records of special sampling operations as required shall also be reported. The reports shall show that the material or materials were sampled and tested in accordance with the requirements of Title 24 and with the approved specifications. Test reports shall show the specified design strength. They shall also state definitely whether or not the material or materials tested comply with requirements.
- C. Each testing agency shall submit to the Division of the State Architect a verified report in duplicate covering tests which are required to be made by that agency during the progress of the project. Such report shall be furnished each time that work on the project is suspended, including tests up to that time, and at the completion of the project.

#### 1.04 PAYMENT FOR TESTING SERVICES

- A. Initial Services: The Owner will pay for initial testing and inspection except as specifically modified herein-after or as specified otherwise in technical sections. Provided the results of inspection indicating compliance with the Contract Documents.
- B. Retesting: When initial tests or inspection indicate noncompliance with the Contract Documents, subsequent retesting or re-inspection occasioned by the noncompliance shall be performed by the same testing laboratory or Inspector and the costs thereof will be deducted by the Owner from the Contract Sum. Retesting and re-inspection will continue until test or inspection results indicate compliance.
- C. Code Compliance Testing: Inspections and tests required by codes or ordinances, or by authorities having jurisdiction and made by a legally constituted authority, shall be the responsibility of and shall be paid for by the Owner, but back charged to the Contractor in case of retesting due to noncompliance.
- D. Specified Inspections and Tests: Tests and inspections specified in the Specifications, directly or by reference, shall be coordinated by the Contractor at his expense and paid for by the Owner. Corrections of noncompliance and test failures shall be paid for by the Owner, but shall be back charged to the Contractor. Re-inspection and retesting shall be in accordance with paragraph 1.04-B.
- E. Contractor's Convenience Testing: Inspecting or testing performed exclusively for the Contractor's convenience shall be the sole responsibility of and at the expense of the Contractor.

#### 1.05 INSPECTION BY THE OWNER

- A. The Owner and his representatives will have access, for the purpose of inspection, to parts of the work and to the shops wherein the work is in preparation, and the Contractor shall maintain proper facilities and provide safe access for such inspection.
- B. The Owner shall have the right to reject materials and workmanship which are defective, and to require their correction. Rejected workmanship shall be satisfactorily corrected and rejected materials shall be removed from the premises without charge to the Owner. If the Contractor does not correct such rejected within a reasonable time, fixed by written notice, the Owner may correct rejected work and charge the expense to the Contractor.
- C. Should it be considered necessary or advisable by the Owner at any time before final acceptance of the entire work to make an examination of work already completed by removing or tearing out the same, the Contractor shall on request promptly furnish

necessary facilities, labor and materials. If such work is found to be defective in respect due to fault of the Contractor or his subcontractor, he shall defray expenses of such examinations and of satisfactory reconstruction. If, however, such work is found to meet the requirements of the contract, the additional cost of labor and material necessarily involved in the examination and replacement will be allowed the Contractor.

## 1.06 PROJECT INSPECTOR

- A. An Inspector employed by the Owner in accordance with the requirements of State of California Building Code, Title 24, Part 1, and qualified in accordance with Division of State Architect will be assigned to the work. His duties are specifically defined in Title 24, Part 1, Section 4-342, reprinted herein:

### 42. Duties of the Project Inspector.

- (A) General: The Project Inspector shall act under the direction of the A/E/Engineer.
- (B) Duties: The general duties of the Project Inspector in fulfilling his or her responsibilities are as follows:
- (1) Inspection: He or she must have actual personal knowledge, obtained by his personal inspection of the work of construction in stages of its progress, that the requirements of the approved plans and specifications are being completely executed.

Inspection means complete inspection of every part of the work. Work, such as concrete work or brick work which can be inspected only as it is placed, shall require the constant presence of the Project Inspector. Other types of work which can be completely inspected after the work is installed may be carried on while the Inspector is not present. In any case, the Project Inspector must personally inspect every part of the work. In no case shall the Project Inspector have or assume duties which will prevent him or her from providing inspection.

The Project Inspector may obtain personal knowledge of the work of construction, either on-site or off-site, performed under the inspection of a Special Inspector or Assistant Inspector from the reporting of others on testing or inspection of materials and workmanship for compliance with the plans, specifications and applicable standards. The exercise of reasonable diligence to obtain the facts shall be required.

- (2) Relations with A/E/Engineer: The Project Inspector shall work under the general direction of the A/E/Engineer. Inconsistencies or seeming errors in the A/E/Engineer for his interpretation and instructions. In no case, however, shall the instruction of the A/E/Engineer be construed to cause work to be done which is not in conformity with the approved plans, specifications, and change orders.
- (3) Job File: The Project Inspector shall keep a file of approved plans and specifications (including approved addenda or change orders) on the job, and shall immediately return unapproved documents to the A/E for proper action. The

Project Inspector, as a condition of his employment, shall have and maintain on the job, codes and documents referred to in the plans and specifications.

(4) Project Inspector's Semi-Monthly Reports: The Project Inspector shall keep the A/E/Engineer thoroughly informed as to the progress of the work by making semi-monthly reports in writing as required in Section 37.

(5) Construction Procedure Records: The Project Inspector shall keep a record of certain phases of construction procedure.

All such records of construction procedure shall be kept on the job until the completion of the work. These records shall be made a part of the permanent school records.

(6) Deviations: The Project Inspector shall notify the Contractor, in writing, of deviations from the approved plans and specifications which are not immediately corrected by the Contractor when brought to his or her attention. Copies of such notice shall be forwarded immediately to the A/E/Engineer.

Failure on the part of the Project Inspector to notify the Contractor of deviations from the approved plans and specifications shall in no way relieve the Contractor of responsibility to complete the work covered by his or her contract in accordance with the approved plans and specifications and laws and regulations.

(7) Verified Reports: The Project and Special Inspectors shall each make and submit to the Division of the State Architect verified reports.

The Project Inspector shall prepare and deliver to the Division of the State Architect detailed statements of fact regarding materials, operations, etc., when requested.

(C) Violations: Failure, refusal, or neglect on the part of the Inspector to notify the Contractor of work which does not comply with the requirements of the approved plans and specifications, or failure, refusal, or neglect to report immediately, in writing, such violation to the A/E/Engineer, to the School Board, and to the Division of the State Architect shall constitute a violation of the act and shall be cause for the Division of the State Architect to take action.

Note: Authority cited: Section 39152 and 81142, Education Code.  
Reference: Sections 39151, 39153, 81141 and 81143, Education Code."

B. The work of construction in stages of progress shall be subject to the personal continuous observation of the Project Inspector as continuous observation is defined by Title 24. He shall have free access to all parts of the work at any time. The Contractor shall furnish the Project Inspector reasonable facilities for obtaining such information as may be necessary to keep him fully informed respecting the progress and manner of the work and the character of the materials. Inspection of the work shall not relieve the Contractor from obligation to fulfill this Contract.

1.07 OWNER'S OTHER PERSONNEL

- A. From time to time, other personnel in the employ of the Owner may inspect the Work when the Work is in progress but shall have no authority to direct the Contractor or request changes in the Work except as may be provided elsewhere in the Contract Documents.

1.08 REPRESENTATIVE OF THE DIVISION OF THE STATE ARCHITECT

- A. Architect shall have access to the site in accordance with Title 24, Part 1, 4-333.
- B. Field Engineers and Inspectors from D.S.A. Structural Safety Section, Fire & Life Safety Review and Access Compliance shall have access to the site in accordance with Title 24, Part 1, 4-334.

**PART 2 - PRODUCTS**

(Not Applicable)

**PART 3 - EXECUTION**

3.01 COOPERATION WITH TESTING LABORATORY AND INSPECTORS

- A. Inspectors and representatives of the testing laboratory shall have access to the work. Provide facilities for such access in order that the testing, inspection, and the obtaining of samples may be done properly.
- B. Contractor shall deliver material specimens to the Owner's testing lab, which must by terms of the Contract be tested prior to inclusion in the Project, at least 45 days prior to scheduled delivery to the job site.
- C. Material shipped by the Contractor from the source of supply prior to having satisfactorily passed such testing and inspection or prior to the receipt of notice from said representative that such testing and inspection will not be required shall not be incorporated in the job.

3.02 TAKING SPECIMENS

- A. Field specimens and samples for testing, unless otherwise provided in these Contract Documents, shall be selected and taken by the Testing Laboratory or Project Inspector and not the Contractor. Sampling equipment and personnel will be provided by the testing laboratory. Deliveries of specimens and samples to the testing laboratory will be performed by the testing laboratory. Soil samples for approval of import fill shall be picked-up by the Testing Laboratory.

3.03 SCHEDULES FOR TESTING

- A. Establishing Schedule:
  - 1. By advance discussion with the testing laboratory selected by the Owner, determine the time required for the laboratory to perform its tests and to issue each of its findings.
  - 2. Provide required time within the construction schedule.

- B. Revising Schedule: When changes of construction schedule are necessary during construction, coordinate such changes of schedule with the testing laboratory as required.
- C. Adherence to Schedule: When the testing laboratory is ready to test according to the determined schedules, but is prevented from testing or taking specimens due to incompleteness of the work, extra charges for testing attributable to the delay may be back-charged to the Contractor and will be deducted by the Owner from the Contract Sum.

3.04 REQUIRED TESTING

Tests and inspections for the following items, where applicable, will be required in accordance with referenced Sections/Chapters of California Building Code, 2016 Edition, Title 24, Part 2:

A. FOUNDATIONS & RETAINING WALL:

1. INSPECTION:

- a. Inspection of Driven Deep Foundations 1704A.8
- b. Inspection of Cast-In-Place Deep Foundation 1704A.9

B. CONCRETE (Chapter 19A)

1. MATERIALS:

- a. Portland Cement 1704A.4.1;  
1916A.1
- b. Concrete Aggregates 1704A.4.1;  
1903A.3
- c. Shotcrete Aggregates 1913A.3
- d. Reinforcing Bars 1704A.4.1;  
1916A.2
- e. Pre-stressing Steel & Anchorage 1704A.4.1;  
1916A.3

2. QUALITY:

- a. Proportions of Concrete 1905A.2;  
1905A.3;  
1905A.4
- b. Strength Tests of Concrete 1905A.1.1;  
1905A.6
- c. Shotcrete Proportions 1913A.2
- d. Shotcrete Cores 1913A.5
- e. Composite Construction Cores 1916A.4

	f.	Gypsum Concrete Strength Tests	1914A; 1916A.6
3.		INSPECTION:	
	a.	Job Site	1905A.7
	b.	Batch Plant	1704A.4.2
	c.	Waiver of Batch Plant	1704A.4.3
	d.	Prestressed Concrete	1704A.4.4
	e.	Shotcrete	1704A.17; 1913A
	f.	Reinforcing Bar Welding	1903A.7; Table 1704A.3
	g.	Post-Installed Anchors in Concrete	1916A.7
C.		LIGHT WEIGHT METALS	
1.		MATERIALS	
	a.	Alloys	2002.1
	b.	Identification	2002.1
2.		INSPECTION	
	a.	Welding	2003.1
D.		MASONRY	
1.		MATERIALS	
	a..	Masonry units	2103A.1
	b.	Portland cement, lime	2103A
	c.	Mortar and grout aggregates	2103A.8; 2103A.12; 2103A.12.3
	d.	Reinforcing bars	2103A.13
2.		QUALITY	
	a.	Portland cement tests	1916A.1
	b.	Mortar and grout tests	2105A.2.2.1.4
	c.	Masonry prism test	2105A.2.2.2
	d.	Masonry core tests	2105A.4

	e.	Masonry Unit Test	2105A.2.2.1
	f.	Reinforcing bar tests	1916A.2
3.		INSPECTION	
	a.	Reinforced masonry	1704A.5
	b.	Reinforced Bar Welding	1704A.3.1.3; 1903A.7
E.		STRUCTURAL STEEL	
1.		MATERIALS	
	a.	Structural Steel	2205A.1
	b.	Cold Form Steel	2209A.1
	c.	Identification	2203A.1
2.		QUALITY	
	a.	Tests of Structural and Cold Form Steel	2210A.1
	b.	Tests of High Strength Bolts, Nuts, Washers	2212A.1
	c.	Tests of End Welded Studs	2212A.2
	d.	Steel Joists	2206A; 1704A.3.2.1
	e.	Non-Destructive Weld Tests	1704A.3.1
3.		INSPECTION	
	a.	Shop Fabrication	1704A.2; 1704A.3
	b.	Welding	1704A.3.1
	c.	Nelson Stud Welding	1704A.3
	d.	High Strength Bolt Installation	1704A.3.3
F.		WOOD	
1.		MATERIALS:	
	a.	Lumber and plywood	2303.1
	b.	Glued Laminated Members	2303.1.3
2.		INSPECTION:	
	a.	Glued Laminated Fabrication	1704A.6.3.1; 2303.1.3

- b. Timber Connectors 1704A.6.4
- c. Manufactured Trusses 1704A.6.2;  
1704.6.3.2;  
2303.4.7

END OF SECTION

**SECTION 01 50 00  
TEMPORARY FACILITIES AND CONTROLS**

**PART 1 - GENERAL**

1.1 SUMMARY

- A. Section includes requirements for temporary utilities, support facilities, and security and protection facilities.
- B. Related Section:
  - 1. Division 1 Section "Summary" for limitations on work restrictions and utility interruptions.

1.2 USE CHARGES

- A. General: Installation and removal of and use charges for temporary facilities shall be included in the Contract Sum unless otherwise indicated. Allow other entities to use temporary services and facilities without cost, including, but not limited to, Owner's construction forces, Architect, occupants of Project, testing agencies, and authorities having jurisdiction.
- B. Water and Sewer Service from Existing System: Water from Owner's existing water system is available for use without metering and without payment of use charges. Provide connections and extensions of services as required for construction operations.
- C. Electric Power Service from Existing System: Electric power from Owner's existing system is available for use without metering and without payment of use charges. Provide connections and extensions of services as required for construction operations.

1.3 INFORMATIONAL SUBMITTALS

- A. Site Plan: Show temporary facilities, utility hookups, staging areas, and parking areas for construction personnel.
- B. Erosion- and Sedimentation-Control Plan: Show compliance with requirements of EPA Construction General Permit or authorities having jurisdiction, whichever is more stringent.

1.4 QUALITY ASSURANCE

- A. Electric Service: Comply with NECA, NEMA, and UL standards and regulations for temporary electric service. Install service to comply with NFPA 70.
- B. Tests and Inspections: Arrange for authorities having jurisdiction to test and inspect each temporary utility before use. Obtain required certifications and permits.
- C. Accessible Temporary Egress: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines and ICC/ANSI A117.1.

## 1.5 PROJECT CONDITIONS

- A. Temporary Use of Permanent Facilities: Engage installer of each permanent service to assume responsibility for operation, maintenance, and protection of each permanent service during its use as a construction facility before Owner's acceptance, regardless of previously assigned responsibilities.

## PART 2 - PRODUCTS

### 2.1 MATERIALS

- A. Chain-Link Fencing: Minimum 2-inch (50-mm), 0.148-inch- (3.8-mm-) thick, galvanized steel, chain-link fabric fencing; minimum 6 feet (1.8 m) high with galvanized steel pipe posts; minimum 2-3/8-inch- (60-mm-) OD line posts and 2-7/8-inch- (73-mm-) OD corner and pull posts, with 1-5/8-inch- (42-mm-) OD top rails. Provide privacy fabric screen.
- B. Portable Chain-Link Fencing: Minimum 2-inch (50-mm), 0.148-inch- (3.8-mm-) thick, galvanized steel, chain-link fabric fencing; minimum 6 feet (1.8 m) high with galvanized steel pipe posts; minimum 2-3/8-inch- (60-mm-) OD line posts and 2-7/8-inch- (73-mm-) OD corner and pull posts, with 1-5/8-inch- (42-mm-) OD top and bottom rails. Provide galvanized steel bases for supporting posts. Provide privacy fabric screen.

### 2.2 TEMPORARY FACILITIES

- A. Field Offices, General: Required.
- B. Common-Use Field Office: Required.
- C. Inspector Office: Contractor to provide 20'-0" X 8'-0" prefabricated or mobile unit with serviceable finishes, temperature controls, power, data, phone service and foundations adequate for normal loading. Office to be used exclusively by Inspector of Record during construction. Access to trailer shall be through gate in temporary fencing.

### 2.3 EQUIPMENT

- A. Fire Extinguishers: Portable, UL rated; with class and extinguishing agent as required by locations and classes of fire exposures.

## PART 3 - EXECUTION

### 3.1 INSTALLATION, GENERAL

- A. Locate facilities where they will serve Project adequately and result in minimum interference with performance of the Work. Relocate and modify facilities as required by progress of the Work.
  - 1. Locate facilities to limit site disturbance as specified in Division 1 Section "Summary."

- B. Provide each facility ready for use when needed to avoid delay. Do not remove until facilities are no longer needed or are replaced by authorized use of completed permanent facilities.

### 3.2 TEMPORARY UTILITY INSTALLATION

- A. General: Install temporary service or connect to existing service.
  - 1. Arrange with utility company, Owner, and existing users for time when service can be interrupted, if necessary, to make connections for temporary services.
- B. Water Service: Install water service and distribution piping in sizes and pressures adequate for construction.
- C. Water Service: Connect to Owner's existing water service facilities. Clean and maintain water service facilities in a condition acceptable to Owner. At Substantial Completion, restore these facilities to condition existing before initial use.
- D. Sanitary Facilities: Provide temporary toilets, wash facilities, and drinking water for use of construction personnel. Comply with requirements of authorities having jurisdiction for type, number, location, operation, and maintenance of fixtures and facilities. Contractor not to use adjacent school toilet facilities.
- E. Heating and/or Cooling: Provide temporary heating and cooling required by construction activities for curing or drying of completed installations or for protecting installed construction from adverse effects of low temperatures or high humidity. Select equipment that will not have a harmful effect on completed installations or elements being installed.
- F. Ventilation and Humidity Control: Provide temporary ventilation required by construction activities for curing or drying of completed installations or for protecting installed construction from adverse effects of high humidity. Select equipment that will not have a harmful effect on completed installations or elements being installed. Coordinate ventilation requirements to produce ambient condition required and minimize energy consumption.
- G. Electric Power Service: Connect to Owner's existing electric power service. Maintain equipment in a condition acceptable to Owner.
- H. Electric Power Service: Provide electric power service and distribution system of sufficient size, capacity, and power characteristics required for construction operations.
  - 1. Install electric power service overhead or underground, unless otherwise indicated.
  - 2. Connect temporary service to Owner's existing power source, as directed by Owner.
- I. Lighting: Provide temporary lighting with local switching that provides adequate illumination for construction operations, observations, inspections, and traffic conditions.
  - 1. Install and operate temporary lighting that fulfills security and protection requirements without operating entire system.
- J. Telephone Service: Provide temporary telephone service in common-use facilities for use by all construction personnel. Install one telephone line(s) for each field office.
  - 1. Provide additional telephone lines for the following:

- a. Provide a dedicated telephone line for each facsimile machine in each field office.
2. At each telephone, post a list of important telephone numbers.
  - a. Police and fire departments.
  - b. Ambulance service.
  - c. Contractor's home office.
  - d. Architect's office.
  - e. Engineers' offices.
  - f. Owner's office.
  - g. Principal subcontractors' field and home offices.
3. Provide superintendent with cellular telephone or portable two-way radio for use when away from field office.

### 3.3 SUPPORT FACILITIES INSTALLATION

#### A. General: Comply with the following:

1. Provide construction for temporary offices, shops, and sheds located within construction area or within 30 feet (9 m) of building lines that is noncombustible according to ASTM E 136. Comply with NFPA 241.
2. Maintain support facilities until Architect schedules Substantial Completion inspection. Remove before Substantial Completion. Personnel remaining after Substantial Completion will be permitted to use permanent facilities, under conditions acceptable to Owner.

#### B. Temporary Use of Permanent Roads and Paved Areas: Locate temporary roads and paved areas in same location as permanent roads and paved areas. Construct and maintain temporary roads and paved areas adequate for construction operations. Extend temporary roads and paved areas, within construction limits indicated, as necessary for construction operations.

1. Coordinate elevations of temporary roads and paved areas with permanent roads and paved areas.
2. Prepare subgrade and install subbase and base for temporary roads and paved areas according to Division 2 Section "Earthwork."
3. Recondition base after temporary use, including removing contaminated material, regrading, proofrolling, compacting, and testing.
4. Delay installation of final course of permanent hot-mix asphalt pavement until immediately before Substantial Completion. Repair hot-mix asphalt base-course pavement before installation of final course according to Division 2 Section "Asphalt Paving."

- C. Traffic Controls: Comply with requirements of authorities having jurisdiction.
  - 1. Protect existing site improvements to remain including curbs, pavement, and utilities.
  - 2. Maintain access for fire-fighting equipment and access to fire hydrants.
- D. Parking: Street parking is available as posted.
- E. Dewatering Facilities and Drains: Comply with requirements of authorities having jurisdiction. Maintain Project site, excavations, and construction free of water.
  - 1. Dispose of rainwater in a lawful manner that will not result in flooding Project or adjoining properties nor endanger permanent Work or temporary facilities.
  - 2. Remove snow and ice as required to minimize accumulations.
- F. Project Signs: Provide Project signs as indicated. Unauthorized signs are not permitted.
  - 1. Identification Signs: Provide Project identification signs as indicated on Drawings.
  - 2. Temporary Signs: Provide other signs as indicated and as required to inform public and individuals seeking entrance to Project.
    - a. Provide temporary, directional signs for construction personnel and visitors.
  - 3. Maintain and touchup signs so they are legible at all times.
- G. Waste Disposal Facilities: Comply with requirements specified in Division 1 Section "Construction Waste Management."
- H. Waste Disposal Facilities: Provide waste-collection containers in sizes adequate to handle waste from construction operations. Comply with requirements of authorities having jurisdiction. Comply with Division 1 Section "Execution Requirements" for progress cleaning requirements.
- I. Lifts and Hoists: Provide facilities necessary for hoisting materials and personnel.
  - 1. Truck cranes and similar devices used for hoisting materials are considered "tools and equipment" and not temporary facilities.
- J. Temporary Elevator Use: Use of elevators is not permitted.
- K. Temporary Stairs: Until permanent stairs are available, provide temporary stairs where ladders are not adequate.
- L. Existing Stair Usage: Use of Owner's existing stairs will be permitted, provided stairs are cleaned and maintained in a condition acceptable to Owner. At Substantial Completion, restore stairs to condition existing before initial use.
  - 1. Provide protective coverings, barriers, devices, signs, or other procedures to protect stairs and to maintain means of egress. If stairs become damaged, restore damaged areas so no evidence remains of correction work.

- M. Temporary Use of Permanent Stairs: Use of new stairs for construction traffic will be permitted, provided stairs are protected and finishes restored to new condition at time of Substantial Completion.

### 3.4 SECURITY AND PROTECTION FACILITIES INSTALLATION

- A. Environmental Protection: Provide protection, operate temporary facilities, and conduct construction as required to comply with environmental regulations and that minimize possible air, waterway, and subsoil contamination or pollution or other undesirable effects.
- B. Temporary Erosion and Sedimentation Control: Comply with requirements of the latest SWRCB Construction General Permit or authorities having jurisdiction, whichever is more stringent and requirements specified in Division 2 Section "Site Clearing."
- C. Temporary Erosion and Sedimentation Control: Provide measures to prevent soil erosion and discharge of soil-bearing water runoff and airborne dust to undisturbed areas and to adjacent properties and walkways, according to requirements of the latest SWRCB Construction General Permit or authorities having jurisdiction, whichever is more stringent.
- D. Stormwater Control: Comply with requirements of authorities having jurisdiction. Provide barriers in and around excavations and subgrade construction to prevent flooding by runoff of stormwater from heavy rains.
- E. Tree and Plant Protection: Comply with requirements specified in Division 2 Section "Tree Protection and Trimming."
- F. Tree and Plant Protection: Install temporary fencing located as indicated or outside the drip line of trees to protect vegetation from damage from construction operations. Protect tree root systems from damage, flooding, and erosion.
- G. Pest Control: Engage pest-control service to recommend practices to minimize attraction and harboring of rodents, roaches, and other pests and to perform extermination and control procedures at regular intervals so Project will be free of pests and their residues at Substantial Completion. Obtain extended warranty for Owner. Perform control operations lawfully, using environmentally safe materials.
- H. Site Enclosure Fence: Before construction operations begin, furnish and install site enclosure fence in a manner that will prevent people and animals from easily entering site except by entrance gates.
  - 1. Extent of Fence: As required to enclose entire Project site or portion determined sufficient to accommodate construction operations.
  - 2. Maintain security by limiting number of keys and restricting distribution to authorized personnel.
- I. Security Enclosure and Lockup: Install temporary enclosure around partially completed areas of construction. Provide lockable entrances to prevent unauthorized entrance, vandalism, theft, and similar violations of security. Lock entrances at end of each work day.
- J. Barricades, Warning Signs, and Lights: Comply with requirements of authorities having jurisdiction for erecting structurally adequate barricades, including warning signs and lighting.

- K. Temporary Egress: Maintain temporary egress from existing occupied facilities as indicated and as required by authorities having jurisdiction.
- L. Temporary Enclosures: Provide temporary enclosures for protection of construction, in progress and completed, from exposure, foul weather, other construction operations, and similar activities. Provide temporary weathertight enclosure for building exterior.
  - 1. Where heating or cooling is needed and permanent enclosure is not complete, insulate temporary enclosures.
- M. Temporary Fire Protection: Install and maintain temporary fire-protection facilities of types needed to protect against reasonably predictable and controllable fire losses. Comply with NFPA 241.
  - 1. Prohibit smoking in construction areas.
  - 2. Supervise welding operations, combustion-type temporary heating units, and similar sources of fire ignition according to requirements of authorities having jurisdiction.
  - 3. Develop and supervise an overall fire-prevention and -protection program for personnel at Project site. Review needs with local fire department and establish procedures to be followed. Instruct personnel in methods and procedures. Post warnings and information.
  - 4. Provide temporary standpipes and hoses for fire protection. Hang hoses with a warning sign stating that hoses are for fire-protection purposes only and are not to be removed. Match hose size with outlet size and equip with suitable nozzles.

### 3.5 MOISTURE AND MOLD CONTROL

- A. Contractor's Moisture Protection Plan: Avoid trapping water in finished work. Document visible signs of mold that may appear during construction.
- B. Exposed Construction Phase: Before installation of weather barriers, when materials are subject to wetting and exposure and to airborne mold spores, protect materials from water damage and keep porous and organic materials from coming into prolonged contact with concrete.
- C. Partially Enclosed Construction Phase: After installation of weather barriers but before full enclosure and conditioning of building, when installed materials are still subject to infiltration of moisture and ambient mold spores, protect as follows:
  - 1. Do not load or install drywall or other porous materials or components, or items with high organic content, into partially enclosed building.
  - 2. Keep interior spaces reasonably clean and protected from water damage.
  - 3. Discard or replace water-damaged and wet material.
  - 4. Discard, replace or clean stored or installed material that begins to grow mold.
  - 5. Perform work in a sequence that allows any wet materials adequate time to dry before enclosing the material in drywall or other interior finishes.

- D. Controlled Construction Phase of Construction: After completing and sealing of the building enclosure but prior to the full operation of permanent HVAC systems, maintain as follows:
  - 1. Control moisture and humidity inside building by maintaining effective dry-in conditions.
  - 2. Remove materials that can not be completely restored to their manufactured moisture level within **48** hours.

### 3.6 OPERATION, TERMINATION, AND REMOVAL

- A. Supervision: Enforce strict discipline in use of temporary facilities. To minimize waste and abuse, limit availability of temporary facilities to essential and intended uses.
- B. Maintenance: Maintain facilities in good operating condition until removal.
  - 1. Maintain operation of temporary enclosures, heating, cooling, humidity control, ventilation, and similar facilities on a 24-hour basis where required to achieve indicated results and to avoid possibility of damage.
- C. Temporary Facility Changeover: Do not change over from using temporary security and protection facilities to permanent facilities until Substantial Completion.
- D. Termination and Removal: Remove each temporary facility when need for its service has ended, when it has been replaced by authorized use of a permanent facility, or no later than Substantial Completion. Complete or, if necessary, restore permanent construction that may have been delayed because of interference with temporary facility. Repair damaged Work, clean exposed surfaces, and replace construction that cannot be satisfactorily repaired.
  - 1. Materials and facilities that constitute temporary facilities are property of Contractor. Owner reserves right to take possession of Project identification signs.
  - 2. At Substantial Completion, repair, renovate, and clean permanent facilities used during construction period. Comply with final cleaning requirements specified in Division 1 Section "Closeout Procedures."

END OF SECTION

**SECTION 01 58 13  
TEMPORARY PROJECT SIGNAGE**

**PART 1 – GENERAL**

1.01 PROJECT IDENTIFICATION

- A. Provide two 32 square foot Project Identification signs of wood frame and exterior grade plywood construction, painted, with exhibit lettering by professional sign painter, to District's design and colors.
1. Confer with District for confirmation of names prior to lettering signs.
  2. Ground Clearance: Two feet.
  3. Materials: ½" MDO panel or exterior grade plywood panel with vertical structural members of 4x8 #2 creosote treated Douglas fir installed to depth of 4 feet below grade.
    - a. Stringers: 2x2 stingers of dense #1 Douglas fir, located behind top, bottom, and center of sign panel.
  4. Paint: Sign panel and structural members shall be painted on all sides and edges with two coats of exterior type alkyd paint over suitable primer and professionally lettered or silk screened.
  5. Typefaces: Optima.
  6. Seal: Obtain from District. Coordinate with Project Manager.
- B. Erect one sign at each street front site at locations established by District. Position parallel with street and locate in areas which will not interfere with construction activities.
- Signs: Remain on site until the buildings permanent exterior signing is installed, or as otherwise directed by the District.
- No other signs shall be permitted.
- C. Signs shall include the following:
1. Name of the School
  2. Title of Project.
  3. Rendering of the Project
  4. Seal of the District.
  5. Logo of Measure TT Program
  6. Logo/Name of the Architect
  7. Logo/Name of the Contractor
- D. The project sign must be erected within 35 calendar days after Notice of award of this contract.

**PART 2 – PRODUCTS (NOT USED)**

**PART 3 – EXECUTION (NOT USED)**

END OF SECTION

**SECTION 01 60 20  
STORAGE AND PROTECTION**

**PART 1 – GENERAL**

1.1 SUMMARY

- A. Protect products scheduled for use in the Work by means including, but not necessarily limited to, those described in this Section.
- B. Related work:
  - 1. Documents affecting work of this Section include, but are not necessarily limited to the General Conditions and Supplementary Conditions.
  - 2. Additional procedures also may be prescribed in other Sections of these Specifications.

1.2 QUALITY ASSURANCE

- A. Include within the Contractor's quality assurance program such procedures as are required to assure full protection of work and materials.

1.3 MANUFACTURERS' RECOMMENDATIONS

- A. Except as otherwise approved by the District, determine and comply with manufacturers' recommendations on product handling, storage, and protection.

1.4 PACKAGING

- A. Deliver products to the job site in their manufacturer's original container, with labels intact and legible.
  - 1. Maintain packaged materials with seals unbroken and labels intact until time of use.
  - 2. Promptly remove damaged material and unsuitable items from the job site, and promptly replace with material meeting the specified requirements, at no additional cost to the Owner.
- B. The District may reject as non-complying such material and products that do not bear identification satisfactory to the District as to manufacturer, grade, quality, and other pertinent information.

1.5 PROTECTION

- A. Protect finished surfaces, including jambs and soffits of openings used as passageways, through which equipment and materials are handled.
- B. Provide protection for finished surfaces in traffic areas prior to allowing equipment or materials to be moved over such surfaces.

- C. Maintain finished surfaces clean, unmarred, and suitably protected until accepted by the Owner.

1.6 REPAIRS AND REPLACEMENTS

- A. In event of damage, promptly make replacements and repairs to the approval of the Architect and at no additional cost to the Owner.
- B. Additional time required to secure replacements and to make repairs will not be considered by the District to justify an extension in the Contract Time of Completion.

**PART 2 – PRODUCTS (NOT USED)**

**PART 3 – EXECUTION (NOT USED)**

END OF SECTION

**SECTION 01 77 00  
CLOSEOUT PROCEDURES**

**PART 1 – GENERAL**

1.01 SECTION INCLUDES

- A. Closeout Procedures.
- B. Final Cleaning.
- C. Pest Control.
- D. Adjusting.
- E. Demonstration and Instructions.
- F. Project Record Documents.
- G. Operation and Maintenance Data.
- H. Warranties.
- I. Spare Parts and Maintenance Materials.

1.02 CLOSEOUT PROCEDURES

- A. Submit written certification that Contract Documents have been reviewed, Work has been inspected, and that Work is complete in accordance with Contract Documents and ready for Architect's review.
- B. Prepare and submit to Architect a list of items to be completed or corrected, the value of the items on the list, and reasons why the Work is not complete.
- C. Submit written request to Architect for review of Work.
- D. Submit warranties, bonds, service agreements, certifications, record documents, maintenance manuals, receipt of spare parts and similar closeout documents.
- E. Make final changeover of permanent locks and deliver keys to Owner.
- F. Terminate and remove temporary facilities from Project site.
- G. Advise Owner of change over in heat and other utilities.
- H. Provide submittals to Architect that are required by governing or other authorities.
- I. Submit final Application for Payment identifying total adjusted Contract Sum, previous payments, and sum remaining due.
- J. Submit affidavit of payment of debts and claims, AIA Document G706.
- K. Submit affidavit of release of liens, AIA Document G706A.
- L. Submit consent of contractor's surety to final payment, AIA Document G707.

M. Owner will occupy all portions of the building as specified in Section 01110.

#### 1.03 FINAL CLEANING

- A. Execute final cleaning prior to final review by Architect.
- B. Employ experienced professional cleaners for final cleaning.
- C. Clean interior and exterior glass and surfaces exposed to view; remove temporary labels, stains and foreign substances, polish transparent and glossy surfaces.
- D. Vacuum carpeted and soft surfaces. Shampoo if visible stains exist.
- E. Clean equipment and plumbing fixtures to a sanitary condition.
- F. Clean exposed surfaces of grilles, registers and diffusers.
- G. Replace filters of operating mechanical equipment.
- H. Clean debris from roofs, gutters, downspouts, and drainage systems.
- I. Clean site; sweep paved areas, rake clean landscaped surfaces.
- J. Remove waste and surplus materials, rubbish, and construction facilities from the site.
- K. Clean light fixtures and replace burned out lamps and bulbs.
- L. Relamp all lamps and bulbs in lighting fixtures.
- M. Replace defective and noisy ballasts and starters in fluorescent fixtures.
- N. Leave project clean and ready for occupancy by Owner.

#### 1.04 PEST CONTROL

- A. Engage an experienced, licensed exterminator to make final inspection and rid Project of rodents, insects, and other pests. Submit final report to Architect.

#### 1.05 ADJUSTING

- A. Adjust operating Products and equipment to ensure smooth and unhindered operation.

#### 1.06 DEMONSTRATION AND INSTRUCTIONS

- A. Demonstrate operation and maintenance of products, systems, and equipment to Owner's personnel two weeks prior to date of final review.
- B. For each demonstration submit list of participants in attendance.
- C. Provide two copies of video tape of each demonstration and instructions session.
- D. For equipment or systems requiring seasonal operation, perform demonstration for other season within six months.
- E. Utilize operation and maintenance manuals as basis for instruction. Review contents of manual with Owner's personnel in detail to explain all aspects of operation and maintenance.

- F. Demonstrate start-up, operation, control, adjustment, trouble-shooting, servicing, maintenance, and shutdown of each item of equipment at agreed-upon times, at equipment location.
- G. Prepare and insert additional data in operations and maintenance manuals when need for additional data becomes apparent during instruction.

#### 1.07 PROJECT RECORD DOCUMENTS

- A. Maintain on site, one set of the following record documents; record actual revisions to the Work in contrasting color.
  - 1. Contract Drawings.
  - 2. Specifications.
  - 3. Addenda.
  - 4. Change Orders and other Modifications to the Contract.
  - 5. Reviewed shop drawings, product data, and samples.
- B. Store Record Documents separate from documents used for construction.
- C. Record information concurrent with construction progress.
- D. Specifications: Legibly mark and record at each Product Section in contrasting color ink, description of actual Products installed, including the following:
  - 1. Manufacturer's name and product model and number.
  - 2. Supplier and installer's name and contact information.
  - 3. Changes made by Addenda and Modifications.
- E. Contract Drawings and Shop Drawings: Legibly mark each item in contrasting color ink to record actual construction including:
  - 1. Measured horizontal and vertical locations of underground utilities and appurtenances, referenced to permanent surface improvements.
  - 2. Measured locations of internal utilities and appurtenances concealed in construction, referenced to visible and accessible features of the Work.
  - 3. Field changes of dimension and detail.
  - 4. Details not on original Contract Drawings.
  - 5. Revisions to electrical circuitry and locations of electrical devices and equipment.
  - 6. Note change orders, alternate numbers, and similar information, where applicable.
  - 7. Identify each record drawing with the written designation of "RECORD DRAWING" located in prominent location.

- F. Record Digital Data Files: Immediately before inspection for Substantial Completion, review marked-up record prints with Architect. When authorized, prepare a full set of corrected digital data files of the Contract Drawings, as follows:
  - 1. Format: Same digital data software program, version, and operating system as the original Contract Drawings.
  - 2. Format: Annotated PDF electronic file with comment function enabled.
  - 3. Incorporate changes and additional information previously marked on record prints. Delete, redraw, and add details and notations where applicable.
  - 4. Refer instances of uncertainty to Architect for resolution.
  - 5. Architect will furnish Contractor one set of digital data files of the Contract Drawings for use in recording information.
    - (a) Refer to Section 01 33 00 Submittal Procedures for requirements related to use of Architect's digital data files.
    - (b) Architect will provide data file layer information. Record markups in separate layers.
- G. Final Property Survey: Under the provisions of Section 01 77 20.
- H. Record Construction Schedule: Under the provisions of Section 01 31 00.
- I. Submit documents to Architect at time of Substantial Completion.

#### 1.08 OPERATION AND MAINTENANCE DATA

- A. Summary:
  - 1. Organize operation and maintenance data with directory.
  - 2. Provide operation and maintenance manuals for products, systems, subsystems, and equipment.
  - 3. Refer to all Divisions for specific operation and maintenance manual requirements for the Work in those Divisions.
- B. Submit two sets prior to final review, bound in 8-1/2 inch x 11 inch, three ring D size binders with durable vinyl covers.
- C. Prepare binder covers with printed title "OPERATION AND MAINTENANCE INSTRUCTIONS", title of project, and subject matter of binder when multiple binders are required.
- D. Internally subdivide the binder contents with permanent page dividers, logically organized as described below; with laminated plastic tabs.
- E. Part 1: Directory, listing names, addresses, and telephone numbers of Architect, Engineers, Contractor, subcontractors, and major equipment suppliers and manufacturers.

- F. Part 2: Operation and maintenance instructions, arranged by specification section. For each category, identify names, addresses, and telephone numbers of Subcontractors and suppliers. Identify the following:
  - 1. Performance and design criteria.
  - 2. List of equipment.
  - 3. Parts list for each component.
  - 4. Start-up procedures.
  - 5. Shutdown instructions.
  - 6. Normal operating instructions.
  - 7. Wiring diagrams.
  - 8. Control diagrams.
  - 9. Maintenance instructions for equipment and systems.
  - 10. Maintenance instructions for finishes, including recommended cleaning methods and materials.
  
- G. Part 3: Project documents and certificates, including the following:
  - 1. Shop drawings and product data.
  - 2. Air and water balance reports.
  - 3. Certificates.
  - 4. Warranties.

#### 1.09 WARRANTIES

- A. Commencement of warranties shall be date of Substantial Completion.
- B. For items of Work delayed beyond date of Substantial Completion, provide updated submittal within ten days after acceptance, listing date of acceptance as start of warranty period.
- C. Provide duplicate notarized copies in operation and maintenance manuals.
- D. Execute and assemble documents from subcontractors, suppliers, and manufacturers.
- E. Provide Table of Contents and assemble in binder with durable plastic cover.
- F. Submit prior to final Application for Payment.
- G. Manufacturer's disclaimers and limitations on product warranties do not relieve Contractor of warranty on the work that incorporates the products.
- H. Manufacturer's disclaimer and limitations on product warranties do not relieve suppliers, manufacturers, and subcontractors required to countersign special warranties with Contractor.

- I. When correcting failed or damaged warranted construction, remove and replace construction that has been damaged as a result of such failure or must be removed and replaced to provide access for correction of warranted construction.
- J. When work covered by warranty has failed and has been corrected, reinstate warranty by written endorsement. Reinstated warranty shall be equal to original warranty with equitable adjustment for depreciation.
- K. Upon determination that Work covered by warranty has failed, replace or repair Work to an acceptable condition complying with requirements of the Contract Documents.

1.10 SPARE PARTS AND MAINTENANCE MATERIALS

- A. Provide products, spare parts, maintenance and extra materials in quantities specified in individual specification Sections.
- B. Deliver to Project site and place in location as directed.
- C. Obtain signed receipt for delivery of materials and submit prior to request for final review by Architect.

END OF SECTION

**SECTION 01 77 01  
PROJECT CLOSEOUT**

**PART 1 – GENERAL**

1.01 REFERENCE

- A. Requirements in Addenda, Alternates, Conditions, and Division 1 collectively apply to this work.

1.02 GENERAL

- A. As a prerequisite for final payment, Contractor to complete the work of this Section.
- B. Comply with requirements stated in "Conditions of The Contract" and in Specifications for administrative procedures in closing out the Work.
- C. Related Work Specified Elsewhere:
  - 1. Guarantee Form: See General Conditions.
  - 2. Close-out Submittals: See Respective Spec. Sections.

1.03 PREFINAL INSPECTION; SUBSTANTIAL COMPLETION

- A. Prefinal Inspection:
  - 1. Upon "substantial completion" of the Work, Contractor shall notify Architect and request a "prefinal inspection" of the Work.
  - 2. If Architect concurs that "substantial completion" has been reached, he will review the Work and list items to be completed or corrected. List will be amended as required to include items subsequently observed.
- B. Substantial Completion Defined: "Substantial Completion" of the Work is the status, as approved by the Architect, when construction is sufficiently complete, in accordance with the Contract Documents, so District can occupy or utilize the Work for the use for which it is intended, without incomplete work scope items either interior or exterior.

1.04 FINAL INSPECTION

- A. Reference: See General and Supplementary Conditions, titled "Final Adjustment And Completion".
- B. Final Inspection: When Contractor has complied with above Article, Architect will review the Work and list any items to be completed or corrected.
- C. Contractor shall correct and/or complete the Work.

1.05 GUARANTEES

- A. General: Contractor shall guarantee in writing to District that:

- B. "Contractor will repair or replace any and all work, together with any other work which may be displaced, damaged or marred in so doing, that may prove defective in workmanship and/or materials, or fail to conform to contract provisions and requirements within the period cited below, such period to begin on date of acceptance of work by District, without any expense whatsoever to District, ordinary wear and tear, and unusual abuse or neglect excepted."
- C. Format: Contractor shall submit guarantees typed in the format indicated in "Guarantee Form", See General Conditions.
- D. Number of Copies: Submit in duplicate to Architect.
- E. Required Guarantees:
  - 1. General: Submit all guarantees listed herein or required by various Spec. Sections; more stringent shall apply. Guarantee periods begin at the date of acceptance written on the "Notice of Completion" as accepted by the School District Board of Education.
  - 2. General Guarantee:
    - a. By General Contractor; For The Entire Work: 1 Year

#### 1.06 WARRANTIES

- A. General: Submit all warranties required by various Spec. Sections.

#### 1.07 CERTIFICATES

- A. General: Submit all certificates and Verified Reports required by various Spec. Sections or listed herein, notarized as required.

#### 1.08 OPERATION & MAINTENANCE DATA

- A. General: Submit all manuals required by various General Conditions, Spec. Sections or listed herein; two copies each.

#### 1.09 PROJECT RECORD DOCUMENTS

- A. See Section 01 77 20.
- B. Additional Information Required: In addition to the requirements in Section 01 77 20, provide the following:
  - 1. By measured dimensions (vertical and horizontal) from permanent improvements or buildings, locate the following new underground utilities, piping systems, and their appurtenances; and existing systems when known, uncovered, in work areas, adjacent to work areas, or modified as part of the work of this Project:
    - a. Site drainage systems piping and cleanouts.
    - b. Landscape sprinkler systems: Complete system, except non-pressure branch lines from automatic control valves to heads.
    - c. All fire protection systems.

- d. All plumbing systems.
  - e. All electrical systems.
  - f. All pool systems.
2. For gravity flow lines such as sewers and storm drains, locate all cleanouts, and indicate invert elevations at building lines, changes in direction, intersections, and property lines.
  3. Electrical Underground: In addition to locations, state number and sizes of conduits and wires, and provide invert elevations.
  4. Work Concealed Within Building Construction: Indicate by dimension the locations of Plumbing Systems, HVAC Systems, and Fire Protection Systems.
  5. Show any work performed that deviates from original Contract Documents.
  6. Show all work authorized by Change Order(s) and number of that Change Order.

**PART 2 – PRODUCTS (Not Used)**

**PART 3 – EXECUTION (Not Used)**

END OF SECTION

**SECTION 01 77 20  
PROJECT RECORD DOCUMENTS**

**PART 1 – GENERAL**

1.01 SUMMARY

- A. Throughout progress of the Work of this Contract, maintain an accurate record of all changes in the Contract Documents, as described in 3.01 below.
- B. Contractor shall periodically transfer the recorded changes to a set of “as-built” documents, as described in Article 3.02 below, and submit such “as-builts” to Architect for Architect’s use as required.
- C. The Project Manager shall verify that as-builts are current, on a monthly basis, prior to the processing of pay requests. Pay Requests WILL NOT be processed unless the as-builts have been verified.
- D. Related work described elsewhere: Section 01 33 00 Submittal Procedures.

1.02 QUALITY ASSURANCE

- A. General: Delegate the responsibility for maintenance of Record Documents to one person on the Contractor’s staff as approved in advance by the Architect.
- B. Accuracy of records: Thoroughly coordinate all changes within the Record Documents, making adequate and proper entries on each page of a clean set of Specifications and each sheet of Drawings and other Documents where such entry is required to properly show the change. Accuracy of records shall be such that future search for items shown in the Contract Document may reasonably rely on information obtained from the approved Record Documents.
- C. Timing of entries: make all entries within 24 hours after receipt of information.

1.03 SUBMITTALS

- A. General: The Architect’s approval of the current status of Record Documents will be a prerequisite to the Architect’s approval of requests for progress payment and request for final payment under the Contract.
- B. Progress submittals: Prior to submitting each request for progress payment, secure the Architect’s approval of the Record Documents as currently maintained.
- C. Final submittals: Prior to submitting request for final payment, submit the Final Record Documents to the Architect and secure his approval.

1.04 PRODUCT HANDLING

- A. Use all means necessary to maintain the job set of Record Documents completely protected from deterioration and from loss and damage until completion of the work and transfer of the recorded data to the Final Record Documents. In the event of loss of recorded data, use all means necessary to secure the data to the Architect’s approval; such means shall include, if necessary in the opinion of the Architect, removal and replacement of concealing materials and, in such case, all replacements shall be to the standards originally specified in the record Documents.

## **PART 2 – PRODUCTS**

### **2.01 RECORD DOCUMENTS**

- A. Promptly following award of Contract, mark one set of documents (prints) as “RECORD DOCUMENTS - JOB SET”. All Addenda, issued during the Bid, shall be “cut and pasted” onto the appropriate sheets or pages of the Plans and Specifications.
  - 1. In addition to the requirements set forth, directing the Contractor to transfer all the information above to a “Reproducible Set of Prints” and “CAD CD”, the Contractor shall provide the actual JOB SET (“marked-up prints”) referenced above to the District at the completion of construction, which will remain the District’s property.

## **PART 3 – EXECUTION**

### **3.01 MAINTENANCE OF JOB SET**

- A. Preservation:
  - 1. Considering the Contract completion time, the probable number of occasions upon which the job set must be taken out for new entries and for examination, and the conditions under which these activities will be performed devise a suitable method for protecting the “RECORD DOCUMENTS - JOB SET” to the approval of the Architect.
  - 2. Do not use the Job Set for any purpose except entry of new data and for review by the Architect, until start of transfer of data to Final Record Documents.
  - 3. Maintain the Job Set at the site of work where designated by the Architect.
- B. Making entries on drawings: Using an erasable colored pencil (not ink or indelible pencil) clearly describe the change by note and by graphic line, as required. Date all entries. Call attention to the entry by a “cloud” around the area or areas affected. In the event of overlapping changes, different colors may be used for each of the changes.
- C. Making entries on other documents:
  - 1. Where changes are caused by directives issued by the Architect, clearly indicate the change by note in ink, colored pencil, or rubber stamp.
  - 2. Where changes are caused by Contractor-originated proposals approved by the Architect, including inadvertent errors by the Contractor that have been accepted by the Architect, clearly indicate the change by note in erasable colored pencil.
  - 3. Make entries in the pertinent documents as approved by the Architect.
- D. Conversion of schematic layouts:
  - 1. In most cases on the Drawings, arrangement of conduits and circuits, piping, ducts, and other similar items is shown schematically and is not intended to portray precise physical layout. Final physical arrangement is as determined by the Contractor subject to the Architect’s approval. However, design of future modifications of the facility may require accurate information as to the final physical arrangement of items that are shown only schematically on the Drawings.
  - 2. Show on the job set of Record Drawings, by dimension accurate to within 1”, the centerline of each run of items such as are described in Paragraph 3.1 D.1 above. Clearly identify the item by accurate note such as “CAST-IRON DRAIN,” “GALV.

WATER” etc. Show by symbol or note the vertical location of the item (“under slab,” “in ceiling plenum” “exposed,” etc.). Make all identification sufficiently descriptive that it may be related reliably to the Specifications.

3. The Architect may waive the requirements for conversion of schematic data where, in the Architect’s judgment, such conversion serves no beneficial purpose. However, do not rely upon waivers being issued except as specifically issued in writing by the Architect.
  4. Timing of entries: Be alert to changes in the work from how it is shown in the Contract Documents. Promptly, and in no case later than 24 hours after the change has occurred and been made known to the Contractor, make the entry or entries required.
- E. Accuracy of entries: Use all means necessary, including the proper tools for measurement, to determine actual locations of the installed items.

### 3.02 FINAL RECORD DOCUMENTS

- A. General: The purpose of the Final Record Documents is to provide factual information regarding all aspects of the work, both concealed and visible, to enable future modification of design to proceed without lengthy and expensive site measurement, investigation, and examination.
- B. Approval of recorded data prior to transfer: Using the “CAD CD” and “Reproducible Set of Prints”, and prior to start of transfer of recorded data thereto, secure a review by the Architect and Project Manager of all recorded data. Make all required revisions.
- C. Transfer of data to drawings: Carefully transfer all change data shown on the job set of Record Drawings to the CAD CD and corresponding prints, coordinating the changes as required, and clearly indicating at each affected detail and other drawing the full description of all changes made during construction and the actual location of items described in Paragraph 3.1 E. above. Call attention to each entry by drawing a “cloud” around the area or areas affected. Make all change entries on the sepias neatly, consistently, and in ink or crisp black pencil.
- D. Transfer of data to other Documents: If the documents other than Drawings have been kept clean successfully during progress of the work, and if entries have been sufficiently orderly thereon to the approval of the Architect, the job set of those Documents (other than Drawings) will be accepted by the Architect as Final Record Documents for those documents. If any such document is not so approved by the Architect, secure a new copy of that document from the Architect at the Architect’s usual charge for reproduction; carefully transfer the change data to the new copy and to the approval of the Architect.
- E. Review and approval: Submit the completed total set of Record Documents to the Architect as described in paragraphs 1.03 C, and 2.01 A above. Participate in review meeting or meetings as required by the Architect, make all required changes in the Record Documents, sign and date Record Documents, and promptly deliver the Final Record Documents to the Architect.

### 3.03 CHANGES SUBSEQUENT TO ACCEPTANCE

- A. The Contractor shall have no responsibility for recording changes in the work subsequent to acceptance of the work by the District, except for changes resulting from replacements, repairs, and alterations made by the Contractor as part of his guarantee.

END OF SECTION

**SECTION 01 77 40  
WARRANTIES**

**PART 1 – GENERAL**

1.01 SUBMITTAL REQUIREMENTS

- A. Assemble Warranties and Service and Maintenance Contracts, executed by each of the respective Manufacturers, Suppliers, and Subcontractors.

Number of original signed copies required: Four (4) each.

Table of Contents: Neatly typed in orderly sequence.

Provide complete information for each one of the following items:

1. Product or Work Item.
2. Firm with name of principal, address, and telephone number.
3. Beginning date of Warranty or Service and Maintenance Contract.
4. Duration of Warranty or Service and Maintenance Contract.
5. Provide the following information for the District's Personnel:
  - a. Procedures in case of failure of malfunction.
  - b. Instances which affect Warranty.
6. Contractor, name of responsible principal, address, and telephone number.

1.02 SUBMITTAL FORM

- A. The list identifies the submittal form requirements for WARRANTIES:

1. Punch sheets for standard 3-ring binder.
2. Size: 8-1/2 x 11 inches.
3. Fold larger sheets to fit into binder.
4. Cover: Identify each packet with typed or printed title "WARRANTIES". List:
  - a. Title of Project.
  - b. Name of Contractor.

**PART 2 – PRODUCTS (NOT USED)**

**PART 3 – EXECUTION (NOT USED)**

END OF SECTION

**SECTION 01 78 23  
OPERATION AND MAINTENANCE MANUALS**

**PART 1 – GENERAL**

1.01 SUMMARY

- A. Section Includes:
  - 1. Compilation of product data and related information appropriate for the District's maintenance and operation of products and equipment furnished under the Contract.
  - 2. Instruction of the District's personnel in the maintenance of products and in the operation of equipment and systems.
- B. Contractor shall comply with the requirements of this Specification Section, except where individual Specification Sections requirements are more stringent.

1.02 SUBMITTAL PROCEDURES

- A. Preliminary: Submit one copy of proposed manuals at least fifteen (15) days prior to final inspection or acceptance to District Project Manager.
- B. Final: Following the indoctrination and instruction of the District's operating and maintenance personnel, review proposed revisions to the manual with District Project Manager.
  - 1. Submit three copies of accepted data in final form 10 days after final inspection. Approval of submittal is a pre-requisite at Substantial Completion prior to the District's agendizing project for acceptance by the Governing Board.

**PART 2 – PRODUCTS**

2.01 FORMAT

- A. Size: minimum 4 inch three-ring binders for 8-1/2 inch by 11 inch punched pages, completely clear plastic covered for insertion of labels on spines and covers.
- B. Provide identifying tabbed pages. Classify by Division and by Section. All tabbing shall be in numerical order.
- C. Drawings:
  - 1. Provide reinforced punched binder tab. Bind drawings with text.
  - 2. Fan fold larger drawings to size of text pages, for easy foldout.
- D. Cover: Identify each volume with typed or printed label, List:
  - 1. Title of Project
  - 2. Identify of separate structures as applicable.

3. Identify of general subject matter covered in the manual.
- E. Spine: Identify each volume with typed or printed label stating OPERATING AND MAINTENANCE INSTRUCTIONS, GUARANTEES AND SERVICE CONTRACTS and the following information:
1. Title of Project.
  2. Divisions and Sections included within volume.
  3. Volume number (i.e. "1 of 4)

### **PART 3 – EXECUTION**

#### **3.01 CONTENT OF MANUAL**

- A. Table of Contents:
1. List of each product indexed to the content of the volume.
  2. List with each product the name, address, and the telephone number of:
    - a. Subcontractor and installer.
    - b. Maintenance contractor, as appropriate.
    - c. Local sources of supply for parts and replacement.
- B. Product Data: Annotate each sheet to clearly identify the data applicable to the installation. Delete references to inapplicable information
- C. Drawings:
1. Supplement product data with Drawings as necessary to illustrate the following:
    - a. Relationship of component parts of equipment and systems.
    - b. Control and flow diagrams.
  2. Do not include Project Record Drawings as maintenance drawings.
- D. Instructions: Provide written text, as required to supplement product data for the particular installation.
- E. Warranties, Guaranties, Bonds, and Service Contracts: Include a copy of each warranty, guarantee, bond and service contract issued.
1. Provide information sheet for the District's personnel describing the following:
    - a. Propose procedures in the event of failure or emergencies.
    - b. Circumstances under which the validity of warranties, guaranties, or bonds might be compromised.

### 3.02 MANUAL FOR MATERIALS AND FINISHES

- A. Instructions for Care and Maintenance: Include manufacturer's data as follows:
  - 1. Recommendations for types of cleaning agents and methods.
  - 2. Cautions against cleaning agents and methods which are detrimental to the product.
  - 3. Recommended schedule for cleaning and maintenance.

### 3.03 MANUAL FOR EQUIPMENT AND SYSTEMS

- A. Content, for each unit of mechanical equipment and system, as appropriate:
  - 1. Description of Unit and Component Parts:
    - a. Function, normal operating characteristics, and limiting conditions.
    - b. Performance curves, engineering data, and tests.
    - c. Complete nomenclature and commercial number of replacement parts.
  - 2. Operating Procedures:
    - a. Start-up, break-in, routine, and normal operating instructions.
    - b. Regulation, control, stopping, shut-down, and emergency instructions.
    - c. Summer and winter operation instructions.
  - 3. Maintenance Procedures:
    - a. Routine operations.
    - b. Guide to "trouble-shooting."
    - c. Disassembly, repair, and reassemble.
    - d. Alignment, adjusting, and checking.
  - 4. Servicing and lubrication schedule including list of lubricants required.
  - 5. Manufacturer's printed operating and maintenance Instructions.
  - 6. Description of sequence of operation by control manufacturer.
  - 7. Original manufacturer's parts list, illustrations, assembly drawings, and diagrams required for maintenance, including:
    - a. Predicted life of parts subject to wear.
    - b. Items recommended to be stocked as spare parts.

8. Control diagrams by manufacturer of controls as installed in project.
  9. Coordination Drawings and color coded piping diagrams.
  10. Charts of valve tag numbers, with the location and function of each valve.
- B. Content, for each electric and electronic system as appropriate:
1. Description of System and Component Parts:
    - a. Function, normal operating characteristics, and limiting conditions.
    - b. Performance curves, engineering data, and tests.
    - c. Complete nomenclature and commercial number of replaceable parts.
  2. Circuit directories of panelboards:
    - a. Electrical service.
    - b. Controls.
    - c. Communication.
  3. As-installed color coded wiring diagrams.
  4. Operating Procedures:
    - a. Routine and normal operating instructions.
    - b. Sequences required.
    - c. Special operating instructions.
  5. Maintenance Procedures:
    - a. Routine operations.
    - b. Guide to "trouble-shooting."
    - c. Disassembly, repair and re-assembly.
    - d. Adjustment and checking.
  6. Manufacturer's printed Operating and Maintenance Instructions.
  7. List of original manufacturer's spare parts, manufacturer's current prices, and recommended quantities to be maintained in storage.

### 3.04 INSTRUCTION OF THE DISTRICT'S PERSONNEL

- A. Prior to final inspection or acceptance, fully instruct the District's designated operating and maintenance personnel in the operation, adjustment and maintenance of all products, equipment, and systems installed in project.
  - 1. Provide services of factory trained instructors from the manufacturer of each major item of equipment or system.
  
- B. Operating and maintenance manual shall constitute the basis of instruction.
  - 1. Review contents of manual with personnel in full detail to explain all aspects of operation and maintenance.
  - 2. Review instruction on how to efficiently use state required energy conservation features, materials, components and mechanical device.

END OF SECTION

**SECTION 01 91 13  
GENERAL COMMISSIONING REQUIREMENTS**

**PART 1 - GENERAL**

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 DESCRIPTION

- A. The District will employ an independent Commissioning Authority. The Commissioning Authority is an independent and knowledgeable third party, hired to verify that the systems work as intended. The Commissioning Authority will inform the District's Representative of the results of the commissioning, and furnish suggestions, as necessary, to correct deficiencies in observed performance or installation.
- B. This project is implementing the requirements of the USGBC LEED® for Schools (2007 edition) protocol and pursuing the Enhanced Commissioning credit as described under Energy and Atmosphere Credit #3 in addition to satisfying the EA Prerequisite for Fundamental Commissioning.
- C. Commissioning is the process to verify to the District that systems, equipment, mechanical, electrical, controls, and special systems function together properly to meet performance requirements and design intent as described in the Contract Documents. The Contractor shall be responsible for participation in the commissioning process as outlined below and in references and attachments throughout the contract documents. The Contractor shall furnish labor and materials sufficient to meet all requirements of building commissioning under this contract.
- D. Various sections in the DIV 15 and 16 specifications outline the specific commissioning responsibilities of applicable subcontractors and Contractor to coordinate and manage the commissioning responsibilities of those subcontractors. References to work performed by subcontractor shall not relieve Contractor from sole responsibility for all Work of the project.

1.3 REQUIREMENTS INCLUDED

- A. Duties of Contractor
- B. Duties of Commissioning Authority
- C. Commissioning Plan
- D. Commissioning Field Notebook
- E. Systems to be Commissioned
- F. Commissioning Activities
- G. Functional Test Procedures
- H. Acceptance Procedures
- I. Training and Instruction
- J. Schedule

1.4 RELATED SECTIONS

- A. Section 23 08 00 – COMMISSIONING OF HVAC
- B. Section 26 08 00 – ELECTRICAL SYSTEMS COMMISSIONING

## 1.5 TERMS

- A. **Acceptable Performance:** A component or system being able to meet specified design parameters under actual load including satisfactory documented completion of all functional performance tests, control system trending and resolution of outstanding issues.
- B. **Basis of Design:** The basis of design is the documentation behind the design decisions that were made to meet the design intent as defined by the District. The basis of design describes the systems, components, conditions, and methods to meet the design intent.
- C. **Commissioning:** The process to assure the District that building equipment, controls, and systems function together properly to meet performance requirements and design intent as shown in a composite manner in the Contract Documents.
- D. **Commissioning Plan:** The preliminary Commissioning Plan has been prepared by the District's Commissioning Authority (CA), included in this specification and shall be implemented by the Contractor and CA together. The commissioning plan outlines the organization, scheduling, documentation, etc., pertaining to the overall commissioning process. A final plan shall be prepared after Contract Award.
- E. **Functional Performance Testing:** That full range of checks and tests carried out to determine if all components, sub-systems, systems, and interfaces between systems function in accordance with the Contract Documents. In this context, "function" includes all modes and sequences of control operation, all interlocks and conditional control responses, and all specified responses to abnormal emergency conditions. The functional performance test will be prepared by the Commissioning Authority.
- F. **OPR:** District's Project Requirements. A document that details the functional requirements of a project and the expectations of how it will be used and operated. These include Project goals, measurable performance criteria, cost considerations, benchmarks, success criteria, and supporting information.
- G. **Pre-functional Test Checklist:** Checklist is prepared by the Commissioning Authority. Checklist shall be by system or equipment to verify installation and start-up of equipment is complete and ready for functional testing. These documents require signature by the Contractor prior to continuing with the commissioning process.
- H. **Resolution Log:** The purpose of this log is to furnish a method for resolution of deficiencies discovered as a result of the commissioning process. This list also includes the current disposition of issues, and the date of final resolution as confirmed by the Commissioning Authority. Deficiencies are defined as those issues where products, execution or performance do not satisfy the specifications and/or the design intent. The resolution log will be created and managed by the Commissioning Authority.

## 1.6 DUTIES OF CONTRACTOR

- A. Furnish component and equipment submittals for systems to be commissioned to the Commissioning Authority.
- B. Review the basis of design and OPR documents for completeness and ensure compliance of the proposed installation conforms to these documents.
- C. Collect the information requested by Commissioning Authority for development of a complete Commissioning Plan, Commissioning Field Notebook, and Functional Tests and furnish to the Commissioning Authority. The Contractor shall review these documents and confirm in writing to the District's Representative, Architect, and Commissioning Authority any known areas of conflict or areas requiring clarification.
- D. Collect all proposed start-up and pre functional documentation and furnish that information to the Commissioning Authority. The Commissioning Authority will incorporate that information into the Commissioning Field Notebook. The Commissioning

Authority will furnish the Contractor with the Commissioning Field Notebook

- E. Incorporate commissioning activities into the construction schedule.
- F. Coordinate participation of the Mechanical, Electrical, Controls and Test and Balance work in the commissioning process.
- G. Furnish Commissioning Authority with controls system and wiring diagrams and narrative sequences of operation, in time for use in preparing the Functional Test Procedures.
- H. Participate in any efforts to finalize sequences of operations with District's Representative, Designers, and Commissioning Authority.
- I. Verify that coordination, installation, quality control, and final testing have been completed such that installed systems and equipment comply with construction documents.
- J. Review the Commissioning Plan, project communication reports and test results and submit comments to the Commissioning Authority.
- K. In a timely manner, address issues identified during construction that may affect the commissioning process or final system performance.
- L. Perform start-up and testing of mechanical and electrical equipment and systems and document as required with start-up reports and completion of Pre-functional Test Checklists. These checklists include installation documentation, Start-up documentation, controls point to point documentation and calibration documentation, verification that controls sequence of operations meets design intent and TAB final documentation. Reports will be stored in the Contractor's field trailer. Contractor shall coordinate efforts to complete the pre-functional documentation.
- M. Furnish preliminary TAB report, indicating all actual field values recorded, to the Commissioning Authority, prior to initiation of functional testing. These reports shall be incorporated in the Commissioning Field Notebook.
- N. Contractor shall issue written Notice of Readiness for each system to Commissioning Authority upon completion of all systems work, start-up and pre-functional test requirements.
- O. Operate equipment and systems as required for functional performance testing. This includes but is not limited to manipulating the appropriate controls systems to achieve the expected response for the functional test procedure.
- P. Participate in the fine-tuning or troubleshooting of system performance if either of these measures becomes necessary.
- Q. Submit complete operation and maintenance information and as-built drawings to the Commissioning Authority for verification, organization, and distribution.
- R. Furnish documentation of training for the systems specified.
- S. The Commissioning Field Notebook shall be stored in the Contractor's field trailer and shall be managed by the Contractor. The Contractor shall confirm in writing to the Commissioning Authority that systems are complete, functional and the appropriate subcontractors have completed the specified tasks and signed off all pre function documentation, see attached sample pre-functional documentation, prior to final functional testing.
- T. Review Operating and Maintenance Data for verification, organization, distribution, and conformance to requirement of Contract Documents.

#### 1.7 DUTIES OF COMMISSIONING AUTHORITY

- A. The duties of the Commissioning Authority are:
  - 1. Develop the Commissioning Plan.
  - 2. Develop the Commissioning Field Notebook with appropriate documentation

furnished by Contractor. Furnish supplemental documentation as necessary to ensure that all aspects of start-up and testing have been complete and documented prior to functional testing.

3. Develop Functional Test Procedures from final Control documentation including narrative sequences of operation, control diagrams and software code, for execution with the assistance of Contractor staff as required.
  4. Review the Contractor's submittals relative to the systems to be commissioned.
  5. Perform site observations to follow installation progress, and to verify system installation quality and readiness for testing.
  6. Observe the start-up activities and initial testing of equipment and systems as required, and review Contractor start-up documentation. Verify that the specified training schedule of District's personnel is furnished.
  7. Review submittal of all required pre-functional and start-up documentation furnished by Contractor for completeness and reasonableness. This includes installation documentation, start-up documentation, point to point checklists and TAB completed preliminary TAB report prior to initiation of functional testing.
  8. Direct and perform functional test with assistance from Contractor as required.
  9. Witness and verify satisfactory completion of equipment and component tests and systems and inter-systems functional performance tests.
  10. Furnish site observation, functional test or other project reports in a timely manner.
  11. Document inconsistencies or deficiencies in system operations and system compliance. System deficiencies shall be forwarded to the District and tracked with normal punch listing activities.
  12. Coordinate via the Contractor participation of District personnel involved with equipment, component and systems performance verification and participation in required training.
  13. When commissioning has been successfully completed, recommend acceptance to the District's Representative.
  14. Once all functional tests have been successfully completed and all outstanding issues resolved the Commissioning Authority will furnish the District's Representative with a final report of all commissioning activities that occurred during the project.
  15. Furnish the District's Representative with a single manual that contains the information required for re-commissioning the building.
  16. Near the end of the warrantee period, the Commissioning Authority will review building operation with the O&M staff and furnish a plan for correction of any outstanding issues.
- B. The Commissioning Authority will formally communicate with the Contractor via approved project channels. It is expected, however, that informal communication and coordination will be conducted directly with the subcontractors; records of all contacts will be sent to the District's Representative through the normal channels.
- C. The Commissioning Authority is not authorized to modify, add to or revoke the requirements of the Contract Document. A change in the Work can only be made as specified in the General Conditions.

#### 1.8 COMMISSIONING PLAN

- A. The Commissioning Plan is a tool through which the commissioning process is described and incorporates the District's Representative, Architect, Contractor and Commissioning

Authority's roll relative to the commissioning process. Commissioning Team Members are all contractors, subcontractors and design professionals whose participation is of benefit in the delivery of a fully functioning building to the District. The plan shall include an organizational chart to detail the communication, authority and responsibility of commissioning team members. The commissioning plan will include the following.

1. The purpose of commissioning.
2. Detail the commissioning process.
3. Commissioning team members responsibilities.
4. Describe prefunctional and functional test procedures.
5. The plan shall furnish a guideline for acceptance of each piece of equipment or system.
6. Systems to be commissioned.
7. Commissioning schedule.

#### 1.9 COMMISSIONING FIELD NOTEBOOK

A. The Commissioning Field Notebook will be assembled by the Commissioning Authority and used by the Contractor to identify and track all pertinent commissioning documentation. The Contractor will maintain and manage completion of this Notebook. The Notebook furnishes a central location for the Commissioning Authority to identify and organize all pertinent information and will include the following format:

1. Summary describing Notebook contents and use.
2. Commissioning Plan for Contractor field reference.
3. Listing of all specification documentation requirements listed by specification section, with construction completion sign off's for appropriate parties. This type of documents includes piping pressure testing, flushing reports, factory start-up reports and any field testing relative to the project.
4. Tabs for each specification section with copies of pre-functional and functional test check sheets furnished by coordination of subcontractors and Commissioning Authority for Contractor completion and space for related Contractor-supplied documents.
5. Commissioning project communication reports, deficiency logs schedule information or any other documentation furnished by the Commissioning Authority.

#### 1.10 SYSTEMS TO BE COMMISSIONED

A. The following system features shall be functionally tested, and other building features shall be evaluated for installation quality during construction. The functional performance testing shall include the following systems and equipment:

1. HVAC Systems and Controls
2. Domestic Hot Water Systems
3. Lighting control and daylight control
4. DDC control system
5. Renewable Energy systems

#### 1.11 COMMISSIONING ACTIVITIES

A. The Commissioning Schedule: This schedule defines the milestones and conditions that must be achieved before system testing and other commissioning activities can commence. The schedule also includes the expected duration of the various tasks, so

that the commissioning process can be incorporated into the overall construction schedule. The Commissioning Authority will furnish the Contractor with a detailed schedule to incorporate in the project construction schedule.

- B. Commissioning Field Notebook: The Commissioning Field Notebook shall be created by the Commissioning Authority and used by the Contractor to identify and track all pertinent commissioning documentation required during the installation start-up and check-out phases. This Notebook shall be maintained by the Contractor on site and will be made available to all subcontractors for their use. The Notebook furnishes a central location for the subcontractors and Commissioning Authority to identify copy and organize all pertinent information.
- C. Preparation for Testing: To prepare for the system performance testing, the Commissioning Authority will examine the design and construction documents, develop with appropriate Contractor's Pre-functional Test Checklists of construction responsibilities that must be completed prior to testing, and develop detailed Functional Test Procedures and data forms.
- D. Using the Pre-functional Test Checklists, the Contractor must verify that the systems they install are in compliance with the Construction Documents and are fully functional. Commissioning is not intended to be a testing or inspection function that replaces any of the Contractor's obligations for testing and proof of performance. Functional testing will only begin when checklists are completed by the appropriate subcontractors, initialed, signed, and returned to the Commissioning Authority accompanied with a written letter from the Contractor indicating specific system completion.
- E. Functional Testing. Functional testing is performed by the Commissioning Authority with the assistance of the Contractor to verify proper sequencing, operation and performance of installed equipment and systems under realistic operating conditions. As tests are successfully completed, a functional test checklist will be used to document the testing progress.
- F. Documentation. In addition to the Pre-functional Test Checklists and Functional Test Procedures, written documentation shall be maintained for all other commissioning activities. Project communication reports shall be issued by the Commissioning Authority to the Contractor and key members of the commissioning team to document apparent deficiencies identified during examination of design and Construction Documents, daily activities on-site, construction deficiencies, and successful or unsuccessful functional testing results. At the end of the commissioning process, all documentation will be assembled and summarized in the final commissioning report.
- G. Deficiency Resolution. When a project communication report is issued to address an identified deficiency, the Contractor shall forward the reports to the appropriate parties to initiate corrective action in an expeditious manner. Deficiencies will be tracked as part of the punch listing activity.

#### 1.12 FUNCTIONAL TEST PROCEDURES

- A. The functional test procedures include, but are not limited to, the following:
  - 1. Verification of testing, adjusting and balancing performance.
  - 2. Verification of all equipment's ability to perform to the design intent.
  - 3. Verification of the performance of subsystems consisting of combinations of equipment (i.e. refrigeration cycle, pumps, and interconnecting piping).
  - 4. Verification of the performance of the automatic controls in all seasonal modes.
  - 5. Verification of the performance of the HVAC system as a whole.
  - 6. Verification of the performance of all life safety devices and systems as the interface with the HVAC systems.

## **PART 2 - PRODUCTS**

- A. Not used.

## **PART 3 - EXECUTION**

### **3.1 GENERAL**

- A. Operating equipment and systems shall be tested in presence of District's Commissioning Authority and District's Representative to demonstrate compliance with specified requirements.
- B. Notify District, in writing, seven (7) days prior to tests scheduled under requirements of this Section. Testing shall be conducted under specified design operating conditions as recommended or approved by District's Representative.
- C. Functional Performance Testing shall be completed and accepted by District's Representative as a condition of Final Completion.
- D. All elements of systems shall be tested to demonstrate that total systems satisfy all requirements of these Specifications. Testing shall be accomplished on hierarchical basis. Test each piece of equipment for proper operation, followed by each subsystem, followed by entire system, followed by entireties to other major systems.
- E. Proprietary test equipment required by the manufacturer, whether specified or not, shall be furnished by the manufacturer of the equipment. Have manufacturer provide the test equipment, demonstrate its use, and assist the Commissioning Authority in the commissioning process.

### **3.2 ACCEPTANCE PROCEDURES**

- A. Prior to functional performance testing of each system, the Commissioning Authority will observe and verify that the physical installation of selected components and systems being tested is substantially installed in accordance with the Contract Documents.
- B. Contractor's Tests
  1. System shall be checked for proper installation, shall be adjusted, and shall be calibrated to verify that it is ready to function as specified.
  2. All system elements shall be checked to verify that they have been installed properly and that all connections have been made correctly.
  3. All discrete elements and sub-systems shall be adjusted and shall be checked for proper operation.
- C. Start-up and Operational Tests shall be complete, with all required pre-functional testing documentation included in the Field Commissioning Notebook submitted for review by Commissioning Authority within five (5) days of each activity, prior to starting Functional Acceptance Tests.
- D. District-Witnessed Functional Tests
  1. Objective of these tests is to demonstrate that system is operating and complying with specified performance requirements.
  2. District's Representative witnessed Functional Performance Tests shall be performed on complete system. Each function shall be demonstrated to satisfaction of District's Representative and District's Commissioning Authority on paragraph-by-paragraph basis of Commissioning Authority's written test procedure, developed to demonstrate conformance to requirements of Contract Specifications.
- E. Functional Performance Test shall be witnessed and endorsed by the Commissioning

Authority upon satisfactory completion.

- F. Actual testing program shall be conducted in accordance with prior approved procedures and shall be documented as required herein.
- G. Contractor shall notify District's Representative at least two weeks prior to date of Functional Performance Tests.
- H. The functional performance testing process shall be accomplished for all equipment types, subsystems, systems, and system interfaces. All must be tested for acceptances, and there shall be a separate checklist for each to ensure documentation specific to each is complete. A 15% sampling is appropriate for multi-type AC systems, exhaust fans, and lighting controls and day lighting controls. Failure of 10% of a sample or any consistent issue will require the contractor to review all equipment of that type before a re-commissioning functional re-test will be conducted. Failure beyond one retest of the sample may require the CxA to witness 100% system testing at contractors expense.
- I. Each system shall be operated through all modes of system operation (for example, seasonal, occupied, unoccupied, warm-up, cool-down, etc, as applicable) including every individual interlock and conditional control logic, all control sequences, both full-load and part-load conditions, and simulation of all abnormal conditions for which there is a specified system or controls response. The warm-up and cool-down test shall be a performance test.
- J. Temporary upsets of systems, such as distribution fault, control loss, setpoint change, equilibrium upset, and component failure, shall be imposed at different operation loads to determine system stability and recovery time.
- K. When the functional performance of all individual systems has been proven, the interface or coordinated responses between systems shall be checked. The systems involved may be within the overall HVAC work, or they may involve other systems, such as emergency systems for life safety.
- L. Corrective Measures: If acceptable performance cannot be achieved, the cause of the deficiency will be identified, if it is determined that the deficiency was caused by the system or component not being installed per the manufacturer's recommendations or Contract Documents, the necessary corrective measures shall be carried out by the Contractor. Every check or test for which acceptable performance was not achieved shall be repeated after the necessary corrective measures have been completed. This re-testing process shall be repeated until acceptable performance is achieved. The Contractor will be allowed one retest after initial testing of the equipment. If the retest fails the Contractor shall be financially responsible, at standard rates, to reimburse the District Representative for the additional time taken to achieve acceptable performance.

### 3.3 TRAINING AND INSTRUCTION

- A. Training and instruction of District personnel is a part of the commissioning process and essential for the proper operation of the facility. The Contractor shall coordinate commissioning activities with training of District personnel. Detailed requirements for training and instruction are contained in other sections of the Contract Documents including, but not limited to, Division 1, Division 23, and Division 26.
- B. The Contractor with the assistance of the equipment vendors shall prepare and submit a training plan for approval by the CxA as part of the submittal process. Contractor shall record the attendance of the owner's staff. The training plan shall include for each training session:
  - 1. Dates, start and finish times, and locations.
  - 2. Outline of the information to be presented.
  - 3. Names and qualifications of presenters.
  - 4. List of texts and other materials required to support training.

5. Copies of the O&M manual for the system to be presented.

- C. The contractor shall obtain assistance from appropriate subcontractors and vendors to provide training for the delegated Owner operations staff as specified for commissioned systems. Record the name of those teaching the class, location, subject and owner's staff attending. Submit to the CxA.
- D. Provide equipment vendors shall train owner on the specifics of each system and philosophy, troubleshooting, maintenance recommendations and repair techniques as specified in the relevant sections of this specification.
- E. Installation subcontractors shall provide training to owner on peculiarities specific to this project and job-specific experience as specified in the relevant sections of this specification.

#### 3.4 SCHEDULE

- A. The schedule includes the expected sequence and duration for the various tasks, so that the commissioning process can be integrated with the Contract Schedule and refined over the course of the project.
- B. It is anticipated that the commissioning will be performed in a phased manner following the flow of construction. Certain systems shall be required to operate in a temporary manor to accommodate functional testing of various system subcomponents.

#### 3.5 SYSTEMS MANUAL (ENHANCED COMMISSIONING)

- A. The Contractor shall provide to the CxA one electronic copy of the following for the commissioned equipment only:
  - 1. Mechanical and Electrical Lighting system operational narrative
  - 2. Control systems sequence of operation narrative
  - 3. All warranty documentation
  - 4. Startup and maintenance procedures.
  - 5. Operations and maintenance procedures.
  - 6. Training plan.
  - 7. Inspection reports and test reports.

END OF SECTION

**SECTION 02 41 19  
DEMOLITION**

**PART 1 - GENERAL**

1.01 SUMMARY

- A. Provisions of the General and Supplementary Conditions and Division 1 apply to this section.
- B. Section Includes: Furnishing all labor, materials and equipment necessary for demolition, dismantling, cutting and alterations as indicated, specified, and required for completion of the Contract, as applicable. Includes items such as the following:
  - 1. Protecting existing work to remain.
  - 2. Cleaning soiled materials that are to remain.
  - 3. Disconnecting and capping utilities.
  - 4. Removing debris and equipment.
  - 5. Removal of items indicated on Drawings.
  - 6. Salvageable items to be retained by the Owner as indicated on the Drawings and during the pre-construction job walk.
- C. Related Sections:
  - 1. Section 01 50 00: Temporary Facilities and Controls
  - 2. Section 31 10 00: Site Clearing.

1.02 QUALITY ASSURANCE

- A. Comply with the following:
  - 1. Applicable codes, ordinances, regulations of local, municipal, state and federal authorities having jurisdiction.
  - 2. Obtain necessary permits and notices, post where required.
  - 3. Comply with safety requirements of the local fire department.
  - 4. Comply with ANSI A10.6.
  - 5. Comply with Standard Specification for Public Works Const.
- B. Demolition Firm Qualifications: Engage an experienced, licensed firm having a minimum of (5) years full time satisfactory experience in demolition work of similar scope and complexity to that indicated for this Project.
- C. Notify affected utility companies before starting Work and comply with their requirements.
- D. Carefully perform demolition work, by skilled workers experienced in building demolition procedures, using appropriate tools and equipment. Perform work, at all times, under the direct supervision of a supervisor approved by the Owner Inspector.

- E. Coordinate demolition with other trades to ensure correct sequence, limits, and methods of proposed demolition. Schedule work to create least possible inconvenience to the public and to facility operations.
- F. Pre-Demolition: Conduct conference at Project site 7 days prior to scheduled installation.
  - 1. Conference agenda shall include review and discussion of requirements of authorities having jurisdiction, instructions and requirements of serving utilities, sequencing and interface considerations and Project conditions.
  - 2. Conference shall be attended by supervisory and quality control personnel of Contractor and all subcontractors performing this and directly related work. Submit minutes of meeting to Owner's Representative for Project record purposes.

### 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 location as directed by Owner's Representative.
- C. Remove and Reinstall: Remove items indicated; clean, service, and otherwise prepare them for reuse; store and protect against damage. Reinstall items in locations indicated.
- D. Existing to Remain: Protect construction indicated to remain against damage and soiling during demolition. When permitted by the Owner's Representative, items may be removed to a suitable, protected storage location during demolition and then cleaned and reinstalled in their original locations.

### 1.04 OWNERSHIP OF MATERIALS

- A. Ownership of Materials: Except for items or materials indicated to be reused, salvaged, 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 PROJECT CONDITIONS

- A. Drawings may not indicate in detail all demolition work to be carried out. Carefully examine existing conditions to determine full extent of demolition required. All utilities, whether shown on the drawings or not, to be capped at the property line U.N.O.
- B. Repair damage due to demolition activities to existing improvements to remain at no additional cost to the Owner. Repair or replace as directed by the Owner Inspector.
- C. Take measures to avoid excessive damage from inadequate or improper means and methods, or improper shoring, bracing or support. Repair or replace any resulting damage at no additional cost to the owner as directed by the Owner Inspector.
- D. If conditions are encountered that vary from those indicated, notify the Owner Inspector for instructions prior to proceeding. Owner assumes no responsibility for actual condition of structures to be demolished.

- E. Inform Owner immediately upon discovery of asbestos products, radioactive materials, toxic wastes or other hazardous materials. Do not remove hazardous materials without Owner authorization.
- F. Adjacent roadways/passageways:
  - 1. Maintain fire department access through all phases of the project.
  - 2. Obstruction of streets, walks or other adjacent facilities will not be allowed.

#### 1.06 DIG ALERT NOTIFICATION

- A. Before any excavation in or near the public right-of-way, the Contractor must contact the Underground Service Alert of Southern California (Dig Alert) at 811 for information on buried utilities and pipelines.
- B. Delineation of the proposed excavation site is mandatory. Mark the area to be excavated with water soluble or chalk based white paint on paved surfaces or with other suitable markings such as flags or stakes on unpaved areas.
- C. Call at least Two (2) full working days prior to digging.
- D. If the members (utility companies) have facilities within the work area, they will mark them prior to the start of your excavation and if not, they will let you know there is no conflict. A different color is used for each utility type (electricity is marked in red, gas in yellow, water in blue, sewer in green, telephone and cable TV in orange).
- E. The Law requires you to hand expose to the point of no conflict 24" (inches) on either side of the underground facility, so you know its exact location before using power equipment.
- F. If caught digging without a Dig Alert ticket you can be fined as much as \$50,000 per California government code 4216.

## **PART 2 - PRODUCTS**

#### 2.01 SOIL MATERIALS

- A. Satisfactory Soil Materials: Soils approved by the testing geotechnical engineer and free of rock or gravel larger than 4 inches in any dimension, debris, waste, vegetation and other deleterious matter and as approved by the Geotechnical Engineer. Rocks or hard lumps larger than approximately 4 inches in diameter should be broken into smaller pieces or should be removed from the site. It is anticipated that most of the on-site soils may be reusable as engineered fill after any vegetation, construction debris, oversized material and deleterious material is removed from the site.
- B. Backfill & Native Fill Materials: The on-site soils may be reused as compacted engineered fill provided they comply to the requirements of "Satisfactory Soil Materials", as described above.
- C. Borrow / Imported Fill Material: Soil excavated from site or imported conforming to requirements for fill material.
  - 1. Materials for the fill shall be free from vegetable matter and other deleterious substances, shall not contain rocks or lumps of a greater dimension than is recommended by the geotechnical consultant, and shall be approved by the geotechnical consultant.

2. Imported materials should have a Plasticity Index (PI) not less than 5 nor greater than 15, as determined by ASTM D 4318; and expansion index not exceeding 10, as determined by ASTM D 4829; and a particle size not exceeding 3 inches as determined by ASTM D 422.
- D. Engineered Fill: Satisfactory Soil Materials / Borrow Fill Material, as described above, placed in lifts no greater than 8 inches thick (loose measurements), and compacted to a minimum of 90% of the soil's maximum dry unit weight.
- E. Backfill Material for Trenches:
  1. The on-site soils may be used for backfilling utility trenches from one foot above the top of pipe to the surface, provided the material is free of organic matter and deleterious substances. Any soft and/or loose materials or fill encountered at pipe invert should be removed and replaced with properly compacted fill or adequate bedding material. Also, rocks larger than 6 inches and boulders should not be used as backfill.

## 2.02 HANDLING OF MATERIALS

- A. Items scheduled for salvage by the Owner shall be delivered to a location designated by the Owner's Authorized Representative. Items shall be cleaned, packaged and labeled for storage.
- B. Items scheduled for reuse shall be stored on site and protected from damage, soiling and theft.

## PART 3 - EXECUTION

### 3.01 GENERAL

- A. Protection:
  1. Do not begin demolition until safety partitions, barricades, warning signs and other forms of protection are installed.
  2. Provide safeguards, including warning signs, lights and barricades, for protection of occupants and the general public during demolition.
  3. Provide and maintain fire extinguishers. Comply with requirements of governing authorities.
  4. Maintain existing utilities which are to remain in service and protect from damage during operations.
- B. Safety: If at any time safety of existing construction appears to be endangered, take immediate measures to correct such conditions; cease operations and immediately notify the Owner Inspector. Do not resume demolition until directed by the Owner Inspector.
- C. Noise and Dust Abatement: Exercise all reasonable and necessary means to abate dust, dirt rising and undue noise. Perform necessary sprinkling and wetting of construction site to allay dust as required by applicable codes and ordinances
- D. Dust Control: Use water mist, temporary enclosures, and other suitable methods to limit the spread of dust and dirt. Comply with governing environmental protection regulations.

Do not create hazardous or objectionable conditions, such as flooding and pollution, when using water.

- E. Water for Dust Control: Contractor shall obtain and pay for all water required for his dust control operations. This may include, but is not limited to, payment of deposits to utility for construction meter, and payment of all monthly service and water charges. Construction meter shall be in place throughout construction period unless alternative arrangements are made with the Water Department to provide construction water for all purposes. Contractor shall be aware of water moratoriums and restrictions, and shall immediately advise Owner of effects on construction schedules.
- F. An 8 foot high, chain link fence, with visual screen and gates, shall be erected prior to any demolition operations at the construction limits perimeter. Coordinate the exact location with Owner. Comply with specification section 32 31 13: Chain Link Fence.
- G. Debris Removal: Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas. Remove debris from elevated portions of building by chute, hoist, or other device that will convey debris to grade level.
- H. Progress Cleaning: Clean adjacent buildings and improvements of dust, dirt, and debris caused by demolition operations. Return adjacent areas to condition existing before start of demolition.

### 3.02 PREPARATION

- A. Prevent movement or settlement of adjacent structures. Provide bracing and shoring as necessary.
- B. Utilities:
  - 1. The Drawings do not purport to show all below-grade conditions and objects on the site. Contractor shall perform field investigations as necessary to establish location of underground utility services and other features affecting earthwork.
  - 2. Mark location of underground utilities on asphalt pavement with paint
  - 3. Disconnect and cap utility services; comply with requirement of governing authorities.
  - 4. Contractor shall arrange and notify utility company in advance of date and time when service needs to be disconnected.
  - 5. Do not commence demolition operations until associated disconnections have been completed.
  - 6. Should utilities and other below-grade conditions be encountered which adversely affect the Work, discontinue affected Work and notify Owner's Representative and Architect and request direction. Unforeseen conditions will be resolved in accordance with provisions of the General Conditions of the Contract.
  - 7. Should a utility line or structure be damaged, immediately notify the responsible utility company or agency and notify Owner's Representative and Architect.
    - a. Repair or replace all damaged utility lines and structures as directed by the responsible utility company or agency.

- b. Repair or replacement of damaged utility lines and structures whose location or existence has been made known to the Contractor shall be at no change in the Contract Time and Contract Price.
- C. Structures to be demolished shall be inspected for hazardous materials. Such materials shall be removed and disposed of before general demolition begins.
- D. Do not interrupt existing utilities serving occupied or operating facilities, except when authorized in writing by Owner's Representative and Authority Having Jurisdiction (AHJ). Provide temporary services during interruptions to existing utilities, as acceptable to Owner's Representative and to Authority Having Jurisdiction (AHJ).

### 3.03 EXPLOSIVES

- A. Explosives: Use of explosives will not be permitted.

### 3.04 DEMOLITION

#### A. Demolition, General:

1. With certain exceptions, the Contractor shall raze, remove and dispose of all buildings and foundations, structures, paving, fences and other obstructions that lie wholly or partially within the construction limits identified on Drawings. The exceptions are utility-owned equipment and any other items the Owner/Documents may direct the Contractor to leave intact or re-use onsite. Cease demolition immediately if adjacent structures appear to be in danger.
2. Conduct demolition operations and remove debris to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.
3. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner's Representative and Authority Having Jurisdiction (AHJ). Provide alternate routes around closed or obstructed traffic ways if required by governing regulations.
4. Conduct demolition operations to prevent injury to people and damage to adjacent buildings and facilities to remain. Ensure safe passage of people around demolition area.
  - a. Erect temporary protection, such as walks, fences, railings, canopies, and covered passageways, where required by authorities having jurisdiction.
  - b. Protect existing site improvements, appurtenances, and landscaping to remain.
  - c. Erect a plainly visible fence around drip line of individual trees or around perimeter drip line of groups of trees to remain.
5. Structural Stability: Provide and maintain interior and exterior shoring, bracing, or structural support to preserve stability and prevent movement, settlement, or collapse of buildings to be demolished and adjacent buildings to remain. Strengthen or add new supports when required during progress of demolition.
6. Below-Grade Construction: Demolish foundation walls and other below-grade construction, as follows:

- a. Remove below-grade construction, including foundation walls and footings, to at least 18-inches below grade, but at least to bottom of footing or foundation wall.
  - b. Completely remove below-grade construction, including foundation walls and footings.
7. Filling Below-Grade Areas: Completely fill below-grade areas and voids resulting from demolition of buildings and pavements with soil materials according to requirements specified in Section 31 20 00 - Earthwork.
  8. Damages: Promptly repair damages to adjacent facilities caused by demolition operations.
  9. Unless otherwise indicated on the plans, remove all demolished material from the site and dispose of at approved disposal sites. Comply with all requirements for recycling of demolished material as called for in Division 1 of this Specification. The contractor shall obtain necessary permits for the transportation of material from the site.

### 3.05 REMOVAL OF EXISTING PLUMBING AND ELECTRICAL EQUIPMENT AND SERVICES

- A. Remove existing plumbing and electrical equipment fixtures and services not indicated for reuse and not necessary for completion of work. Remove abandoned lines and cap unused portions of existing lines. The Contractor is responsible for completely surveying the site and locating all existing utilities, above and below ground, before contracting to perform the work.
- B. Asbestos – Cement (A-C) Pipe Removal and Disposal: The plans for the project may indicate that existing asbestos-cement pipe is to be removed from the ground. Where so indicated the Contractor shall excavate with care, expose the pipeline and remove the A-C pipe to the nearest joint. Should the plans not call out the removal of the A-C pipe and A-C pipe is encountered, the Contractor shall obtain approval from the Owner as to whether or not the A-C pipe is to be removed or can be left in place. Cutting of the pipe shall only be done if absolutely there is no other way to expose the length of pipe to the nearest joint that be separated and the Owner approves the cutting of the pipe. Cutting of the pipe shall be done with a mechanical saw with a pressure water source to dampen the pipe and the dust from the cutting. To remove a coupling, the coupling may have to be broken in the trench. The pipe once removed from the trench may be broken for handling. The breaking shall be done within a plastic bagging or sheeting material to minimize the release of asbestos fibers into the atmosphere. Once removed and broken, if necessary, the A-C material shall be bagged and disposed of legally with the Owner to be given a copy of all Contractor paperwork as to the legal disposal of the material. If the A-C pipe section(s) are removed intact the pipe can be removed by the Contractor from the project site and become the property and responsibility of the Contractor.

### 3.06 CLEANING

- A. Clean existing materials to remain, using appropriate tools and materials.
- B. Protect adjacent materials and equipment during cleaning operations.

### 3.07 PATCHING AND RESTORATION

- A. Patching: Where removals leave holes and damaged surfaces that will be exposed in the completed construction, such holes and damaged surfaces shall be patched and restored to match adjacent finished surfaces.
  - 1. Where new finish construction is applied over existing holes and damaged surfaces, patching and restoration shall be performed to the extent to make the substrate suitable for the provision of new finish construction.
  - 2. Surfaces of patched and restored areas shall be flush with the adjacent existing surfaces and shall closely match existing adjacent surfaces in texture and finish.
- B. Restoration of Site Finishes:
  - 1. Concrete paving: Where it is necessary to excavate a trench across make a cut in concrete paved areas, cut concrete cutting saw, full depth of paving.
  - 2. Bituminous paving: Where it is necessary to excavate a trench across make a cut in bituminous paved areas, either first score paving with a concrete cutting saw, in neat straight lines, prior to removing paving or make straight cuts with pneumatic spade.
  - 3. Restoration of paving: Restore all paved areas to their original condition using material of like type and quality as the removed paving. Paving in public ways shall conform to applicable requirements of authorities having jurisdiction. Repaired surfaces shall match existing adjacent paving except minimum depth shall be 3-1/2 inches where existing paving is less than 3-1/2 inches.
  - 4. Restoration of landscape planting: Restore soil and plant materials to match original condition, including additional topsoil, topsoil grading and preparation, new plant materials and plant maintenance during establishment period.

### 3.08 MAINTENANCE

- A. Install and maintain all erosion control devices, including sandbag and gravel bag dikes, silt fences, de-silting basins, inlet barricades, vehicle wash traps, and other features as required per Specification Section 01060.

### 3.09 CLEAN-UP/DISPOSAL

- A. Coordinate building access with the Owner Inspector. Review and schedule waste storage and removal, include truck access to site.
- B. Debris shall be dampened by fog water spray prior to transporting by truck.
- C. Debris pick-up area shall be kept broom-clean and shall be washed daily with clean water.
- D. Remove waste and debris, other than items to be salvaged. Turn over salvaged items to Owner, or store and protect for reuse where scheduled. Continuously clean-up and remove items as demolition work progresses. Do not allow waste and debris to accumulate in building or on site.

END OF SECTION

**SECTION 03 30 00  
CAST-IN-PLACE CONCRETE**

**PART 1 - GENERAL**

1.1 SUMMARY

- A. Section includes cast-in-place concrete, including formwork, reinforcement, concrete materials, mixture design, placement procedures, and finishes.

1.2 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Design Mixtures: For each concrete mixture.
- C. Steel Reinforcement Shop Drawings: Placing drawings that detail fabrication, bending, and placement.
- D. Welding certificates.
- E. Material certificates.
- F. Material test reports.
- G. Floor surface flatness and levelness measurements.

1.3 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.
  - 1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities."
- B. Testing Agency Qualifications: An independent agency, acceptable to authorities having jurisdiction, qualified according to ASTM C 1077 and ASTM E 329 for testing indicated.
- C. Welding Qualifications: Qualify procedures and personnel according to AWS D1.4/D 1.4M, "Structural Welding Code - Reinforcing Steel."
- D. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:
- E. Concrete Testing Service: Engage a qualified independent testing agency to perform material evaluation tests and to design concrete mixtures.
- F. Pre installation Conference: Conduct conference at Project site

- G. Tests for Concrete Materials at Batch Plant: Utilizing batch plant test records, perform the following tests in accordance with provisions of the building code:
1. Cement: Sample and test cement, or provide mill test reports, as accepted, certifying that the cement conforms to the requirements of this specification.
  2. Aggregate:
    - a. Sample and test concrete aggregate for grading and soundness before concrete mix designs are established.
    - b. Test aggregate for shrinkage characteristics in accordance with ASTM C 157.
    - c. Conduct petrographic examinations of aggregate proposed for use in accordance with ASTM C 295.
  3. Air Content: ASTM C 173, volumetric method or ASTM C 231, pressure method. One test for each set of compressive strength test specimens.

## **PART 2 - PRODUCTS**

### **2.1 FORM-FACING MATERIALS**

- A. Smooth-Formed Finished Concrete: Form-facing panels that will provide continuous, true, and smooth concrete surfaces. Furnish in largest practicable sizes to minimize number of joints.
- B. Rough-Formed Finished Concrete: Plywood, lumber, metal, or another approved material. Provide lumber dressed on at least two edges and one side for tight fit.

### **2.2 STEEL REINFORCEMENT**

- A. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (Grade 420), deformed.
- B. Plain-Steel Welded Wire Reinforcement: ASTM A 185/A 185M, plain, fabricated from as-drawn steel wire into flat sheets.
- C. Deformed-Steel Welded Wire Reinforcement: ASTM A 497/A 497M, flat sheet.
- D. Galvanized-Steel Welded Wire Reinforcement: ASTM A 185/A 185M, plain, fabricated from galvanized-steel wire into flat sheets.
- E. Epoxy-Coated Welded Wire Reinforcement: ASTM A 884/A 884M, Class A coated, Type 1, plain steel.
- F. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire reinforcement in place. Manufacture bar supports from steel wire, plastic, or precast concrete according to CRSI's "Manual of Standard Practice.

## 2.3 CONCRETE MATERIALS

- A. Cementitious Material: Use the following cementitious materials, of the same type, brand, and source, throughout Project:
  - 1. Portland Cement: ASTM C 150, Type II, gray.
- B. Normal-Weight Aggregates: ASTM C 33, graded.
  - 1. 1. Maximum Coarse-Aggregate Size: No larger than three-fourths of the clear space between reinforcing bars or between reinforcing bars and forms, nor larger than one-fifth of the narrowest dimension between sides of forms, nor larger than one-third of the depth of slab. 1-inch maximum aggregate may be used in other than mass concrete. 1 ½-inch maximum aggregate may be used in mass concrete where reinforcement clearance will permit.
  - 2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.
- C. Water: ASTM C 94/C 94M and potable.

## 2.4 ADMIXTURES

- A. Air-Entraining Admixture: ASTM C 260.
- B. Chemical Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures and that will not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.
  - 1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.

## 2.5 WATERSTOPS

- A. Flexible PVC Waterstops: CE CRD-C 572, with factory-installed metal eyelets, for embedding in concrete to prevent passage of fluids through joints. Factory fabricate corners, intersections, and directional changes.

## 2.6 CURING MATERIALS

- A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.
- B. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. (305 g/sq. m) when dry.
- C. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.
- D. Water: Potable.
- E. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, dissipating.

- F. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, nondissipating, certified by curing compound manufacturer to not interfere with bonding of floor covering.
- G. Clear, Solvent-Borne, Membrane-Forming Curing and Sealing Compound: ASTM C 1315, Type 1, Class A.
- H. Clear, Waterborne, Membrane-Forming Curing and Sealing Compound: ASTM C 1315, Type 1, Class A.

## 2.7 RELATED MATERIALS

- A. Expansion- and Isolation-Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber or ASTM D 1752, cork or self-expanding cork.

## 2.8 CONCRETE MIXTURES

- A. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, according to ACI 301. Comply with ACI 318 Sec 3.6
- B. Cementitious Materials: Use fly ash, pozzolan, ground granulated blast-furnace slag, and silica fume as needed to reduce the total amount of portland cement, which would otherwise be used, by not less than 40 percent.
- C. Admixtures: Use admixtures according to manufacturer's written instructions.
  - 1. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
  - 2. Use water-reducing admixture in pumped concrete, concrete for heavy-use industrial slabs and parking structure slabs, concrete required to be watertight, and concrete with a water-cementitious materials ratio below 0.50.
- D. Proportion normal-weight concrete mixture as follows:
  - 1. Minimum Compressive Strength: 3000 psi (24.1 MPa) at 28 days.
  - 2. Maximum Water-Cementitious Materials Ratio: 0.50.
  - 3. Slump Limit: 4 inches for concrete with verified slump of 2 to 4 inches before adding high range water-reducing admixture or plasticizing admixture, plus or minus 1 inch.
  - 4. Air Content: Do not allow air content of trowel-finished floors to exceed 3 percent.
  - 5. Synthetic Micro-Fiber: Uniformly disperse in concrete mixture at manufacturer's recommended rate, but not less than 1.5 lb/cu. yd. (0.90 kg/cu. m)
  - 6. Slump Limit: 4 inches (100 mm), plus or minus 1 inch (25 mm).
  - 7. Air Content: Do not allow air content of trowel-finished floors to exceed 3 percent.

## 2.9 FABRICATING REINFORCEMENT

- A. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

## 2.10 CONCRETE MIXING

- A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94/C 94M, and furnish batch ticket information.
  - 1. When air temperature is between 85 and 90 deg F (30 and 32 deg C), reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F (32 deg C), reduce mixing and delivery time to 60 minutes.

## PART 3 - EXECUTION

### 3.1 FORMWORK

- A. Design, erect, shore, brace, and maintain formwork, according to ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads.
- B. Construct formwork so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117.
- C. Do not chamfer exterior corners and edges of permanently exposed concrete.

### 3.2 EMBEDDED ITEMS

- A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

### 3.3 STEEL REINFORCEMENT

- A. General: Comply with CRSI's "Manual of Standard Practice" for placing reinforcement.
  - 1. Do not cut or puncture vapor barrier. Repair damage and reseal vapor barrier before placing concrete.

### 3.4 JOINTS

- A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.
- B. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect. Comply with ACI 318 Sec 6.4.
- C. Contraction Joints in Slabs-on-Grade: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. When not shown on drawings locate not more than twenty five

feet on center. Construct contraction joints for a depth equal to at least one-fourth of concrete thickness as follows:

1. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut **1/8-inch- (3.2-mm-)** wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before concrete develops random contraction cracks. Sawcutting to occur within 18 hours of finishing.
- D. Isolation Joints in Slabs-on-Grade: After removing formwork, install joint-filler strips at slab junctions with vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.
- E. Waterstops: Install in construction joints and at other joints according to manufacturer's written instructions.

### 3.5 CONCRETE PLACEMENT

- A. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections have been performed.
- B. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete will be placed on concrete that has hardened enough to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as indicated. Deposit concrete to avoid segregation.
  1. Consolidate placed concrete with mechanical vibrating equipment according to ACI 301.
  2. Comply with ACI 318 Sec 5.10
- C. Cold-Weather Placement: Comply with ACI 306.1.
- D. Hot-Weather Placement: Comply with ACI 301.

### 3.6 FINISHING FORMED SURFACES

- A. Rough-Formed Finish: As-cast concrete texture imparted by form-facing material with tie holes and defects repaired and patched. Remove fins and other projections that exceed specified limits on formed-surface irregularities.
  1. Apply to concrete surfaces not exposed to public view
- B. Smooth-Formed Finish: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch tie holes and defects. Remove fins and other projections that exceed specified limits on formed-surface irregularities.

Apply to concrete surfaces exposed to public view and/or to receive a rubbed finish.

- C. Rubbed Finish: Apply the following to smooth-formed finished as-cast concrete where indicated:

1. Grout-Cleaned Finish: Wet concrete surfaces and apply grout of a consistency of thick paint to coat surfaces and fill small holes. Mix one part portland cement to one and one-half parts fine sand with a 1:1 mixture of bonding admixture and water. Add white portland cement in amounts determined by trial patches so color of dry grout will match adjacent surfaces. Scrub grout into voids and remove excess grout. When grout whitens, rub surface with clean burlap and keep surface damp by fog spray for at least 36 hours.
- D. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces unless otherwise indicated.

### 3.7 FINISHING FLOORS AND SLABS

- A. General: Comply with ACI 302.1R recommendations for screeding, restraighening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.
- B. Float Finish: Consolidate surface with power-driven floats or by hand floating if area is small or inaccessible to power driven floats. Restraighten, cut down high spots, and fill low spots. Repeat float passes and restraighening until surface is left with a uniform, smooth, granular texture.
1. Apply float finish to surfaces to receive trowel finish and to be covered with fluid-applied or sheet waterproofing, built-up or membrane roofing, or sand-bed terrazzo.
- C. Trowel Finish: After applying float finish, apply first troweling and consolidate concrete by hand or power-driven trowel. Continue troweling passes and restraighten until surface is free of trowel marks and uniform in texture and appearance. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.
1. Apply a trowel finish to surfaces exposed to view or to be covered with resilient flooring, carpet, ceramic, porcelain or quarry tile set over a cleavage membrane, paint, or another thin-film-finish coating system.
  2. Finish and measure surface so gap at any point between concrete surface and an unveled, freestanding, 10-ft.- (3.05-m-) long straightedge resting on two high spots and placed anywhere on the surface does not exceed **1/8 inch (3.2 mm)**.
- D. Trowel and Fine-Broom Finish: Apply a first trowel finish to surfaces where ceramic or quarry tile is to be installed by either thickset or thin-set method. While concrete is still plastic, slightly scarify surface with a fine broom.
1. Comply with flatness and levelness tolerances for trowel-finished floor surfaces.
- E. Broom Finish: Apply a broom finish to exterior concrete platforms, steps, ramps, and elsewhere as indicated.
1. After floating, draw broom across the surface at right angle to flow of traffic producing a uniform non-skid surface. For light broom finish, draw a soft bristle broom across float-finished concrete surface perpendicular to line of traffic to provide a uniform, fine-line texture. For medium broom finish, use a fiber broom, leaving depressions approximately 1/16" deep. For heavy broom finish, use a coarse broom leaving depressions approximately 1/8" deep. Use liquid curing membrane.

2. At sloped surfaces, provide medium broom finish for slopes 6% or less and heavy broom finish for slopes greater than 6%.

### 3.8 CONCRETE PROTECTING AND CURING

- A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and ACI 301 for hot-weather protection during curing.
- B. Evaporation Retarder: Apply evaporation retarder to unformed concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h (1 kg/sq. m x h) before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.
- C. Comply with ACI 318 Sec 5.11. Cure concrete according to ACI 308.1, by one or a combination of the following methods:
  1. Moisture Curing: Keep surfaces continuously moist for not less than seven days.
  2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches (300 mm), and sealed by waterproof tape or adhesive. Cure for not less than seven days. Immediately repair any holes or tears during curing period using cover material and waterproof tape.
  3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.
    - a. Removal: After curing period has elapsed, remove curing compound without damaging concrete surfaces by method recommended by curing compound manufacturer unless manufacturer certifies curing compound will not interfere with bonding of floor covering used on Project.

Curing and Sealing Compound: Apply uniformly to floors and slabs in a continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Repeat process 24 hours later and apply a second coat. Maintain continuity of coating and repair damage during curing period. Acceptable manufacturers include "#1100 Clear" as manufactured by W.R. Meadows, Inc. ; "Curetox" as manufactured by Toch Brothers, Inc., or "Kure-N-Seal", manufactured by Sonneborn Building Products.

### 3.9 CONCRETE SURFACE REPAIRS

- A. Defective Concrete: Repair and patch defective areas when approved by Architect. Remove and replace concrete that cannot be repaired and patched to Architect's approval.
- B. Corrective work: Grinding (if needed) shall be done dry with a vacuum attachment. Ensure any patching materials that are used are compatible with the flooring adhesive to be used.

3.10 FIELD QUALITY CONTROL

- A. Testing and Inspecting: Owner will engage a qualified testing and inspecting agency to perform field tests and inspections and prepare test reports. Comply with Sec. 01-45-29.

END OF SECTION

**SECTION 04 22 00  
CONCRETE UNIT MASONRY (CMU)**

**PART 1 - GENERAL**

1.1 SUMMARY

A. Section Includes:

1. Furnish materials and perform labor required to execute this work as indicated on the drawings, as specified and as necessary to complete the Contract, including, but not limited to, these major items:
  - a. Concrete masonry units.
  - b. Precast concrete caps.
  - c. Vertical and horizontal reinforcing and dowels projecting into subsequently placed concrete.
  - d. Setting of flashing and other work to be embedded in masonry.

B. Work installed but furnished in other Sections:

1. Sleeves, inserts and similar items furnished by other trades for installation in masonry.

C. Related sections:

1. Section 03 30 00 - Cast-In-Place Concrete: Concrete, including dowels installed in concrete, placed prior to installation of masonry work, for anchorage of masonry.
2. Section 05 55 00 Miscellaneous Metals.
3. Section 07 19 00 Water Repellent Coating.
4. Section 07 60 00 Flashing and Sheet Metal.
5. Section 07 92 00 Joint Sealants.

1.2 DEFINITIONS AND REFERENCES

- A. ASTM A615 - Deformed and Plain Carbon Steel Bars for Concrete Reinforcement.
- B. ASTM C33 - Concrete Aggregates.
- C. ASTM C90 - Test Method Pullout Strength for Hardened Concrete.
- D. ASTM C114 - Test Methods for Chemical Analysis of Hydraulic Cement.
- E. ASTM C144 - Aggregate for Masonry Mortar.
- F. ASTM C150 - Portland Cement.
- G. ASTM C207 - Hydrated Lime for Masonry Purposes.
- H. ASTM C404 - Aggregates for Masonry Grout.

### 1.3 SUBMITTALS

- A. Procedures: In accordance with requirements of Section 01300.
- B. Product data: Manufacturer's information for all specified items.
- C. Samples: Samples of all blocks used in the work.
- D. Sample panel: Erect a 3' high x 4' long sample panel of concrete block masonry. After review and acceptance by Architect, ensure that all masonry work matches accepted panel.
- E. Certificates: Prior to delivery, submit certificates attesting compliance of CMU with applicable specifications for grades, types or classes.

### 1.4 QUALITY ASSURANCE

- A. Regulatory requirements:
  - 1. Materials and work: Conform to California Building Code latest edition, Chapter 21, Title 24, Part 2, California Code of Regulations latest edition. In case of conflict between these specifications and Building Codes, the more stringent shall govern.
  - 2. Provide for testing and quality control per CBC 2016 Sections 2105A.1 and 2105A.2.1.
  - 3. NOTE! All structural masonry requires continuous inspection by an inspector approved by enforcement agency.
- B. Verify that masonry units have been cured for 28 days before delivery to project site.

### 1.5 PRODUCT HANDLING

- A. Procedures: In accordance with Section 01 60 20.
- B. Deliver reinforcement to site bundled, tagged and marked; handle to prevent damage to material. Use metal tags indicating size, length and other markings shown on placement drawings. Maintain tags after bundles are broken.
- C. Protection: Safeguard all materials against injury in transit, delivery, storage, sorting, installation, cleaning, and until final acceptance of completed work.
- D. Store cement and lime in rain proof sheds with elevated floors.
- E. Store sand on tightly floored space, protected against mixing with ground or other materials.

## **PART 2 - PRODUCTS**

### 2.1 MANUFACTURERS AND PRODUCT

- A. Manufacturer: Orco Block Co., Inc.
- B. Specified manufacturer establishes a standard of quality, function and design for this project. Other acceptable manufacturers having equivalent products may be used only with Architect's approval.
  - 1. Alternate manufacturers: Angelus Block Company, or equal.



- C. Mixing: Mix water, and cement for two minutes, then add lime and admixture, continue mixing in a mechanically operated batch mixer; a continuous mortar mixer will not be permitted. Mix to maintain a slump of from 2 1/2" to 3".
- D. Discard mortar and grout not used within 30 minutes after leaving mixer. Retempering of mixture shall not be allowed.

## 2.4 QUALITY CONTROL OF MASONRY CONSTRUCTION

- A. The compressive strength of concrete masonry shall be determined by the **PRISM TEST METHOD** prior to the start of construction and during construction per CBC 2016, Section 2105A.2.2.2.
- B. Mortar and grout sample shall be taken for test to establish whether the masonry components meet the specified component strengths per CBC 2016, section 2105A.3.
- C. Masonry core test shall be performed to determine the quality of the masonry constructed per CBC 2016, section 2105A.4.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine adjacent construction and supports. Verify that surfaces are within allowable tolerances, plumb, level, clean, and will provide solid anchoring surfaces.
- B. Correct conditions detrimental to proper or timely completion of this work before proceeding with installation.

### 3.2 SCAFFOLD AND PROTECTION

- A. Provide and maintain scaffolding, staging and forms of protection necessary for execution of work, as required, substantially constructed, moved and dismantled as necessary to properly follow sequence of operations.

### 3.3 SHORES AND CENTERING

- A. Provide shores and centering for work, constructed true to required shape, size and form, well braced and made rigid, and capable of supporting and sustaining loads to which subjected. Leave shores and centering in place until the masonry is sufficiently set to safely carry its own weight and added loads of construction.

### 3.4 PLACING REINFORCEMENT

- A. Reinforcement steel, except dowels in other material. Accurately set and place strictly as shown or noted. In spaces containing reinforcement, except small rods or mesh one-quarter inch or less in diameter, the clear distances between masonry and the reinforcement shall be at least 1/4".
  - 1. Vertical bars: Continuous from bottom of cell to top of wall, centered in cells, except where otherwise shown on drawings. Where necessary, hold vertical steel firmly in place by frames or other suitable devices as reviewed and accepted.
  - 2. Horizontal bars: Wire temporarily above exact position and tag to correct locations shown on drawings. Use calibrated vertical markers to indicate correct location. Provide horizontal bars where shown on drawings, held in contact to vertical bars or dowels.

### 3.5 PREPARATION

- A. Previously placed concrete or masonry: Clean of encrustation, laitance, oil, and coatings which would reduce bond, including sandblasting as required. Clean thoroughly and roughen contact surfaces of all foundations and floors that are to receive masonry work, before start of laying masonry units. Protect roughened surface during construction to assure a good bond between grout fill and concrete surface. Wash surfaces thoroughly with water under pressure; leave surfaces damp where masonry units connect with earlier placed work.
- B. Masonry units: Thoroughly clean of dust, grease, oil or other matter which would reduce bond.
- C. Wetting: Protect concrete masonry unit against wetting before installation.
- D. Reinforcement: Clean of mill scale; lose rust, oil and coatings which would reduce bond.
- E. Obtain approval of methods of placement and fastening of reinforcement prior to start of work.

### 3.6 BONDING

- A. Masonry bonding to concrete: Clean top surface of concrete. Remove laitance and expose aggregates before placing masonry units.
- B. Lay up wall in straight uniform courses with regular running bond or as shown on drawings.

### 3.7 GROUTING - LOW LIFT

- A. Low-lift grout if used shall conform to CBC 2016, Section 2104A.1.3.1.1.1.1.
- B. Prior to grouting, clean grout space so that all spaces to be filled with grout do not contain mortar projections greater than 1/2", mortar drippings or other foreign material.
- C. Maximum lift: 4 feet.
- D. Grouting of the wall: Complete in one day, with no interruptions greater than one hour.
- E. Fill all cells and spaces with grout.
- F. Consolidate grout by mechanical vibration or other means which are approved by Division of State Architect, during placing, before loss of plasticity, in a manner to fill grout space without contacting reinforcing. Mechanical vibration requires use of high frequency vibration equipment producing 10,000 cycles per second, minimum, and sized as required.

### 3.8 GROUTING - HIGH LIFT

- A. High-lift grout shall conform to CBC 2016, Section 2104A.1.3.1.1.1.2.
- B. Additional requirements for high-lift grouted wall construction shall be per DSA IR 21-2.

### 3.9 BLOCK LAYING (GENERAL)

- A. Notes: General Notes on structural drawings are part of this Section.
- B. Preserve unobstructed vertical continuity of cells to be filled. Fully bed webs and cross-walls forming such cells in mortar to prevent leakage of grout. Strike joints around such cells smooth.

- C. Fractional parts of masonry units are prohibited where whole units can be used. Chinking of interstices with fragments will not be allowed. Provide special units as necessary to form opening and lintels.
- D. Install lintel units at lintels, corner units at corners.
- E. No miters are permitted. No exposed cells are permitted.
- F. No part of any masonry wall may be carried more than 3 feet higher than adjoining portions.
- G. Where it is absolutely necessary, for construction purposes, to stop off longitudinal runs of masonry, stop off only racking back one-half unit length in each course. Tothing will not be permitted.
- H. Execute masonry work according to best standards of practice for trade. Erect masonry plumb, square, straight and true to indicated lines, position and dimensions and in level courses.
- I. Make provision for special units as required to form bond beams, openings and offsets and maintain a proper bond throughout entire length of wall.
- J. Masonry units: Sound, dry, clean and free from cracks when placed in the structure.
- K. Do not wet masonry units except in very dry weather, moisten contact surfaces of units immediately before laying.
- L. Cut units accurately to fit openings for other work. Cut and patch holes neatly and accurately.
- M. If it is necessary to move a unit after it has been once set in place, remove unit from wall, clean and set in fresh mortar.
- N. Where necessary to cut concrete masonry units in order to conform to adjacent construction or to indicate joint pattern, saw masonry units with diamond or other abrasive saw to produce a straight, sharp edge without spalling or other defects. Cut units as required to maintain uniform joint widths throughout.
- O. When possibility of rain occurs, cover tops of all walls exposed to weather, and all concrete masonry units with sheets of polyethylene, or other reviewed and accepted effective forms of protection, to prevent absorption of water. Store masonry units above ground if there is a possibility of surface flooding exists.

### 3.10 JOINTS

- A. Exterior joints: Point mortar joints flush, using a pointing trowel, and then tool to a slight concave profile, making solid, smooth, watertight joints.
- B. Interior joints: Strike flush and sack as work progresses.
- C. Unless otherwise shown, make joints 3/8" thick with full mortar coverage on face shells and on webs surrounding cells to be filled.
- D. Set lintels, capping units and bearing plates in a full bed of mortar.

### 3.11 BOLTS, ANCHORS AND REGLETS

- A. Set bolts, anchors, reglets, and inserts necessary for attachment of subsequent work, and items furnished under other sections. Provide a minimum of 1" grout around all anchor bolts.

### 3.12 POINTING AND CLEANING

- A. Leave exposed surfaces clean and free of surplus mortar or foreign material. Exercise care to keep grout and mortar droppings off finished surfaces.
  - 1. Defective joints: Point holes or defective mortar joints, in exposed masonry, and where necessary, cut out defective joints and repoint.
  - 2. Staining and excess mortar: Protect exposed masonry against staining. Where grout or mortar does contact faces of masonry, remove it immediately. Where accidental spillage occurs, wash and clean surfaces immediately.

### 3.13 FIELD QUALITY CONTROL

- A. Contact testing laboratory to test mortar and grout to extent required by governing code. Mortar and Grout testing per CBC 2016, Section 2105A.3 and Core testing per CBC 2016, Section 2105A.4.
- B. Whenever there is any evidence that materials to be used in masonry construction do not conform to the Contract Documents, test materials for compliance before being used in project.
- C. District will pay for tests if they prove compliance with Contract Documents; otherwise costs of tests shall be paid by Contractor.
- D. Continuous inspection: As required by structural drawings.

END OF SECTION

**SECTION 05 12 00  
STRUCTURAL STEEL**

**PART 1 – GENERAL**

1.1 SCOPE

- A. Requirements of Division 1 apply to this Section.
- B. Furnish materials and perform labor required to execute this work as indicated on the drawings, as specified and as necessary to complete the Contract, including, but not limited to, these major items:
  - 1. All structural steel framing, including plates and channels.
  - 2. Base plate and furnishing anchor bolts.

1.2 RELATED WORK SPECIFIED ELSEWHERE AS REQUIRED

- A. Miscellaneous metalwork.
- B. Setting anchor bolts and grouting base plates.

1.3 GENERAL REQUIREMENTS

- A. Codes: All work to conform to Chapter 22A of Title 24, of the California Building Code latest Edition, and Chapter 22A, of UBC latest edition.
- B. Shop Drawings: In accordance with section 01 33 00, submit complete checked shop drawings as required for this work.
  - 1. Improper Corrections: Should the Architect, in reviewing shop drawings, make corrections that would cause incorrect fitting or reduced strength, give written notice of such fact at once, so that the correction may be modified before the work affected is started.
  - 2. As-Built Drawings: After this work has been erected, correct or revise the originals of the reviewed shop drawings and erection diagrams to correspond with field changes.
- C. Test and Inspections: The Owner will pay for all tests and inspections of completed installation of this work. Costs of all tests and inspections at materials sources, and costs of retests of rejected work, shall be borne by the Contractor. Arranging for scheduling of tests and inspections shall be the responsibility of the Contractor. See Section 01 45 29 for testing requirements.

**PART 2 – PRODUCTS**

2.1 MATERIALS

- A. Materials: New tested stock of domestic manufacture, complying with standard specifications hereinafter referenced. If foreign materials are used, they shall meet or exceed the requirements of all authorities having jurisdiction.
- B. Machine Bolts: A307, and ANSI B18.2, 36 square or hexagonal heads.
- C. Paint: Use primer as specified under Painting Section.

- D. Structural Pipe Columns: ASTM A53, Type S, Grade B.
- E. Grout: "Por-Rok" as manufactured by Minwax Construction Products Division.
- F. Structural Tubes: ASTM A500, Grade B.
- G. Arc-Welding Electrodes: Conform to requirements of AWS; as required for the conditions of intended use.
  - 1. All welds on members comprising the Seismic-Force-Resisting System, except as noted below for joining of material conforming to ASTM A913, grade 65, shall employ weld filler metals classified for nominal 70 psi tensile strength, referred to as E70 electrodes, meeting the following minimum mechanical property requirements:
    - a. CVN toughness of 20 ft-lb at 0°F, using AWS A5 classification test methods
    - b. CVN toughness: 40 ft-lb at 70°F.
    - c. yield strength: 58 ksi minimum, using both the AWS A5 classification test (for E70 classification electrodes).
    - d. tensile strength: 70 ksi minimum, using both the AWS A5 classification test (for E70 classification electrodes).
    - e. Elongation: 22% minimum, using both the AWS A5 classification test.
  - 2. Welded joints of ASTM A913, grade 65 material shall be made with weld fillet metals classified as E80 electrodes with a minimum yield strength of 68 ksi, minimum tensile strength of 80 ksi, and a minimum elongation of 19%. CVN toughness requirements of (1) and (2) above shall apply.
  - 3. Packaging Requirements of weld filler metals shall conform to the requirements of AWS D.1.1. FCAW electrodes shall be received in moisture-resistant packages that are undamaged. They shall be protected against contamination and injury during shipment and storage. Electrode packages shall remain effectively sealed against moisture until the electrode is required for use. When removed from protective packaging and installed on machines, care shall be taken to protect the electrodes and coatings, if present, from deterioration or damage. Modification or lubrication of an electrode after manufacture for any reason is not permitted, except that drying shall be permitted when recommended by the manufacturer.

## 2.2 TESTS

Identified Material: If material is properly identified, mill reports will be accepted.

Unidentified Material: One tension and one bend test for every 20 tons or fractional part thereof. Submit copies of all test reports to the Architect a reasonable time before starting fabrication.

## 2.3 TESTS OF WELDING AND BOLTING

- A. Testing agency shall inspect all shop and field welding, and furnish qualified deputy inspectors, approved by the Architect and Division of the State Architect. Testing and inspection shall comply with all regulations of the Division of the State Architect. Testing agency shall certify in writing, upon completion of the work, that the welding has been performed by fully qualified welders in accordance with drawing and specifications

requirements and with all applicable requirements of regulatory agencies having jurisdiction.

B. Weld Acceptance Criteria

1. Engineer's Authority: Welds or portions of welds that fail to meet the acceptance criteria of AWS D1.1 shall be repaired or replaced.
2. Magnetic Particle Testing: If a surface discontinuity or near-surface discontinuity, within 1/8 inch of the surface, is detected, the discontinuity shall be rejected and removed. If the separation from the surface cannot be determined, the discontinuity shall be categorized as a surface flaw, rejected and removed.
3. Ultrasonic Testing - Flaw Detection:
  - a. When ultrasonic testing is required, the joint shall be scanned for flaw detection purposes following the procedures prescribed in AWS D1.1, Annex K, with exceptions as noted below. Joints that fail the acceptance criteria described below may be inspected using the Ultrasonic Testing - Flaw Sizing methods as prescribed in Section 5.8.4 of this specification, or, at the Contractor's option, may be excavated for further investigation and repaired, then reinspected using these Flaw Detection procedures.
  - b. When ultrasonic testing is required, CJP and PJP groove welds shall be scanned for flaw detection. Acceptance criteria shall be as for statically loaded welds in Annex K, Table K-1, of AWS D1.1.
  - c. Joints with backing bars remaining in place shall not be rejected on the basis of indication ratings (db values) from the interfaces between backing bar and base metal or backing bar and weld. The UT Procedure shall prescribe methods for distinguishing between backing bar indications and root discontinuities.
  - d. PJP groove weld joints shall not be rejected on the basis of indication ratings (db values) from the root area of the weld. Notches within the weld, located a distance more than 1/8 inch from the as-welded root, shall be scanned for acceptance using the criteria above.
  - e. Regions of welds adjacent to cope holes may be inspected with multiple probe techniques.
4. Ultrasonic Testing – Flaw Sizing: Ultrasonic testing for flaw sizing shall be performed following written procedures as required by AWS D1.1, Annex X. When flaw-sizing techniques are implemented, the following acceptance criteria applies to groove welds:
  - a. If a surface flaw or near-surface flaw (within 1/8 inch of the surface) is detected, the flaw shall be rejected and removed. If the separation from the surface cannot be measured, the flaw shall be categorized as a surface flaw, rejected and removed.
  - b. When backing bars remain in place, the position of notch tips that extend into the weld metal shall be determined. The notch shall be rejected if it extends greater than 1/8-inch into the thickness of the weld. The weld present between the backing bar and column face shall not be considered a part of the weld thickness in determining the depth of notch or thickness of weld.

- c. Embedded flaws, defined as those that do not come within 1/8 inch of the surface, shall be rejected if their height exceeds 1/4 inch.
- d. Embedded flaws shall be rejected if their area, as calculated by multiplying the maximum discontinuity height by the maximum discontinuity length, exceeds the thickness of the thinner parent metal multiplied by the thickness of the thicker parent metal.
- e. Embedded flaws, either individually or as a group within a length of weld 12 inches or less, shall be rejected if they exceed a total area (the sum of the areas of individual discontinuities) equal to 10% of the thickness of the thinner parent metal multiplied by the weld length. The weld length used for this calculation shall not exceed 12 inches, with longer welds being evaluated in multiple parts.
- f. Aligned discontinuities of lengths L1 and L2 separated by less than  $(L1+L2)/2$  shall be evaluated as continuous.
- g. Parallel discontinuities of heights H1 and H2 separated by less than  $(H1+H2)/2$  shall be evaluated as continuous.

## 2.4 PAINTING

- A. Thoroughly clean structural steel of loose mill scale, grease, dirt and foreign matter, by thoroughly scraping, wire brushing or sandblasting, and apply paint to a dry film thickness of one mil.

## PART 3 - EXECUTION

### 3.1 FIELD MEASUREMENTS

- A. Before starting work obtain measurements pertaining to this work, and verify the locations and exact positions of concrete supports and anchor bolts.

### 3.2 WORKMANSHIP

- A. Workmanship: Equal to the best standard practices in modern structural shops, conforming to applicable provisions contained in the AISC Code of Standard Practice, except where these requirements herein govern.
- B. Injury and Excessive Stress: Transport, handle and erect structural steel, in shop and field, to preclude injury. Do not subject material to excessive stress in any part or connection.
- C. Welded Construction
  - 1. Each welder working on the project shall be assigned an identification symbol or mark. Each welder shall mark or stamp this identification symbol at each weldment completed. Stamps, if used, shall be the low-stress type.
  - 2. Welding personnel shall be qualified in accordance with AWS D1.1, Section 4, Parts X and C. WPQR testing performed more than six months prior to the start of the welding by the welder is acceptable, provided written documentation is submitted showing that the welder has continued to use the applicable welding process on an ongoing basis since the test was conducted, with no lapse in service exceeding six months. Welders whose work routinely exhibits poor workmanship shall be requalified before performing further welding.

3. WPSs shall be available to welders and inspectors prior to and during the welding process. Prior to welding, joint fit-up shall be verified by the welder for conformance with the WPS and AWS D1.1.
  4. For all complete joint penetration (CJP) and partial joint penetration (PJP) groove welds subjected to ultrasonic testing (UT), a visible mark, "for UT," shall be accurately placed on the steel a distance of 4 inches away from the root of the edge preparation.
  5. Welding shall be performed in accordance with the appropriate WPS for the joint.
  6. Groove welds shall be complete joint penetration groove welds, unless specifically designated otherwise on the Drawings. Groove preparation details are at the Contractor's selection, subject to qualification, is required, in accordance with AWS D1.1.
  7. Faces of fillet and groove welds exposed to view shall have as-welded surfaces that are reasonably smooth and uniform. No finishing or grinding shall be required, except where clearances or fit of other items may so necessitate, or as preparation for coating.
- D. Supplemental Welding Personnel Testing and Qualification Period.
1. Welders and welding operators shall pass Supplemental Welder Qualification Testing, as prescribed in Appendix B, on special test joint mock-ups. Testing shall be performed using the process to be used in the work, with the WPS set at the highest deposition rate to be used in the work. FCAW-S and FCAW-G shall be considered separate processes for welding personnel qualification. Tack welders need not perform such Supplemental Testing.
  2. Welding personnel required to be tested using the Supplemental Welding Personnel Testing prescribed in Section 3.3.1.1 shall be qualified by test within 12 months prior to beginning welding on the project.
  3. Should the 12-month period elapse during welding on the project, the Supplemental Welder Qualification remains valid. It is not required to repeat the testing during the course of the project, unless the quality of the workmanship for that welder routinely fails to meet the applicable project weld quality standards.
- E. Welding Sequence for Moment Connection of Bottom Beam Flange.
1. When welding the bottom flange to the column flange of welded moment-resisting connections, the following sequence shall be followed:
    - a. When welding from Side A (one side of the beam), the root pass shall begin beyond the center of the joint on Side B, reaching past the beam web (or web plate, for FF connections) through the weld access hole (or opening, for FF connections). After the arc is initiated, travel shall progress toward the edge of the Side A beam flange, and the weld shall be terminated on the Side A weld tab.
    - b. The Side A root pass, and the root pass deposit on Side B, shall be thoroughly cleaned and visually inspected by the welder to ensure fusion, soundness, and freedom from cracks, slag inclusions and excessive porosity. The resulting bead profile shall be suitable for obtaining good fusion by the subsequent root pass to be initiated from Side B. If the profile is not conducive to good fusion, the start of the first root pass shall be ground, gouged, chipped, or otherwise prepared to ensure adequate profile to achieve fusion.

- c. The second half of the weld joint, from Side B, shall have the root pass applied before and other weld passes are performed. The arc shall be initiated in the area of the start of the first Side A root pass, and travel shall progress to the end of the joint, terminating of the Side B weld tab.
  - d. The above sequence shall be repeated for subsequent weld layers, and each weld layer shall be completed on both sides of the joint before a new layer is deposited. The order of operations (Side A, then Side B, or vice versa) is not restricted and may vary for each weld layer.
2. Weld passes shall be placed in horizontal layers. Each pass shall be thoroughly cleaned of slag and wire brushed. Each pass shall be inspected by the welder, as described above in Step 2.
  3. Both top and bottom beam flanges should be completely welded prior to any supplemental welding to the beam web or shear tab, unless otherwise detailed in the approved erection plan and the WPS.

### 3.3 FABRICATION AND ASSEMBLY

Before being fabricated or worked, material shall be thoroughly wire brushed, cleaned of loose mill scale and rust, and straightened by methods that will not injure it. After punching or working the component parts of a member, remove twists or bends before the parts are assembled. Finished members shall be free from twists, bends, and open joints when erected.

Field Joining: Members and sections shall be of sizes, weights, shapes, and arrangements indicated, closely fitted, and finished true to line and in precise position necessary to allow accurate erection and proper joining of parts in the field. Drifting to enlarge unfair holes will not be allowed. Rolled sections, except for minor details, shall not be heated without prior approval.

Contact: Component parts of built-up members shall be well pinned and rigidly maintained in close contact using clamps or temporary bolting during welding. Compression joints depending upon contact bearing shall have bearing surfaces accurately milled perpendicular to their axes, or as detailed.

- A. In addition to special care used to handle and fabricate AESS, comply with the following:
  1. Fabricate with exposed surfaces smooth, square, and free of surface blemishes.
  2. Grind sheared, punched, and flame-cut edges smooth
  3. Fabricate with exposed surfaces free of mill marks.
  4. Fabricate with exposed surfaces free of seams to maximum extent possible.
  5. Remove blemishes by filling or grinding or by welding and grinding, before cleaning, treating, and shop priming.
  6. Fabricate with piece marks fully hidden in the completed structure or made with media that permits full removal after erection.
  7. Fabricate to the tolerances specified in AISC 303 for steel that is designated AESS.
  8. Seal-weld open ends of hollow structural sections with 3/8-inch (9.5-mm) closure plates.

- B. Coping, Blocking, and Joint Gaps: Maintain uniform gaps of 1/8 inch (3.2 mm) with a tolerance of 1/32 inch (0.8 mm)

### 3.4 GAS CUTTING

- A. When permitted by the Architect, use of a cutting torch is allowed where the metal being cut is not carrying stress during the operation, and provided stresses will not be transmitted through a flame-cut surface. Make gas cuts smooth and regular in contour. To determine the effective width of members so cut, deduct 1/8" from the width of the gas cut edges. Make the radius or re-entrant gas cut fillets as large as practicable, but in no case less than one inch.

### 3.5 PUNCHING, DRILLING AND REAMING

- A. Material may be punched 1/16" larger than the nominal diameter of the bolt for standard bolt holes. Holes for anchor bolts are oversized to facilitate erection as follows:

Bolts	3/4" to 1"	5/16" oversize
	1" to 2"	1/2" oversize
Bolts over 2"		1" oversize

- B. Holes shall be drilled or sub-punched or reamed. The diameter for sub-punched holes, and the drill for sub-drilled holes, shall be 1/16" smaller than the nominal diameter of the bolt to be accommodated. Precisely locate finish holes to insure passage of bolts through assembled materials without drifting. Poor matching of holes is sufficient cause for rejection.

### 3.6 WELDING

- A. Welding and Welded Joints: Detail and execute in accordance with the requirements of the American Welding Society standards and as modified by AISC Specifications or as detailed and noted on the drawings. In the event of conflict, the notes and details on the drawings take precedence. Structural welding shall be done by Low Hydrogen, CO<sub>2</sub>, Innershield or Submerged Arc.
- B. Electrode Storage and Exposure Limits.
  - 1. FCAW electrodes shall be receive and stored in the original, undamaged manufacturer packaging, until ready for use. Electrodes in packages that have had the internal plastic wrapping damaged shall not be used. Modification or lubrication of an electrode after manufacture is not permitted, except that drying is permitted as recommended by the manufacturer.
  - 2. When welding is to be suspended for more than 8 hours, electrodes shall be removed from the machines and stored in an electrode wire oven maintained at a temperature between 250o and 550o F, or as recommended by the manufacturer. Electrodes not consumed within 24 hours of accumulated exposure outside closed or heated storage shall not be used. Electrode spools shall be identified to facilitate monitoring of total atmospheric exposure time. FCAW electrodes that have been exposed for periods exceeding an accumulated 24 hours may be dried if manufacturer's tasting and recommendations show that drying is effective at removing moisture and restoring electrodes to their designated diffusible hydrogen level.
- C. Minimum Preheat and Interpass Temperature.
  - 1. Minimum preheat and interpass temperatures shall be provided for all welds, including tack welds, in accordance with AWS D1.1, Table 3.2. The Contractor

may specify higher minimum temperatures, if desired, as a part of the Contractor's WPS for a particular application. In such cases, the WPS minimum reheat and interpass temperatures shall be provided.

2. Preheat and interpass temperatures lower than those required by AWS D1.1, Table 3.2, are permitted provided the WPS has been qualified by test, and the WPS and PQR have been accepted by the Engineer.
  3. Minimum preheat and interpass temperatures shall be verified at a distance of 3 in. from the weld, at the joint of arc initiation or for materials over 3 inches in thickness at a distance equal to the thickness of the part.
- D. Maximum Preheat and Interpass Temperature
1. The maximum preheat and maximum interpass temperature permitted is 550oF, measured at a distance of 1 in. from the point of arc initiation. This maximum temperature may not be increased by the WPS, regardless of qualification testing.
- E. Backing Bar and Weld Tab installation and removal specifications and requirements are shown on the Structural drawings.

### 3.7 ERECTION

- A. Erect structural steel by professional riggers, carefully plan and lay out so that a minimum of cutting will be necessary. Erect the work plumb, square and true to line and level, and in precise positions as indicated. Provide temporary bracing and guys wherever necessary to provide for loads and stresses to which the structure may be subjected including those due to erection equipment and its operations, and leave in place as long as necessary to safeguard all parts of the work.
- B. Temporary Connections: As erection progresses, the work shall be securely bolted up as necessary to maintain the steel in proper position while field bolting and welding is being done, and as necessary to take care of dead loads, wind, and erection stresses. No field welding or high strength bolting shall be done until the work has been properly aligned, plumbed and leveled.
- C. Set column base plates in exact position, as to alignment, level, and elevation, as well as support on steel wedges, or equivalent until the grout thereunder has thoroughly set. The center of each base shall be true to the column center within 1/16". Adjust elevation to  $\pm 1/32$ ". Exactly level plates on both axes.
- D. Sequence: Carry out the erection of structural steel in proper sequence with the work of other trades. Frame, bed, and anchor to the concrete and related work in accordance with detailed drawings and reviewed setting diagrams.
- E. Erection Tolerance: In accordance with the current AISC Code or Standard Practice for Steel Buildings and Bridges.

### 3.8 ANCHOR BOLTS

- A. Furnish to the site when and as required to maintain job progress, for installation under Concrete Section, all anchor bolts to be embedded in the concrete for the securing of structural steel in position. Provide the necessary drawings and templates for the setting of such anchor bolts in the concrete forms. Be jointly responsible with others for the proper location, and installation, and make good deficiencies and errors. Setting of anchor bolts in hardened concrete, necessitated through error or oversight, shall be made under direction of the Architect in suitably drilled holes solidly grouted in place, embedded in an approved structural epoxy.

### 3.9 GROUTING OF BASES AND PLATES

- A. Be responsible for maintaining bases and bearing plates in proper location and in proper level while they are being grouted and be jointly responsible for a perfect job. Refer to Concrete Section for materials, mix and procedures for grouting of base plates.

### 3.10 CUTTING STRUCTURAL STEEL

- A. Provide cuts in structural steel for mechanical, plumbing and electrical pipes as approved by Architect. Locate as shown on Mechanical, Plumbing and Electrical drawings.

### 3.11 GALVANIZING

- A. Hot-Dip Galvanized Finish: Apply zinc coating by the hot-dip process to structural steel according to ASTM A 123/A 123M.
  - 1. Do not quench or apply post-galvanizing treatments that might interfere with paint adhesion.
  - 2. Fill vent and drain holes that will be exposed in the finished work, unless indicated to remain as weep holes, by plugging with zinc solder and filling off smooth.
  - 3. Galvanize attached to structural-steel frame and located in exterior walls.
- B. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.

END OF SECTION

**SECTION 05 40 00  
LIGHT GAUGE STEEL FRAMING SYSTEM**

**1.00 GENERAL**

A. Requirements of Division 1 apply to this Section.

**1.01 DESCRIPTION**

A. Steel framing systems as indicated on the drawings and specified herein.

**1.02 RELATED WORK SPECIFIED ELSEWHERE AS REQUIRED**

A. Rough Hardware - Rough Carpentry.

**1.03 SUBMITTALS**

A. Submit a materials list, indicating structural values and conformance with governing standards in conformance with Section 01 33 00.

**1.04 REFERENCED STANDARDS**

- A. All work shall conform to latest edition of the California Building Code, California Code of Regulations, Title 24, Chapter 22A
- B. American Welding Society (AWS) Structural Welding Code (D1.3). Specification for Welding Sheet Metal in Structures (E1.3).
- C. American Iron and Steel Institute (AISI) Cold Formed Steel Design Manual, "Spec for the Design of Cold Formed Steel Structural Members, latest edition.

**2.00 MATERIALS**

**2.01 STUDS, TRACK, BRACING BRIDGING AND JOISTS.**

- A. Size, type and thickness as indicated on the drawings.
- B. Steel Stud and Track Member: "C" flange type, ASTM A653 SS Grade 33 or ASTM A1011 SS Grade 33 - rust - inhibitive primed.
- C. Steel-16 Gauge and Heavier: Conform to ASTM A653 SS Grade 50, Class 1 or 3 or ASTM 1011 SS Grade 50 and as set forth in Section A3.1 of referenced AISI Spec.
- D. Steel-18 Gauge: Conform to ASTM A653 SS yield 33 ksi and as set forth in Section A3.1 of referenced AISI Spec.
- E. Steel-20 Gauge: Conform to ASTM A653 SS, yield 33 ksi and as set forth in Section A1.2 of referenced AISI Spec.
- F. Paint: Use primer as specified in Painting Section.
- G. Welding Electrodes: AWS AS.1.

H. Stud Channel: Non-bearing locations only: 20 gauge.

## 2.02 FASTENERS

A. Fasteners shall be the size and type indicated on the drawings. Note that the materials indicated are manufactured by S SMA, ICBO ER-4943P. Similar materials which will meet the fastening requirements of each detail may be acceptable substitutes. Minimum finish: Cadmium or zinc plating per ASTM A-165 Type NS.

B. Since proper installation and load transfer is dependent on depth and pressure sensitive drive equipment, fasteners shall be the products of one manufacturer; recommended washers and other accessories as well as recommended drive equipment shall be required.

## 2.03 COLD ROLLED CHANNELS

A. Fabricated from 16 ga. sheet.

B. Provide galvanized finish for use in conjunction with galvanized framing and in exterior surfaces.

C. Provide painted finish for use in generally dry interior areas.

D. Depths.

1. 1 1/2" minimum for bridging and for miscellaneous framing.

2. Provide deeper channels as required by span and load.

3. Provide deeper channels when so indicated.

## 2.04 MISCELLANEOUS COLD AND HOT ROLLED SHAPES

A. Square or Rectangular Steel Tubing: Steel conforming to ASTM A500, Grade B.

B. Round Steel Tubing: Steel conforming to ASTM A53, Type E or S, Grade B.

C. Angles, Channels, Etc.: Steel conforming to ASTM A36.

## 2.05 BOLTS, NUTS, WASHERS

A. Steel conforming to ASTM A307.

B. Provide headed bolts for embedment in concrete and masonry.

1. Minimum headed bolt size, 5/8" diameter with 6" embedment unless indicated otherwise.

## 2.06 EXPANSION ANCHORS

A. Hilti Fastener Systems "Kwik Bolt" wedge expansion anchors, or acceptable equivalent by Simpson, Ramset or Rawl. Minimum size 5/8" unless indicated otherwise.

## 2.07 POWDER ACTUATED FASTENERS (LOW VELOCITY)

- A. Fastener Tool: Hilti Fastener Systems powder actuated, piston driven installation tool, or acceptable equivalent, model as required for fastener pin as indicated or specified.
- B. Fastener Pins
  - 1. As indicated. If not indicated, assume the following and verify with Architect or Engineer prior to ordering.
  - 2. Hilti X-DNI37 P8 with steel washer.
    - a. Pin 0.145" shank dia. by 7/8" shank length.

## 2.08 SELF-DRILLING, SELF-TAPPING FASTENERS

- A. Buildex "TEK" brand fasteners or acceptable equivalent.
- B. Provide type, diameter and length indicated.
- C. If not indicated, assume the following for joining two thicknesses cold formed metal framing and verify with Architect/Engineer prior to ordering.
  - 1. #12 diameter hex head by 5/8" minimum length.

## 3.00 EXECUTION

### 3.01 STORAGE OF MATERIALS

- A. Store materials and assemblies in a manner and location protected from damage, deformation and corrosion.
- B. Materials shall be stored on a flat plane.

### 3.02 INSTALLATION

- A. Connections: Self-drilling screws or welding shall meet or exceed the design loads, without distortion. All exterior connections shall be welded.
- B. Transversely loaded studs shall be installed seated squarely in tracks, and must be attached to them.
- C. Axially loaded studs shall be installed seated squarely (within 1/16") against the web portion of the top and bottom tracks. Tracks shall rest on a continuous uniform bearing surface. Cutting of steel framing members may be performed with saw or shear. Torch cutting of load bearing members is not permitted. Cutting of loaded members is not permitted unless under the supervision of the Project Engineer.
- D. Temporary bracing shall be provided and left in place until the work is permanently stabilized.
- E. Bridging - See Drawings.

- F. Diaphragm rated sheathing materials may be substituted for bridging, however, it shall be installed prior to loading the panel. If such a material is installed on one face only, then the other stud flanges shall be bridged with suitable bridging. This bridging may be removed if and when such diaphragm rated sheathing is installed.
- G. Install jamb assemblies at all openings. Jamb shall consist of members as indicated.
- H. Install headers in all openings in axially loaded panels that are larger than the stud spacing in that panel. Form headers as indicated.
- I. Insulation, as specified elsewhere and of thickness and value indicated for adjacent spaces, shall be installed in locations that will be inaccessible after their installation in the panel, or assembly.
- J. Provide jack studs to support each end of headers. These studs shall be securely connected to the header and jamb stud and must seat squarely in the lower track of the wall, and be properly attached to it.
- K. If by design, a header is low in the wall, the cripple studs over the header shall be designed to carry all imposed loads.
- L. Wall track shall not be used to support any load unless specifically designed for that purpose. Axially loaded members shall be aligned vertically, to allow for full transfer of the loads down to the foundation or other support member.
- M. Holes that are field cut into steel framing members shall be within the limitations of the member and its designed use, as referenced in the ICBO Report. Provide reinforcement where holes are cut through load bearing members in accordance with manufacturers' recommendations and as approved by the project engineer.
- N. Splicing of axially loaded members - not permitted.
- O. Provide additional members as required for joining panel to panel as well as for edge support for finish materials. Provide additional members where expansion joints are indicated, either in the panels or in the finish materials, as indicated.
- P. Wire ties - not permitted.
- Q. Where splices of track are necessary, between stud spacings, a piece of stud shall be placed in the track, fastened with two screws or welds to the flanges of each piece of track.
- R. Joists shall be installed as indicated with web stiffeners where indicated and in precise alignment with supporting members.

### 3.03 ERECTION

- A. Erect plumb and true. Install accessories as shown and as necessary for proper installation.
- B. Anchor top and bottom runner track to structure as shown.
  - 1. Studs shall sit squarely in the top and bottom runner track with firm abutment against track webs.

2. Align and plumb studs and fasten to flanges of both top and bottom runner track. At corner and intersections of stud walls provide three studs minimum. Provide double studs at doors and other large openings. Double studs at head of door openings larger than 3 feet. Locate so as to provide surfaces for attachment of facings on all sides. See structural drawings for exterior wall openings.
- C. Joining of members not indicated to be welded: Attach with self-drilling screws. Wire tying of framing members not permitted.
  - D. Provide lateral bracing and bridging in accordance with manufacturer's recommendations and as shown.
  - E. Splice or butt weld all butt joints in the runner track. No splices are permitted in tracks over lintels, or diagonal bracing.
1. Weld connections by resistance spot or projection weld, fillet weld, or plug weld in accordance with AWS recommended procedures and practices.

END OF SECTION

**SECTION 05 50 00  
METAL FABRICATIONS**

**1.00 GENERAL**

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

1.02 SUMMARY

- A. This section includes the following metal fabrications:
  - 1. Rough hardware.
  - 2. Miscellaneous framing and supports for the applications where framing and supports are not specified in other sections.
  - 3. Laser cut fence and gate panels.

1.03 DEFINITIONS

- A. Definitions in ASTM E 985 for railing-related terms apply to this Section.

1.04 SUBMITTALS

- A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.
- B. Product data for products used in miscellaneous metal fabrications, including paint products and grout.
- C. Shop drawings detailing fabrication and erection of each metal fabrication indicated. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items. Provide templates for anchors and bolts specified for installation under other sections.
- D. Samples representative of materials and finished products as may be requested by Architect.
- E. Welder certificates signed by Contractor certifying that welders comply with requirements specified under "Quality Assurance" article.
- F. Qualification data for firms and persons specified in "Quality Assurance" article to demonstrate their capabilities and experience. Include list of completed projects with project name, addresses, names of Architects and Owners, and other information specified.

1.05 QUALITY ASSURANCE

- A. Fabricator Qualifications: Firm experienced in successfully producing metal fabrications similar to that indicated for this Project, with sufficient production capacity to produce required units without causing delay in the Work.

- B. Installer Qualifications: Arrange for installation of metal fabrications specified in this section by same firm that fabricated them.
- C. Qualify welding processes and welding operators in accordance with AWS D1.1 "Structural Welding Code - Steel," D1.3 "Structural Welding Code - Sheet Steel", and D1.2 "Structural Welding Code -Aluminum."
  - 1. Certify that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.

#### 1.06 PROJECT CONDITIONS

- A. Field Measurements: Check actual locations of walls and other construction to which metal fabrications must fit, by accurate field measurements before fabrication; show recorded measurements on final shop drawings. Coordinate fabrication schedule with construction progress to avoid delay of Work.

## 2.00 PRODUCTS

### 2.01 FERROUS METALS

- A. Metal Surfaces, General: For metal fabrications exposed to view upon completion of the Work, provide materials selected for their surface flatness, smoothness, and freedom from surface blemishes. Do not use materials whose exposed surfaces exhibit pitting, seam marks, roller marks, rolled trade names, roughness, and, for steel sheet, variations in flatness exceeding those permitted by reference standards for stretcher-leveled sheet.
- B. Steel Plates, Shapes, and Bars: ASTM A 36.
- C. Rolled Steel Floor Plates: ASTM A 786.
- D. Steel Bars for Gratings: ASTM A 569 or ASTM A 36.
- E. Wire Rod for Grating Cross Bars: ASTM A 510.
- F. Steel Tubing: Cold-formed steel tubing, ASTM A 500, Grade B.
- G. Uncoated Structural Steel Sheet: Product type (manufacturing method), quality, and grade, as follows:
  - 1. Cold-Rolled Structural Steel Sheet: ASTM A 611, Grade A, unless otherwise indicated.
- H. Uncoated Steel Sheet: Commercial quality, product type (method of manufacture) as follows:
  - 1. Cold-Rolled Steel Sheet: ASTM A 366.
- I. Galvanized Steel Sheet: Quality as follows:
  - 1. Structural Quality: ASTM A 446; Grade A, unless another grade required for design loading, and G90 coating designation unless otherwise indicated.
- J. Steel Pipe: ASTM A 53; finish, type, and weight class as follows:

- K. Gray Iron Castings: ASTM A 48, Class 30.
- L. Malleable Iron Castings: ASTM A 47, grade 32510.
- M. Brackets, Flanges and Anchors: Cast or formed metal of the same type material and finish as supported rails, unless otherwise indicated.
- N. Concrete Inserts: Threaded or wedge type; galvanized ferrous castings, either malleable iron, ASTM A 47, or cast steel, ASTM A 27. Provide bolts, washers, and shims as required, hot-dip galvanized per ASTM A 153.
- O. Welding Rods and Bare Electrodes: Select in accordance with AWS specifications for the metal alloy to be welded, and as indicated on drawings.

## 2.02 NONSHRINK NONMETALLIC GROUT

- A. Premixed, factory-packaged, non-staining, noncorrosive, nongaseous grout complying with CE CRD-C 621. Provide grout specifically recommended by manufacturer for type of application used.
- B. Available Products: Subject to compliance with requirements, products that may be incorporated in the Work include but are not limited to the following:
  - 1. "Masterflow 713"; Master Builders.
  - 2. "Five Star Grout"; U.S. Grout Corp.

## 2.03 FASTENERS

- A. General: Provide zinc-coated fasteners for exterior use or where built into exterior walls. Select fasteners for the type, grade, and class required.
- B. Bolts and Nuts: Regular hexagon head type, ASTM A 307, Grade A.
- C. Lag Bolts: Square head type, FS FF-B-561.
- D. Machine Screws: Cadmium plated steel, FS FF-S-92.
- E. Wood Screws: Flat head carbon steel, FS FF-S-111.
- F. Plain Washers: Round, carbon steel, FS FF-W-92.
- G. Drilled-In Expansion Anchors: Expansion anchors complying with FS FF-S-325, Group VIII (anchors, expansion, [nondrilling]), Type I (internally threaded tubular expansion anchor); and machine bolts complying with FS FF-B-575, Grade 5.
- H. Toggle Bolts: Tumble-wing type, FS FF-B-588, type, class, and style as required.
- I. Lock Washers: Helical spring type carbon steel, FS FF-W-84.

## 2.04 PAINT

- A. Shop Primer for Ferrous Metal: Manufacturer's or fabricator's standard, fast-curing, lead-free, universal modified alkyd primer selected for good resistance to normal atmospheric corrosion, for compatibility with finish paint systems indicated, and for capability to provide a sound foundation for field-applied topcoats despite prolonged exposure complying with performance requirements of FS TT-P-645.

## 2.05 FABRICATION, GENERAL

- A. Form metal fabrications from materials of size, thickness, and shapes indicated but not less than that needed to properly complete the work. Work to dimensions indicated using proven details of fabrication and support. Use type of materials indicated or specified for various components of each metal fabrication.
- B. Form exposed work true to line and level with accurate angles and surfaces and straight sharp edges.
- C. Shear and punch metals cleanly and accurately. Remove burrs.
- D. Ease exposed edges to a radius of approximately 1/32 inch, unless otherwise indicated. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.
- E. Remove sharp or rough areas on exposed traffic surfaces.
- F. Weld corners and seams continuously to comply with AWS recommendations and the following:
  - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
  - 2. Obtain fusion without undercut or overlap.
  - 3. Remove welding flux immediately.
  - 4. At exposed connections, finish exposed welds and surfaces smooth and blended so that no roughness shows after finishing and contour of welded surface matches those adjacent.
- G. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners wherever possible. Use exposed fasteners of type indicated or, if not indicated, Phillips flat-head (countersunk) screws or bolts. Locate joints where least conspicuous.
- H. Provide for anchorage of type indicated; coordinate with supporting structure. Fabricate and space anchoring devices to provide adequate support for intended use.
- I. Shop Assembly: Preassemble items in shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.
- J. Cut, reinforce, drill and tap miscellaneous metal work as indicated to receive finish hardware, screws, and similar items.
- K. Fabricate joints that will be exposed to weather in a manner to exclude water, or provide weep holes where water may accumulate.

## 2.06 ROUGH HARDWARE

- A. Furnish bent or otherwise custom fabricated bolts, plates, anchors, hangers, dowels, and other miscellaneous steel and iron shapes as required for framing and supporting woodwork, and for anchoring or securing woodwork to concrete or other structures. Straight bolts and other stock rough hardware items are specified in Division 6 sections.
- B. Fabricate items to sizes, shapes, and dimensions required. Furnish malleable-iron washers for heads and nuts which bear on wood structural connections; elsewhere, furnish steel washers.

## 2.07 MISCELLANEOUS FRAMING AND SUPPORTS

- A. General: Provide steel framing and supports for applications indicated or which are not a part of structural steel framework, as required to complete work.
- B. Fabricate units to sizes, shapes, and profiles indicated and required to receive adjacent other construction retained by framing and supports. Fabricate from structural steel shapes, plates, and steel bars of welded construction using mitered joints for field connection. Cut, drill, and tap units to receive hardware, hangers, and similar items.

## 2.08 MISCELLANEOUS STEEL TRIM

- A. Provide shapes and sizes indicated for profiles shown. Unless otherwise indicated, fabricate units from structural steel shapes, plates, and steel bars, with continuously welded joints and smooth exposed edges. Use concealed field splices wherever possible. Provide cutouts, fittings, and anchorages as required for coordination of assembly and installation with other work.

## 2.09 LASER CUT PANELS

- A. Provide panels per details as shown in the approved drawings. Fabricate panels from steel sheets with smooth exposed edges at all locations, both at the panel perimeter as well as all of the cut openings. Attach panels to mounting plates with continuously welded joints, with all welds ground smooth. Panels shall have factory finish color coat to be selected by Architect from manufacturer's full range of available colors.
- B. Panel Fabricator: Panels shall be fabricated by a company thoroughly experienced in laser cutting of sheet steel. Acceptable fabricators:
  1. Precision Waterjet & Laser, 880 West Crowther Ave., Placentia, CA 92870 (888)289-4449
  2. Artisan Panels Inc., 880 West Crowther Ave., Placentia, CA 92870 (714)351-3234
  3. Equal fabricator, approved prior to bidding by the Architect.

## 2.10 STEEL AND IRON FINISHES

- A. Apply shop primer to uncoated surfaces of metal fabrications, except those with galvanized finish or to be embedded in concrete, sprayed-on fireproofing, or masonry, unless otherwise indicated. Comply with requirements of SSPC-PA1 "Paint Application Specification No. 1" for shop painting.

### 3.00 EXECUTION

#### 3.01 PREPARATION

- A. Coordinate and furnish anchorages, setting drawings, diagrams, templates, instructions, and directions for installation of anchorages, including concrete inserts, sleeves, anchor bolts, and miscellaneous items having integral anchors that are to be embedded in concrete or masonry construction. Coordinate delivery of such items to project site.

#### 3.02 INSTALLATION, GENERAL

- A. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing miscellaneous metal fabrications to in-place construction; include threaded fasteners for concrete and masonry inserts, toggle bolts, through-bolts, lag bolts, wood screws, and other connectors as required.
- B. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installation of miscellaneous metal fabrications. Set metal fabrication accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.
- C. Provide temporary bracing or anchors in formwork for items that are to be built into concrete masonry or similar construction.
- D. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints, but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade the surfaces of exterior units which have been hot-dip galvanized after fabrication, and are intended for bolted or screwed field connections.
- E. Field Welding: Comply with AWS Code for procedures of manual shielded metal-arc welding, appearance and quality of welds made, methods used in correcting welding work, and the following:
  - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
  - 2. Obtain fusion without undercut or overlap.
  - 3. Remove welding flux immediately.
  - 4. At exposed connections, finish exposed welds and surfaces smooth and blended so that no roughness shows after finishing and contour of welded surface matches those adjacent.
- F. Corrosion Protection: Coat concealed surfaces of aluminum that will come into contact with grout, concrete, masonry, wood, or dissimilar metals with a heavy coat of bituminous paint or zinc chromate primer.

#### 3.03 SETTING LOOSE PLATES

- A. Clean concrete and masonry bearing surfaces of any bond-reducing materials, and roughen to improve bond to surfaces. Clean bottom surface of bearing plates.
- B. Set loose leveling and bearing plates on wedges, or other adjustable devices. After the bearing members have been positioned and plumbed, tighten the anchor bolts. Do not remove wedges or shims, but if protruding, cut off flush with the edge of the bearing plate before packing with grout.
  - 1. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

#### 3.04 INSTALLATION OF LASER CUT HANDRAIL PANELS

- A. General: Install handrail panels all at the same consistent, aligned top-of-panel elevation.
- B. Position handrail panels square and plumb in their respective bays between pipe rail verticals.
- C. Position handrail panels centered between the pipe rail verticals to the right and left of each panel. Ensure that the clear space between the left, right and top sides of each panel to the pipe rail verticals and top rail is the same for all panels.

#### 3.05 ADJUSTING AND CLEANING

- A. Touch-Up Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with same material as used for shop painting to comply with SSPC-PA 1 requirements for touch-up of field painted surfaces.
  - 1. Apply by brush or spray to provide a minimum dry film thickness of 2.0 mils.

END OF SECTION

**SECTION 05 55 00  
MISCELLANEOUS METALS**

**PART 1 - GENERAL**

A. Requirements of Division 1 apply to this Section.

1.1 WORK INCLUDED

A. Shapes, sleeves, anchors, connectors, plates, backing plates, supports, and fastenings required but which are not specified in other Sections.

B. Other metal fabrications indicated.

1.2 RELATED WORK SPECIFIED ELSEWHERE AS REQUIRED

A. Setting of items to be embedded in concrete.

1.3 GENERAL REQUIREMENTS:

A. Field conditions: Verify drawing dimensions with actual field conditions. Inspect related work and adjacent surfaces. Report all conditions which prevent proper execution of this work.

B. Shop Drawings: Submit in accordance with Section 01340 showing incomplete detail all information required for fabrication, finishing and installation of this work.

C. Codes: Materials and work shall conform to the governing Building Code. In case of conflict between these specifications and the Building Code, the more stringent shall govern.

D. General: Examine all drawings and specifications and include all miscellaneous metal that is not required to be furnished by another trade. Provide all connections, anchors, bolts, and other fastenings as required. Do all cutting, punching, drilling and tapping required for proper assembly of the work.

E. Delivery: Insure that items to be set in concrete are delivered at the proper time.

**PART 2 - PRODUCTS**

2.1 MATERIALS:

A. Steel shapes: Conform to ASTM A36.

B. Structural pipe columns: Conform to ASTM A53, Grade B.

C. Pipe for railings: Conform to ASTM A53 or A120.

D. Cast iron: Conform to ASTM A48, soft gray iron.

E. Malleable iron castings: Conform to ASTM A47.

- F. Welding rods: Conform to requirements of AWS for intended use.
- G. Galvanizing: Conform to ASTM A123.
- H. Bolts, nuts, screws: Conform to ASTM A307, Grade A.
- I. Steel plate: Conform to ASTM A283, Grade A.
- J. Steel tubing: Conform to ASTM A501 or A500.
- K. Bars, flats, rounds: Conform to ASTM A36, standard grade mild steel.
- L. Primer: Conforming to FS-TT-P-86, Type I.
- M. Touch-up for galvanized surfaces: All State #321 Galvanizing Powder (30% tin, 30% zinc, 40% lead and flux), "Galvalloy", "Galvover", or approved equal.
- N. Miscellaneous material: As indicated or specified.

## 2.2 SHOP PRIME COAT:

- A. Ferrous metal: Properly clean and prepare for painting in compliance with the paint manufacturer's instructions and apply one shop coat of material of the type specified. Thoroughly and completely cover all exposed surfaces as well as surfaces concealed after assembly. Apply paint by brush or spray gun, as best adapted to the paint material and surface conditions. Allow paint to become dry and hard before handling.
  - 1. Apply primer to 2 mil minimum dry coat thickness and touch up after installation and leave in proper condition to receive finish coats.

## 2.3 GALVANIZING:

- A. Galvanize all items to be exposed on the exterior and those interior items so specified. Use the hot dip process, conforming to ASTM A123.
- B. Average weight of zinc coating per square foot of actual surface: Not less than 2.0 ounces, with no individual specimen showing less than 1.8 ounces. (One oz. of zinc corresponds to a coating thickness of 0.0017".)

## 2.4 FABRICATION:

- A. Using skilled mechanics, form and fabricate items of work as indicated and as required to meet installation conditions. Make provisions to connect with or receive the work of other trades.
- B. Unless otherwise indicated, weld or bolt connections between members. Where possible, conceal connections in the finished work. Where exposed screw fastenings are required, use Phillips ovalhead screws to match parent material. Fit or miter exposed joints to hairline tolerance or use welded joints. On finished surfaces, grind all welds smooth and flush with base metal.
- C. Bend pipe or tubing without collapsing or deforming the walls, and so as to provide a smooth uniform curved section and maintain uniform sectional shape.

- D. Where items are to be embedded in concrete, provide welded-on anchors or lugs as indicated or required.

### **PART 3 - EXECUTION**

#### **3.1 ITEMS EMBEDDED IN CONCRETE OR MASONRY:**

- A. Provide bolts, eyebolts, dowels, anchors, plates, inserts, and other miscellaneous items that are to be installed in forms before concrete pouring, or for building into masonry, as indicated. Examine and check the drawings for the number, type and location of such items.

#### **3.2 INSTALLATION:**

- A. Install all items plumb, level and square, securely and rigidly attached to supporting construction and as detailed.

#### **3.3 DESCRIPTION OF ITEMS:**

- A. Those items which are of standard or stock design or which are sufficiently detailed or described on the drawings to permit their fabrication and installation, are not covered herein even though they may be included in the Scope.
- B. Backing plates in connection with studs and furring necessary for engaging and fastening of stair rail brackets, lavatories and fixtures, etc., shall be provided in locations indicated, or as necessary. Securely fasten backing plates to studs supporting members in required position. Dap into wood studs. Weld between steel studs. Finish with rust inhibitive prime coat.
- C. Pipe handrails (if shown): Fabricate from 1 1/4" standard steel pipe to shapes and dimensions indicated. Make joints flush with concealed seamless fittings. Accurately cut, miter, weld and grind smooth to flush surfaces. Make bends to preserve the contour of the pipe. All railings shall meet all disabled access requirements. Install as follows:
  - 1. To masonry walls: Provide cast brackets providing 1 1/2" min. or indicated clearance between railing and wall. Secure to wall with screws into expansion shields.
  - 2. To stud walls: Provide cast brackets providing 1 1/2" min. or indicated clearance between railing and wall. Provide proper backing at studs at proper locations before application of gypsum board. Provide collar, flush metal filler, and secure to backing.
- D. Pipe guards and bollards: standard steel pipe as shown. Galvanized after fabricated.
- E. Wrought Iron Fence and Gates: Fabricate from wrought steel square tubes as shown and to match existing. Provide all necessary operating hardware for the gates. Reinstall salvaged fence and gates as required. Fence and gates to be hot dip galvanized. Provide factory applied architectural coating over hot-dip galvanized steel "Colorgalv" by Duncan Galvanizing. Primer coat shall be factory applied prime coating. Apply primer within 12 hours after galvanizing at the same facility where the galvanizing is done. Finish coat shall be factory-applied high performance architectural finish. Apply finish coating at the galvanizer's plant, in a controlled environment as recommended by the finish coating manufacturer. Color to match existing steel fencing to remain at campus. Submit two 3

inch by 6 inch samples of factory applied coatings and colors proposed for use for approval prior to coating application. Provide 20 year warranty against rust.

- F. Other miscellaneous metal work as indicated.

END OF SECTION

**SECTION 07 19 00  
WATER REPELLENT COATING**

**PART 1 – GENERAL**

1.1 WORK INCLUDED

- A. Water repellent coating for all exterior masonry wall enclosures where surface is not covered by exterior cement plaster finish.

1.2 RELATED WORK

- A. 04 22 00 – Concrete Unit Masonry (CMU)
- B. 07 92 00 - Joint Sealants

1.3 GENERAL REQUIREMENTS

- A. Field conditions: Verify drawing dimensions with actual field conditions. Inspect related work and adjacent surfaces. Report all conditions which prevent proper execution of this work.
- B. Warranty: As specified in Section 01700. Written warranty is required from the manufacturer and applicator, jointly in approved form, that the repellent coating installed will remain for a period of five years from date of acceptance. The applicator shall guarantee the installation against poor workmanship for a period of 2 years from the date of acceptance of the building by Owner. He shall make all necessary repairs without charge to Owner during that period. Manufacturer shall guarantee material against moisture penetration for 5 years.
- C. Certification: Upon completion, issue to the Architect a Certificate of Inspection and Compliance indicating that the completed work meets all the requirements of these specifications and the manufacturer's printed instructions. Certificate shall be signed by both the manufacturer and applicator.

**PART 2 – PRODUCTS**

2.1 MANUFACTURER AND TYPE

- A. "RAINPROOF" by Rainproof Systems, Inc., (800) 675-1665.
- C. "RAINGUARD" by Rainguard Products Co., (888) 765-7070.
- C. "OKON W-1" by Okon Inc., Lakewood, Colorado, (800)237-0565.

**PART 3 – EXECUTION**

3.1 SURFACE PREPARATION

- A. Masonry surfaces to receive repellent shall have cured not less than 10 days under normal dry weather conditions shall have clean surfaces and shall have all voids in mortar joints filled and pointed.

### 3.2 INSPECTION

- A. Not less than 72 hours prior to starting work, arrange for material manufacturer's representative to inspect masonry and certify its suitability to receive repellent.
- B. During application of repellent, arrange to have manufacturer's representative observe and advise regarding procedures and application.

### 3.3 APPLICATION

- A. Apply material in strict accordance with manufacturer's instructions. Make vertical and horizontal passes to entirely cover and saturate all surfaces from every angle. Pay particular attention to joints.

### 3.4 PROTECTION

- A. Mask surfaces adjacent to the masonry. Protect all landscaping, sidewalks and other paving, repair any damage to adjacent surfaces to the Architect's satisfaction.

### 3.5 WATER TEST (EXTERIOR MASONRY SURFACES)

- A. Ten days after completion of this work, the applicator, under the manufacturer's supervision, shall test a representative wall area, designated by the Architect.
- B. Use a water hose with a garden type spray nozzle, so located that the water strikes the wall at a 45 degree downward angle. Run test continuously as recommended.
- C. Should the inside face of the block wall show traces of moisture, apply another coat of repellent to the entire job at no additional expense to the Owner.

### 3.6 GUARANTEE

- A. Provide manufacturer's 5-year warranty.

### 3.7 CLEANUP

- A. As specified in Project General Conditions.

END OF SECTION

**SECTION 07 60 00  
SHEET METAL FLASHING AND TRIM**

**PART 1 – GENERAL**

1.1 SUMMARY

- A. Division 1 applies to this Section. Provide flashing and sheet metal items, complete.
- B. Section includes:
  - 1. Sheet metal flashings in connection with roofing.
  - 2. Reglet, Counter-flashing, and Drip edge assemblies.
  - 3. Miscellaneous metal flashing and counter-flashing as required, except where provided under mechanical and electrical sections.
  - 4. Caulking.
- C. Related Work Not In This Section:
  - 1. Sheet metal in connection with Plumbing, Air Conditioning, and Electrical.
  - 2. Metal accessories for drywall, lathing, and acoustical treatments.
  - 3. Sleeves for embedded items.

1.2 QUALITY ASSURANCE

- A. Drawings and requirements specified govern. Conform to the current "Architectural Sheet Metal Manual" published by Sheet Metal and Air Conditioning Contractors National Association, Inc. (SMACNA), 1611 North Kent Street, Arlington, VA 22209 for conditions not indicated or specified and for general fabrication of sheet metal items.

1.3 SUBMITTALS

- A. Shop Drawings: Submit for fabricated sheet metal showing details, methods of joining, anchoring and fastening, thicknesses and gauges of metals, concealed reinforcement, expansion joint details, sections, and profiles.
- B. Samples: Submit (6) samples for each material or assembly requested.
- C. Product Data: Submit brochures of manufactured items.

**PART 2 - PRODUCTS**

2.1 MATERIALS

- A. Pre-finished sheet metal roofing panel. Color to be selected by Architect from manufacturer's standard colors.

- B. Galvanized steel: ASTM A525, coating G90, mill phosphatized for paint adhesion, 22 gauge unless otherwise shown or specified.
- C. Solder: ASTM B32, B284.
- D. Solder flux: Standard brand non-corrosive acid-base type.
- E. Fasteners: Zinc or cadmium coated steel or stainless steel.
- F. Felt: ASTM D226, 15-pound type.
- G. Primer: Approved brand of zinc-dust zinc-oxide primer per Section 09 90 00 with manufacturer's pretreatment materials.
- H. Sealant: Single component non-sag polyurethane conforming to Section 07 92 00.
- I. Building Paper: Fed. Spec. UU-B-790, Style 4, Grade B.

## 2.2 RELATED MATERIALS

- A. Reglets and Counterflashings: Fry Reglet Corp. flashing systems complete with unions and preformed corners of necessary types for particular locations, of 22 gauge galvanized steel, or approved equals by Metco Metal Products Co., Pacific Loxtite Flashing Co., National Cornice Works, Redco, Lane-Air, or equal. Use a single manufacturer's products, equivalent to Type MA at masonry, Type ST at plaster, or Type SM, as required by Drawings and details.

## 2.3 GENERAL FABRICATION REQUIREMENTS

- A. Fabricate items to avoid distortion and overstressing of fastenings due to expansion and contraction. Provide expansion joints where necessary in continuous runs of sheet metal, constructed watertight and spaced 30-feet apart maximum. Lock and solder corners and blind hem exposed edges. Make joints with 4" lap and solder unless otherwise shown or specified. Fill single lock seams with sealant where soldering is infeasible. Run flanges 4" minimum onto roof and wall surfaces. Fabricate sheet metal items in nominal 8-foot lengths unless otherwise shown or specified.
- B. Soldering: All soldered joints shall be continuous. Do soldering slowly, immediately after application of flux, seams showing evenly flowed solder. Clean and neutralize finished soldering.
- C. Shop Priming: Clean completed items, apply pretreatment, and prime all exposed surfaces with specified primer.

## 2.4 FABRICATED ITEMS

- A. Fabricated Items of 22 gauge galvanized steel unless otherwise indicated or specified.
- B. Counter-flashing: Except where indicated or specified otherwise, insert counter-flashing in reglets and extend down vertical surfaces over upturned vertical leg of base flashings not less than 3 inches. Fold the exposed edges of counterflashings 1/2 inch. Provide end laps in counterflashings not less than 3 inches and make

weathertight with single component, not sag urethane sealant, as specified in Section 07920. Lengths of metal counterflashings shall not exceed 10 feet. Form the flashings to the required shapes before installation. Factory form the corners not less than 12 inches from the angle. Secure the flashings in the reglets with soft metal wedges (no lead) and space not more than 18 inches apart; short runs, place wedges closer together. Fill caulked-type reglets or raked joints which receive counter-flashing with caulking compound as covered in Section 07920. Turn up the concealed edge of counterflashings built into masonry or concrete walls not less than 1/4 inch and extend not less than 2 inches into the walls. Install counter-flashing to provide a spring action against base flashing.

- C. Coping Caps: Corner units having maximum 18" long legs and joints locked and soldered watertight, intermediate joints spaced at maximum 8-foot centers and equally spaced. Make intermediate joints of the flush butted type, edges spaced about 1/4" apart and centered over an 8" long backing plate of the same profile and gauge as the cap, set in a 1/2" wide bead of sealant. Secure both edges of caps with 1-1/2" wide 20 gauge galvanized steel cleats spaced at maximum 32" centers and locked into drip hem.
- D. Drip Flashings: Provide at heads of windows and doors. Use material compatible with window and frame materials. Coordinate installation of flashing with that of windows and doors. Provide hemmed exposed edges, 1-piece lengths.

### **PART 3 - EXECUTION**

#### **3.1 GENERAL INSTALLATION REQUIREMENTS**

- A. Install metal items as indicated, according to approved submittals, and as required to complete the entire work. Securely fasten and assemble, and make watertight and weathertight. Provide manufactured joints in copper gutters and solder in place.
- B. Coordination: Coordinate sheet metal items in connection with roofing for proper installation, and furnish in sufficient time to avoid delay in roofing construction. Install roofing sheet metal simultaneously with roofing.
- C. Caulking: Provide sealant caulking as indicated and required to seal and complete work of this section. Conform to Section 07920.
- D. Protection from Contact with Dissimilar Materials:
  - 1. Metal Surfaces: Paint surfaces in contact with mortar, concrete, or other masonry materials with alkali-resistant coatings such as heavy-bodied bituminous paint.
  - 2. Wood or Other Absorptive Materials: Paint surfaces that may become repeatedly wet and in contact with metal with two coats of aluminum paint or a coat of heavy-bodied bituminous paint.
- E. Expansion and Contraction: Provide expansion and contraction joints at not more than 30-foot intervals. Where the distance between the last expansion joint and the end of the continuous run is more than half the required interval, an additional joint shall be provided. Space joints evenly.

3.2 COMPLETION

- A. Examine installed sheet metal, water test if necessary or directed, and correct damaged or defective items.

END OF SECTION

**SECTION 07 92 00  
JOINT SEALANTS**

**PART 1 - GENERAL**

1.1 SUMMARY

- A. Section Includes:
  - 1. Silicone joint sealants.
  - 2. Urethane joint sealants.
  - 3. Latex joint sealants.
  - 4. Preformed joint sealants.

1.2 PRECONSTRUCTION TESTING

- A. Preconstruction Compatibility and Adhesion Testing: Submit to joint-sealant manufacturers eight samples of materials that will contact or affect joint sealants. Use ASTM C 1087 or manufacturer's standard test method to determine whether priming and other specific joint preparation techniques are required to obtain rapid, optimum adhesion of joint sealants to joint substrates.
- B. Preconstruction Field-Adhesion Testing: Before installing sealants, field test their adhesion to Project joint substrates. Test joint sealants according to Method A, Field-Applied Sealant Joint Hand Pull Tab, in Appendix X1 in ASTM C 1193 or Method A, Tail Procedure, in ASTM C 1521.

1.3 SUBMITTALS

- A. Product Data: For each joint-sealant product indicated.
- B. Samples: For each kind and color of joint sealant required.
- C. Joint-Sealant Schedule: Include the following information:
  - 1. Joint-sealant application, joint location, and designation.
  - 2. Joint-sealant manufacturer and product name.
  - 3. Joint-sealant formulation.
  - 4. Joint-sealant color.
- D. Product test reports.
- E. Preconstruction compatibility and adhesion test reports.
- F. Preconstruction field-adhesion test reports.

- G. Field-adhesion test reports.
- H. Warranties.

#### 1.4 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Qualified according to ASTM C 1021 to conduct the testing indicated.
- B. Preinstallation Conference: Conduct conference at Project site.

#### 1.5 WARRANTY

- A. Special Installer's Warranty: Manufacturer's standard form in which Installer agrees to repair or replace 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**

#### 2.1 MATERIALS, GENERAL

- A. VOC Content of Interior Sealants: Provide sealants and sealant primers for use inside the weatherproofing system that comply with the following limits for VOC content when calculated according to 40 CFR 59, Part 59, Subpart D (EPA Method 24):
  - 1. Architectural Sealants: 250 g/L.
  - 2. Sealant Primers for Nonporous Substrates: 250 g/L.
  - 3. Sealant Primers for Porous Substrates: 775 g/L.
- B. Liquid-Applied Joint Sealants: Comply with ASTM C 920 and other requirements indicated for each liquid-applied joint sealant specified, including those referencing ASTM C 920 classifications for type, grade, class, and uses related to exposure and joint substrates.
  - 1. Suitability for Immersion in Liquids. Where sealants are indicated for Use I for joints that will be continuously immersed in liquids, provide products that have undergone testing according to ASTM C 1247. Liquid used for testing sealants is deionized water, unless otherwise indicated.
- C. Stain-Test-Response Characteristics: Where sealants are specified to be nonstaining to porous substrates, provide products that have undergone testing according to ASTM C 1248 and have not stained porous joint substrates indicated for Project.

#### 2.2 SILICONE JOINT SEALANTS

- A. Neutral-Curing Silicone Joint Sealant : ASTM C 920.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. BASF Building Systems.
  - b. Dow Corning Corporation.
  - c. GE Advanced Materials - Silicones.
  - d. Pecora Corporation.
  - e. Polymeric Systems, Inc.
  - f. Schnee-Morehead, Inc.
  - g. Sika Corporation; Construction Products Division.
  - h. Tremco Incorporated.
2. Type: Single component (S) or multicomponent (M).
3. Grade: Pourable (P) or nonsag (NS).
4. Class: 100/50.
5. Uses Related to Exposure: Traffic (T).

## 2.3 LATEX JOINT SEALANTS

- A. Latex Joint Sealant [LS-<#>]: Acrylic latex or siliconized acrylic latex, ASTM C 834, Type OP, Grade NF.
  1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. BASF Building Systems.
    - b. Bostik, Inc.
    - c. Pecora Corporation.
    - d. Schnee-Morehead, Inc.
    - e. Tremco Incorporated.

## 2.4 JOINT SEALANT BACKING

- A. Cylindrical Sealant Backings: ASTM C 1330, Type C (closed-cell material with a surface skin) and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance.
- B. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer.

## 2.5 MISCELLANEOUS MATERIALS

- A. Primer: Material recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.
- B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials.
- C. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

## PART 3 - EXECUTION

### 3.1 PREPARATION

- A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions.
  - 1. Remove laitance and form-release agents from concrete.
  - 2. Clean nonporous joint substrate surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants.
- B. Joint Priming: Prime joint substrates where recommended by joint-sealant manufacturer or as indicated by 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.
- C. Masking Tape: Use masking tape where required to prevent contact of sealant or primer 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.

### 3.2 INSTALLATION

- A. Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.
- B. Install sealant backings of kind indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
  - 1. Do not leave gaps between ends of sealant backings.
  - 2. Do not stretch, twist, puncture, or tear sealant backings.
  - 3. Remove absorbent sealant backings that have become wet before sealant application and replace them with dry materials.

- C. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.
- 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. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.
- E. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified in subparagraphs 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. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.
  - 3. Provide concave joint profile per Figure 8A in ASTM C 1193, unless otherwise indicated.
- F. Acoustical Sealant Installation: Comply with ASTM C 919 and with manufacturer's written recommendations.
- G. 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.

### 3.3 FIELD QUALITY CONTROL

- A. Field-Adhesion Testing: Field test joint-sealant adhesion to joint substrates as follows:
  - 1. Extent of Testing: Test completed and cured sealant joints as follows:
    - a. Perform 5 tests for the first 500 feet (300 m)] of joint length for each kind of sealant and joint substrate.
    - b. Perform 1 test for each 1000 feet (300 m) of joint length thereafter.
  - 2. Test Method: Test joint sealants according to Method A, Field-Applied Sealant Joint Hand Pull Tab, in Appendix X1 in ASTM C 1193 or Method A, Tail Procedure, in ASTM C 1521.
- B. Evaluation of Field-Adhesion 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.

### 3.4 JOINT-SEALANT SCHEDULE

- A. Joint-Sealant Application: Exterior joints in horizontal traffic surfaces.
  - 1. Joint Locations:
    - a. Isolation and contraction joints in cast-in-place concrete slabs.
    - b. Tile control and expansion joints.
    - c. Joints between different materials listed above.
    - d. Other joints as indicated.
  - 2. Joint Sealant: Silicone.
  - 3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.
- B. Joint-Sealant Application: Exterior joints in vertical surfaces and horizontal nontraffic surfaces.
  - 1. Joint Locations:
    - a. Construction joints in cast-in-place concrete.
    - b. Control and expansion joints in unit masonry.
    - c. Joints between different materials listed above.
    - d. Perimeter joints between materials listed above and frames of doors, windows and louvers.
    - e. Control and expansion joints in ceilings and other overhead surfaces.
    - f. Other joints as indicated.
  - 2. Joint Sealant: Silicone.
  - 3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.
- C. Joint-Sealant Application: Interior joints in horizontal traffic surfaces.
  - 1. Joint Locations:
    - a. Isolation joints in cast-in-place concrete slabs.
    - b. Control and expansion joints in tile flooring.
    - c. Other joints as indicated.
  - 2. Joint Sealant: Silicone.
  - 3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors
- D. Joint-Sealant Application: Interior joints in vertical surfaces and horizontal nontraffic surfaces.
  - 1. Joint Locations:

- a. Control and expansion joints on exposed interior surfaces of exterior walls.
  - b. Perimeter joints of exterior openings where indicated.
  - c. Tile control and expansion joints.
  - d. Vertical joints on exposed surfaces of interior unit masonry, concrete, walls and partitions.
  - e. Perimeter joints between interior wall surfaces and frames of interior doors windows and elevator entrances.
  - f. Other joints as indicated.
2. Joint Sealant: Latex.
  3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.
- E. Joint-Sealant Application: Mildew-resistant interior joints in vertical surfaces and horizontal nontraffic surfaces.
1. Joint Sealant Location:
    - a. Joints between plumbing fixtures and adjoining walls, floors, and counters.
    - b. Tile control and expansion joints where indicated.
    - c. Other joints as indicated.
  2. Joint Sealant: Silicone.
  3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.

END OF SECTION

**SECTION 09 24 00  
PORTLAND CEMENT PLASTER**

**PART 1 - GENERAL**

1.1 SUMMARY

A. Section Includes:

1. Exterior portland cement plasterwork (stucco) on metal lath, and CMU enclosure walls.

1.2 SUBMITTALS

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

B. Shop Drawings: Show locations and installation of control and expansion joints including plans, elevations, sections, details of components, and attachments to other work.

C. Samples: For each type of factory-prepared finish coat indicated.

1.3 QUALITY ASSURANCE

A. Fire-Resistance Ratings: Where indicated, provide portland cement plaster assemblies identical to those of assemblies tested for fire resistance per ASTM E 119 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

B. Mockups: Before plastering, install mockups of at least 100 sq. ft. (9.3 sq. m) in surface area to demonstrate aesthetic effects and set quality standards for materials and execution.

1. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.4 PROJECT CONDITIONS

A. Comply with ASTM C 926 requirements.

B. Factory-Prepared Finishes: Comply with manufacturer's written recommendations for environmental conditions for applying finishes.

1.5 METAL LATH

A. Expanded-Metal Lath: ASTM C 847 with ASTM A 653/A 653M, G60 (Z180), hot-dip galvanized zinc coating.

1. Diamond-Mesh Lath: Self-furring, 2.5 lb/sq. yd. (1.4 kg/sq. m).

B. Paper Backing: FS UU-B-790, Type I, Grade D, Style 2 vapor-permeable paper.

1. Provide paper-backed lath at exterior locations.

## 1.6 ACCESSORIES

A. General: Comply with ASTM C 1063 and coordinate depth of trim and accessories with thicknesses and number of plaster coats required.

B. Metal Accessories:

1. Foundation Weep Screed: Fabricated from hot-dip galvanized-steel sheet, ASTM A 653/A 653M, G60 (Z180) zinc coating.
2. Cornerite: Fabricated from metal lath with ASTM A 653/A 653M, G60 (Z180), hot-dip galvanized zinc coating.
3. External-Corner Reinforcement: Fabricated from metal lath with ASTM A 653/A 653M, G60 (Z180), hot-dip galvanized zinc coating.
4. Cornerbeads: Fabricated from zinc-coated (galvanized) steel.

a. Small-nose style; use unless otherwise indicated.

5. Casing Beads: Fabricated from zinc-coated (galvanized) steel; square-edged style; with expanded flanges.
6. Control Joints: Fabricated from zinc-coated (galvanized) steel; one-piece-type, folded pair of unperforated screeds in M-shaped configuration; with perforated flanges and removable protective tape on plaster face of control joint.
7. Expansion Joints: Fabricated from zinc-coated (galvanized) steel; folded pair of unperforated screeds in M-shaped configuration; with expanded flanges.
8. Two-Piece Expansion Joints: Fabricated from zinc-coated (galvanized) steel; formed to produce slip-joint and square-edged reveal that is adjustable from 1/4 to 5/8 inch (6.34 to 16 mm) wide; with perforated flanges.

C. Plastic Accessories: Fabricated from high-impact PVC.

1. Cornerbeads: With perforated flanges.

a. Small-nose style; use unless otherwise indicated.

2. Casing Beads: With perforated flanges in depth required to suit plaster bases indicated and flange length required to suit applications indicated.

a. Square-edge style; use unless otherwise indicated.

3. Control Joints: One-piece-type, folded pair of unperforated screeds in M-shaped configuration; with perforated flanges and removable protective tape on plaster face of control joint.

4. Expansion Joints: Two-piece type, formed to produce slip-joint and square-edged 1/2-inch- (13-mm-) wide reveal; with perforated concealed flanges.

## 1.7 MISCELLANEOUS MATERIALS

- A. Water for Mixing: Potable and free of substances capable of affecting plaster set or of damaging plaster, lath, or accessories.
- B. Fiber for Base Coat: Alkaline-resistant glass or polypropylene fibers, 1/2 inch (13 mm) long, free of contaminants, manufactured for use in portland cement plaster.
- C. Steel Drill Screws: For metal-to-metal fastening, ASTM C 1002 or ASTM C 954, as required by thickness of metal being fastened; with pan head that is suitable for application; in lengths required to achieve penetration through joined materials of no fewer than three exposed threads.
- D. Fasteners for Attaching Metal Lath to Substrates: Complying with ASTM C 1063.
- E. Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, not less than 0.0475-inch (1.21-mm) diameter, unless otherwise indicated.

## 1.8 PLASTER MATERIALS

- A. Portland Cement: ASTM C 150, Type I.
- B. Lime: ASTM C 206, Type S; or ASTM C 207, Type S.
- C. Sand Aggregate: ASTM C 897.
  - 1. Color for Job-Mixed Finish Coats: as indicated on drawings.
- D. Acrylic-Based Finish Coatings: Factory-mixed acrylic-emulsion coating systems, formulated with colorfast mineral pigments and fine aggregates; for use over portland cement plaster base coats. Include manufacturer's recommended primers and sealing topcoats for acrylic-based finishes.
  - 1. Color: As selected by Architect from manufacturer's full range.

## 1.9 PLASTER MIXES

- A. General: Comply with ASTM C 926 for applications indicated.
  - 1. Fiber Content: Add fiber to base-coat mixes after ingredients have mixed at least two minutes. Comply with fiber manufacturer's written instructions for fiber quantities in mixes, but do not exceed 1 lb of fiber/cu. yd. (0.6 kg of fiber/cu. m) of cementitious materials.
- B. Base-Coat Mixes for Use over Metal Lath: Scratch and brown coats for three-coat plasterwork as follows:
  - 1. Portland Cement Mixes:
    - a. Scratch Coat: For cementitious material, mix 1 part portland cement and 3/4 to 1-1/2 parts lime. Use 2-1/2 to 4 parts aggregate per part of cementitious material.

- b. Brown Coat: For cementitious material, mix 1 part portland cement and 3/4 to 1-1/2 parts lime. Use 3 to 5 parts aggregate per part of cementitious material, but not less than volume of aggregate used in scratch coat.
- 2. Masonry Cement Mixes:
  - a. Scratch Coat: 1 part masonry cement and 2-1/2 to 4 parts aggregate.
  - b. Brown Coat: 1 part masonry cement and 3 to 5 parts aggregate, but not less than volume of aggregate used in scratch coat.
- 3. Portland and Masonry Cement Mixes:
  - a. Scratch Coat: For cementitious material, mix 1 part portland cement and 1 part masonry cement. Use 2-1/2 to 4 parts aggregate per part of cementitious material.
  - b. Brown Coat: For cementitious material, mix 1 part portland cement and 1 part masonry cement. Use 3 to 5 parts aggregate per part of cementitious material, but not less than volume of aggregate used in scratch coat.
- 4. Plastic Cement Mixes:
  - a. Scratch Coat: 1 part plastic cement and 2-1/2 to 4 parts aggregate.
  - b. Brown Coat: 1 part plastic cement and 3 to 5 parts aggregate, but not less than volume of aggregate used in scratch coat.
- 5. Portland and Plastic Cement Mixes:
  - a. Scratch Coat: For cementitious material, mix 1 part plastic cement and 1 part portland cement. Use 2-1/2 to 4 parts aggregate per part of cementitious material.
  - b. Brown Coat: For cementitious material, mix 1 part plastic cement and 1 part portland cement. Use 3 to 5 parts aggregate per part of cementitious material, but not less than volume of aggregate used in scratch coat.
- C. Factory-Prepared Finish-Coat Mixes: For acrylic-based finish coatings, comply with manufacturer's written instructions.

## **PART 2 - EXECUTION**

### **2.1 PREPARATION**

- A. Protect adjacent work from soiling, spattering, moisture deterioration, and other harmful effects caused by plastering.
- B. Prepare solid substrates for plaster that are smooth or that do not have the suction capability required to bond with plaster according to ASTM C 926.

### **2.2 INSTALLATION, GENERAL**

- A. Fire-Resistance-Rated Assemblies: Install components according to requirements for design designations from listing organization and publication indicated on Drawings.

- B. Sound Attenuation Blankets: Where required, install blankets before installing lath unless blankets are readily installed after lath has been installed on one side.

### 2.3 INSTALLING ACCESSORIES

- A. Install according to ASTM C 1063 and at locations indicated on Drawings.
- B. Reinforcement for External Corners:
  - 1. Install lath-type, external-corner reinforcement at exterior locations.
  - 2. Install cornerbead at exterior locations.
- C. Control Joints: Install control joints at locations indicated on Drawings.
  - 1. As required to delineate plasterwork into areas (panels) of the following maximum sizes:
    - a. Vertical Surfaces: 144 sq. ft. (13.4 sq. m).
    - b. Horizontal and other Nonvertical Surfaces: 100 sq. ft. (9.3 sq. m).
  - 2. At distances between control joints of not greater than 18 feet (5.5 m) o.c.
  - 3. As required to delineate plasterwork into areas (panels) with length-to-width ratios of not greater than 2-1/2:1.
  - 4. Where control joints occur in surface of construction directly behind plaster.
  - 5. Where plasterwork areas change dimensions, to delineate rectangular-shaped areas (panels) and to relieve the stress that occurs at the corner formed by the dimension change.

### 2.4 PLASTER APPLICATION

- A. General: Comply with ASTM C 926.
- B. Walls; Base-Coat Mixes for Use over Metal Lath: Scratch and brown coats for three-coat plasterwork, 3/4-inch (19-mm) thickness.
  - 1. Portland cement mixes.
  - 2. Masonry cement mixes.
  - 3. Portland and masonry cement mixes.
  - 4. Plastic cement mixes.
  - 5. Portland and plastic cement mixes.

- C. Ceilings; Base-Coat Mixes for Use over Metal Lath: Scratch and brown coats for three-coat plasterwork; 1/2 inch (13 mm) thick.
  - 1. Portland cement mixes.
  - 2. Masonry cement mixes.
  - 3. Portland and masonry cement mixes.
  - 4. Plastic cement mixes.
  - 5. Portland and plastic cement mixes.
- D. Plaster Finish Coats: Apply to provide finish to match existing building color and texture.
- E. Acrylic-Based Finish Coatings: Apply coating system, including primers, finish coats, and sealing topcoats, according to manufacturer's written instructions.

## 2.5 PLASTER REPAIRS

- A. Repair or replace work to eliminate cracks, dents, blisters, buckles, crazing and check cracking, dry outs, efflorescence, sweat outs, and similar defects and where bond to substrate has failed.

END OF SECTION

**SECTION 09 29 00  
GYPSUM BOARD**

**PART 1 - GENERAL**

1.1 SUMMARY

A. This Section includes the following:

1. Interior gypsum board.
2. Tile backing panels.

1.2 SUBMITTALS

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

B. Samples: For the following products:

1. Trim Accessories: Full-size Sample in 12-inch- (300-mm-) long length for each trim accessory indicated.
2. Textured Finishes: Manufacturer's standard size for each textured finish indicated and on same backing indicated for Work.

1.3 QUALITY ASSURANCE

A. Fire-Resistance-Rated Assemblies: For fire-resistance-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 119 by an independent testing agency.

B. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 90 and classified according to ASTM E 413 by an independent testing agency.

C. Mockups: Before beginning gypsum board installation, install mockups of at least 100 sq. ft. (9 sq. m) in surface area to demonstrate aesthetic effects and set quality standards for materials and execution.

1. Install mockups for the following:

- a. Each level of gypsum board finish indicated for use in exposed locations.
- b. Each texture finish indicated.

2. Apply or install final decoration indicated, including painting and wallcoverings, on exposed surfaces for review of mockups.

3. Simulate finished lighting conditions for review of mockups.

4. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

## **PART 2 - PRODUCTS**

### **2.1 INTERIOR GYPSUM BOARD**

- A. General: Complying with ASTM C 36/C 36M or ASTM C 1396/C 1396M, as applicable to type of gypsum board indicated and whichever is more stringent.
  1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. American Gypsum Co.
    - b. National Gypsum Company.
    - c. PABCO Gypsum.
    - d. USG Corporation.
- B. Regular Type:
  1. Thickness: 1/2 inch (12.7 mm).
  2. Long Edges: Tapered and featured (rounded or beveled) for prefilling.
- C. Type X:
  1. Thickness: 5/8 inch (15.9 mm).
  2. Long Edges: Tapered and featured (rounded or beveled) for prefilling.
- D. Ceiling Type: Manufactured to have more sag resistance than regular-type gypsum board.
  1. Thickness: 1/2 inch (12.7 mm).
  2. Long Edges: Tapered.
- E. Abuse-Resistant Type: Manufactured to produce greater resistance to surface indentation and through-penetration (impact resistance) than standard, regular-type and Type X gypsum board.
  1. Core: 5/8 inch, Type X, USG VHI Abuse-Resistant or approved equal.
  2. Long Edges: Tapered.

F. Moisture- and Mold-Resistant Type: With moisture- and mold-resistant core and surfaces.

1. Core: 5/8 inch (15.9 mm), Type X.
2. Long Edges: Tapered.

## 2.2 TILE BACKING PANELS

A. Water-Resistant Gypsum Backing Board: ASTM C 630/C 630M or ASTM C 1396/C 1396M.

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. American Gypsum Co.
  - b. National Gypsum Company.
  - c. USG Corporation.
3. Core: As indicated on Drawings.

B. Cementitious Backer Units: ANSI A108.1.

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
2. Products: Subject to compliance with requirements, provide one of the following:
  - a. Custom Building Products; Wonderboard.
  - b. FinPan, Inc.; Util-A-Crete Concrete Backer Board.
  - c. USG Corporation; DUROCK Cement Board.
3. Thickness: 1/2 inch (12.7 mm).

## 2.3 TRIM ACCESSORIES

A. Interior Trim: ASTM C 1047.

1. Material: Galvanized or aluminum-coated steel sheet or rolled zinc.
2. Shapes:
  - a. Cornerbead.
  - b. Bullnose bead.
  - c. LC-Bead: J-shaped; exposed long flange receives joint compound.
  - d. L-Bead: L-shaped; exposed long flange receives joint compound.

- e. U-Bead: J-shaped; exposed short flange does not receive joint compound.
  - f. Expansion (control) joint.
  - g. Curved-Edge Cornerbead: With notched or flexible flanges.
- B. Aluminum Trim: Extruded accessories of profiles and dimensions indicated.
- 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - 2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Fry Reglet Corp.
    - b. Gordon, Inc.
    - c. Pittcon Industries.
  - 3. Aluminum: Alloy and temper with not less than the strength and durability properties of ASTM B 221 (ASTM B 221M), Alloy 6063-T5.
  - 4. Finish: Corrosion-resistant primer compatible with joint compound and finish materials specified.

## 2.4 JOINT TREATMENT MATERIALS

- A. General: Comply with ASTM C 475/C 475M.
- B. Joint Tape:
- 1. Interior Gypsum Wallboard: Paper.
  - 2. Exterior Gypsum Soffit Board: Paper.
  - 3. Glass-Mat Gypsum Sheathing Board: 10-by-10 glass mesh.
  - 4. Tile Backing Panels: As recommended by panel manufacturer.
- C. Joint Compound for Interior Gypsum Wallboard: For each coat use formulation that is compatible with other compounds applied on previous or for successive coats.
- 1. Prefilling: At open joints, rounded or beveled panel edges, and damaged surface areas, use setting-type taping compound.
  - 2. Embedding and First Coat: For embedding tape and first coat on joints, fasteners, and trim flanges, use setting-type taping or drying-type, all-purpose compound.
    - a. Use setting-type compound for installing paper-faced metal trim accessories.
  - 3. Fill Coat: For second coat, use setting-type, sandable topping compound.
  - 4. Finish Coat: For third coat, use setting-type, sandable topping compound.
  - 5. Skim Coat: For final coat of Level 5 finish, use setting-type, sandable topping compound.

- D. Joint Compound for Exterior Applications:
  - 1. Exterior Gypsum Soffit Board: Use setting-type taping compound and setting-type, sandable topping compound.
  - 2. Glass-Mat Gypsum Sheathing Board: As recommended by sheathing board manufacturer.
- E. Joint Compound for Tile Backing Panels:
  - 1. Water-Resistant Gypsum Backing Board: Use setting-type taping compound and setting-type, sandable topping compound.
  - 2. Glass-Mat, Water-Resistant Backing Panel: As recommended by backing panel manufacturer.
  - 3. Cementitious Backer Units: As recommended by backer unit manufacturer.

## 2.5 AUXILIARY MATERIALS

- A. General: Provide auxiliary materials that comply with referenced installation standards and manufacturer's written recommendations.
- B. Laminating Adhesive: Adhesive or joint compound recommended for directly adhering gypsum panels to continuous substrate.
  - 1. Use adhesives that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- C. Steel Drill Screws: ASTM C 1002, unless otherwise indicated.
  - 1. Use screws complying with ASTM C 954 for fastening panels to steel members from 0.033 to 0.112 inch (0.84 to 2.84 mm) thick.
  - 2. For fastening cementitious backer units, use screws of type and size recommended by panel manufacturer.
- D. Sound Attenuation Blankets: ASTM C 665, Type I (blankets without membrane facing) produced by combining thermosetting resins with mineral fibers manufactured from glass, slag wool, or rock wool.
  - 1. Fire-Resistance-Rated Assemblies: Comply with mineral-fiber requirements of assembly.
- E. Acoustical Sealant: As specified in Division 7 Section "Joint Sealants."
  - 1. Provide sealants that have a VOC content of 250 < g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- F. Thermal Insulation: As specified in Division 7 Section "Building Insulation."
- G. Vapor Retarder: As specified in Division 7 Section "Building Insulation."

## 2.6 TEXTURE FINISHES

- A. Primer: As recommended by textured finish manufacturer.
- B. Polystyrene Aggregate Ceiling Finish: Water-based, job-mixed, polystyrene aggregate finish with flame-spread and smoke-developed indexes of not more than 25 when tested according to ASTM E 84.
  - 1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
  - 2. Products: Subject to compliance with requirements, provide one of the following:
    - a. G-P Gypsum; Georgia-Pacific Regency Ceiling Textures/Polystyrene.
    - b. National Gypsum Company; Perfect Spray.
    - c. USG Corporation; SHEETROCK Ceiling Spray Texture, QT.
  - 3. Texture: Fine.
- C. Aggregate Finish: Water-based, job-mixed, aggregated, drying-type texture finish for spray application.
  - 1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
  - 2. Products: Subject to compliance with requirements, provide one of the following:
    - a. G-P Gypsum; Georgia-Pacific Ceiling Textures/Vermiculite.
    - b. USG Corporation; SHEETROCK Wall and Ceiling Spray Texture (Aggregated).
  - 3. Texture: Light spatter.

## PART 3 - EXECUTION

### 3.1 APPLYING AND FINISHING PANELS, GENERAL

- A. Comply with ASTM C 840.
- B. Examine panels before installation. Reject panels that are wet, moisture damaged, and mold damaged.
- C. Isolate perimeter of gypsum board applied to non-load-bearing partitions at structural abutments, except floors. Provide 1/4- to 1/2-inch- (6.4- to 12.7-mm-) wide spaces at these locations, and trim edges with edge trim where edges of panels are exposed. Seal joints between edges and abutting structural surfaces with acoustical sealant.
- D. Wood Framing: Install gypsum panels over wood framing, with floating internal corner construction. Do not attach gypsum panels across the flat grain of wide-dimension lumber, including floor joists and headers. Float gypsum panels over these members, or provide control joints to counteract wood shrinkage.

### 3.2 APPLYING INTERIOR GYPSUM BOARD

- A. Install interior gypsum board in the following locations:
  - 1. Regular Type: Vertical surfaces, unless otherwise indicated].
  - 2. Type X: As indicated on Drawings or Where required for fire-resistance-rated assembly.
  - 3. Ceiling Type: Ceiling surfaces.
  - 4. Abuse-Resistant Type: Gymnasium walls typical.
  - 5. Moisture- and Mold-Resistant Type: As indicated on Drawings.

### 3.3 APPLYING TILE BACKING PANELS

- A. Water-Resistant Gypsum Backing Board: Install at showers, tubs, and where indicated. Install with 1/4-inch (6.4-mm) gap where panels abut other construction or penetrations.
- B. Cementitious Backer Units: ANSI A108.1, at [showers, tubs, and where indicated] [locations indicated to receive tile].
- C. Areas Not Subject to Wetting: Install regular-type gypsum wallboard panels to produce a flat surface except at showers, tubs, and other locations indicated to receive water-resistant panels.
- D. Where tile backing panels abut other types of panels in same plane, shim surfaces to produce a uniform plane across panel surfaces.

### 3.4 INSTALLING TRIM ACCESSORIES

- A. General: For trim with back flanges intended for fasteners, attach to framing with same fasteners used for panels. Otherwise, attach trim according to manufacturer's written instructions.
- B. Control Joints: Install control joints according to ASTM C 840 and in specific locations approved by Architect for visual effect.
- C. Interior Trim: Install in the following locations:
  - 1. Cornerbead: Use at outside corners, unless otherwise indicated.
  - 2. Bullnose Bead: Use at outside corners.
  - 3. LC-Bead: Use at exposed panel edges.
  - 4. L-Bead: Use where indicated.
  - 5. U-Bead: Use at exposed panel edges.
  - 6. Curved-Edge Cornerbead: Use at curved openings.
- D. Exterior Trim: Install in the following locations:
  - 1. Cornerbead: Use at outside corners.

2. LC-Bead: Use at exposed panel edges.

E. Aluminum Trim: Install in locations indicated on Drawings.

### 3.5 FINISHING GYPSUM BOARD

A. General: Treat gypsum board joints, interior angles, edge trim, control joints, penetrations, fastener heads, surface defects, and elsewhere as required to prepare gypsum board surfaces for decoration. Promptly remove residual joint compound from adjacent surfaces.

B. Prefill open joints, rounded or beveled edges, and damaged surface areas.

C. Apply joint tape over gypsum board joints, except those with trim having flanges not intended for tape.

D. Gypsum Board Finish Levels: Finish panels to levels indicated below:

1. Level 1: Ceiling plenum areas, concealed areas, and where indicated.

2. Level 2: Panels that are substrate for tile.

3. Level 3: Not Used.

4. Level 4: At panel surfaces that will be exposed to view, unless otherwise indicated.

a. Primer and its application to surfaces are specified in other Division 9 Sections.

5. Level 5: Not Used.

a. Primer and its application to surfaces are specified in other Division 9 Sections.

E. Cementitious Backer Units: Finish according to manufacturer's written instructions.

### 3.6 APPLYING TEXTURE FINISHES

A. Surface Preparation and Primer: Prepare and apply primer to gypsum panels and other surfaces receiving texture finishes. Apply primer to surfaces that are clean, dry, and smooth.

B. Texture Finish Application: Mix and apply finish using powered spray equipment, to produce a uniform texture matching approved mockup and free of starved spots or other evidence of thin application or of application patterns.

C. Prevent texture finishes from coming into contact with surfaces not indicated to receive texture finish by covering them with masking agents, polyethylene film, or other means. If, despite these precautions, texture finishes contact these surfaces, immediately remove droppings and overspray to prevent damage according to texture-finish manufacturer's written recommendations.

### 3.7 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, and mold damaged.
  - 1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or 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 09 51 13**  
**ACOUSTICAL TILE CEILINGS**

**PART 1 - GENERAL**

1.1 SUMMARY

- A. This Section includes acoustical panels and exposed suspension systems for ceilings.

1.2 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Coordination Drawings: Drawn to scale and coordinating acoustical panel ceiling installation with hanger attachment to building structure and ceiling mounted items:
- C. Samples: For each exposed finish.
- D. Product test reports.
- E. Research/evaluation reports.
- F. Maintenance data.

1.3 QUALITY ASSURANCE

- A. Acoustical Testing Agency Qualifications: An independent testing laboratory or an NVLAP-accredited laboratory.
- B. Fire-Test-Response Characteristics:
  - 1. Fire-Resistance Characteristics: Where indicated, provide acoustical panel ceilings identical to those of assemblies tested for fire resistance per ASTM E 119 by UL or another testing and inspecting agency acceptable to authorities having jurisdiction.
    - a. Identify materials with appropriate markings of applicable testing and inspecting agency.
  - 2. Surface-Burning Characteristics: Acoustical panels complying with ASTM E 1264 for Class **A** materials, when tested per ASTM E 84.
    - a. Smoke-Developed Index: 450 or less.
- C. Seismic Standard: Comply with the following:
  - 1. Standard for Ceiling Suspension Systems Requiring Seismic Restraint: Comply with ASTM E 580.

2. UBC Standard 25-2, "Metal Suspension Systems for Acoustical Tile and for Lay-in Panel Ceilings."
  3. ASCE 7, "Minimum Design Loads for Buildings and Other Structures": Section 9, "Earthquake Loads."
- D. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
1. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.
- E. Pre-installation Conference: Conduct conference at Project site

#### 1.4 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Acoustical Ceiling Panels: Full-size panels equal to 2.0 percent of quantity installed.
  2. Suspension System Components: Quantity of each exposed component equal to 2.0 percent of quantity installed.

### **PART 2 - PRODUCTS**

#### 2.1 ACOUSTICAL PANEL CEILINGS, GENERAL

- A. Acoustical Panel Standard: Comply with ASTM E 1264.
- B. Metal Suspension System Standard: Comply with ASTM C 635.
- C. Attachment Devices: Size for five times the design load indicated in ASTM C 635, Table 1, "Direct Hung," unless otherwise indicated. Comply with seismic design requirements.
1. Anchors in Concrete: Expansion anchors fabricated from corrosion-resistant materials, with holes or loops for attaching hangers of type indicated and with capability to sustain, without failure, a load equal to five times that imposed by ceiling construction, as determined by testing per ASTM E 488 or ASTM E 1512 as applicable, conducted by a qualified testing and inspecting agency.
  2. Power-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hangers of type indicated, and with capability to sustain, without failure, a load equal to 10 times that imposed by ceiling construction, as determined by testing per ASTM E 1190, conducted by a qualified testing and inspecting agency.
- D. Wire Hangers, Braces, and Ties: Zinc-coated carbon-steel wire; ASTM A 641/A 641M, Class 1 zinc coating, soft temper.

1. Size: Select wire diameter so its stress at 3 times hanger design load (ASTM C 635, Table 1, "Direct Hung") will be less than yield stress of wire, but provide not less than 0.106-inch- (2.69-mm-) diameter wire.

E. Seismic perimeter stabilizer bars, seismic struts, and seismic clips.

F. Metal Edge Moldings and Trim: Type and profile indicated or, if not indicated, manufacturer's standard moldings for edges and penetrations that comply with seismic design requirements; formed from sheet metal of same material, finish, and color as that used for exposed flanges of suspension system runners.

## 2.2 ACOUSTICAL PANELS FOR ACOUSTICAL PANEL CEILING

A. Products: Subject to compliance with requirements:

1. Match existing panel type and size being removed for new work which may not be salvageable.

## 2.3 METAL SUSPENSION SYSTEM FOR ACOUSTICAL PANEL CEILING

A. Basis-of-Design Product: Subject to compliance with requirements, provide USG Interiors, Inc., Finline DXF/DXLF or approved equal.

B. Double-Web, Steel Suspension System: Main and cross runners roll formed from cold-rolled steel sheet, prepainted, electrolytically zinc coated, or hot-dip galvanized according to ASTM A 653/A 653M, not less than G30 (Z90) coating designation, with prefinished 9/16-inch- (15-mm-) wide metal caps on flanges.

1. Structural Classification: Heavy-duty system.
2. End Condition of Cross Runners: Override (stepped) or butt-edge type.
3. Cap Material: Steel cold-rolled sheet.
4. Cap Finish: Painted in color as selected from manufacturer's full range.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. Comply with UBC Standard 25-2 and seismic design requirements indicated, per manufacturer's written instructions and CISCA's "Ceiling Systems Handbook."

B. Measure each ceiling area and establish layout of acoustical panels to balance border widths at opposite edges of each ceiling. Avoid using less-than-half-width panels at borders.

C. Suspend ceiling hangers from building's structural members, plumb and free from contact with insulation or other objects within ceiling plenum. Splay hangers only where required to miss obstructions; offset resulting horizontal forces by bracing, countersplaying, or other equally effective means. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with location of hangers, use trapezes or equivalent devices.

When steel framing does not permit installation of hanger wires at spacing required, install carrying channels or other supplemental support for attachment of hanger wires.

1. Do not support ceilings directly from permanent metal forms or floor deck; anchor into concrete slabs.
  2. Do not attach hangers to steel deck tabs.
- D. Install edge moldings and trim of type indicated at perimeter of acoustical ceiling area and where necessary to conceal edges of acoustical panels. Screw attach moldings to substrate at intervals not more than 16 inches (400 mm) o.c. and not more than 3 inches (75 mm) from ends, leveling with ceiling suspension system to a tolerance of 1/8 inch in 12 feet (3.2 mm in 3.6 m). Miter corners accurately and connect securely.
- E. Install suspension system runners so they are square and securely interlocked with one another. Remove and replace dented, bent, or kinked members.
- F. Install acoustical panels with undamaged edges and fit accurately into suspension system runners and edge moldings. Scribe and cut panels at borders and penetrations to provide a neat, precise fit.

END OF SECTION

**SECTION 09 90 00  
PAINTING**

**PART 1 – GENERAL**

1.1 SECTION INCLUDES:

- A. This section covers painting of exposed elements of the project, interior and exterior, Sealing and back priming of wood in the field. Surfaces that are left unfinished by requirements of other sections shall be finished as part of this section.

1.2 SECTION EXCLUDES:

- A. Control panels and control systems.
- B. Fabric connections to fans.
- C. Flexible conduit connections to equipment, miscellaneous name plates, stamping and instruction labels and manufacturer's data.
- D. Equipment and products having a complete factory finish, except as specified or noted on drawings.
- E. Flag, floodlight, parking light poles and loudspeaker poles furnished with a factory finish.
- F. The following items if specified or furnished with galvanized finish shall not be painted: Metal shelving, chain link fencing, areaway and catch basin gratings and frames.
- G. Brass, bronze, lead, stainless steel, and chrome or nickel-plated elements.
- H. Non-metallic walking surfaces unless specifically shown or specified to be painted.
- I. Fire rating labels at fire doors and frames.
- J. Cement masonry units at exterior.

1.3 RELATED SECTIONS:

- A. Section 05 50 00- Metal Fabrications.
- B. Section 07 62 00 –Sheet Metal Flashing and Trim
- C. Section 09 24 00 – Portland Cement Plaster.
- D. Section 09 29 00– Gypsum Board.

1.4 QUALITY ASSURANCE

- A. Certification of Materials: With every delivery of paint materials, the manufacturer shall certify on the manufacturer's letterhead that materials comply with the requirements of this section.

- B. Paint materials shall comply with the Food and Drug Administration's (F.D.A.) Lead Law and the current rules and regulations of local, state and federal agencies governing the use of paint materials.
- C. Coats: The number of coats specified is the minimum number acceptable. If full coverage is not obtained with the specified number of coats, apply such additional coats as are necessary to produce the required finish.
- D. Employ coats and undercoats for all types of finishes in strict accordance with the recommendations of the paint manufacturer and approved by Architect.

#### 1.5 SUBMITTALS

- A. Submittals shall be made in accordance with Section 01 33 00.
- B. List of Paint Materials: Prior to submittal of samples, submit a complete list of proposed paint materials, identifying each material by manufacturer's name, product name and number, including primers, thinners, and coloring agents, together with manufacturers' catalog data fully describing each material as to contents, recommended usage, and preparation and application methods. Identify surfaces to receive various paint materials. Do not deviate from approved list.
- C. Submit manufacturer's standard color samples for each type of paint used. Once colors have been selected, submit 3 samples of each color selected for each type of paint, on standard 8-1/2 x 11 inch spray-out panel with substrate textures demonstrated.
- D. For transparent and stained finishes, prepare samples (16" long) on same species and quality of wood to be installed on the project, showing system used and each step of the finishing process>.
- E. Manufacturers shall verify that their products conform to latest California Air Resources Board and AQMD regulations.
- F. An MSDS sheet will be included with each individual submittal.

#### 1.6 DELIVERY, STORAGE AND HANDLING

- A. Materials shall be delivered to the project site in original unbroken containers bearing manufacturer's name, brand number and batch number corresponding to description on list of materials as approved.
- B. Open and mix ingredients on the premises in the presence of the District Inspector. Immediately remove rejected materials from the premises.
- C. Storage and Mixing of Materials: Store materials and mix only in spaces designated for the purpose by the District Inspector. Keep such spaces clean and take necessary precautions to prevent fire. Hang out oily rags flat and singly in the open air. Stack paint containers so that manufacturer's labels are clearly displayed.

#### 1.7 ENVIRONMENTAL CONDITIONS

- A. General: Follow mfr.'s printed recommendations for product when they are more stringent than limits stated herein.

- B. Do not apply "paint" to "wet-applied" construction until such work is "dry", and acceptable to Construction Manager and "paint" mfr.
- C. Temperature and Humidity: Do not apply exterior paint in damp, rainy or foggy weather (above 90% relative humidity) or until the surface has thoroughly dried from the effects of such weather. Do not apply paint, interior or exterior, when the temperature is below 50 or above 100 degrees F., or dust conditions are unfavorable to proper workmanship.
- D. Ventilation: As necessary to provide air movement, aid drying, disperse noxious fumes.

## 1.8 GUARANTEE

- A. Materials and workmanship guarantee shall be in accordance with the requirements of the Contract Documents, except that guarantee shall be furnished jointly by the Contractor and the materials manufacturer.

## PART 2 – PRODUCTS

### 2.1 PAINT MATERIALS

- A. General: All materials used in the work are listed for Dunn-Edwards Paint. Dunn-Edwards has been adopted by the PUSD Board of Education as the "sole source" paint for use in the District.
- B. Regulatory changes may affect the formulation, availability, or use of specified coatings. Verify with supplier or your representative regarding such changes prior to start of painting project.
- C. Use the paint products of one Paint manufacturer unless otherwise specified or approved. In any case, primers, intermediate and finish coats in each painting system must all be the products of the same manufacturer, including thinners and coloring agents, except for materials furnished with shop prime coat by other trades. To the maximum extent feasible, factory mix paint materials to correct color, gloss, and consistency for application. Dunn-Edwards products are specified herein except as otherwise noted, to establish types and qualities.

## PART 3 – EXECUTION

### 3.1 PREPARATION

- A. Inspect surfaces to receive paint finish for surface blemishes and repair as required. Surfaces that are not properly prepared or sanded or cleaned or which are not in condition to receive the specified finish, shall be corrected, before priming is done. Wash and rinse walls and trim with T.P.S. before applying any primer. No priming shall be done until District IOR Inspector or the Owner's representative approves the surfaces.
- B. Protect floors and all adjacent surfaces from paint smears, spatters, and accidental droppings. Cover fixtures and remove hardware not to be painted. Mask off areas where necessary. Any accidental spills, over-painting or spatters shall be cleaned up immediately before additional work proceeds.

Hardware: Insure that hardware is removed before painting is started and replaced only when paint finishes are thoroughly dry.

1. Removal and reinstallation of hardware is specified in Section 06200--Finish Carpentry and Millwork.
  2. Items to be removed include, without limitation: Signs and graphics; switch and receptacle plates; escutcheons and plates; all surface-mounted equipment; free-standing equipment blocking access; grilles and louvers at ducts opening into finished spaces; all tape on doors, walls or other District property; and other items as required and directed.
- C. Woodwork shall be thoroughly cleaned, hand sandpapered parallel to the grain, and dusted off. Nail holes, cracks or defects in all work shall be carefully puttied. Caulk all woodwork joints with specified caulking. Wash and rinse trim with T.P.S. both before applying any primer. On stained woodwork the putty shall be colored to match the stain. Puttying shall be done after the first coat of paint, shellac or varnish has been applied.
- D. Gypsum board: Remove all foreign matter. Fill all pits flush and smooth with spackle. Wash and rinse Gypsum board walls with T.P.S. before applying any primer.
- E. Plaster surfaces shall be allowed to dry at least 3 weeks before painting, or plaster shall be allowed to dry sufficiently to receive paint as determined by moisture meter tests. Clean off dirt, dust, excess mortar, encrustation and foreign matter. Fill holes, pits and other imperfections flush and smooth. Wash and rinse Plaster walls with T.P.S. before applying primer.
- F. Concrete Surfaces shall be dry, cleaned of dirt and foreign materials and in proper condition to receive paint. Neutralize spots showing effects of alkali.
- G. Metal surfaces to be painted shall be thoroughly cleaned of rust, corrosion, oil, foreign materials, blisters, and loose paint removed to bright metal. Apply the metal paint preparation coating recommended by the paint manufacturer prior to applying the primer. All shop and field painted metal shall follow these procedures.
- H. Surfaces Not Mentioned: Prepare surfaces according to recommendations of the paint manufacturer and as approved by the Architect or the Owner.
- I. Do not apply painting materials to wet, damp, dusty, dirty, fingermarked, rough, unfinished, or defective surfaces.
- J. Bond breakers and curing agents must be removed and the surface cleaned, as specified is section 3.01-A above, before primers, sealers or finish paints are applied.

### 3.2 APPLICATION

- A. General: Employ experienced painters supervised by a foreman with a minimum of 5 years' experience in public works projects, thoroughly familiar with code requirements, the best recommendations of the painting materials manufacturer. Utilize the following methods and procedures:
1. Apply material evenly, free from sags, runs, crawls, holidays or defects. Mix to proper consistency, brush out smooth, leaving minimum of brush marks, enamel uniformly flowed on. Sand between enamel coats.
  2. Apply paint by brushes, rollers or spray except rollers shall not be used on wood surfaces or on wood floors. If rollers are used on other surfaces, then all surfaces

shall be brushed out by hand. Spraying is not permitted on wood floors. Paint wood floors by using a hand brush, applying the paint at the specified application rate as recommended by the manufacturer. Apply in thin coats allowing proper drying time between coats. The use of two ventilation fans is required in each room to accelerate the drying of the floors. One fan in the door pushing air into the room and one fan in a window exhausting air out of the room. Keep fans running until all paint fume smells and non-existence in the rooms.

3. Tint all pigmented undercoats to approximately same shade as final coat. Perceptibly increase the depth of shade in successive coats.
  4. Allow each coat to thoroughly dry before succeeding coat application, a minimum of 24 hours. Sand between enamel coats.
  5. Finish all four edges of doors with the same number and kind of coatings as specified for their main surfaces on all new or reused doors. Where opening into rooms have different finishes, finish door edges to match the side into which it swings. The top of all doors that open to the outside shall have a continuous painted top coating to prevent moisture from penetrating the door material.
  6. Finish mill or shop primed items with materials compatible with prime coat.
  7. Mechanical and electrical work shall be cleaned, pretreated and painted with 3 coats or as noted:
    - a. Paint that portion of ductwork or plenum spaces, the interior of which is visible through the grilles: they shall be pretreated and painted with 2 coats of flat black paint.
    - b. Shop primed metal surface of all mechanical and electrical equipment shall receive two finish coats of paint to match adjoining wall or ceiling surfaces. Prime coat, in addition to above, on all unprimed surfaces.
    - c. All other mechanical and electrical equipment exposed to view, such as covered and uncovered piping and ductwork, supports for piping and ductwork, pumps compressors, air conditioning equipment, tanks, etc., shall be painted as specified herein, where not supplied finished under other sections.
  8. Miscellaneous painting: Surfaces to be painted and not specifically described herein shall be painted with a product specifically manufactured or prepared for the material and surface; prime coat and two finish coats and subjected to all the conditions previously mentioned above governing painting.
- B. Back-painting: Immediately upon delivery to the building, exterior finish lumber and millwork shall be back-painted on surfaces that will be concealed after installation. Items to be painted shall be back-painted with the priming coat specified under "Priming".
- C. Priming: Wood and metal surfaces specified to receive paint finish shall be primed as specified in section 3.01. Surfaces of miscellaneous metal and steel not embedded in concrete, and surfaces of unprimed plain sheet metal work shall be primed immediately upon delivery to the project. Galvanized metal work and interior and exterior woodwork shall be primed immediately after erection. Priming of surfaces and priming coat shall be as follows and as specified in schedule:
1. Knots, Pitch and Sap Pockets: Shellac, or approved equivalent, before priming.

2. Exterior Woodwork: Prime with one coat of exterior water borne emulsion wood primer.
  3. Interior Woodwork: Where indicated to be painted, prime with one coat of water borne wood primer.
  4. Stain: Woodwork indicated to receive a stain and varnish finish shall be stained to an even color with water borne stain. On open-grained hardwood, mix stain with paste filler and completely fill pores in wood.
  5. Galvanized Metal Work: Clean oil, grease and other foreign materials from surfaces. Apply the recommended muratic acid etching solution and thoroughly wash metal. Apply pretreatment coating and follow manufacturer's instructions for drying time, and then prime with one coat of metal primer as specified in section 3.01.
  6. Unprimed Iron, Steel, and Other Uncoated Metals: Where specified to be painted, prime with one coat of metal primer as specified in section 3.01..
  7. Shop Primed Metal Items: Metal shall be primed as specified in section 3.01 and touch up bare and abraded areas with metal primer prior to application of second and third coats.
- D. The number of paint coats specified to be applied are the minimum required. Apply additional coats if required to obtain complete coverage and approved results. Ensure acceptable paint finishes of uniform color, free from cloudy or mottled areas and evident thinness on arises. "Spot" or undercoat surfaces as necessary to produce such results. Conform to the approved Samples. Obtain approval of each coat before applying next coat. If this inspection step is missed, apply an additional coat over entire surface involved at no additional contract cost.
  - E. Each coat of painted woodwork and metal, except the last coat, shall be sandpapered smooth when dry. Texture-coated gypsum board shall be sanded lightly to remove surface imperfections after first coat of paint has been applied.
  - F. Each coat of paint or enamel shall be a slightly different shade as directed. The District Inspector will inspect each coat of paint, enamel, stain, shellac, and varnish before the next coat is applied. Notify the District Inspector that such work is ready for inspection. If this inspection step is missed, apply an additional coat over entire surface involved at no additional contract cost. FASO will be sent 48 hour notices for paint completion inspection.
  - G. Do not "paint-out" underwriters' labels, fusible links, sliding surfaces and identification stamps.
  - H. Damaged shop prime coat shall be touched-up with metal primer prior to application of second and third coats.
  - I. Apply each coat of material to the manufacturers recommended dry film thickness and spread rate.

### 3.3 CLEANING

- A. Remove rubbish, waste and surplus material and clean woodwork, hardware, floors and other adjacent work.

- B. Remove paint, varnish and brush marks from glazing material and, upon completion of the painting work, wash and polish the glazing material both sides. Glazing material that is damaged shall be removed and replaced with new material at no cost to the District.
- C. Clean hardware and other unpainted metal surfaces with approved cleaner. Do not use abrasives or edged tools.
- D. Leave paint storage spaces clean and in condition required for equivalent spaces in the project. Specified shelf stock shall consist of new unopened paint containers and shall be turned over to the District per the contract documents.
- E. Collect waste material, which may constitute a fire hazard, place in closed metal containers, and remove daily from site.

### 3.4 EXTERIOR PAINT SCHEDULE

#### A. Metal Work; Exterior:

- 1. Galvanized Metal & Galvanized Metal Deck; Exterior:
  - a. Preparation: Before application, properly clean and etch (solvent wash) galvanized surfaces in accordance with preparation instructions for galvanized metal per Articles 3.02 H and 3.04F herein.
  - b. Coat 1: **ULTRASHIELD Galvanized Metal Primer (ULGM00) 2.0 mil DFT**
  - c. Coat 2: 100% Acrylic Semi-Gloss Enamel EVERSIELD (EVSH50) **1.5 mil DFT**  
or EVERSIELD, 100% Acrylic Gloss Enamel (EVSH60)-**1.5 mil DFT**
  - d. Coat 3: EVERSIELD 100% Acrylic Semi-Gloss Enamel-(EVSH50) **1.5 mil DFT**  
or EVERSIELD, 100% Acrylic Gloss Enamel (EVSH60)-**1.5 mil DFT**
  - e. **Total DFT: 5 mils DFT**
- 2. Ungalvanized Steel; Apply first prime coat immediately after steel is cleaned.
  - a. Coat 1: Rust Inhibitive Primer: **BLOC-RUST Premium Primer (BRPR00)**
  - b. Coat 2: 100% Acrylic Enamel Sash EVERSIELD, 100% Acrylic Semi-Gloss Enamel (EVSH50) **1.5 mil DFT**  
or EVERSIELD, 100% Acrylic Gloss Enamel (EVSH60) **1.5 mil DFT**
  - c. Coat 3: 100% Acrylic Enamel Sash EVERSIELD, 100% Acrylic Semi-Gloss Enamel (EVSH500) **1.5 mil DFT**  
Or EVERSIELD, 100% Acrylic Gloss Enamel (EVSH60) **1.5 mil DFT**
  - d. **Total DFT 5 mils.**
- 3. Ungalvanized Steel: Concealed: Apply prime coat immediately after steel is cleaned.
  - a. Scope: Apply to all structural steel surfaces hidden and enclosed, within the building envelope (not exposed to view), except members with flanges ¼" or thicker and webs 3/16" or thicker need NOT to be painted.
  - b. Prime Coat: Rust Inhibitive Primer BLOC-RUST Premium Primer **(BRPR00) 2 mil DFT**
  - c. **Total DFT: 2 mils.**

4. All Shop Primed Metals; Exterior:
  - a. Preparation: Touch up damaged, scratched, or missing prime coat paint using top-quality rust-inhibitive primer recommended by paint mfr. lightly sand smooth, ready to receive finish coats.
  - b. Coat 1: 100% Acrylic Enamel BLOC-RUST Premium Primer Rust Preventative Acrylic Primer (BRPR00) 2 mil DFT
  - c. Coat 2: 100% Acrylic Enamel-EVERSHIELD, 100% Acrylic Semi-Gloss Enamel (EVSH50) 1.5 mil DFT  
or EVERSHIELD, 100% Acrylic Gloss Enamel (EVSH60) 1.5 mil DFT
  - d. Coat 3: 100% Acrylic Enamel Sash EVERSHIELD, 100% Acrylic Semi-Gloss Enamel (EVSH500) 1.5 mil DFT  
or EVERSHIELD, 100% Acrylic Gloss Enamel (EVSH60) 1.5 mil DFT
  - e. Total DFT: 5 mils.
  
5. Factory Finished Equipment & Items:
  - a. Coat 1: Acrylic Enamel Sash & Trim EVERSHIELD, 100% Acrylic Semi-Gloss Enamel (EVSH50) 1.5 mil DFT  
or EVERSHIELD, 100% Acrylic Gloss Enamel (EVSH60) 1.5 mil DFT
  - b. Coat 2: 100% Acrylic Enamel Sash EVERSHIELD, 100% Acrylic Semi-Gloss Enamel (EVSH500) 1.5 mil DFT  
or EVERSHIELD, 100% Acrylic Gloss Enamel (EVSH60) 1.5 mil DFT
  - c. Coat 3: 100% Acrylic Enamel Sash EVERSHIELD, 100% Acrylic Semi-Gloss Enamel (EVSH500) 1.5 mil DFT  
or EVERSHIELD, 100% Acrylic Gloss Enamel (EVSH60) 1.5 mil DFT
  - b. Total DFT: 5 mils.
  
6. Aluminum; Where Indicated To Be Painted Or Where Previously Painted:
  - a. Follow paint mfr's. recommendations, and specifications.
  - b. Prepare surface by phosphatizing and cleaning same as for Galvanized Surfaces, Articles 3.02H and 3.04F.
  - c. Coat 1: ULTRASHIELD Galvanized Metal Primer (ULGM00) 2.0 mil DFT
  - d. Coat 2: 100% Acrylic Enamel EVERSHIELD, 100% Acrylic Semi-Gloss Enamel (EVSH50) 1.5 mil DFT  
or EVERSHIELD, 100% Acrylic Gloss Enamel (EVSH60) 1.5 mil DFT
  - e. Coat 3: 100% Acrylic Enamel EVERSHIELD, 100% Acrylic Semi-Gloss Enamel (EVSH60) 1.5 mil DFT  
or EVERSHIELD, 100% Acrylic Gloss Enamel (W 960V) (EVSH60) 1.5 mil DFT
  - f. Total DFT: 5 mils.

B. Exterior Work: Other Than Metals: Existing and At Repairs or New to Match Existing; Match Existing Finishes/Paint:

1. Wood (Painted):
  - a. Coat 1: Exterior Wood Primer E-Z Premium PRIME, Ext. 100% Acrylic Wood Primer (EZPR00) 2 mil DFT
  - b. Coat 2: 100% Acrylic Exterior Wood EVERSHIELD, 100% Acrylic Semi-Gloss Enamel (EVSH50) 1.5 mil DFT  
or EVERSHIELD, 100% Acrylic Gloss Enamel (EVSH60) 1.5 mil DFT

- c. Coat 3: 100% Acrylic Exterior Wood EVERSIELD, 100% Acrylic Semi-Gloss Enamel (EVSH50) 1.5 mil DFT  
or EVERSIELD, 100% Acrylic Gloss Enamel (EVSH60) 1.5 mil DFT
  - d. Total DFT: 5 mils.
  
- 2. Wood (Stained/Natural Finish) Smooth or "Rough Surface" Materials, Trim, Boards, Fascia, Etc., Wood Trellis Siding, Trim, Boards, and Fascia:
  - a. Coat 1: Exterior Wood Stain OKON WeatherPro Tinted, (WPT-3)  
Prime all surfaces of all new pieces completely before installation (faces, edges, ends). After installation, inspect members; touch-up any damage, cuts, and nail holes.
  - b. Coat 2: Exterior Wood Stain OKON WeatherPro Tinted, (WPT-3)
  - c. Application Rate: 150 sf./per gallon per coat.
  
- 3. Cement Plaster:
  - a. Coat 1: Masonry Concrete Sealer EFF-STOP PERMIUM Masonry Primer/Sealer (ESPR00) 1.5 mil DFT
  - b. Coat 2: Exterior Masonry Finish SPARTASHIELD, Exterior 100% Acrylic Flat Finish (SSHL10) 1.5 mil DFT  
or EVERSIELD, 100% Acrylic Ext. Masonry Finish (EVSH10) 1.5 mil DFT
  - c. Coat 3: Exterior Masonry Finish SPARTASHIELD, Exterior 100% Acrylic Flat Finish (SSHL10) 1.5 mil DFT  
or EVERSIELD, 100% Acrylic Ext. Masonry Finish (EVSH10) 1.5 mil DFT
  - d. Total DFT: 4.5 mils.
  
- 4. Concrete; Columns, Wall Caps, Beams, Wall Exposed Foundation Walls & Curbs and Where Indicated:
  - a. Coat 1: Masonry/Concrete Sealer, on bare concrete and as required EFF-STOP PERMIUM, (W709) (ESPR00) 1.5 mil DFT
  - b. Coat 2: Exterior Masonry Finish EVERSIELD, 100% Acrylic Semi-Gloss Enamel (EVSH50) 1.5 mil DFT  
or EVERSIELD, 100% Acrylic Gloss Enamel (EVSH60) 1.5 mil DFT
  - c. Coat 3: Exterior Masonry Finish EVERSIELD, 100% Acrylic Semi-Gloss Enamel (EVSH50) 1.5 mil DFT  
or EVERSIELD, 100% Acrylic Gloss Enamel (EVSH60) 1.5 mil DFT
  - d. Total DFT: 4.5 mils.
  
- 5. Concrete Block:
  - a. Coat 1: Masonry Filler BLOCFIL SMOOTH BLOCFIL PREMIUM, Concrete Block Filler, Smooth (SBPR00) 3.5 mil DFT
  - b. Coat 3: Exterior Masonry Finish SPARTASHIELD, Exterior 100% Acrylic Flat Finish (SSHL10) 1.5 mil DFT
  - c. Coat 4: Exterior Masonry Finish SPARTASHIELD, Exterior 100% Acrylic Flat Finish (SSHL10) 1.5 mil DFT
  - d. Total DFT 6.5 mil.

6. Painted Stripes At Exterior Concrete Stairs; Conform to State HDCP Requirements:
  - a. Stripes: 2" wide, Located 1" max from and parallel to nosing.
  - b. Required Locations: All treads and upper approach of each flight of stairs.
  - c. Application Rate: 2 coats of Traffic Paint, at 375 sf/per gallon per coat. VIN-L-STRIPE, (VSZM00) 8.0 mil DFT
  
- 7 Plastic or Rubber Condensate Piping & Other Plastic Piping Exposed on Roof-Tops:
  - a. Coat 1: Multipurpose Primer ULTRA-GRIP PREMIUM, Multi-Purpose Latex Primer (UGPR00) 2 mil DFT
  - b. Coat 2: 100% Acrylic Enamel EVERSIELD, 100% Acrylic Semi-Gloss Enamel (EVSH50) 1.5 mil DFT
  - c. Coat 2: 100% Acrylic Enamel EVERSIELD, 100% Acrylic Semi-Gloss Enamel (EVSH50) 1.5 mil DFT
  - d. Total 5.0 mil DFT
  
8. Painted Stripes At Exterior Concrete Stairs; Conform to State HDCP Requirements:
  - a. Required Locations: Bottom tread and upper approach of each flight of stairs, where indicated.
  - b. Stripes: 2" wide, located 1" max form parallel to nosing.
  - c. Applications Rate: 2 coats of Traffic Paint, at 375 sf/ per gallon per coat. VIN-L-STRIPE, (VSZM00) 8.0 mil DFT

#### INTERIOR PAINT SCHEDULE

Interior Work: Typically Match Existing Finishes/Paint:

1. Softwood; Typically, and Medium Density Overlaid (MDO) Doors; Existing and at Repairs or New To Match Existing:
  - a. Coat 1: ULTRA-GRIP PERMIUM, Multi-Purpose Primer (UGRP00) 2 mil DFT
  - b. Coat 2: 100% Acrylic Semi-Gloss Enamel EVERSIELD, 100% Acrylic Semi-Gloss Enamel (EVSH50) 1.5 mil DFT or EVERSIELD, 100% Acrylic Semi-Gloss Enamel (EVSH60) 1.5 mil DFT
  - c. Coat 3: 100% Acrylic Semi-Gloss Enamel EVERSIELD, 100% Acrylic Semi-Gloss Enamel (EVSH50) 1.5 mil DFT or EVERSIELD, 100% Acrylic Gloss (EVSH60) 1.5 mil DFT
  - d. Total DFT: 5 mils.
  
2. Interior Hardwood Doors, Paneling, Doors, Transom Panels, Trim, Handrails, Softwood Casework, Paneling & Casework & Similar; With Stained/Natural Finish/Transparent Finish and; where not factory finished, Plastic Laminate, or Painted:
  - a. Sealer: At contractors option and expense N/A
  - b. Coat 1: GEMINI Clear W/B Sealer (WBS—0100)

- c. Coat 2: Gloss, GEMINI W/B Conversion Varnish Gloss (MOD-0090)
  - d. Coat 3: Gloss, GEMINI W/B Conversion Varnish (MOD-0090)
  - e. Coat 4: Satin, GEMINI W/B Conversion Varnish (MOD-0020)  
DFT: 3.5 mils. Dry Film Thickness: Maximum DFT for a complete system must not exceed 4 dry mils.
  - g. Lacquer Option: With specific approval or Architect Construction Manager & District, Lacquer may be used in lieu of varnish. In existing buildings, match existing finishes unless noted otherwise.
3. "Rough Surface" Wood Trim; Existing and at Repairs or New to Match Existing:
- a. Coat 1: Exterior Wood Stain OKON WeatherPro Tinted, (WPT-3)
  - b. After installation, inspect members; touch-up any damage, cuts and nail holes.
  - c. Coat 2: Exterior Wood Stain OKON WeatherPro Tinted, (WPT-3)
  - d. Application Rate: 150 sf/per gallon per coat.
4. "Smooth Surface" Plywood at Equipment Backboards:
- a. Coat 1: Enamel Undercoater ULTRA-GRIP PREMIUM, Multi-Purpose Latex Primer (UGPR00) 2 mil DFT
  - b. Coat 2: EVERSIELD, 100% Acrylic Semi-Gloss Enamel (EVSH50) 1.5 mil DFT  
or EVERSIELD, Int. 100% Acrylic Gloss Enamel (EVSH60) 1.5 mil DFT
  - c. Coat 3: Enamel, Semi-Gloss EVERSIELD, 100% Acrylic Semi-Gloss Enamel (EVSH50) 1.5 mil DFT  
or EVERSIELD, Int. 100% Acrylic Gloss Enamel (EVSH60) 1.5 mil DFT
  - d. Total DFT: 5 mils.
5. Existing Painted Casework and or Painted Wall Paneling:
- a. Coat 1: Enamel Undercoater INTER-KOTE PREMIUM, Int. 100% Acrylic Enamel Undercoater (IKPR00) 2.0 mil DFT  
or ULTRA-GRIP PREMIUM, Multi-Purpose Latex Primer (UGPR00)
  - b. Coat 2: Enamel, Semi-Gloss EVERSIELD, 100% Acrylic Gloss Enamel (EVSH50) 1.5 mil DFT  
or EVERSIELD, Int. 100% Acrylic Semi-Gloss Enamel (EVSH60) 1.5 mil DFT
  - c. Coat 3: Enamel, Semi-Gloss EVERSIELD, 100% Acrylic Semi-Gloss Enamel (EVSH50) 1.5 mil DFT  
or EVERSIELD, Int. 100% Acrylic Gloss Enamel (EVSH60) 1.5 mil DFT
  - d. Total DFT: 5 mils.
6. Plaster Walls & Ceilings; Existing and at Repairs or New to Match Existing:
- a. Coat 1: Latex Sealer, Pigmented ULTRA-GRIP PREMIUM, Multi-Purpose Latex Primer (UGPR00) 2.0 mil DFT
  - b. Coat 2: Enamel Undercoater Not Needed
  - c. Coat 3: Typically match existing: One of the following as applicable or selected by Architect Construction Manager:
    - 1) Enamel Semi-Gloss: EVERSIELD, 100% Acrylic Semi-Gloss Enamel (EVSH50) 1.5 mil DFT

- EVERSHIELD, Int. 100% Acrylic Semi-Gloss Enamel (EVSH50)  
1.5 mil DFT
- 2) Enamel, Low Sheen: SUPREMA, 100% Acrylic Eggshell Low Sheen Enamel (EVSH40) 1.5 mil DFT  
SUPREMA, Int. 100% Acrylic Low Sheen Enamel (SPMA40) 1.5 mil DFT
- (1) Stipple Enamel, Semi-Gloss. Apply with an Architect approved heavy-texture stipple roller.
- d. DFT: 5mils.
7. Concrete, Concrete Block and Brick; Existing Painted and at Repairs or New To Match Existing:
- a. Coat 1: Concrete Sealer EFF-STOP Masonry Primer (ESPR00) 1.5 mil DFT
- b. Coat 2: Match existing: Enamel, 1.5 mil DFT
- c. Coat 3: Match existing: Enamel, Semi-Gloss, Low Sheen, or Velvet or Stipple as selected by Architect Construction Manager. SUPREMA, (SPMA20) 1.5 mil DFT or SUPREMA, (SPMA40) 1.5 mil DFT or, SUPREMA (SPMA50) 1.5 mil DFT
- d. Total DFT: 5 mils.
8. Drywall Walls: Typical:
- a. Coat 1: Latex Sealer VINYLASTIC PREMIUM, Interior Pigmented Sealer (VNPR00) 1.5 mil DFT
- b. Coat 2: Enamel or Flat Latex SUPREMA, Int. 100% Acrylic Semi-Gloss Enamel (SPMA50) 1.5 mil DFT  
or EVERSHIELD, Int. 100% Acrylic Low Sheen Enamel (EVSH40) 1.5 mil DFT
- c. Coat 3: Enamel Semi-Gloss or Low Sheen SUPREMA, Int. 100% Acrylic Semi-Gloss Enamel (SPMA50) 1.5 mil DFT  
or SUPREMA, Int. 100% Acrylic Low Sheen Enamel-(SPMA40) 1.5 mil DFT
- (1) Enamel, Semi-Gloss EVERSHIELD, 100% Acrylic Semi-Gloss Enamel (EVSH50) 1.5 mil DFT  
Or EVERSHIELD, Int. 100% Acrylic Semi-Gloss Enamel (SPMA50) 1.5 mil DFT
- (2) Enamel, Low Sheen SUPREMA, Int. 100% Acrylic Low Sheen Enamel (SPMA40) 1.5 mil DFT
- (3) Enamel Velvet SUPREMA, Latex Low Gloss Enamel (SPMA20) 1.5 mil DFT
- (4) Flat Wall Latex SUPREMA, Interior Flat Wall Finish (SPMA10) 1.5 mil DFT
- d. Total DFT: 4.5 mils.
9. Drywall Ceilings
- a. Coat 1: Latex Sealer VINYLASTIC PREMIUM, Interior Pigmented Sealer (W 101V) (VNPR00) 1.5 mil DFT

- b. Coat 2: Flat Wall Latex SUPREMA, Interior Velvet Flat Wall Finish (W 401) (SPMA10) 1.5 mil DFT
    - c. Coat 3: Flat Wall Latex SUPREMA, Interior Velvet Flat Wall Finish (W 401) (SPMA10) 1.5 mil DFT
    - d. Total DFT: 4.5 mils.
  
- 10. Drywall Walls & Ceilings At Toilets, Storage Rooms, and Electrical and Mechanical Rooms:
  - a. Coat 1: Latex Sealer VINYLASTIC PREMIUM, Interior Pigmented Sealer (VNPR00) 1.5 mil DFT
  - b. Coat 2: 100% Acrylic Enamel EVERSIELD, Int. 100% Acrylic Semi-Gloss Enamel (EVSH50) 1.5 mil DFT
  - c. Coat 3: 100% Acrylic Enamel Semi-Gloss EVERSIELD, Int. 100% Acrylic Semi-Gloss Enamel (EVSH50) 1.5 mil DFT
  - d. Total DFT: 4.5 mils.
  
- C. Metal Work; Interior:
  - 1. Galvanized Metal & Galvanized Metal Deck;
    - a. Preparation: Before application, properly clean and etch (solvent wash) galvanized surfaces in accordance with preparation instructions for galvanized metal per Articles 3.02 H and 3.04F herein. (SCME-01)
    - b. Coat 1: Rust Preventative Metal Primer BLOC-RUST Premium Primer (BRPR00) 2.0 mil DFT
    - c. Coat 2: 100% Acrylic Enamel EVERSIELD 100% Acrylic Semi-Gloss Enamel (EVSH50) 1.5 mil DFT  
or EVERSIELD, 100% Acrylic Gloss Enamel (EVSH60) 1.5 mil DFT
    - d. Coat 3: 100% Acrylic Enamel Enamel EVERSIELD, 100% Acrylic Semi-Gloss Enamel (EVSH50) 1.5 mil DFT  
Or EVERSIELD, 100% Acrylic Gloss Enamel (EVSH60) 1.5 mil DFT
    - e. Total DFT: 5 mils.
  
  - 2. Ungalvanized Steel Interior Apply prime coat immediately after steel is cleaned.
    - a. Coat 1: Rust Preventative Metal Primer BLOC-RUST Premium Primer (BRPR00) 2.0 mil DFT
    - b. Coat 2: 100% Acrylic Enamel EVERSIELD 100% Acrylic Semi-Gloss Enamel (EVSH50) 1.5 mil DFT  
or EVERSIELD, 100% Acrylic Gloss Enamel (EVSH60) 1.5 mil DFT
    - c. Coat 3: 100% Acrylic Enamel Enamel EVERSIELD, 100% Acrylic Semi-Gloss Enamel (EVSH50) 1.5 mil DFT  
Or EVERSIELD, 100% Acrylic Gloss Enamel (EVSH60) 1.5 mil DFT
    - d. Total DFT: 5 mils.
  
  - 5. Ungalvanized Steel Interior: Concealed: Apply prime coat immediately after steel is cleaned.
    - a. Scope: Apply to all structural steel surfaces hidden and enclosed, within the building envelope (not exposed to view), except members with flanges 1/4" or thicker and webs 3/16" or thicker need NOT to be painted.

- b. Prime Coat: Rust Inhibitive Primer Bloc-Rust Premium Primer (BRPR00)
  - c. Total DFT: 2 mils.
6. All Shop Primed Metals; Interior:
- a. Preparation: Touch up damaged, scratched, or missing prime coat paint using top-quality rust-inhibitive primer recommended by paint mfr. lightly sand smooth, ready to receive finish coats.
  - b. Coat 1: Rust Preventative Metal Primer BLOC-RUST Premium Primer (BRPR00) 2 mil DFT
  - c. Coat 2: 100% Acrylic Enamel EVERSIELD, 100% Acrylic Semi-Gloss Enamel (EVSH50) 1.5 mil DFT  
or EVERSIELD 100% Acrylic Gloss Enamel (EVSH60) 1.5 mil DFT
  - d. Coat 3: Sash and Trim Industrial Enamel EVERSIELD, 100% Acrylic Semi-Gloss Enamel (EVSH50) 1.5 mil DFT  
or EVERSIELD, 100% Acrylic Gloss Enamel (EVSH60) 1.5 mil DFT
  - e. Total DFT: 5 mils.
7. All Shop Primed Metals; Interior:
- a. Preparation: Touch-up damaged, scratched, or missing prime coat paint using top-quality rust-inhibitive primer recommended by paint mfr. Lightly sand smooth, ready to receive finish coats.
  - b. Coat 1: Sash and Trim Rust Preventative Metal Primer BLOC-RUST Premium Primer (BRPR00) 2 mil DFT
  - c. Coat 2: Sash and Trim Industrial Enamel EVERSIELD, 100% Acrylic Semi-Gloss Enamel (EVSH50) 1.5 mil DFT  
or EVERSIELD, 100% Acrylic Gloss Enamel (EVSH60) 1.5 mil DFT
  - d. Coat 3: Sash and Trim Industrial Enamel EVERSIELD, 100% Acrylic Semi-Gloss Enamel (EVSH50) 1.5 mil DFT  
or EVERSIELD, 100% Acrylic Gloss Enamel (EVSH60) 1.5 mil DFT
  - e. Total DFT: 5 mils.
8. Factory Finished Equipment & Items:
- a. Coat 1: Acrylic Enamel Sash & Trim EVERSIELD, 100% Acrylic Semi-Gloss Enamel (EVSH50) 1.5 mil DFT  
or EVERSIELD, 100% Acrylic Gloss Enamel (EVSH60) 1.5 mil DFT  
Coat 2: Acrylic Enamel Sash & Trim EVERSIELD, 100% Acrylic Semi-Gloss Enamel (EVSH50) 1.5 mil DFT  
or EVERSIELD, 100% Acrylic Gloss Enamel (EVSH60) 1.5 mil DFT
  - b. Total DFT: 3 mils.
9. Aluminum; Where Indicated To Be Painted Or Where Previously Painted:
- a. Follow paint mfr's. recommendations and specifications.
  - b. Prepare surface by phosphatizing and cleaning same as for Galvanized Surfaces, Articles 3.02H and 3.04F.
  - c. Coat 1: ULTRASHIELD Galvanized Metal Primer (ULGM00) 2.0 mil DFT
  - d. Coat 2: 100% Acrylic Enamel EVERSIELD, 100% Acrylic Semi-Gloss Enamel (EVSH50) 1.5 mil DFT  
or EVERSIELD, 100% Acrylic Gloss Enamel (EVSH60) 1.5 mil DFT

- e. Coat 3: 100% Acrylic Enamel EVERSIELD, 100% Acrylic Semi-Gloss Enamel (EVSH50) 1.5 mil DFT  
or EVERSIELD, 100% Acrylic Gloss Enamel (EVSH60) 1.5 mil DFT
- f. Total DFT: 5 mils.

END OF SECTION

**SECTION 12 49 20  
MOTOR OPERATED SHADE SYSTEM**

**PART 1 – GENERAL**

**A. SUMMARY**

1. Section Includes:
  - a. Motor Operated TZ100 Zipper System.
2. Related Work includes the following:
  - a. Section 05 40 00 – Light Gauge Steel Framing.

**B. REFERENCES**

1. National Fire Protection Association (NFPA) 701.
2. Department of Transportation Motor Vehicle Safety Standard 302 Flammability of Interior Materials.
3. California Administrative Code Title 19.
4. Federal Standard 191 Method 5903 (used by Port Authority of New York and New Jersey for drapery, curtain, and upholstery material).

**C. SUBMITTALS**

1. Subject under provisions of Section 01 33 00 – Submittal Procedures.
2. Product Data: Manufacturer's data sheets shall be submitted for each product specified, including:
  - a. Preparation instructions and recommendations.
  - b. Finishes, material descriptions, dimensions of individual components.
  - c. Construction and installation instructions.
  - d. Manufacturer's recommendations for maintenance and cleaning.
3. Drawings and Diagrams: Product details, installation details, working and assembly drawings shall be supplied as requested.
4. Sample: Responsible contracting officer or agent shall supply one sample shade of each type specified in this contract for approval. Supplied units shall be furnished complete with all required components, mounting and associated hardware, instructions and warranty.

5. Electric shade motors shall comply with UL standards. Copy of compliance available for submission upon request.

#### D. QUALITY ASSURANCE

1. Supplier: Manufacturer, subsidiary, or licensed agent shall be approved to supply the products specified, and to honor any claims against product presented in accordance with warranty.
2. Installer: Installer or agent shall be qualified to installed specified products by prior experience, demonstrated performance and acceptance of requirements of manufacturer, subsidiary, or licensed agent. Installer shall be responsible for an acceptable installation.
3. Uniformity: Provide product of only one manufacturer for entire project.
4. Mock up: Provide one (1) mock-up shade for each roller shade type/assembly specified.

#### E. DELIVERY, STORAGE, AND HANDLING

1. Product shall be delivered to site in manufacturer's original packaging.
2. Product shall be handled and stored to prevent damage to materials, finishes, and operating mechanisms.

#### F. JOB CONDITIONS

1. Prior to shade installation, building shall be enclosed.
2. Interior temperature shall be maintained between 60 degrees Fahrenheit and 90 degrees Fahrenheit during and after installation; relative humidity shall not exceed 80%. Wet work shall be complete and dry.

#### G. WARRANTY

1. Provide a limited manufacturer's warranty from date of Substantial Completion covering the following periods.
  - a. External Application
    1. 2 years - Shading system bracket/hardware
    2. 2 years - Shade cloth
    3. 2 years - Electric motors and drive adapters
    4. 2 years - Electronic control equipment
    5. 2 years – Aluminum and Steel Coatings
  - b. Interior Application
    1. 5 years – Shading system brackets/hardware
    2. 5 years – Shade cloth
    3. 2 years – Electric motors and drive adapters
    4. 2 years – Electronic control equipment
    5. 5 years – Aluminum and Steel Coatings

## PART 2 – PRODUCTS

### A. ACCEPTABLE MANUFACTURER

1. Hunter Douglas Architectural Window Coverings – 13915 Danielson Street, Suite 100, Poway, CA 92064; Phone 800.727.8953 x1; Fax 800.205.9819; Website [www.hunterdouglasarchitectural.com/windowcoverings](http://www.hunterdouglasarchitectural.com/windowcoverings); or architect approved equivalent.
2. Request for substitutions must be approved by architect minimum of 30 days prior to close of bid.
3. Find a representative: <http://www.hunterdouglasarchitectural.com/contacts/index.jsp#>

### B. MOTORIZED TENSION TZ100 Zipper System

1. Head box
  - a. The head box shall be 4.125" x 5" (105mm x 125mm), manufactured from extruded aluminum components and shall house the complete operating mechanism and fabric for maximum weather protection. The head box shall be in two pieces with the front section removable to allow access to the roller tube assembly. The underside of the front head box section is to incorporate two holes to allow the access to the roller tube assembly. The underside of the front head box section is to incorporate two holes to allow the motor limits to be adjusted without requirement to remove the front section. The holes are closed off with a black PVC cap.
  - b. The inside of the back head box profile is to incorporate a polypropylene profile that positions and guides the fabric into the side guide channels. This profile also functions as an end stop for the bottom rail in its retracted position.
  - c. The end caps shall be manufactured from aluminum plate and shall incorporate the necessary components for the installation of the roller tube assembly. The end caps also incorporate lugs to allow the mounting of the head box onto the side guide profiles.
2. Shade Mounting Brackets: Provide as required per drawings.
3. Roller Tube Assembly:
  - a. One piece extruded aluminum tube at the manufacturer's recommended engineered diameter and wall thickness for acceptable deflection over the span of the shade.
  - b. The roller tube shall incorporate the motor at one end and has provision for mechanical engagement with the motor hardware and the tension package at the other end. Motor to be installed on the right or left hand side depending on the specific project requirements.

- c. Tension package engineered to fit inside of the roller tube, on the opposite side of the motor, designed to keep the fabric constantly under tension and produces a smooth and quiet fabric travel with no risk of hembar jamming.
  - d. Fabric panels incorporate a welded spline to allow them to be replaceable on site. The spline also allows the fabric to lay flat where it connects to the roller tube to reduce the risk of visible horizontal lines. Attachment of the fabric to the tube with double-sided adhesive tapes, adhesives, staples, or rivets is not acceptable.
4. Hem Bar
- a. Manufactured from extruded aluminum 2.535" (64mm) tall x 0.875" (22mm) deep. Hem bar profile to incorporate circular profile zinc coated steel weights to keep the fabric straight and flat.
  - b. Both ends of the bottom rail have guiding pins made of high impact plastic (Polyamide) that run in the side guide channels.
  - c. A flexible black PVC profile is attached to the underside of the hem bar, as appropriate, to provide good closure with the sill.
5. Side Channels
- a. The side guide profiles 2.125" (54mm) x 1.125" (29mm) comprise two extruded aluminum profiles that clip together. Each side guide profile incorporates an additional dark grey plastic profile that retains the welded on zipper of the fabric panel. This plastic profile is to be held in place by black neoprene buffers that compensate for any movement of the fabric panel.
  - b. The back section of the side guide profile can be face or side fixed. The fasteners are covered by the second part of the side guide to ensure a smooth appearance with no visible fasteners.
6. Zipper
- a. Zipper is to be welded to the edges of the fabric. The zipper prevents the fabric from being pulled out of the side channel and makes the product wind resistant.
7. Electrical Shade Motor
- a. Standard motor – 110 VAC, 60 Hz, asynchronous unit, single phase with 4-wire pigtail, lifetime lubricated, and equipped with internal thermal overload protector, electric brake, and pre-set assessable limit switches.
  - b. Shade motor located inside the extruded aluminum roller tube with appropriate adapters to allow for a smooth operation. Lifting capacity with a 30% safety ratio not exceeding 50 db noise volume.
  - c. Motor speed shall range from 12 to 30 RPM and draw 0.9 to 3.4 Amps, as selected by the shade manufacturer for proper system operation.
  - d. Installation to include all components for proper unit operation.

8. Fabric
  - a. E Screen 7501 (1% open)
9. Controls
  - a. Radio Technology Somfy – 110 VAC motor with build-in radio receiver.
  - b. Standard Motor with Centralized Intelligence, Somfy IGC 4N1 control box (one per four motors) to be operated with a Decorator Wall Keypad.

### **PART 3 – EXECUTION**

#### **A. Inspection**

1. Subcontractor shall be responsible for inspection on site, approval of mounting surface, installation conditions, and field measurement for this work.
2. Other interacting trades shall receive drawings of shade systems, dimensions, assembly, and installation methods from subcontractor upon request.

#### **B. Installation**

1. Installation shall comply with manufacturer's specifications, standard and procedures as detailed on contract drawings.
2. Adequate clearance shall be provided to permit unencumbered operation of shade and hardware.
3. Clean finish installation of dirt and finger marks. Leave work area clean and free of debris.

#### **C. Demonstration**

1. Demonstrate operation method and instruct owner's personnel in the proper operation and maintenance of the roller shades.

#### **D. Schedule**

1. Provide at all existing skylight wells.

END SECTION

## SECTION 22 05 00

### COMMON WORK RESULTS FOR PLUMBING

#### PART 1 – GENERAL

##### 1.1 SUMMARY

###### A. Section Includes:

1. This Section provides the basic plumbing requirements that apply to the Work of Division 22.

###### B. Related Requirements:

1. Division 01: General Requirements.
2. Division 22: Plumbing
3. Division 23: HVAC
4. Division 26: Electrical.

##### 1.2 REGULATORY REQUIREMENTS

- A. Current federal Safe Drinking Water Act (SDWA) regulations require the furnishing of lead-free pipe, solder, and flux in the installation or repair of plumbing in non-residential facilities connected to public drinking water systems. Under this regulation, solders and flux are considered lead-free when they contain 0.2 percent lead or less. Under California regulations pipes and pipe fittings are considered lead-free when they contain 0.25 percent lead or less as defined in California Assembly Bill 1953 (AB 1953). No pipe, pipe fittings, or any other fitting or fixture intended to convey or dispense water for human consumption by drinking or cooking is allowed in the domestic plumbing system, if they do not meet the low lead definition of AB 1953. Weighted average lead content of the wetted surface area of pipes, fittings and fixtures may not exceed 0.25 percent.

1. Provide lead-free water pipe, solder, and flux materials that meet the standards as outlined by the federal SDWA regulations and California AB 1953 if installed in drinking water system.
2. Collect pipe, solder, and flux material samples as required by the Project Inspector. Test samples shall be delivered to an Owner designated testing laboratory for testing of lead content.
  - a. Test samples for lead content by the atomic absorption spectrophotometry method.
3. Materials found not conforming to SDWA and California AB 1953 regulations shall be deemed defective Work and shall be replaced with lead-free materials.
4. Comprehensive testing of the remaining materials for their lead content shall be performed as required by the Project INSPECTOR.

- A. Materials, fabrication, equipment, and installation shall comply with industry standards and code requirements. Where manufacturer's recommendations exceed industry standards, the manufacturer's recommendation shall establish the minimum standard. As a minimum, standards from the following organizations shall apply:
1. ANSI - American National Standards Institute.
  2. ASME - American Society of Mechanical Engineers.
    - a. ASME Boiler and Pressure Vessel Code.
    - b. ASME B31 - Standards for Pressure Piping.
  3. ASHRAE - American Society of Heating, Refrigerating and Air-Conditioning Engineers.
  4. ASTM - American Society for Testing and Materials.
    - a. ASTM A53 Specification for Welded and Seamless Pipe.
  5. AWWA - American Water Works Association.
  6. CSA - Canadian Standards Association.
  7. FM Global - Factory Mutual Global
  8. IAPMO - International Association of Plumbing and Mechanical Officials.
  9. NFPA - National Fire Protection Association.
  10. OSHA - Occupational Safety and Health Administration.
  11. SMACNA - Sheet Metal and Air Conditioning Contractors' National Association.
  12. UL - Underwriters Laboratories Inc.
  13. Intertek (ETL Certification).
- B. Materials, fabrication, equipment, and installation shall comply with federal, state, and local codes including, but not limited to, the following:
1. CBC, California Building Code, and CMC, California Plumbing Code.
    - a. Latest edition as adopted by the City of Ventura, the County of Ventura, and the State of California including amendments effective on the Effective Date of the Contract.
  2. California Code of Regulations, Title 8, Industrial Relations, Division 1, Chapter 4, Division of Industrial Safety.
  3. OSHA - Occupational Safety and Health Administration.
  4. CDPH - California Department of Public Health.
  5. SCAQMD - South Coast Air Quality Management District.

- C. Specifications or Drawings shall not be construed to permit deviation from the requirements of governing codes unless approval has been obtained from legally constituted authorities having jurisdiction, and the Architect. The Contract Documents may contain more stringent requirements than those legally required.
- D. Permits and Fees: Refer to the General and Supplementary Conditions.

### 1.3 SUBMITTALS

- A. Provide submittals in accordance with Section 01 33 00: Submittal Procedures and with specific requirements of Division 22 sections, as applicable.
- B. The above information shall become the basis for inspecting and testing materials and actual installation procedures performed in the Work.
- C. Shop Drawings: Submit one additional copy when control diagrams having line voltage connections are indicated. Shop Drawings shall be specifically prepared for the Work of this Project. Drawings prepared in accordance with requirements of Section 01 31 13: Project Coordination and Section 01 33 00 may be provided by the Architect to serve as a background for the Shop Drawings. Shop Drawings shall comply with the requirements of Section 01 31 13 and Section 01 33 00 and shall indicate at a minimum:
  - 1. Complete system layout of equipment, components, plumbing fixtures, piping, indicating service clearances, and pipe sizes, fitting types and sizes and pipe elevations, distances of pipes and equipment from building reference points and hanger support locations. The above items shall be coordinated on the shop drawings according to the requirements of Section 01 31 13.
  - 2. Schedule and description of equipment, piping and fittings.

### 1.4 PROJECT RECORD DOCUMENTS

- A. Comply with provisions of Section 01 77 00: Contract Closeout.
- B. Project Record Drawings:
  - 1. Provide a complete set of plumbing and fire protection drawings in AutoCAD and, if available, BIM, complete with external reference drawings, fonts, blocks and plotter pen color/line thickness settings on CD-ROM. Also submit one set of full size reproducible plots on vellum and 3 sets of prints.
  - 2. Before Contract Completion, deliver corrected and completed prints to the OAR. Delivery of project record documents to the OAR does not relinquish responsibility of furnishing required information omitted from project record documents.
- C. Operation and Maintenance Manuals:
  - 1. Submit two copies of operation and maintenance manuals in required form and content. If no revisions are required, furnish one additional copy. If revisions are required, one copy shall be returned with instructions for changes; perform such changes and return three copies of manuals. Manuals shall be bound in accordance to Section 01 77 00. Deliver manuals to the OAR. Submit an electronic copy of the entire manual in PDF file format.
  - 2. Contents of Manual:

- a. Title sheet with Project name, including names, addresses and telephone number of Contractor, installer, and related equipment suppliers.
- b. Manufacturer's operating instructions including, but not limited to, the following:
  - 1) Identification of components and controls.
  - 2) Trouble shooting checklist and guidelines.
  - 3) Recommendations for optimum performance.
  - 4) Warnings and safety precautions on improper or hazardous operational procedures or conditions
- c. Manufacturer's product data and parts and maintenance booklet for each item of equipment furnished under Division 22 that includes the following as a minimum:
  - 1) Manufacturer's model, identification and serial numbers.
  - 2) Exploded view of assembly drawings identifying each component or part with the relevant part number.
  - 3) Directory of manufacturer's representatives, service contractors and part distributors.
  - 4) Maintenance and trouble-shooting instructions, including schedule for preventive maintenance, periodic inspection and cleaning criteria.
- d. Project Record Drawings: Complete set of plumbing, fire protection and control system drawings in 50 percent reduced print format shall be furnished with the manual. Submit the above record drawings on CD-ROM in AutoCAD and, if available, BIM, complete with external reference drawings, fonts, blocks, and plotter pen color/line thickness settings.
- e. Testing, Adjusting, and Balancing reports: Submit as specified in Section 23 05 93.
- f. South Coast Air Quality Management District (SCAQMD) permits to install and operate boilers, water heaters and other fuel burning equipment and third-party source test reports as required by SCAQMD to allow start-up and operation of equipment.
- g. Ventura County industrial waste permits.
- h. Valve directory complete with location, function, size, and model of each valve with reference to the project record drawings.
- i. Equipment and component identification chart complete with location, function, size, and model of each equipment or component with reference to the project record drawings.

## 1.5

## COORDINATION

- A. Contract Documents indicate extent and general arrangement of Work under Division 22. Contractor shall coordinate work in accordance with Section 01 31 13 requirements and make adjustments as required to provide maximum headroom, a neat arrangement to keep passageways and openings clear to provide accessibility and provisions for maintenance, and to meet code requirements.

#### 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Delivery and Storage: Deliver materials to Project site in their original unopened containers with labels intact and legible at time of delivery. Store in strict accordance with manufacturer's recommendations.
- B. Do not store plastic pipe or materials in direct sunlight.

#### 1.7 PRELIMINARY OPERATION

- A. OAR may require any portion of plumbing Work to be operated before Substantial Completion. Such operation shall be in addition to regular tests, demonstrations and instructions required under the Contract Documents, and shall be performed as required.
- B. Notify the INSPECTOR at least 24 hours in advance of lighting or re-lighting pilots.

#### 1.8 TRAINING OF OWNER PERSONNEL

- A. Training of Owner's personnel shall include:
  - 1. A minimum of 4 hours of on-site overview of the overall Plumbing System.
  - 2. Refer to Division 22 sections for specific training on each of the components of the Plumbing System.
- B. Contract shall include the cost of training Owner operation and maintenance personnel in operating, adjusting, maintenance, trouble-shooting, and Project site repair of each component, equipment, or system provided under this Contract.
- C. Operational and maintenance training shall be conducted on the Project site, unless indicated otherwise.
- D. Upon completion of Owner training, a completion certificate indicating the nature of the training and a description of the systems, complete with equipment and component lists shall be issued to each trainee. The certificate should be issued in duplicate with one copy retained by OAR.
- E. An attendance sheet with the names and signatures of all participants attending the training shall be submitted to the OAR and kept as part of the project documents.

#### 1.9 GUARANTEES AND DAMAGE RESPONSIBILITY

- A. Sound of water flowing in piping shall not be transmitted to building structure. Operation of mechanical system shall not produce operational sounds that can be heard outside of rooms enclosing apparatus or equipment.

### **PART 2 – PRODUCTS**

#### 2.1 MATERIALS AND EQUIPMENT

- A. Unless otherwise specified, materials and equipment shall be new, in good and clean condition. Equipment, materials, and components shall be of the make; type and model number noted on Drawings or specified. Pieces of equipment of the same type shall be by the same manufacturer.
- B. Whenever an item is listed by a single proprietary name, with or without model number and type, it shall be for purpose of design only, to indicate characteristics and quality desired. Proprietary designation listed on Drawings, or listed first in Specifications, is used as a basis for design to establish a standard for quality and performance and space requirements.
- C. Equipment and materials indicated or required to be installed outdoors shall be of the type that is designed, manufactured, listed or approved by authorities having jurisdiction for outdoor installation by being resistant to the adverse effects of weather. The additional protective measures against outdoor weather required by the manufacturers' installation instructions and prevalent practice shall be provided.
- D. For substitution of materials or products, refer to the General Conditions.

### **PART 3 – EXECUTION**

#### **3.1 SERVICE INTERRUPTIONS, OFF-SITE, GAS AND WATER**

- A. Schedule Work so there shall be no service interruptions of existing systems or systems during normal hours of operation of affected systems and facilities.
- B. When service interruptions are mandatory, arrange in advance with the OAR as to time and date of such interruptions.
- C. Systems, which are interrupted, shall be returned back into operation in such manner that they will function as originally intended.

#### **3.2 CUTTING, NOTCHING, AND BACKING**

- A. Conform to California Building Code, Title 24, Part 2, for notches and bored holes in wood and for pipes and sleeves embedded in concrete and for cuts in steel, as detailed on structural Drawings.
- B. Where pipes pass through, or are located within one inch of any construction element, install a resilient pad, ½ inch thick minimum, to prevent contact.
- C. Furnish provisions for recesses, chases, and accesses and provide blocking and backing for proper reception and installation of plumbing Work.

#### **3.3 LOCATION OF PIPING AND EQUIPMENT**

- A. Location of piping, apparatus and equipment indicated on the Drawings is approximate and shall be altered to avoid obstructions, preserve headroom, and provide free and clear openings and passageways.
- B. Trenches parallel to footings shall not be closer than 18 inches to the face of footings and shall not be below a plane having a downward slope of 2 horizontal to one vertical, from a line 9 inches above bottom of footing.

- C. Pipe in tunnels shall be installed close to one side of tunnel to provide maximum space for passage. Pipe shall not be installed through crawl hole unless otherwise specified or detailed on Drawings.
- D. Place equipment in locations and spaces indicated, disassemble and/or reassemble equipment as required by Project conditions.

3.4 TESTS AND TESTING

- A. Tests shall be as required under the applicable sections of Division 22, including this Section.
- B. Additional tests may be required in the case of products, materials, and equipment if:
  - 1. Submitted items are altered, changed, or cannot be determined as exactly conforming to the Contract Documents.
  - 2. Performance testing and results may also be required on certain items which are as specified, including fan, and pump performance.
- C. Piping Tests:
  - 1. Perform tests required to demonstrate that operation of plumbing systems and their parts are in accordance with Specifications covering each item or system, and furnish materials, instruments and equipment necessary to conduct such tests. Tests shall be performed in presence of the Inspector, and representatives of any governmental agency having jurisdiction. Work shall not be concealed or covered until required results are provided.
  - 2. If required tests are not performed, Owner may provide in accordance with the Contract Documents.
  - 3. Pressure gauges furnished in testing shall comply with CPC. Air shall be bled from lines requiring hydrostatic or water tests.
  - 4. Systems shall be pressure-tested in accordance with pipe testing schedule below. Pipe test shall indicate no loss in pressure after a minimum duration of 4 hours at test pressures indicated. Where local codes require higher test pressures than specified herein for fire sprinkler systems, local codes shall govern.
  - 5. Fuel gas lines shall be first tested with piping exposed, before backfilling trenches or lathing; second with piping in finished arrangement, backfilled and paved where required, and walls finished.
  - 6. Piping systems may be tested as a unit or in sections, but entire system shall successfully meet requirements specified herein, before final testing by the Inspector.
  - 7. Repair of damage to pipes and their appurtenances or to any other structures resulting from or caused by these tests, shall be provided.

D. Pipe Testing Schedule:

System Tested	Test Pressure (psig)	Test With:
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Durham system, glass or plastic acid waste, vent and roof drain (except pipes running under a slab or underground)	Fill with water to top of highest vent; allow to stand two hours, or longer, as required by Inspector. Minimum head required for any joint shall be 10 feet in building.	Water
Cast-iron soil, waste and interior downspout, condensate drain from air conditioning equipment	10 feet of water, vertically	
Storm water disposal lines	Running water test	Water
Domestic water piping	200	Water
Fire sprinkler piping	200	Water

E. Equipment Performance Assurance Tests:

1. Before operating any equipment or systems, a thorough check shall be performed to determine that systems have been flushed and cleaned as required and that equipment has been properly installed, aligned, lubricated, and serviced. Factory instructions shall be checked to verify installations have been completed and recommended lubricants have been installed in bearings, gearboxes, crankcases, and similar equipment. Particular care shall be furnished in lubricating bearings to avoid damage by over-lubrication and blowing out seals. Equipment shall also be checked for damage that may have occurred during shipment, after delivery, or during installation. Damaged equipment, products, and materials shall be replaced or repaired as required.
2. Upon completion of the above, adjust the system settings to within normal operating conditions to prevent the system from being damaged upon start-up.
3. Run-test the equipment after start-up for five consecutive days. Tests shall include operation of all equipment and systems for a period of not less than two 8 hour periods at 90 percent of the full specified capacities.
4. Equipment Start-up Reports: For each equipment or system on which start-up is performed, submit 8 copies of start-up report for review by the Architect.
  - a. The start-up report shall include the manufacturer's standard start-up form completed and signed by the start-up technician.
5. Provide, maintain, and pay costs for equipment, instruments, and operating personnel as required for specified tests.
6. Provide electric energy and fuel required for tests.
7. Final adjustment to equipment or systems shall meet specified performance requirements.
8. Equipment, systems, or Work deemed defective during testing shall be replaced or corrected as required. Test until satisfactory results are provided.

F. Specific Coordinated Plan for Test and Balance:

1. Provide a narrative of the operational intent that clearly describes the function and sequence of operation of each component, equipment, or system installed. Instruct designated Owner personnel in the operation of the installed systems.
2. Prior to final test and balance, plumbing equipment and systems shall be operated and tested as indicated in Article 3.04.F above to demonstrate satisfactory overall operation of the installed systems.
3. Welding performed as part of this Division may be subject to radiographic inspections at random in accordance with requirements specified in Section 22 05 13: Basic Plumbing Materials and Methods.

### 3.5 NOISE AND VIBRATION REDUCTION

- A. Correct noise or vibration caused by plumbing systems. Provide all necessary adjustments to specified and installed equipment and accessories to reduce noise to the lowest possible level
- B. Correct noise or vibration problems caused by failure to install work in accordance with Contract Documents. Include all labor and materials required as a result of such failure. Pay for re-testing of corrected noise or vibration problems by the project acoustical consultant including travel, lodging, test equipment expenses, etc.

### 3.6 PROTECTION, CARE AND CLEANING

- A. In addition to storage criteria of the General Conditions, and provisions under Section 01 50 00: Construction Facilities and Temporary Controls, the following shall be provided:
  1. Provide for the safety and good condition of materials and equipment until Substantial Completion. Protect materials and equipment from damage.
  2. Protect installed Work.
  3. Replacements: In case of damage, immediately provide repairs and/or replacements as required.
  4. Protect covering for bearings, open connections to tanks, pumps, compressors and similar equipment.
  5. Interior of piping shall be maintained free of dirt, grit, dust, and other foreign materials.
  6. Fixtures, piping, finished brass or bronze, and equipment shall have grease, adhesive, labels, and foreign materials removed. Chromium, nickel plate, polished bronze or brass Work shall be polished. Glass shall be cleaned inside and out.
  7. Before initial start-up and again before Substantial Completion, piping shall be drained and flushed to completely remove grease and foreign matter. Pressure regulating assemblies, traps, strainers, boilers, flush valves, and similar items shall be thoroughly cleaned. Tag system with an information tag listing responsible party and date of element, before initial start-up and again before Substantial Completion. Compressed air, oil, and gas piping shall be blown out with oil-free compressed air or inert gas.

END OF SECTION

## SECTION 22 05 13

### BASIC PLUMBING MATERIALS AND METHODS

#### PART 1 – GENERAL

##### 1.1 SUMMARY

###### A. Section Includes:

1. This Section prescribes basic materials and methods generally common to the Work of Division 22.

###### B. Related Requirements:

1. Division 01: General Requirements.
2. Division 22: Plumbing.
3. Division 26: Electrical.

##### 1.2 SUBMITTALS

- ###### A.
- Provide in accordance with Division 01, Section 22 05 00 and specific requirements of each section of Division 22.

- ###### B.
- Types of welding rods to be used.

##### 1.3 QUALITY ASSURANCE

- ###### A.
- Standards: Comply with applicable national, state, and local codes and standards: ASTM, ASME, and ANSI. Federal Specifications, AWWA, SISPI, NFPA, FM, UL, CPC (California Plumbing Code), CMC (California Plumbing Code), CSA.

- ###### B.
- Qualifications of Manufacturer: Products used in the Work of this Section shall be produced by manufacturers regularly engaged in manufacture of similar items and with a history of successful production as reviewed by the Architect.

##### 1.4 COORDINATION

- ###### A.
- Coordinate related Work in accordance with provisions of Section 01 31 13: Project Coordination.

#### PART 2 – PRODUCTS

##### 2.1 GENERAL

- ###### A.
- Provide the following products if they are indicated in the Contract Documents or if they are required for the proper installation, function or operation of equipment, systems or components indicated in the Contract Document.

- B. Provide the following products as a complete assembly with required accessories for a complete and functioning entity in compliance with governing codes and applicable standards as specified in Section 22 05 00, manufacturer's instructions or as required.
1. Omission of minor details in the Contract Documents does not waive and/or otherwise relinquish compliance with the above requirements.

## 2.2 MANUFACTURERS AND MATERIALS

- A. Ball Valves: Bronze, 2-inch and smaller:

BV-1: Class 150, 600 psi, CWP, 2 piece construction reinforced Teflon seats, full port, adjustable packing gland, stainless ball and stem, threaded ends.

Hammond UP-8303A/UP-8305/UP-8513, NIBCO T-685-80-LF/TS-685-66-LF, Milwaukee UPBA400S/450S, or equal.

- K. Piping:

1. Piping shall be continuously and permanently marked with manufacturer's name, type of material, size, pressure rating, and the applicable ASTM, ANSI, UL, or NSF listing. On plastic pipe, date of extrusion must also be marked.

2. Underground non-ferrous pressure pipes shall be installed with proper color tracer wires. Refer to color code provisions in Section 22 05 53: Plumbing Identification.

P-4 Copper drainage tube, inside structure and above grade. Type DWV hard temper, ASTM B 306, Mueller, Anaconda, Cerro Brass, Cambridge-Lee, Halstead or equal.

P-6 Copper water tube, Type L hard, ASTM B88. Mueller, Cambridge-Lee, Halstead or equal. (when used above ground only)

P-18 CPVC (Chlorinated polyvinyl Chloride) schedule 40 pipe, conforming to ASTM D1784 and complying with UL723 (ASTM E84). The joints shall be of solvent cement type conforming to ASTM F493. Installer shall be certified by the manufacturer for this type of joint installation. Spears, Corzan, Charlotte or equal.

- L. Pipe Fittings:

PF-4 Cast brass drainage fittings ASA B 16.23, ASTM B 42. Provide with copper drainage tube.

Mueller Brass, Nibco, Stanley Flagg, Lee Brass Or equal.

PF-5 Wrought copper - solder type ANSI B 16.22

Mueller Brass, Nibco, Lee Brass or equal.

Central Plastics Company or equal.

PF-8 Bronze and brass, 250 psi, threaded, ASA B16.17 and F S WW-P-460.

Mueller Brass, Lee Brass Or equal.

PF-9 Malleable iron, Class 125, ANSI B 16.3, threaded or welded Schedule 40 black steel for 2-inches and below and welded for 2 ½-inch and above, by Stockham or equal.

PF-10 Cast iron, threaded, Class 125, ANSI B 16.1.

Stockham or equal.

PF-11 Cast-iron OD sized,, bell and spigot gasket joints.

PF-12 Steel butt weld type, ASTM A 234WPB.

PF-13a No-hub couplings for factory grooved PVDF or polypropylene, schedule 40 piping. The coupling shall be of the same material and gauge as the pipe. Each coupling shall have 300 series stainless steel outer band and 5/16 inch bolts, nuts and washers plated to meet a 100-hour salt spray test per ASTM B117. Installer shall be certified by the manufacturer for this type of joint installation. Orion, Fuseal or equal.

PF-13b The pipe and fitting shall be joined using the socket fusion system conforming to ASTM 2657. Installer shall be certified by the manufacturer for this kind of joint installation. Orion, Fuseal or equal.

PF-13c CPVC (Chlorinated Polyvinyl Chloride) schedule 40 pipe and fittings, conforming to ASTM D1784 and complying with UL723 (ASTM E84), shall be joined using solvent cement conforming to ASTM F493. Installer shall be certified by the manufacturer for this kind of joint installation. Spears, Corzan or equal.

PF-14a Drains, bottle traps and similar devices for CPVC, PVDF or polypropylene, schedule 40 piping, shall be of same material and gauge as the pipe with mechanical joints. Installer shall be certified by the manufacturer for this kind of joint installation. Orion, Fuseal or equal.

PF-14b Type 316L Stainless steel joint for chemical waste piping systems including drain or bottle traps. Blucher-Josam or equal.

Victaulic Vic Press 304TM or equal.

PF-15 Precision cold drawn austenitic 304/304L stainless steel, with elastomer O-rings

PF-16 Grooved end type– ASTM A395 and A536 ductile iron; ASTM A234 WPB forged steel; fabricated from ASTM A53 carbon steel. Couplings shall be supplied with angle-pattern bolt pads for rigidity, except in locations where flexibility is desired. Gaskets shall be pre-lubricated. Galvanized or painted, by Victaulic or equal.

PF-17 Grooved end type– ASTM B75 or B152 and ANSI B16.22 wrought copper, bronze sand casting per ASTM B584-87 copper alloy CDA 836 per ANSIB16.18. Couplings shall be CTS style 606 supplied with angle pattern bolt pads for rigidity, coated with copper coated alkyd enamel. Gaskets shall be pre-lubricated Flush seal type by Victaulic or equal.

PF-18 CPVC fittings must conform to ASTM D2846 specification for chlorinated polyvinylchloride (CPVC) plastic for hot and cold water distribution system.

M. Pipe Isolators:

PLA-1 Absorption pad shall be not less than ½ inch thick, unloaded. Pad shall completely encompass pipe.

Holdrite, LSP, Stoneman, Potter-Roemer, Trisolator, PR-Isolator, or equal.

Hydra-Zorb Cushion Clamps, Acousto-Clamp, or equal.

U. Pipe and Fitting Requirements Schedule: Unless otherwise specified or indicated on Drawings, pipe and fittings shall be installed in accordance with the following table:

TABLE I

PIPE AND FITTING SCHEDULE

Use	Limits	Pipe	Fittings
Domestic Hot and Cold water, underground	Up To 8 inches	P-6	PF-5
Copper, underground only		P-7	PF-5
Cold water, underground (Site piping)	4-inch and over	P-15	PF-11
Domestic hot and cold water, in building and above ground	All	P-6	PF-5
In building above ground	2 to 8-inch	P-6	PF-5
Compressed air	Underground or in concrete	P-9	PF-8
	Above ground	P-10	PF-3
Condensate drains and drains From HVAC Equip.		P-6	PF-5
Downspouts, interior above and below grade, up to 5 feet from building.		P-1	PF-1 Or PF-2
Acid Vent	All	P-12	PF-10
Fire Mains (Fire Hydrant)	Underground	P-15	PF-11
Gas Natural	Underground	P-8	PF-6

Gas Natural	Above ground	P-10	PF-9
Copper Drainage Tube (Underground)	Waste and Vent	P-3	PF-4
Copper Drainage Tube (Above Ground)	Waste and Vent	P-4	PF-4
Vents	New Building	P-1	PF-1 or PF-2 (IRE) if required by engineer
Vents	Existing Buildings and Exposed Downspouts	P-2	PF-3
Vents	For acid waste lines underground	P-13, 14, 16, 17, 18	PF- 13a, 13b, 13c, 14a, 14b or 15
Waste lines, Sanitary		P-1	PF-1 or PF-2 (IRE) if required by engineer
Waste lines, Acid	To nearest water dilution jet	P-13, 14, 16, 17, 18	PF- 13a, 13b, 13c,14a, 14b or 15

R. Unions:

- 1.. Unions shall be furnished and installed in accordance with the following requirements (unless flanges are furnished):
  - a. At each threaded or soldered connection to equipment and tanks, except in Freon or fuel gas, piping systems, whether indicated or not.
2. Unions shall be located so that piping can be easily disconnected for removal of equipment, tank, or valve.

**PART 3 – EXECUTION**

3.1 EXAMINATION

- A. Examine areas and conditions under which Work of this Section shall be performed. Correct conditions detrimental to proper and timely completion of Work. Do not proceed until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Provide all materials and equipment for the Work. Furnish and install necessary apparatus, parts, materials, and accessories.
- B. Pipe Installation:

1. Install piping parallel to wall and provide an orderly grouping of proper materials and execution.
2. Piping shall clear obstructions, preserve headroom, provide openings and passageways clear, whether indicated or not. Verify the Work of other Divisions to avoid interference.
3. If obstructions or the Work of other Divisions prevent installation of piping or equipment as indicated by the Drawings, perform minor deviations as required by the Architect.
4. Install piping after excavation or cutting has been performed. Piping shall not be permanently enclosed, furred in, or covered before required inspection and testing is performed.
5. Exposed polished or enameled connections from fixtures or equipment shall be installed with no resulting tool marks or threads at fittings. Residue or exposed pipe compound shall be removed from exterior of pipe.
6. Piping shall be concealed in chases, partitions, walls, and between floors, unless otherwise directed or specifically noted on Drawings. When penetrating wood studs, joists, and other wood members, provide such members with reinforcement steel straps of Continental Steel & Tube Co., ULINE, Independent Metal Strap, or equal.
7. Reduce fitting where any change in pipe size occurs. Bushings shall not be furnished unless specifically reviewed by the Architect, or indicated on Drawings.
8. Piping subject to expansion or contraction shall be anchored in a manner, which permits strains to be evenly distributed. Swing joints or expansion loops shall be installed. Seismic restraints shall be installed so as not to interfere with expansion and contraction of piping. Seismic loops required at all building separations.
9. Immediately after lines have been installed, openings shall be capped or plugged to prevent entrance of foreign materials. Caps shall be left in place until removal is necessary for completion of installation.
10. Couplings shall not be installed except where required pipe runs between other fittings are longer than standard length of type of pipe being installed and except where their installation is specifically reviewed by the Architect.
11. Water piping shall be installed generally level, free of traps, unnecessary offset, arranged to conform to building requirements, clear of ducts, flues, conduits, and other Work. Piping shall be arranged with valves installed to provide for complete drainage and control of system. Piping shall not be installed which causes an objectionable noise from flow of water therein under normal conditions. Refer to Section 23 0500: Common Work Results for Plumbing.
12. Water lines may be installed in same trench with sewer lines, provided bottom of water line is 12 inches minimum above top and to the side of sewer line.
13. Changes in pipe sizes shall be furnished with eccentric reducers, flat on top. Offsets to clear obstruction shall not be installed so as to produce air pockets.

C. Pipe Sleeves and Plates:

1. Provide pipe sleeves of Schedule 40 black steel pipe or Schedule 40 PVC plastic pipe in concrete or masonry walls, footings, and concrete floors below grade. Provide adjustable submerged deck type sleeves at locations where pipes pass through concrete floors, except concrete slab floors on grade, and at locations where soil pipe for floor type water closets passes through concrete floors.
2. Sleeves shall provide ½ inch clearance around pipes, except plastic pipe shall have 1 inch clearance. Caps of deck type sleeves shall be removed just prior to installation of pipe. Area around sleeves shall be smooth and without high or low spots. Sleeves in walls shall not extend beyond exposed surface of wall. Sleeves in concrete floors and walls shall be securely fastened to forms to prevent movement while concrete is being placed.
3. Piping installed on a roof shall clear the roof surface by 10 inches minimum, with or without insulation. Bottom of individual fittings may infringe on 10 inches clear space but not groups of fittings or fittings located within 27 inches of each other.
4. Stiles shall be provided to facilitate crossing of piping when parallel piping runs are laterally greater than 12 inches out-to-out, or any pipe is higher than 18 inches, and more than 40 feet long or runs between two or more major pieces of equipment or housings greater than 20 feet apart. Stiles shall be not less than 20 inches wide with a minimum tread depth of 10 inches. Where stiles are required, they shall be located so greatest obstructed distance is 30 feet.
5. Where pipes pass through waterproofed walls, floors, or floors on grade, sealant with Link-Seal Modular Seals, or equal, between pipe and sleeve to provide a waterproof joint. Where earth is in contact with pipe on both sides of a wall or foundation, the waterproof joint is not required. Commercial rubber compression units may be furnished instead of sealed sleeves if reviewed by the Architect.
6. A swing joint, or other required device, shall be furnished and installed in hot water lines with 10 feet of sealant or compression joint to allow for expansion.
7. Provide polished, chrome-plated flanges when plumbing pipes pass through walls at plumbing fixtures, etcetera as specified in Section 22 4000 Plumbing. Provide polished steel, chromium-plated split floor and ceiling plates at locations where pipes pass through walls, floors, ceilings, and partitions in finished portion that neatly conceals pipe insert.
8. Pipe sleeves shall be provided where pipes intersect footings or foundation walls and sleeve clearances shall provide for footing settlement, but not less than one inch all around pipe.
4. Before any welder performs welding on the Work, furnish the INSPECTOR with a copy of welder's valid qualification papers and obtain verification. Welder qualification is not valid unless it has been issued while welder was performing work for current employer, and has performed type of work described by qualification in the preceding 3 months.
5. Welding performed under these Specifications is subject to special tests and inspections including rigid Ultra Sonic Testing (UT) and radiographic inspection at random, in accordance with Technique for Radiographic Examination of Welded Joints by an Owner recognized, DSA approved testing laboratory.

Q. Valves: Valves shall conform to the following:

1. Piping systems shall be furnished with valves at points indicated on Drawings and specified, arranged to provide complete regulating control of piping system throughout building and the Project site.
2. Valves shall be installed in a neat grouping, so that parts are easily accessible and maintained.
3. Valves shall be full size of line in which they are installed, unless otherwise indicated on Drawings or otherwise specified, and shall be one of types specified.
4. Provide chain operators on valves 2-inch and larger located 7 feet or more above the servicing floor level.
5. Valves for similar service shall be of one manufacturer.
6. Except where otherwise specified, valves shall be Belimo, Victaulic, Stockham, Crane, Jenkins, Milwaukee, Hammond, American, NIBCO, Hoffman, or equal.
7. Ball valves below grade in yard boxes shall have stainless steel handles.
8. Hose bibs in dense garden areas shall be  $\frac{3}{4}$  inch in size with one hose bib in the lunch pavilion 1 inch in size. Other hose bibs shall be  $\frac{3}{4}$  inch lock shield type. Bibs shall be furnished with vacuum breaker protection.
9. Safety valves and pressure relief valves shall have stamp of approval as required by ASME and shall be provided with annual test lever. Where a hot water storage tank is heated by means of a coil, pressure relief valve shall have a steam BTU discharge rating of the coil. Discharge pipe from safety or pressure relief valves shall be not less than one pipe size larger than inlet pipe size of valve. Discharge pipe shall terminate as indicated and shall be free of traps. In addition to locations specified, pressure relief valves shall be installed in the following locations:
  - a. On discharge side of each pressure-reducing valve.
  - b. On each water heater connected to a hot water storage tank and other pressure vessels.
  - c. On cold water line to each water heater or hot water storage tank when there is a check valve, backflow prevention valve or similar device between water heater or hot water storage tank and meter or relief valve at the pressure reducing valve assembly.
  - d. On discharge side of each air compressor.
  - e. On each air receiver connected to an air compressor.
10. Temperature relief valves and combination temperature and pressure relief valves shall be as specified and furnished as set forth in this Section. Discharge pipe from relief valves shall be not less than discharge area of valve or valves it connects, based on discharge area of valves, and shall terminate as indicated and free of any traps. Valves shall be installed at following locations:
11. A combination temperature and pressure relief valve or combination of valves on each heating hot water storage tank. Temperature sending element shall extend into water inside tank.

12. Manual air vent valve assemblies shall be installed at each high point of hot water space heating and chilled water piping systems. Valves shall discharge through 1/4 inch diameter copper tubing and drain to nearest floor sink. Automatic type air vent valve shall only be installed where specifically indicated. Radiator, convectors, and finned pipe convectors shall be fitted with packless radiator valves, angle or straight pattern. Each convector or radiator installed as part of a space hot water heating system shall be furnished with a manual-type air vent valve.
- R. Strainers: Strainers shall be installed on each water main (except for fire line) downstream of the meter, above grade, when a pressure regulator assembly is not installed. Main strainer shall be of Y-flange or groove type. On closed loop chilled and heating hot water systems pump systems, a strainer shall be installed at each pump inlet and upstream of each flow control valve assembly. The control valve assembly may include a modulating temperature control valve and a flow-limiting valve, manufactured by Griswold, AutoFlow, Flow Control Industries, Inc., or equal.
- S. Hangers and Supports:
1. Piping shall be securely fastened to building structure by approved iron hangers, supports, guides, anchors, and sway braces to maintain pipe alignment to prevent sagging and to prevent noise or excessive strain on piping due to uncontrolled or seismic movement under operating conditions. Hangers and supports shall conform to Manufacturer's Standardization Society Specification SP-69. Hangers shall be relocated as required to correct unsatisfactory conditions that may become evident when system is placed into operation. Appliances, heat exchangers, storage tanks, and similar equipment shall be securely fastened to structure in accordance with seismic requirements. Outdoor metal hangers and supports shall be hot-dipped galvanized steel, unless otherwise specified.
  2. Hose faucets, compressed air outlets, and similar items at ends of pipe branches shall be rigidly fastened to building construction near point of connection.
  3. Piping shall not be supported by wire, rope, wood, plumbers' tape, or other non-recognized devices.
  4. Hangers and supports shall be designed to support weight of pipe, fittings, weight of fluid and weight of pipe insulation, and shall have a minimum factor of safety of five, based on ultimate tensile strength of material installed.
  5. Burning or welding of any structural member under load is not permitted. Field welding not specified on Drawings or reviewed Shop Drawings is not permitted without review by Architect and DSA.
  6. Burning holes in beam flanges or other structural members is not permitted without review by the Architect and DSA.
  7. Pipe hangers on piping covered with low temperature insulation shall be installed on outside of insulation and not in contact with pipe unless otherwise detailed on Drawings. Insulation shall be protected by 18 gage galvanized steel shield, with a minimum length of 10 inches, installed completely around pipe covering between covering and hanger. Installing hangers directly on pipe and butting adjoining sections of insulation against hanger is permitted provided void and hanger rod are properly insulated and sealed so that no sweating occurs at hangers.

8. Hanger rods shall be fastened to structural steel members with suitable beam clamps. Clamps shall be Tolco, Carpenter & Patterson, Fee and Mason, or equal, as follows:
  - a. Tolco I beam, Fig.62 for maximum 1000 pounds.
  - b. Tolco I or WF beam, Fig. 329, for maximum of 1290 pounds.
9. Hanger rods shall be fastened to concrete inserts in concrete slabs or beams. Inserts shall be Tolco, Carpenter & Patterson, Fee and Mason, or equal, as follows:
  - a. Tolco Fig.310 for maximum of 600 pounds.
  - b. Tolco Fig. 309 for maximum of 1140 pounds.
10. For fastening to wood ceilings, beams, or joists, furnish Grinnell Fig. 128R, Grinnell Fig. 153, Tolco 78, or equal pipe hanger flange fastened with drive screws. Under wood floors, 3/8 inch hanger rods shall be hung from 2-inch by 2-inch by 1/4 inch angle clips 3 inches long, with 2, staggered 10d nails, clinched over joist.
11. Hanger rod sizes for copper, iron, or steel pipe: 3/8 inch for pipe sizes 1/2 inch through 2-inch, 1/2 inch for pipe sizes 3-inch, 4-inch and 5-inch, 5/8 inch for pipe size 6-inch, and 3/4 inch for 8-inch and 10-inch pipe.
12. Turnbuckles, if furnished, shall provide a load carrying capacity equal to that of the pipe hanger with which they are being installed.
13. Pipe hangers shall be of same size, or nearest larger manufactured size available, as pipe or tubing on which they are being installed.
14. Hangers, clamps, and guides furnished for support of non-metallic pipe shall be padded with 1/8 inch thick rubber, neoprene, or soft resilient cloth.
15. Where special pipe-supporting requirements in the Specifications conflict with any standard requirements specified herein, the Specification requirements shall govern.
16. Horizontal Piping:
  - a. Roof Mounted Piping: Pressure and non-pressure piping shall be supported from channels, stands, clamps, trapezes, rollers, or structures mounted on 100% rubber, UV resistant rooftop supports with reflective strips, Dura-Block, or equal. Roller type supports shall be provided below and above pipe to prevent its dislodgement. Bottom of pipes shall clear the roof surface by 10 inches.
  - b. Maximum hanger and support spacing shall conform to CPC schedule for horizontal piping installed above grade.
18. A hanger or support shall be installed close to the point of change in direction of a pipe run, in either a horizontal or vertical plane.
19. When practicable, supports and hangers for cast iron soil pipe shall be installed as close as possible to joints and when hangers or supports are not located within one foot of a branch line fitting, an additional hanger or support shall be installed at fitting.

T. Flashings:

1. Each pipe, duct, or gas-fired equipment vent passing through roof shall be installed with waterproof flashing.
  2. Flashing or flanges on pipes, vents, and ducts passing through a tile or slate roof shall be constructed of sheet lead. Flashing for pipes and heater vents passing through a roof shall be 4 pound soft sheet lead. Flashing and flanges for ducts and heater vents passing through exterior walls shall be 22 gage sheet metal. Flanges and flashing shall be installed waterproof at point of connection with pipe or duct. No soldered joints on roof flashings will be allowed.
  3. Lead flashing and flanges shall be constructed of 4 pound sheet lead with burned joints. Flange of lead flashing or lead flange on a duct shall extend out onto roof a minimum of 12 inches from pipe or duct. Lead flashing shall extend up the pipe or duct not less than 7 inches.
  4. Sheet metal flashing shall be constructed of 24 gage galvanized sheet steel. Flanges on these flashings shall extend out onto roof a minimum of 10 inches from pipe or duct. Flanges on ducts through exterior walls shall extend out from duct a minimum of 2 ½ inches. Flanges on gas-fired equipment single-wall vents shall be of ventilated type. Type B gas vents through a roof shall be furnished with non-ventilated flashing as per NFPA Pamphlet 211.
  5. Cast iron, steel, brass, and copper pipe, which terminates less than 18 inches above roof, shall be furnished with a combination counter-flashing and vandal-proof hood for protection against water, birds and foreign matter. Cast iron, steel, brass and copper pipe, which does not terminate within 18 inches of roof, shall be furnished with a counter-flashing sleeve. Pipe, which terminates more than 18 inches above roof, shall be furnished with protection against entrance of water, birds, and foreign matter.
  6. Counter-flashing and combination counter-flashing sleeves and vandal-proof hoods shall be cast iron, vandal-proof, threaded, sealed or approved gas-heated sleeve type. Counter-flashing sleeves on each of these items shall extend down over flashing a minimum of ¾ inch.
  7. Flashing and flanges on ducts shall be installed waterproof at point of connection to the duct by riveting and soldering. Storm collars shall be securely screwed and installed waterproof around appliance vent pipe immediately above flashing.
  8. Vent piping above roof shall be furnished with a combination counter-flashing sleeve and vandal-proof hood.
- U. Equipment Installation: Install roof or floor mounted equipment on level platforms, housekeeping pads or curbs and provide sound, vibration and seismic control measures per Section 23 0548 even if not indicated on Drawings.

END OF SECTION

## SECTION 22 05 53

### PLUMBING IDENTIFICATION

#### PART 1 – GENERAL

##### 1.1 SUMMARY

- A. Section Includes: Marking and identification on mechanical piping systems, ducts, controls, valves, and apparatus.
- B. Related Requirements:
  - 1. Division 01: General Requirements
  - 3. Section 22 05 13: Basic Plumbing Materials and Methods.
  - 4. Section 22 10 00: Plumbing.
  - 5. Section 22 20 13: Plumbing Piping.

##### 1.2 SUBMITTALS

- A. Submit in accordance with Division 01 and Section 22 05 00: Common Work Results for Plumbing.
- B. Submit product data and installation instructions for each item specified.
- C. Submit Samples of materials.

##### 1.3 QUALITY ASSURANCE

- A. Comply with provisions of:
  - 1. Section 22 05 00: Common Work Results for Plumbing.
  - 2. ANSI/ASME A13.1: Scheme for the Identification of Piping Systems.
  - 3. APWA: Uniform Color Code.
  - 4. IAPMO: Uniform Plumbing Code (UPC)

#### PART 2 – PRODUCTS

##### 2.1 MATERIALS

- A. General: Piping systems, controls, valves, apparatus, etc., except those that are installed in inaccessible locations in partitions, walls, and floors, shall be permanently identified.

##### 2.2 VALVES

- A. Furnish prepared chart or diagram for each piping system, indicating by identifying letter or model number of each valve in the system, its location, and function.
- B. Install charts in aluminum frame with clear glass front and secure on wall where designated by the Project Inspector.
- C. Bind copies of each chart in operating instructions manual.
- D. Provide each valve with a brass, aluminum, or plastic disc, not less than 1-1/4 inches diameter bearing engraved numbers corresponding to those indicated on chart. Fasten discs to valve with No. 14 brass wire.
- E. Provide an additional tag for safety valves and other valves that could be hazardous to safety and health of occupants. Distinguish these tags from regular valve tags by color (such as yellow with black letters, and marked "Danger"); submit Sample tag to the Architect for review.

2.3 INSTRUMENTS AND CONTROLS

- A. Identify panel-mounted instruments and controls with engraved bakelite nameplates permanently affixed to panel boards.
- B. Identify alarm indicating devices and alarm reset devices by nameplates.
- C. Identify automatic valves, flow switches, and pressure switches, with embossed aluminum or plastic tape affixed to controller, indicating service and setting.

2.4 EQUIPMENT

- A. Identify each major piece of equipment with engraved bakelite nameplates permanently affixed to the equipment, indicating the room numbers it services, Equipment identification designation shall be the same to its designation indicated on the "As-Built Drawings". Room numbers in the nameplates shall correspond to the final room numbers.

2.5 ABOVE GRADE PIPE IDENTIFICATION

- A. Identify pipes by means of colored labels with directional flow arrows and identification of the pipe content, in conformance to ANSI/ASME A13.1 or the UPC.
- B. Materials: Precoiled acrylic plastic with clear polyester coating, all-temperature, self-adhering, as manufactured by Brady, Brimar Industries, Seton, Stranco, Inc., or equal.
- C. Size:

Outside Diameter of Pipe or Insulation (in inches)	Length of Color Field (in inches)	Size of Letter (in inches)
3/4 to 1 1/4	8	1/2
1 1/2 to 2	8	3/4
2 1/2 to 6	12	1 1/4
8 to 10	24	2 1/2

over 10	32	3 ½
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D. Locations:

1. On accessible piping, whether insulated or not (including mechanical rooms, attic and ceiling spaces); except that labels shall be omitted from piping where contained material is obvious due to its connection to fixtures (such as faucets, water closets, etcetera.).
2. Near each valve and branch connection in such accessible piping.
3. At each pipe passage through wall or floor.
4. At not more than 20 feet spacing on straight pipe run between bands required in 2 and 3 above.
5. At each change in direction.

E. Application: Install on clean surfaces free of dust, grease, oil, or any material that will prevent proper adhesion. Replace non-adhering or curling labels with new labels.

F. Color Schedule:

Content of Pipe	Legend	Background Color	Lettering Color
Domestic cold water	Domestic. C.W.	Green	White
Non-potable cold water	Caution: Non-potable Water Do Not Drink (1)(2)	Purple	Black
Domestic hot-water 140°F	Domestic H.W. 140°F	Blue	Black
Sanitary waste	San waste	Green	White
Sanitary vent	San vent	Green	White
Storm drain or downspout	Storm drain	Green	White
Indirect drain	Ind drain	Green	White
Sump pump discharge	Pump discharge	Green	White
Fire sprinkler supply	Fire Sprinkler supply	Red	White
Fire sprinkler drain	Sprinkler drain	Red	White
Fuel oil	Diesel oil	Yellow	Black
Gas	Gas	Yellow	White

Reclaimed Water	Caution: Reclaimed Water Do Not Drink (1)(3)	Purple	Black
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H. Notes on Schedule:

1. Note (1) indicates 2 ¼ inch by 1 inch yellow label with ½ inch letters reading UNSAFE WATER at one end of primary label.

Note (2) words should read “CAUTION: NONPOTABLE WATER DO NOT DRINK.” with international *do not drink* symbol.

Note (3) words should read “CAUTION: RECLAIMED WATER DO NOT DRINK.” with international *do not drink* symbol.

2.6 UNDERGROUND PIPE

A. Detectable Marking Tape:

1. Provide and install detectable marking tape along buried piping. Tape shall be specifically manufactured for marking and locating underground utilities with electronic equipment. Tape shall be acid and alkali resistant, and manufactured with integral wires or foil backing, encased with protective cladding. Tape shall be a minimum of two inches in width.
2. Manufacturer: Reef Industries, Inc., Advantage Brands, Inc., Northtown Company, Mutual Industries, Inc., or equal.
3. Detectable marking tape shall be color-coded per APWA Color Code:
  - a. Yellow: Oil and gas.
  - b. Blue: Water, irrigation and slurry lines.
  - c. Green: Sewer and drain lines.

B. Tracer Wire:

1. Solid copper wire type THWN, 12 AWG gauge, with heat and moisture resistant insulation.

**PART 3 – EXECUTION**

3.1 INSTALLATION

- A. Correct detrimental conditions prior to commencing the Work of this Section. Install markers and identification tags as specified with materials and installation procedures recommended by manufacturer.
- B. Place tracer wire on top of non-metal utility lines allowing some slack. Do not wrap tracer wire around pipe. Fasten tracer wire in place at approximately 10 feet on centers with non-metal ties.

- C. Install underground detectable pipe marking tape continuously buried 8 to 10 inches above the buried utility pipe. Wrap tape on pipe risers up to a height of 12 inches above grade.

3.2 CLEANUP

- A. Remove rubbish, debris, and waste materials and legally dispose of off the Project site.

END OF SECTION

## SECTION 22 07 00

### PLUMBING INSULATION

#### PART 1 – GENERAL

##### 1.1 SUMMARY

###### A. Section Includes:

1. Insulation for plumbing piping.

###### B. Related Requirements:

1. Division 01: General Requirements.
2. Section 22 05 00: Common Work Results for Plumbing.
3. Section 22 0513: Basic Plumbing Materials and Methods.
4. Section 22 05 53: Plumbing Identification.
5. Section 22 10 00: Plumbing.

##### 1.2 REFERENCES

###### A. American Society for Testing and Materials International (ASTM):

1. ASTM C302 - Standard Test Method for Density and Dimensions of Preformed Pipe-Covering-Type Thermal Insulation.
2. ASTM C411 - Standard Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation.
3. ASTM C423 - Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method.
4. ASTM C533 - Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation.
5. ASTM C547 - Standard Specification for Mineral Fiber Pipe Insulation.
6. ASTM C1104 - Standard Test Method for Determining the Water Vapor Sorption of Unfaced Mineral Fiber Insulation.
7. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
8. ASTM G21 - Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.

- B. Underwriters Laboratories, Inc.
  - 1. UL 723 - Test for Surface Burning Characteristics of Building Materials.
- C. National Fire Protection Association:
  - 1. NFPA 255 - Standard Method of Test of Surface Burning Characteristics of Building Materials.
- D. California Code of Regulation Title 24.
  - 1. California Green Building Standards Code.

### 1.3 SUBMITTALS

- A. Submit in accordance with Division 01 and Section 22 05 00: Common Work Results for Plumbing.
  - 1. Complete material list of items to be furnished and installed under this Section.
  - 2. Manufacturer's specifications and other data required demonstrating compliance with the specified requirements.
  - 3. Shop Drawings, catalog cuts and manufacturer's data indicating insulation, jacketing, adhesives, and coating. Insulating materials shall be certified by manufacturer to comply with the California quality standards for insulating materials.
  - 4. Display sample cutaway sections.
  - 5. Manufacturer's recommended method of installation procedures, which will become part of this Section.

### 1.4 QUALITY ASSURANCE

- A. Qualifications of Manufacturer and Installer, Materials, Fabrication, Execution, and Standard of Quality: Comply with provisions stated under Section 22 05 00: Common Work Results for Plumbing and Section 22 05 13: Basic Plumbing Materials and Methods.
- B. Insulation Work shall be in accordance with the California Building Energy Efficiency Standards, CBC, and Uniform Mechanical Code and the California Green Building Standards Code.
- C. Test Ratings:
  - 1. Comply with provisions stated under Section 22 05 00 and 22 05 13 with emphasis on ASTM E84, NFPA 255, or UL 723. ASTM C167, ASTM C302, UL label or listing of satisfactory test results from the National Institute of Standards and Technology, or a satisfactory certified test report from an acceptable testing laboratory. Approval by the State Fire Marshal is required.
  - 2. Furnish labels, legibly printed with the name of the manufacturer or listings indicate that fire hazard ratings do not exceed those specified for materials proposed for

installation. Flame spread index of not more than 25 and smoke developed rating not exceeding 50.

3. Tests shall be performed on each item individually when insulation, vapor barrier covering, wrapping materials, or adhesives are installed separately at the Project site.
  4. Test insulation, vapor barrier covering, wrapping materials and adhesives as an assembly when they are factory composite systems.
- D. Regulatory Requirements: Insulation furnished and installed under this Section shall meet minimum legal requirements of the Building Energy Efficiency Standards adopted and incorporated in the California Energy Commission, Title 24, Part 2, Chapters 2 through 53 and the California Green Building Standards Code unless otherwise noted, for the piping,
- E. Chemically based products such as sealers, primers, fillers, adhesives, etcetera must meet the California air quality regulations.

#### 1.5 PRODUCT HANDLING

- A. Protection, Replacement, Delivery and Storage: Comply with provisions stated under Sections 22 05 00: Common Work Results for Plumbing and 22 0513: Basic Plumbing Materials and Methods.

### PART 2 – PRODUCTS

#### 2.1 MATERIALS

- A. General:
1. Insulating material shall be fire resistant, non-corrosive, shall not break, settle, sag, pack or disintegrate under vibration, nor absorb more than 1 percent moisture by weight.
  2. Insulating material shall be furnished with thickness indicated in Table 1, and shall furnish thermal resistance in the range of R-4.0 to 4.6 in accordance with inch at 75 degrees F. For any other value of R, insulation thickness shall be calculated accordingly and submitted for review.
  3. Asbestos in any quantity in insulating material is not permitted.
  4. Provide insulation materials, adhesives, coatings, sealants, fitting covers, and other accessories with a fire hazard rating not to exceed 25 for flame spread, 25 for fuel contributed and 50 for smoke developed, except for materials listed as follows:
    - a. Nylon anchors for installing insulation to equipment.
    - b. Treated wood blocks.
  5. Flame-proofing treatments subject to moisture damage are not permitted.

TABLE 1 - MINIMUM PIPING INSULATION THICKNESS <sup>(1)</sup>

Insulation Thickness Required (in inches)

Piping System Type	Temp. Range (degrees F)	Runouts up to 2 (2)	1 and less	1.25 to 2	2.5 to 4	5 to 6	8 and larger
Service Water Heating Systems (recirculating, piping supply and return)							
Hot Water	Up to 180	0.5	1.0	1.0	1.5	1.5	1.5
Condensate Drain	½ inch minimum insulation thickness.	0.5	0.5	0.5	0.5	0.5	0.5
From A/C Equipment:	Insulate condensate drain lines within building, in room, inside walls and  above ceilings.	0.5	0.5	0.5	0.5	0.5	0.5

NOTES: (1) For piping exposed to ambient temperatures, increase thickness by 0.5 inch.

(2) Runouts to individual terminal units, not exceeding 12 feet in length.

B. Lagging Adhesives: Shall be nonflammable and fire-resistant and shall have a maximum flame spread index of 25 and a maximum smoke developed index of 50 when tested in accordance with ASTM E84. Insulation finished with canvas shall be provided with laps adhered in accordance to manufacturer's recommendation. A finish coat of same material shall be applied to entire outer surface of lagging cloth at coverage specified by manufacturer.

C. Canvas Jackets: Provide 6 ounce, in accordance with square foot minimum, 48 by 48 thread count canvas jacketing.

D. Insulation Jackets:

1. Exterior insulation exposed to weather shall be weatherproofed with Childers aluminum jacketing as basis of design, or Pabco, RPR, or equal. Jacketing shall be manufactured from 1100, 3105 or 5010 aluminum alloy with 3/16 inch corrugations. Smooth or embossed jackets may be permitted in special situations to match an existing installation. Jacketing shall be furnished with an integrally bonded moisture barrier over entire surface in contact with insulation. A minimum thickness of 0.016 aluminum jacketing is to be provided on ducts and piping. A minimum thickness of 0.020 shall be provided on tanks, equipment, and heat exchangers.
2. Insulated elbows, of 90 degrees and 45 degrees, with a nominal iron pipe size of ½ inch to 8-inch shall be provided with Childers aluminum Ell-Jacs insulation covers as basis of design, or Pabco, RPR, or equal, manufactured from 1100 aluminum

alloy of 0.024 inch thickness. Insulated elbows with a nominal pipe size of 10-inch to 18-inch shall be provided with Childers 4-piece aluminum Ell-Jacs as basis of design, or Pabco, RPR, or equal.

3. Tees, Flanges, and Valve Insulation in Conjunction with Aluminum Jacketing: Furnish Childers Aluminum Special Fabrications Insulation Covers as manufactured by Childers Products Company, Pabco, RPR, or equal.
- E. Adhesives: Adhesives shall be water based, UL Classified, meet the requirements of NFPA 90A and NFPA 90B, have been tested according to relevant ASTM requirements, and be acceptable to the State Fire Marshal. Name, type and method of installation shall be submitted for review.
- F. Valve and Fitting Cover: When installed in conjunction with PVC jacketing, furnish Zeston 25/50 rated polyvinyl chloride fitting covers as manufactured by Johns Manville, Knaufl Insulation, Speedline, or equal.

## 2.2 DOMESTIC HOT WATER PIPING SYSTEM INSULATION (NOT USED)

### **PART 3 – EXECUTION**

#### 3.1 INSTALLATION

- A. Except as specified herein, install material in accordance with recommendations of manufacturer. Do not install insulation materials until tests specified in other sections are completed. Remove foreign material such as rust, scale, or dirt. Surfaces shall be clean and dry. Maintain insulation clean and dry at all times.
- B. On cold surfaces where a vapor barrier must be provided and maintained, insulation shall be installed with a continuous, unbroken moisture and vapor seal. Hangers, supports, anchors, or other projections that are fastened to cold surfaces shall be insulated and vapor sealed to prevent condensation.
- C. Surface finishes shall be extended in such a manner as to protect raw edges, ends, and surfaces of insulation.
- D. Pipe or duct insulation shall be continuous through walls, ceiling or floor openings, or sleeves; except where firestop or firesafing materials are required.
- E. Metal shields shall be installed between hangers or supports and the piping insulation. Rigid insulation inserts shall be installed between the pipe and the insulation shields. Inserts shall be of equal thickness to adjacent insulation and shall be vapor sealed accordingly.
- F. Insulation shall not be installed in the following locations unless otherwise noted:
  1. On unions, flanged connections or valve handles.
  2. Over edges of any manhole, clean-out hole, clean-out plug, and to restrict opening or identification of access.
  3. Over any label or stamp indicating make, approval, rating, inspection, or similar data, unless provision is made for identification and access to label or stamp.

### 3.2 INSTALLATION OF DOMESTIC HOT WATER PIPING SYSTEM INSULATION

- A. General: Domestic hot water, tempered water supply and return piping and condensate return piping, after having been tested, shall be cleaned and insulated.
- B. Application: Insulate condensate return piping, domestic hot water supply and return, including tempered supply and return piping in accordance with manufacturer's instructions and as specified herein.
  - 1. Install insulation on valve bodies up to valve bonnet. Fill void in saddles, in accordance with Section 22 05 13: Basic Plumbing Materials and Methods, with insulation and seal joints.
  - 2. Install insulating material to fittings, valves, and strainers and smooth to thickness of adjacent covering. Leave strainer clean-out plugs accessible. Covers fabricated from polyvinyl chloride shall be furnished.
- C. Insulation Jackets in Exposed Indoor Locations:
  - 1. Cover completed insulation with canvas jacket tightly pasted to covering with lagging adhesive. Lap jacket seams 1 1/2-inch minimum. Finish entire jacket with coating of undiluted adhesive.
  - 2. Equivalent factory applied pre-sized, glass fiber reinforced, or glass fiber jackets may be furnished. Seal jacket seams with adhesive in accordance with manufacturer's instructions.
  - 3. Johns Manville Zeston 2000, Knauf Insulation Proto PVC Fitting Cover, Speedline Polyco Smoke Safe, or equal, fitting covers may be furnished, with molded or segmented insulation equal to specified insulation applied to fittings. Secure covers in accordance with manufacturer's instructions.
  - 4. In addition to above requirements, cover exposed insulated piping within a distance of 8 feet above floors with 26 gage galvanized steel jacket. Omit jacket in areas accessible only to maintenance personnel, such as mechanical equipment rooms, utility corridors, accessible pipe tunnels and manholes.
- D. Concealed Indoor Locations: Cover insulation over fittings, valves, and strainers with canvas. Provide pipe insulation with factory or field applied standard jacket of 4 ounce minimum canvas, fiberglass cloth, or glass fiber reinforced jacket. Seal jacket laps with adhesive in accordance with manufacturer's instructions.
- E. Exposed Outdoors: In addition to canvas or fiberglass cloth cover, pipe insulation exposed to weather shall be provided with an additional 0.016 inches thick aluminum jacket with 2-inch lap connected with one inch hem overlap joint located on side of pipe and turned down to shed water. Jacket shall be strapped 12 inches on center with 1/2-inch wide stainless steel strapping and wing seals. Aluminum jacket shall be mitered to fit fittings.

### 3.3 CLEANUP

- A. Remove rubbish, debris, and waste materials and legally dispose of off the Project site.

### 3.4 PROTECTION

A. Protect the Work of this Section until Substantial Completion.

END OF SECTION

## SECTION 22 10 00

### PLUMBING

#### PART 1 - GENERAL

##### 1.1 SUMMARY

- A. Section Includes: Labor, materials, tools, and equipment to install plumbing systems as indicated.
- B. Related Sections:
  - 1. Division 01 - General Requirements.
  - 2. Section 22 05 00: Common Work Results for Plumbing.
  - 3. Section 22 05 13: Basic Plumbing Materials and Methods.
  - 4. Section 22 05 53: Identification for Plumbing piping and Equipment.
  - 5. Section 22 07 00: Plumbing Insulation.

##### 1.2 SUBMITTALS

- A. Provide in accordance with Division 01 and Section 22 05 00: Common Work Results for Plumbing.
- B. Provide necessary documentation to Owner for processing rebates for water efficient fixtures.

##### 1.3 QUALITY ASSURANCE

- A. Unless otherwise noted, the California Plumbing Code is hereby made part of this section.
- B. Conform to provisions of Section 22 05 00: Common Work Results for Plumbing.
- C. Manufacturer of plumbing products must be third-party certified to ANSI/NSF Standard 61, Section 9 certification, and ANSI/NSF 372 to demonstrate compliance with the federal requirements for lead contribution to drinking water, the Safe Drinking Water Act SDWA, and the California Health and Safety Code Section 116875.

##### 1.4 PRODUCT HANDLING

- A. Conform to provisions of Section 22 05 13: Basic Plumbing Materials and Methods.

#### PART 2 - PRODUCTS

##### 2.1 PIPING SYSTEMS

- A. Materials: Refer to Section 22 05 13: Basic Mechanical Materials and Methods.
- B. Insulation for Piping: Refer to Section 23 07 00: Plumbing Insulation.

## 2.2 FIXTURES AND DRAINS

- A. General: Fixtures specified shall be furnished complete with trim and fittings. Cast iron plumbing fixtures shall be acid resistant enamel, and identified by casting letters "AR" or words "acid-resistant" into metal. Fixtures shall be white unless otherwise specified. Cast iron fixtures shall be white enamel inside and on back, rim and apron, with exposed unfinished surfaces painted white. Fixtures of same general classifications shall be of same make.
- B. Finished Brass:
  - 1. Unless otherwise specified, finished brass of a similar type shall be of same manufacturer and model throughout buildings.
  - 2. Finished and exposed brass equipment, except floor, shower and urinal drains shall be chromium-plated and polished. Floor, shower and urinal drains, unless otherwise specified, shall be nickel-bronze metal.
- C. Traps, Trap Arms and Tailpieces:
  - 1. Fixture traps shall be all cast brass, chromium-plated and polished. (No tubular traps). Exceptions as follows:
    - a. Traps that are an integral part of a fixture.
    - b. Traps concealed in floors, walls and furring.
    - c. Traps standard for service sinks and Industrial Shop equipment.
    - d. Laboratory traps and tailpieces shall be as specified in section 22 07 00.  
"Basic Plumbing Materials and Methods"
  - 2. Concealed traps and 17 gage tailpieces may be rough brass finish, except as otherwise specified. Laboratory traps and tailpieces shall be as specified in Section 22 07 00: Basic Plumbing Materials and Methods. Furnish chromium-plated and polished cast brass wall flanges with setscrews and chromium-plated and polished brass casing on discharge side of each trap.
  - 3. Tailpieces shall be not lighter than 17 gage, brass, chromium-plated, and polished. Furnish and install chromium brass plated wall flanges with set screws and chromium-plated 20 gage brass casing on discharge side of each chrome-plated all cast trap.
- D. Faucet and Shower Valve Handles: Faucet and shower valve handles shall be solid brass, chromium-plated and polished, and fastened to their stems by Allen type hollow head stainless steel set screws through the side of the handle extending into the stem. Handles with sharp edges or projections shall not be furnished. At accessible fixtures: handles shall

be operable with one hand and shall not require tight grasping, pinching, or twisting of the wrist. The force required to activate handles shall be 5 pounds maximum.

E. Fixture Supplies:

1. Supplies for water heaters shall be unplated rigid copper water tube with threaded adaptors for connections to valves and other threaded connections. All other supplies shall be chromium-plated brass with hospital threads or shall be furnished with fittings and valves, which completely cover threads.
2. Exposed supplies for showers shall be chromium-plated brass pipe up to header with hospital threads or shall be furnished with fittings and valves, which completely cover threads.
3. Supplies to water closet tanks, lavatories, and drinking fountains shall be furnished with chromium-plated and polished screwed type angle compression stops with square shank stems and lock shields extending beyond stem. Instead of solid supply piping, polished chrome-plated risers of 3/8 inch outside diameter with ferrule stop end and metal nosepiece may be furnished. The installation of braided stainless or easy hooker's supplies is not permitted. Exception: Supplies that rise vertically from floor shall be furnished with straight type instead of angle type stops.
4. Each supply or pipe that penetrates a finished surface and plumbing pipes passing through a countertop or part of a cabinet shall be furnished with a chromium-plated brass flange except flanges furnished by manufacturer of flush valves as an assembly.
5. Water supplies of plumbing fixtures shall be protected against back-siphonage in event of a vacuum in piping system.
6. Discharge outlets of supply faucets for lavatories and sinks shall clear top of overflow rim by at least one inch.
7. Toilet and urinal flush valves shall be furnished with recognized atmospheric vacuum breakers, installed a minimum of 6 inches above fixture.

2.3 ACCESS PLATES (To cleanouts, valves, water hammer arrestors and hose faucets)

A. Schedule Numbers:

AP-1: Square, unless otherwise noted, steel, prime coated; frame, 18 gage minimum. Door shall be 16 gage minimum with concealed hinge or be removable, with vandal-proof lock operated by Allen wrench.

(Specify for painted and stucco walls.)

SMITH	ZURN	ELMDOR	MILKOR	WATTS	MIFAB	JOSAM
Fig 4760 AK	Z-1462- VP	DW-AKL	MOR DW AK1	CO-300- S-6	UA-A	58650-VP OR EQUAL

AP-2: Round type, stainless steel, vandal-proof, 5/16 inch No. 18 or 1/4 inch No. 20 flat-head machine screw into cleanout plug. Plate shall be prime coated minimum 18 gage steel or polished chrome-plated brass, 18-8 No. 302 stainless steel, or polished nickel bronze.  
(To be specified for painted walls, screwed into cleanout plug.)

SMITH	ZURN	JOSAM	WADE	WATTS	MIFAB	OR EQUAL
4710U	Z-1469-VP	58600	8480R	CO-480-RD-6	C1400-RD-6	

AP-3: Square, polished face chrome-plated bronze, aluminum alloy or brass chrome-plated brass frame with 14 gage polished 18-8 No. 302 stainless steel or brass chrome-plated secured cover with vandal-proof screws.  
(To be specified for tile walls.)

SMITH	ZURN	WADE	WATTS	MIFAB	JOSAM	OR EQUAL
4735U	Z-1460-VP	58630	CO-300-S-6	C1400-S-3-6	58640-VP	

AP-4: Square, floor type, cast nickel-bronze aluminum alloy or brass, with carborundum or scoriated, secured top.

(To be specified for floor access to solid interceptor in Science Room, Ceramic Room, and Agriculture Room.)

SMITH	ZURN	JOSAM	WATTS	MIFAB	OR EQUAL
4910U	Z-1461-VP	58630	CO-300-S-6	C1300-S-6	

2.4 BACKFLOW PREVENTION ASSEMBLIES (NOT USED)

2.5 BACKWATER SEWER VALVE ASSEMBLY (NOT USED)

2.6 CLEANOUT ASSEMBLIES

A. Cleanout plug shall be line size.

B. Schedule Numbers:

CO-1: Iron body cleanout tee full line size up to 4 inches and round access plate, plugs shall be brass, countersunk with tapped boss for 5/16 inch No. 18 or 1/4 inch No. 20 screws. (Specify for finished walls at base of waste stack, above urinal and service sink.) AB&I and TYLER may be used as iron body cleanouts. Trim and accessories shall be Smith or Zurn or equal.

SMITH	ZURN	WATTS	MIFAB	JOSAM	OR EQUAL

4532-U	Z-1446-BP	CO-460-RD-34B	C1460-RD-6	58600-CO	
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2.7 CIRCULATING PUMPS, HOT WATER HEATING SYSTEM (NOT USED)

2.8 DRINKING FOUNTAINS (NOT USED)

2.9 DRUM TRAPS

A. Schedule Numbers:

DT-1: Extra heavy cast iron, bolted top.

SMITH	ZURN	WATTS	MIFAB	JOSAM	OR EQUAL
8714	ZA1180	SI-742-X	MI-SOLID-S	61030	

DT-2: Aluminum solid interceptor, furnish for on-floor installation.

SMITH	ZURN	WATTS	MIFAB	JOSAM	OR EQUAL
8710-AA	Z-1180	SI-742	MI-SOLID-S-AL	61030-26	

2.10 DIELECTRIC UNIONS

A. Schedule Numbers:

1. Dielectric style Unions using ferrous and no-ferrous metals are prohibited. Dielectric flanges are admitted for use – see DU-2.

DU-1: Lead Free Brass union with 6-inch Lead Free Brass nipple.

DU-2: Lead Free Brass union or Lead Free Brass flanged fittings are to be used in between pipes made of dissimilar metals to prevent accelerated corrosion and deterioration in the piping systems due to galvanic and stray current.

WATTS	WILKINS	ZURN	NIBCO	OR EQUAL
LF3100M3			733-LF	

2.11 EMERGENCY EYE WASH / EMERGENCY SHOWER (NOT USED)

2.12 ELECTRIC WATER COOLERS (NOT USED)

2.13 FAUCETS (NOT USED)

2.14 FLOOR DRAINS (NOT USED)

2.15 FLEXIBLE HOSES

A. Schedule Numbers:

FLH-1: Braided stainless steel metal hose (for gas use). US Flex, Metraflex, Nelson Dunn or equal.

FLH-2: Braided bronze metal hose (for non-pressure condensate connection use). US Flex, Metraflex, Nelson Dunn or equal.

2.16 FLUSH VALVE ASSEMBLY (NOT USED)

2.17 FLOOR SINKS

A. Schedule Numbers:

FS-1: Round, cast iron, acid-resistant enamel body with bottom aluminum dome strainer, less grate.

(To be specified for use in Multi-Purpose Buildings and Cafeteria Buildings.)

SMITH	ZURN	WATTS	MIFAB	JOSAM	OR EQUAL
3400Y-10	Z-1950-1	FS-760-22	FS1760-22	49580A	

FS-2: 6 inches to 8 inches deep, square cast iron acid-resistant enamel, bottom aluminum dome strainer with nickel bronze rim and grate top.

(To be specified for use in Multi-Purpose Buildings, High School Cafeteria and Mechanical Equipment Rooms.)

SMITH	ZURN	WATTS	MIFAB	JOSAM	OR EQUAL
3140Y 3150Y	Z-1901 ZN-1900	FS-740-1 FS-730-1	or FS1720-1, FS1730-1	49320A-NB, 49340A-NB	

FS-3: Round, cast iron body with dome bottom strainer, under deck clamp and 2-inch high water dam; no hub type.

(To be specified for outdoor use near cooling tower, near rooftop HVAC unit, chillers, Mechanical Equipment Rooms.)

SMITH	ZURN	WATTS	MIFAB	JOSAM	OR EQUAL
3980Y-C	Z-108-NH	RD-400-F	R1200-RS-U	25500-1	

2.18 GREASE TRAPS (INTERCEPTORS): (NOT USED)

2.19 HOSE BIBBS

A. Schedule Numbers:

HB-1: For plaster or stucco wall, furnished with box and stop, exposed trim chrome-plated, with or without door and with vacuum breaker.

(To be specified for use in swimming pool area, outside eating area and at 75 feet spacing around exterior building walls.)

ACORN	WOODFORD	PRIER	OR EQUAL
-	Y30	-	

HB-2: The is intended for irrigation purposes and to provide water availability on commercial building roofs

ACORN	WOODFORD	PRIER	OR EQUAL
-	RHY2-MS	-	

HB-3: ASTM B 62 bronze body, rubber composition disc or renewable seat, straight nose with brass die cast or enamel iron hand wheel.

(To be specified for use for Lath House.)

ACORN	ZURN	WOODFORD	PRIER	OR EQUAL
8131-RBVB	Z-1343-VB	Y24	C-155	

HB-4: Same as HB-3 except furnish loose key stop and lockshield.

(To be specified for use at animal wash-down areas.)

ACORN	ZURN	WOODFORD	PRIER	OR EQUAL
8131-LK-RBVB	Z-1343-VB-LK	Y24 WITH LOOSE TEE KEY	C-155	

HB-5: Same as HB-3 except furnish with bent nose.

(To be specified for use at roof top AC Unit. Mechanical Equipment Room, Boiler Rooms, etc.)

ACORN	ZURN	CHAMPION	PRIER	OR EQUAL
8126-LK-RBVB	Z-1343-VB-LK	B-401 LK	C-255NP	

## 2.20

### LAVATORIES

- A. Access compliant faucets for Lavatories: Force to activate controls shall be no greater than 5 pounds. Self closing metering, when specified, to remain open 10 seconds minimum when activated.
- B. Cast Iron Lavatories shall be acid resistant enamel, and shall conform to Commercial Standards CS 77.63. Unites furnished in conjunction with strainer installation or faucet installation shall be brass. Exposed brass nuts shall be chrome plated.

- C. Exposed trim shall be free from sharp edges or points. Fixture shall be furnished with other listed manufacturer specified trim. Instead of solid supply pipe, polished chrome-plated risers, 3/8 inch outside diameter with ferrule stop end and metal nosepiece may be furnished.
- D. Insulate cold water, hot water and drain lines under all access compliant lavatories with approved type insulation.

PLUMBEREX	LAV-GUARD	OR EQUAL
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Schedule Numbers:

- L-1: 20-inch by 18-inch cast iron, acid-resistant enamel punched with three holes, 4-inch on center and supplied with tempered or cold water only. Unit shall be furnished with cast iron hangers. Stops shall be loose key, square shank, lock shield type.

(To be specified for use in Student Toilet Rooms, Typing, Math, and Industrial Art Rooms.)

	COMMERCIAL ENAMEL	KOHLER	BRASS CRAFT	CHICAGO	ZURN OR EQUAL
Bowl	551 (3 holes)	K-2867			Z5844-CB
Faucet (See Section 2.13)	F-15	F-15	F-15	F-15	F-15
Drain		K-7715		327 XCP	Z8743
Supply			HSTR 1720 A-CB-C	1017	ZH-8822-CE-LK

Note: Provide cast iron hangers for sinks.

- L-2: Same as L-1, 20-inch by 18-inch cast iron, acid resistant enamel punched with three holes, 4 inches on center and supplied with tempered cold water only. Unit shall be furnished with cast iron hangers. Stops shall be loose key, square shank and lock shield type.

(To be specified for access compliant, student restrooms).

	COMMERCIAL ENAMEL	ZURN	KOHLER	OR EQUAL
Bowl	553 (3 holes)	Z5844	K-2867	

Faucet (See Section 2.13)	F-15	F-15	F-15	
Drain	Chicago 1-1/4-inch grid drain 327- XCP  ProFlo 1 ¼-inch grid drain PF 155A	Chicago 1-1/4-inch grid drain 327- XCP  ProFlo 1 ¼-inch grid drain PF 155A	Chicago 1-1/4-inch grid drain 327- XCP  ProFlo 1 ¼-inch grid drain PF 155A	OR EQUAL

L-3: 20-inch by 18-inch cast iron, acid-resistant enamel lavatory, with 4-inch center set combination push button metered faucet, supplied with hot and cold water, complete with cast iron hangers. (To be specified for non-accessible installation at nurse's office and faculty restrooms).

	CECO	KOHLER	BRASS CRAFT	CHICAGO	ZURN	OR EQU AL
Bowl	551(3 hole)	K-2867			Z-5844	
Faucet (See Section 2.13)	F-14	F-14	F-14	F-14	F-14	
Drain		K-7715		327A	Z-8743	
Supply			HSTR 1720-A- CB-C	1017	ZH822- CE-LK	

L-4: 20-inch by 18-inch cast iron, acid resistant enamel lavatory with 4-inch center set combination push button metered faucet, supplied with hot and cold water complete with cast iron hangers. (To be specified for access compliant installations at faculty restrooms).

	COMMERCIAL ENAMEL	ZURN	KOHLER	OR EQUAL
Bowl	553 (3 holes)	Z5844	K-2867	
Faucet (See Section 2.13)	F-14	F-14)	F-14	
Drain	Chicago 1 ¼-inch	Chicago 1 ¼-inch grid	Chicago 1-1/4-inch	OR EQUAL

	grid drain 327-XCP ProFlo 1 ¼-inches grid drain PF155A	drain 327-XCP ProFlo 1 ¼-inches grid drain PF155A	grid drain 327- XCP ProFlo 1 ¼-inch grid drain PF 155A	
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2.21 LABORATORY GAS VALVES (NOT USED)

2.22 LAUNDRY TRAYS AND TRIM (NOT USED)

2.23 PIPE HANGERS

A. Refer to Section 22 05 13: Basic Plumbing Materials and Methods.

B. Schedule Numbers:

1. PH-1: Complete with clamps, inserts, etc.

SUPERSTRUT	UNISTRUT	TOLCO	B-LINE	OR EQUAL
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2.24 P-TRAPS

A. Schedule Numbers:

PT-1: Cast brass complete, chrome-plated.

ZURN	AB&A	KOHLER	OR EQUAL
Z-8712-LC	107	K-9018	

2.25 PRESSURE REGULATING VALVE ASSEMBLIES (NOT USED)

2.26 ROOF DRAINS (NOT USED)

2.27 SHOWER ASSEMBLIES (NOT USED)

2.28 SERVICE SINKS and TRIM (NOT USED)

2.29 SINKS and TRIM

For classrooms, offices and dining room sinks.

A. Access compliant faucets for sinks: Force to activate controls shall be no greater than 5 pounds. where specified self closing metering to remain open 10 seconds minimum when activated.

B. Cast iron sinks shall be acid resistant enamel, and shall conform to Commercial Standards CS 77.63. Units furnished in conjunction with strainer installation or faucet installation shall be brass. Exposed brass nuts shall be chrome-plated. Refer to the Fixture Supplies paragraph of this section.

- C. Exposed trim shall be free from sharp edges or points. Fixture shall be furnished with other listed manufacturer specified trim. Instead of solid supply pipe, polished chrome-plated risers, 3/8-inches outside diameter with ferrule stop end and metal nosepiece may be furnished.
- D. For access compliant sinks: Insulate cold water, hot water and drain pipes under sinks with district approved type insulation.

PLUMEREX	LAV GUARD	OR EQUAL
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E. Schedule Numbers:

ST-1: Cast Iron, 24-inch by 16-inch by 5-inch, flat rim, with 3 ½-inch flat strainer, and deck mounted stainless steel pantry faucet, mounted on left side center line, with stainless steel drinking bubbler mounted on right side near front.

(To be specified for use in Elementary and kindergarten classrooms.)

	AMERICAN STANDARD	HAWS	KOHLER	JUST
Sink		4110 ADA	K-5990	
Faucet		F-16 (see 2.13)	F-16 (see 2.13)	
Strainer	4311.023	6455	K-8807	
Bubbler				JSB-10-VR

ST-2: Same as ST-1, except stainless steel faucet on the right side and stainless steel bubbler on the left side.

(To be specified for use in Elementary and Kindergarten classrooms.)

ST-3: Cast Iron, 18-inch by 12-inch – 24-inch by 18-inch or 30-inch by 18-inch (Designer to select and specify the size) or as indicated on drawings, with basket strainer, hot and cold deck mounted faucet.

(To be specified for use in Administration Offices, Conference Rooms, Teacher Workrooms, Faculty Lounge, Library and Kiln Room.)

	KOHLER	AMERICAN STANDARD	CECO	HAWS	OR EQUAL
Sink			720C, 720I, 720G,		
Faucet	F-15	F-15	F-15	F-15	

Strainer	K-8801	4331.013		6457	
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ST-4: Same as ST-3, except with flat strainer and deck mounted faucet.

(To be specified for Art Classroom, Shop and Industrial Craft rooms, Ceramic, Science Room - replacement only, and Special Education Classrooms.)

Strainer	KOHLER K-8807	CHICAGO	HAWS 6455	AMERICAN STANDARD 4311.023	OR EQUAL
Faucet	F-10	F-10	F-10	F-10	

2.30 SEWAGE EJECTORS (NOT USED)

2.31 SERVICE STOP GAS VALVES

A. Schedule Numbers:

SGV-1: Bronze/Brass gas cock valve with double stake packing nut, ½ inch to 2-inch, with IPS, inclusive, with flat or square head. CSA approved.

(To be specified for oven ranges, convection ovens, skillets.)

AMERICAN	Mc DONALD	NIBCO	OR EQUAL
85 CBK or 86C	10596, flat 10604, square	GB2A	

SGV-2: Bronze/Brass, ¾-inches to 2-inch IPS (WOG) water, oil, or gas – full port ball valve. CSA approved.

(To be specified for larger water heaters, small boilers, pool heaters, and A/C units on roofs.)

WATTS	NIBCO	WILKINS	OR EQUAL
LFFBV-4	F-510-CS-R-66-FS	Model 850	

SGV-3: Cast iron, 2-inch to 4-inch flanged ball valves (WOG) water, oil, or gas. CSA approved.

(To be specified for larger heating equipment.)

WILKINS	NIBCO	WATTS	OR EQUAL
Model 850	F-510-CS-R-66-FS	G4000M1	

SGV-4: Lubricated plug gas valve, 3/4-inch to 2-inch IPS valve.

To be specified for use after gas meter headers, gas regulators, and isolation valves for building isolation, individual floor level isolation, and boiler rooms.)

NORDSTROM	WALWORTH	RESUN	OR EQUAL
142	1786	1430	

SGV-5: Lubricated plug gas valve flanged type 2 ½-inch and larger valve.

(To be specified for use after gas meter headers, gas regulators, isolation valves for buildings isolation, individual floor level isolation and boiler rooms.)

NORDSTROM	WALWORTH	RESUN	OR EQUAL
142	1786	1430	

SGV-6: Bronze/Brass ½-inches to 2-inch IPS with lever handle full port ball valve (WOG) water, oil, or gas, CSA Approved.

(To be specified for use in Science, Home Economics, Physics, Biology, physiology, and Modern Science work rooms behind access panel.)

RED and WHITE	NIBCO	WILKINS	OR EQUAL
Fig. 5544	T-585-70-UL T-580-70-UL	Model 80	

SGV-7: Bronze/Brass ½ inch to 2-inch IPS X Flare Appliance ball valves with Tee handle. Flares to be used in conjunction with corrugated flex lines.

(To be specified for clothes dryer, water heaters, unit heaters, and wall heaters up to 100,000 BTU.)

RED and WHITE	BRASSCRAFT	NIBCO	OR EQUAL
RW 5210 RW 5211 RW 5221	TBV 10-12 TBV 8-8 TBV 6-8	GBV 12 GBV 1516	

2.32 SUMP PUMP (NOT USED)

2.33 STOP VALVES

A. Stops shall be loose key type, ½-inches IPS inlet and outlet chrome-plated brass casting, except as noted.

B. Schedule Numbers:

STV-1: Angle:

CHICAGO,	CRANE	NIBCO	OR EQUAL
442-LKABCP	8.5113.	77	

STV-2: Partition:

CHICAGO	T& S BRASS	OR EQUAL
1771-ABCP	B-1028	

STV-3: Straight Type, with Loose Key:

CHICAGO	CRANE	T&S BRASS	OR EQUAL
45-LKABCP (1/2 inch)	8-5111	B-O418	

2.34 THERMOSTATIC MIXING VALVE ASSEMBLIES (TMVA): (NOT USED)

2.35 TRAP PRIMERS

A. Schedule Numbers:

ATP-1: Automatic, multi-trap primer, cast bronze with access panel. Pressure drop of three p.s.i. shall activate trap seal primers. Manufactured by MIFAB, or equal. (Installed in accessible location.)

MIFAB	OR EQUAL
MR-500-NPB	

2.36 URINALS (NOT USED)

2.37 WATER CLOSETS (NOT USED)

2.38 WATER TEMPERATURE CONTROLLERS (NOT USED)

2.39 WATER HEATERS / Domestic / Boilers (NOT USED)

2.40 WATER HAMMER ARRESTORS (NOT USED)

2.41 WATER TANKS, HOT – UNFIRED (NOT USED)

2.42 YARD BOXES (NOT USED)

2.43 FIXTURE CONNECTIONS

A. Branches to individual fixtures shall be of the following sizes (Inches) unless larger sizes are indicated on Drawings:

Fixture	Copper, Cold (Inches)	Copper, Hot (Inches)	Trap and Connections (Inches)	Soil/ Waste (Inches)	Vent (Inches)
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WC Flush Valve	1	N/A	4	4	2
Lavatories	1/2	1/2	1-1/2 by 1-1/4	2	1-1/2
Service Sink	1/2	1/2	2	2	1-1/2
Kitchen Sink	1/2	1/2	1-1/2 by 1-1/2	2	1-1/2
Classroom Sink	3/8	3/8	1-1/2 by 1-1/2	2	1-1/2
Wash Sink	3/4	1/2	1-1/2 by 1-1/2	2	1-1/2
Multiple Drinking Fountains	3/8	N/A	1-1/2 by 1-1/2	2	1-1/2
Single Drinking Fountains	3/8	N/A	1-1/2	2	1-1/2
Individual Showers	1/2	1/2	2	2	2
Standard Urinals, Wall-Hung Flush Valve:	3/4	N/A	N/A	2	1-1/2
Access Compliant Urinals, Wall-Hung Flush Valve:	1	N/A	N/A	2	1-1/2
Sillcocks	3/4 minimum	N/A	N/A	N/A	N/A

B. Water headers serving water closets shall be copper water tube, with following size throughout length:

1. 1-1/2 inches for 2 flush valves.
2. 2 inches for 3 to 9 flush valves.

C. Water headers serving urinals shall be of following size throughout length:

1. 1" for 1 or 2 flush valves.
2. 1-1/4" for 3 flush valves.
3. 1-1/2" for 4 to 8 flush valves.

D. Water headers serving showers shall be same as listed above for urinals.

E. Water headers serving lavatories shall be of following size throughout length:

1. 1/2 inch for 2 lavatories.
2. 3/4 inch for 3 and 4 lavatories.
3. One inch for 5 and 6 lavatories.

## 2.44 HEIGHT OF FIXTURES

A. Heights for standard fixtures.

Fixture	Adult and High School (Inches)	Secondary (Inches)	Elementary (Inches)	Kindergarten and Younger (Inches)
Water Closets	15 to 17	15 to 17	15	10
Lavatories	32	32	30	25
Drinking Fountains	38 to 43	40	32	30
Wash Sinks	30	30	28	24
Urinals, lip height	24	21	18	N/A
Shower Heads Male (Student and Instructor)  From tip of shower head to finish floor.	72	60		
Shower Heads Female (Student and Instructor)  From tip of shower head to finish floor.	72	60		
Shower valves	48	48		

B. Heights for access compliant fixtures.

Fixture	Adult Ages 12 and Over (Inches)	Elementary Ages 6 to 11 (Inches)	Kindergarten and Younger Ages 3 to 5 (Inches)
Toilets, center line from wall	17 to 18	15	12
Toilets, height to top of seat	17 to 19	15	10 to 12
Lavatories, sink top height	34 maximum	29 maximum	24 maximum
Lavatories, sink knee clearance	27 minimum	24 minimum	19 minimum
Urinals, lip height	17 maximum	15 maximum	13 minimum
Urinals, flush handle height	44 maximum	37 maximum	32 maximum
Drinking fountains, bubbler height.	36 maximum	32 maximum	30 maximum
Drinking fountains, knee clearance	27 minimum	24 minimum	22 minimum
Wash Sink	Per Drawings		
Shower Valves	Per CBC		
Shower Seat	Per CBC	Per CBC	Per CBC
Shower Head (adjustable) Bar	Per CBC		

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Examine areas and conditions under which Work of this section will be performed. Correct conditions detrimental to proper and timely completion of Work. Do not proceed until unsatisfactory conditions have been corrected.

#### 3.2 INSTALLATION

A. General:

1. Unless otherwise specified, plumbing fixtures, equipment and appliances that require connections to plumbing line shall be connected. This shall include fixtures specified or indicated as furnished by others, furnished by Owner, or specified in other related sections. Install supplies, stops, valves, traps, wall flanges, or pipe casing for connection of this equipment.
2. Install equipment as indicated on reviewed and accepted Shop Drawings.

3. Avoid interference with Work of other trades. Do not deviate from Drawings without review of the Architect.
- B. Examination: Check each piece of equipment in system for defects verifying that parts are properly furnished and installed.
- C. For piping Work, refer to Section 22 05 13: Basic Plumbing Materials and Methods.
- D. Plumbing Fixture and Equipment Installation:
1. Unless otherwise indicated, fixtures shall be installed with 5/16 inch brass bolts or screws of sufficient length to securely fasten fixture to backing, wall, or closet ring.
  2. Fixtures installed against concrete or masonry walls shall have their hangers fastened with 5/16 inch brass bolts, Philip Shield type anchors, or 2 unit cinch anchors. Wood or plastic plugs are not permitted.
  3. Fixtures installed against wood or metal stud walls shall have their hangers fastened to metal backing plates with 5/16 inch brass bolts screwed into plate. Fixture hangers for urinals shall be fastened centered vertically on metal backing plate with three 5/16 brass bolts each for small individual hangers and six, for larger one piece hangers. Lavatories shall be hung with not less than four 5/16 inch brass bolts or not less than five 1/4 inch brass bolts. Each sink hanger shall be hung with not less than four 5/16 inch brass bolt or not less than five 1/4 inch brass bolts.
  4. Rough-in for fixtures, equipment and appliances shall be as indicated on Drawings and as specified, including those items indicated as furnished by others, furnished by Owner, or future capacity. When connections to equipment from capped or plugged lines are required, caps or plugs shall be removed at time equipment is set and stops or valves installed and connections provided as specified.
  5. Piping materials for trap arms shall be Brass, Cast Iron or DWV copper
  6. Piping shall be stubbed out to exact location of fixtures and stubs shall be installed symmetrical with fixtures. Hot and cold water supplies for center set faucets on lavatories shall be installed on 8-inch centers, unless otherwise specified or required.
- E. Cleanouts in Drain, Waste, Vent and Sewer Lines:
1. Cleanouts shall be installed at locations stated in the California Plumbing Code and accessible at following locations:
    - a. At locations above first floor as stated on construction documents and 5 feet outside of the building.
    - b. Install an accessible main line upper terminal cleanout in all restrooms above water closet over flow. (Install above upper terminal water closet where there are more than one water closet in a restroom).

- c. Above faucets of each sink with brass plug.
  - d. Above service sink with brass plug.
  - e. At each Drinking Fountain with brass plug.
  - f. At each urinal and locate above urinal with brass plug.
  - g. Above overflow level of pot sinks with brass plug.
  - h. In vertical line at base of each downspout connected to an underground storm drain system extend cleanout to exterior of building.
  - i. At upper end of a horizontal vent line when any part of horizontal line is below overflow level of fixture it serves.
  - j. Not to exceed 100-foot intervals in sewer and waste lines exterior of building.
  - k. At property line connection.
  - l. Where indicated on Drawings.
2. Cleanouts shall be extended to grade as follows:
- a. Not to exceed 100-foot intervals in straight runs of pipe outside buildings.
  - b. At horizontal changes of direction in aggregate greater than 135 degrees (underground).
  - c. At property lines.
  - d. Where cleanouts occur under concrete.
  - e. Where marked for future connections.
3. Cleanouts in building shall be extended to floor level or above floor level or above floor level in walls or furring when cleanouts are not accessible or where clearance is less than 18 inches.
4. Cleanouts in finished areas in building shall be concealed except that cleanouts above service sinks in janitor's rooms or closet, and cleanouts above service sinks or in exposed piping in boiler or heater equipment rooms, may be exposed. Cleanouts for urinals shall be installed above urinal and shall terminate behind an access plate.
5. Cleanouts in floors of covered areas and those extended to grade in concrete areas shall be floor level type with extensions body brass plugs and detachable nickel-bronze or aluminum alloy scoriated.
6. Concealed cleanouts in vertical lines shall be service weight soil cleanout tees with brass plugs and round cover plates unless otherwise specified or indicated. A snug

fitting sleeve of galvanized sheet metal shall be placed around hub of tee and shall extend to flush with finished soil, or cleanout shall be extended to finished wall.

7. Cleanouts extended from below floor to a wall or furring or on horizontal lines above floor that terminate at a wall or furring shall be iron body type with brass plugs and round cover plates.
8. Cover plates over cleanouts in painted walls shall be steel, bonderized and prime coated. Cover plates over cleanouts in tile walls shall be chromium-plated brass or nickel bronze. Plates shall be attached to cleanout plugs with 5/16 inch No. 18 or 1/4 inch No. 20 stainless steel vandal-proof type screws. Plates shall be one inch larger in diameter than fitting opening.
9. Cleanouts at bases of downspouts shall be tapped soil tees with brass plugs as hereinafter specified, full size of line.
10. Cleanouts extended to grade in exterior sewer lines other than floors or concrete areas shall be a cleanout assembly with secured top, extra heavy-duty, adjustable sleeve, cut-off ferrule, countersunk threaded brass plug and scoriated tractor type cover.
11. Other cleanouts shall be iron body type.
12. Cleanout extensions shall be no-hub cast iron soil pipe. Exterior cleanouts, those in concrete excepted, shall terminate in a 14-inch by 6-inch thick concrete block with cleanout assembly and top of block flush with finish grade.
13. Fittings in lines utilized as cleanouts shall be approved soil fittings including no-hub pipe. Tees and crosses in vent headers excepted.
14. Pipe joint compound shall not be installed on cleanout plug. After lines are tested and approved, each cleanout plug shall be removed, greased, and replaced.

### 3.3 EXCAVATION, TRENCHING AND BACKFILLING

- A. Perform trenching, excavation, and backfilling required for Work of this section as specified herein and in Section 31 23 23: Excavating, Backfilling, and Compacting for Utilities.

### 3.4 SERVICE CONNECTIONS

- A. Determine exact location of required water, drain, and sewer connections and provide proper connections.
- B. Potable water lines shall be purged completely before connecting to sources of water for the Project. Determine quality of water supply before connection.

### 3.5 WATER HAMMER ARRESTORS

- A. Install water hammer arrestors indicated on Drawings and in following locations (only non-ferrous arrestors may be installed in copper water system):
  1. Water lines to lavatory headers, water closet and urinal headers, service sinks, kitchen sinks, wash fountains, drinking fountains, laboratories with medical type

faucets and on wash sinks having three or more stations and all other quick closing fixture such as clothes washers, as close to fixture as possible.

2. Between last two fixtures when three or more fixtures, other than those listed in Number 1 above, are served by a common header.
- B. When possible, arrestor shall be installed in wall or furring. When arrestor is installed in wall or furring, furnish an access plate large enough to permit removal of arrestor. Access plate shall be a minimum of 2 inches larger in each direction than the arrestor.
  - C. Fixture water lines shall be provided with mechanical water arrestor hammer dampening devices. Air chambers are not approved.

### 3.6 CONDENSATE DRAINS - FROM AIR CONDITIONING UNITS

- A. Connect drain piping from drain pan of air conditioning unit to condensate disposal location indicated. When coil or unit housing is shock or vibration isolated, connection shall be furnished through a flexible connector not less than 10 inches long. Drain line shall pitch to flow out at not less than one inch in 8 feet. Drain line shall not be reduced smaller than unit outlet connection.
- B. Condensate drain piping installed within building whether in air conditioned space or not shall be insulated. Refer to Section 22 07 00: Plumbing Insulation, for type of material required.
- C. Condensate Trap:
  1. A condensate trap shall be installed for each air conditioning coil. Trap shall be assembled from 2 brass unions: one between A/C unit and inlet of trap, and one at outlet of trap that connects to main drain.
  2. Trap configuration shall be per manufacturer's recommendations based on total unit casting static pressure (simulated plugged filter condition), but not less than 3 inch water seal.
  3. Running trap design is not permitted.
  4. Secondary drain shall not be trapped.
- D. Condensate trap shall be checked at equipment operational tests for proper water drainage flow from air conditioning unit. Cooling condensate pan shall be filled with water, filters covered with plastic (plugged filter simulated), unit panels replaced, and unit motor running at design condition. Pan shall drain without hesitation to bottom of inlet connection. Tests are made prior to installation of ceiling.
- E. Secondary Overflow Drain:
  1. Drain pan installed underneath air conditioning units in concealed ceiling space or units that incorporate dam fitting shall be furnished with secondary drain piped to outside planter area with outflow location clearly visible.

- 2 If outside building location is not available or feasible, secondary drains shall be piped to a classroom sink, if sink is not available pipe to a room corner away from cabinets, computers, desks, door ways/entrances or stairs.
- 3 Secondary vertical pipe that penetrates through suspended ceiling shall be furnished with a coupling or threaded adapter so ceiling tile can be removed without damage.

3.7 CONDENSATE DRAINS - FROM WINDOW TYPE HEAT PUMP AND EXTERIOR WALL MOUNT HEAT PUMP UNITS

- A. Whether indicated on Drawings or not, window units and wall mount units without built in bottom drain pan for evaporator and condenser coils shall be provided with galvanized steel condensate pan at bottom of unit with drain line that drains into approved drywell. Install copper 1/2 inch diameter pipe for window type air conditioners and 3/4 inch diameter pipe for exterior wall-mounted heat pump units.

3.8 MAKE-UP WATER SYSTEMS (NOT USED)

3.9 GREASE TRAPS (INTERCEPTORS): (NOT USED)

3.10 GAS SERVICE

- A. Above Grade Service: Pipe shall be steel, hammered, free of dirt and scale, and blown out with oil-free air or nitrogen to a clean, dry condition. Piping shall not be installed in or through a ventilation duct or plenum.
- B. Underground Service, Gas approved (yellow) Polyethylene Plastic Pipe: Refer to Section 22 05 13: "Basic Plumbing Materials and Methods".
  1. Pipes shall be joined with polyethylene fitting and joined together by thermal fusion in accordance with procedures recommended by Polyethylene plastic pipe and fitting manufacturer.
  2. Plastic pipe shall be installed not less than 30 inches below grade..
  3. Underground Warning Tape shall be installed 12 inches above buried gas piping. Warning tape shall be yellow with caution statement as follows: "CAUTION – BURIED GAS LINE BELOW".
  4. Plastic pipe shall not be installed in or under a building or structure. Pipe shall be installed under bituminous surfacing or compacted soil area, free from large stones. Pipe may be installed under sidewalks or driveways, as long as no joint occurs. Pipe installed under paved covered areas wider than 40 feet shall be installed in ventilated conduits extending 2 feet past paving.
  5. Pipe shall be installed on a 6 inches deep sand bed. After required pressure-leak test, pipe shall be covered with sand not less than 6 inches thick.
  6. Piping shall not support weight of valves, metal fittings or other items. Pipe shall be installed strain free.

7. Plastic pipe fittings shall not be stored or left exposed to sunlight. Pipe in open trenches shall be shielded. A sand envelope of 6 inches minimum shall be placed around pipe, with exception of joints, until inspection by IOR is completed. Protection for pipe shall be provided when necessary to leave pipe exposed overnight.
8. Installer of piping is required to have training and to have attained a certification. Non-trained/Non-certified installer must contact the manufacturer or manufacturer's representative to provide on-site fusion training and certification, prior to work commencement
9. Polyethylene plastic pipe shall connect to a steel epoxy coated anodeless type riser to minimum of 6 inches above grade, when exiting the underground installation and transitioning to steel pipe connection.
10. Where a steel pipe riser passes into a structure or building, a double swing or double-offset joint shall be furnished. Pipe shall pass into structure 6-inches above grade and through a sleeve with a minimum one inch clearance. An isolation valve is required before pipe entering the building.

### 3.11 CLEANING - PLUMBING PIPING SYSTEMS AND FIXTURES

- A. Plumbing lines and fixtures shall be flushed to remove dirt and foreign material until water runs clear and no foreign substance or odor is present. Strainers and screens on faucets shall be removed during this cleaning operation.
- B. After satisfactory cleaning of strainer and screen replacements has been witnessed by the Project Inspector, post and maintain signs stating: "CAUTION - Water at this construction project has not yet been certified for human consumption." Signs shall be furnished with letters at least 1/2 inch in height, and shall be conspicuously posted at entrances to the Project site. Signs shall be paneled, black and yellow, in conformance with OSHA Section 1910.1455.

### 3.12 DISINFECTING DOMESTIC WATER PIPING SYSTEMS

- A. Newly installed or replaced piping and/or fixtures dispensing potable water shall be disinfected and undergo an approved bacteriological analyses before water system is allowed for public use.
- B. Work shall be performed by Technicians Certified by the American Water Works Association (AWWA) and/or the State of California Department Health Services, Grade II Water Treatment Operator Certification or higher issued by the Department of Health Services (DHS) for the State of California. Comply with Title 22, Code of Regulations Division 4, Chapter 13, and Article 2 Operator Certification Grades.
- C. Method:
  1. A Reduced Pressure Backflow assembly shall be installed to protect from cross contamination of the local water purveyor's meter service supply when at any time there is any type of water connection with the piping to be disinfected (Chlorinated) and the water meter service supply.

2. System is to be flushed to remove any materials that may have entered the system.
  3. Using a chemical feed metering pump and a chlorine tank, the chlorine solution is injected into the water system.
- D. Disinfection and De-chlorination procedure (24 or 3 Hour Contact Time):
1. 24-hour Test Method:
    - a. Prior to disinfection, post signs on all water outlets of the system to be disinfected. Sign or tags shall read, "Water System Being Chlorinated- "Danger Do Not Drink Water" or similar warning.
    - b. Piping system shall then be adequately flushed with water to remove any particles and eliminate air pockets.
    - c. Using the continuous feed method, sodium hypochlorite conforming to ANSI/ AWWA B300 will be injected into the water system at a minimum of 50 PPM. A water flow meter provided by the water treatment technician will be used to determine the rate of injection and a chlorine test kit, Hach or equivalent, will be used to monitor the residual.
    - d. Chlorine residual test will be taken at all appropriate points and outlets to verify 50 PPM residual levels.
    - e. The chlorinated system shall be shut down for any use and the chlorinated water shall remain in the water system for retention of 24 hours.
    - f. After 24 hours, chlorine residual levels will again be tested at various points throughout the system to insure a minimum of 25 PPM residual. If the system has not met the minimum of a 25 PPM residual, the above disinfection process shall be repeated.
    - g. After satisfactory completion of the residual testing, flush out system until Hach or equivalent test reveal the water outlets have a free chlorine residual concentration less than 0.5 PPM. The procedure shall be in accordance with the AWWA standard C651-05.
    - h. The OAR may allow temporary use of the water system for construction purposes pending results of the bacteriological test analysis. Sign or Tags shall be left on all outlets stating water system is not safe for consumption until laboratory results are complete and meet these specifications.
  2. 3 Hour Test Method:
    - a. If the water systems must be turned on for use as soon as possible, a 3 hours chlorine contact time to allow for disinfection is permitted with the OAR's approval.
    - b. Prior to disinfection, post signs on all water outlets of the system to be disinfected. Sign or tags shall read, "Water System Being Chlorinated- "Danger Do Not Drink Water" or similar warning.

- c. Piping system shall be then adequately flushed with water to remove any particles and eliminate air pockets. Using the continuous feed method, sodium hypochlorite conforming to ANSI/ AWWA B300 will be injected into the water system at a minimum of 200 PPM. A water flow meter provided by the water treatment technician will be used to determine the rate of injection and a chlorine test kit, Hach or equivalent, will be used to monitor the residual.
- d. Chlorine residual test will be taken at all appropriate points and outlets to verify 200 PPM levels. The chlorinated system shall be shut down for any use and the chlorinated water shall remain in the water system for retention of 3 hours.
- e. After satisfactory completion of a 3 hour disinfection period, flush out system until Hach or equivalent test reveal the water outlets have a free chlorine residual concentration less than 0.5 PPM. The procedure shall be in accordance with the AWWA standard C651-05.
- f. The OAR may allow temporary use of the water system for construction purposes pending results of the bacteriological test analysis. Sign or Tags shall be left on all outlets stating water system is not safe for consumption until laboratory results are complete and meet these specifications.

E. Bacteriological Test:

- 1. After final flushing and satisfactory results from the residual free chlorine concentration test, Bacteriological test samples shall be collected. The intent of the following is to provide insurance for an accurate representation to a complete Bacteriological test of the water system. At least two samples shall be taken from each floor of each building.
- 2. Bacteriological test samples shall be delivered to a State of California Department of Health Services Certified Laboratory to perform qualitative and quantitative bacterial analyses on the water samples for the presence of any Total Coliform bacteria and Plate Count. This count must be less than 500 cfu/mL.
- 3. The procedure shall be repeated if it shown by bacteriological examination made by an approved agency that the level of Disinfection does not meet these specifications.
- 4. After satisfactory results for the bacteriological test are provided to the OAR, warning sign or tags shall be removed.

F. Drinking Fountain and Bottle Filler Lead Test: After installation of Drinking Fountain or Bottle Filler, and successful Disinfection Test, shut off domestic water supply line feeding the fixture, and inform OAR. OAR will coordinate with the Drinking Water Quality Program (DWQP) Supervisor in local Project Unit and M&O's Plumbing Technical Unit Supervisor to conduct lead detection test, and mitigate as necessary. Do not remove related construction warning sign and tags.

3.13 VALVES ON PLUMBING SYSTEM

- A. Furnish and install gates, ball, globes, angles, and check valves on plumbing Work at following locations whether indicated on drawings or not.
- B. Hot and cold valves shall be:
  - 1. Lead free complying with AB1953.
  - 2. Above the ground copper water system, 2-inch and larger, may utilize Victaulic butterfly valves and fittings for their connections. A 2-inch or larger Victaulic valve may be in a wall if an adequately sized access panel is provided for maintenance or removal.
- C. Valves shall be accessible and installed within an access panel approximately 3 feet above floor and no more than 7 feet above floor, or in a marked yard box to prevent tampering.
  - 1. Immediately after each water meter, in addition to any valve furnished by utility company, there shall be an accessible valve on the inlet side for a strainer assembly, dual backflow device assembly and/or possibly a dual pressure reducing valve assembly.
  - 2. A gate or ball valve on each water supply before it enters building. Valves shall be accessible from outside building and shall be installed in a marked yard box, unless otherwise indicated on drawings. Ball valves 2 ½-inch size or larger shall omit gate valve handle and furnish 2-inch square operating nut.
  - 3. Install a gate or ball valve on each building branch line, which serves two or more fixtures, when these fixtures are not provided with a group isolation valve as specified above. These valves shall be located approximately 3 feet but not more than 7 feet above finish floor.
  - 4. Install a gate, ball valve or partition stop for hot and cold water supply to plumbing fixtures with no accessible supply stops, such as wall mounted faucets.
  - 5. Install a gate, ball valve or partition stop for stops adjacent to, and controlling water flow to each sill cock and hose bib except as follows:
    - a. A sill cock immediately below an exterior drinking fountain may be controlled by the same gate, ball valve or partition stop as drinking fountain.
    - b. Valves or stops will not be required for individual hose bibs when these hose bibs are on a branch line serving only hose bibs and branch line is furnished with a shut-off valve.
  - 6. Install a lose key angle stop, on each exposed fixture supply, and for each flush valve unless otherwise specified,
  - 7. Install gate or ball valve at each location where a water line is connected to a piece of equipment other than items mentioned above.
  - 8. Provide a handle or a key for each five, or fraction thereof, loose key valves, bibs, or stops and deliver them to the project OAR.

3.14

VALVES - GAS SERVICE

- A. A gas readily accessible shut-off stop shall be installed on each gas line entering a building immediately prior to the point it enters the building. Unless otherwise specified or indicated, shut-off valves for lines entering a permanent structure, buildings or portable buildings, shall be installed in a vertical riser above grade.
  - 1. Gas shut off valve for portable buildings – A dedicated Gas shut off valve shall be provided in a marked Yard Box, for each portable building to facilitate relocation/removal of building without the need to shut off gas to entire school.
- B. Gas Shut off valve within a building – A gas shut off valve with handles shall be accessible and serviceable within an access panel. Install valve minimum 3 feet above floor but less than 7 feet above floor.
- C. In addition to locations specified, gas shut off valve shall be installed at following locations:
  - 1. Install a lubricated plug gas shut off valve on any line connected to gas main or header at master assembly.
  - 2. Install a lubricated plug gas shut off valve before entering any building or structure.
  - 3. Install a gas valve on each outlet, in addition to any gas stop furnished with equipment.
  - 4. Service to laboratory gas cocks shall be furnished with a special precision check valve, located downstream from gas stop servicing room outlet at each laboratory cock. Unless otherwise specified, 1/8-inches bore shall be provided for each outlet cock.
  - 5. Install a gas shut-off valve on each gas line serving 2 or more gas outlets in same room. Service stop shall be installed not more than 7 feet above floor, and shall be in the room it serves.
  - 6. Install a gas shut-off valve on inlet side of each gas pressure regulating valve.
  - 7. Gas shut-off valves to be furnished with equipment.
  - 8. Install gas shut-off valve at not more than 1,000 foot intervals on each gas main.
  - 9. At multi-story buildings, provide gas-shut off valve(s) to isolate and control each floor or level. Install valves in a concealed manner in walls with access panels.
  - 10. Gas shut-off valves in classrooms and locations subject to tampering shall be protected while remaining accessible.
- D. When a gas-shut off valve adjacent to gas-fired equipment is indicated in Contract Documents it shall be furnished and installed as part of Work of this section.
- E. When electrical wall switches with emergency push button are specified for controlling gas outlets at Laboratory Classrooms, provide main shut-off gas valve with normally closed electric solenoid valve within an accessible access panel.

### 3.15 ELECTROLYSIS PREVENTION

- A. Brass nipples, 6 inches, with recognized brass unions; flanges shall be furnished and installed at locations described herein. Flanges shall be installed with complete insulating component consisting of gasket bolt sleeves and bolt washers. Dielectric insulators shall be installed at following locations:
  - 1. Where special applications indicated on Drawings require an insulation flange or brass union, with 6-inch brass nipple to be installed in a condensate line, or steam line, flange insulation shall be of a high temperature type, suitable for continuous operation at temperatures up to 220 degrees F. for condensate and 400 degrees F. for steam.
  - 2. Where steel or cast iron in ground connects to copper or brass piping above ground, transition from steel or cast iron pipe to copper or brass pipe shall be provided in an accessible location.
  - 3. Underground dielectric connections shall be furnished in accessible yard boxes.
  - 4. Above ground dielectric connections shall be exposed; or if in finished rooms shall be located in accessible access boxes.

### 3.16 UNDERGROUND PIPE MARKERS

- A. Pipe markers shall be furnished according to Section 22 05 53: "Plumbing Identification"
- B. Under ground Caution Tape shall be placed 12 to 18 inches above the utility line. The Caution Tape shall be a designated color and marked with the appropriate name for the specific type of utility pipe as follows:
  - 1. Yellow – with the words: CAUTION GAS LINE BELOW
  - 2. Blue – with the words: CAUTION WATER LINE BELOW

### 3.17 HOT WATER CIRCULATING PUMPS (NOT USED)

### 3.18 WATER TEMPERATURE CONTROLLERS (NOT USED)

### 3.19 DEPTH OF SEWER LINES

- A. Minimum depth of below grade sewer lines shall be 24 inches to centerline of pipe. Sewer lines shall slope  $\frac{1}{4}$  inch per foot minimum, unless otherwise indicated. Minimum depth at Owner property line shall be 6 feet, unless otherwise required.

### 3.20 BACKFLOW PREVENTION DEVICES

- A. Backflow Devices: Installation of backflow devices shall be tested and certified by Ventura County backflow device tester before Substantial Completion. Tests shall be performed in presence of Project Inspector. Test reports shall be turned over to Project Inspector for mailing to proper agency.

### 3.21 CLEANUP

- A. Remove rubbish, debris, and waste materials and legally dispose off Project site.

3.22 PROTECTION

- A. Protect Work of this section until Substantial Completion.

END OF SECTION

## SECTION 23 05 00

### COMMON WORK RESULTS FOR HVAC

#### PART 1 GENERAL

##### 1.1 RELATED DOCUMENTS

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

##### 1.2 SUMMARY

- a. This Section includes the following:
  - 1) Piping materials and installation instructions common to most piping systems.
  - 2) Transition fittings.
  - 3) Dielectric fittings.
  - 4) Mechanical sleeve seals.
  - 5) Sleeves.
  - 6) Escutcheons.
  - 7) Grout.
  - 8) HVAC demolition.
  - 9) Equipment installation requirements common to equipment sections.
  - 10) Painting and finishing.
  - 11) Concrete bases.
  - 12) Supports and anchorages.

##### 1.3 DEFINITIONS

- a. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.
- b. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

- c. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- d. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and chases.
- e. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.
- f. The following are industry abbreviations for plastic materials:
  - 1) CPVC: Chlorinated polyvinyl chloride plastic.
  - 2) PE: Polyethylene plastic.
  - 3) PVC: Polyvinyl chloride plastic.
- g. The following are industry abbreviations for rubber materials:
  - 1) EPDM: Ethylene-propylene-diene terpolymer rubber.
  - 2) NBR: Acrylonitrile-butadiene rubber.

#### 1.4 SUBMITTALS

- a. Product Data: For the following:
  - 1) Transition fittings.
  - 2) Dielectric fittings.
  - 3) Mechanical sleeve seals.
  - 4) Escutcheons.
- b. Welding certificates.

#### 1.5 QUALITY ASSURANCE

- a. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."
- b. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
  - 1) Comply with provisions in ASME B31 Series, "Code for Pressure Piping."

- 2) Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.
- c. Electrical Characteristics for HVAC Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

#### 1.6 DELIVERY, STORAGE, AND HANDLING

- a. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.
- b. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

#### 1.7 COORDINATION

- a. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for HVAC installations.
- b. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.
- c. Coordinate requirements for access panels and doors for HVAC items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section "Access Doors and Frames."

### **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) Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the manufacturers specified.
  - 2) Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

#### 2.2 PIPE, TUBE, AND FITTINGS

- a. Refer to individual Division 23 piping Sections for pipe, tube, and fitting materials and joining methods.
- b. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

## 2.3 JOINING MATERIALS

- a. Refer to individual Division 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 maximum thickness unless thickness or specific material is indicated.
    - a) Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
    - b) Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
  - 2) AWWA C110, rubber, flat face, 1/8 inch thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.
- c. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
- d. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.
- e. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
- f. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.
- g. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
- h. Solvent Cements for Joining Plastic Piping:
  - 1) CPVC Piping: ASTM F 493.
  - 2) PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.
- i. Fiberglass Pipe Adhesive: As furnished or recommended by pipe manufacturer.

## 2.4 DIELECTRIC FITTINGS

- a. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.
- b. Insulating Material: Suitable for system fluid, pressure, and temperature.

- c. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig minimum working pressure at 180 deg F.
  - 1) Manufacturers:
    - a) Capitol Manufacturing Co.
    - b) Central Plastics Company.
    - c) Eclipse, Inc.
    - d) Epco Sales, Inc.
    - e) Hart Industries, International, Inc.
    - f) Watts Industries, Inc.; Water Products Div.
    - g) Zurn Industries, Inc.; Wilkins Div.
  
- d. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.
  - 1) Manufacturers:
    - a) Capitol Manufacturing Co.
    - b) Central Plastics Company.
    - c) Epco Sales, Inc.
    - d) Watts Industries, Inc.; Water Products Div.
  
- e. Dielectric-Flange Kits: Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.
  - 1) Manufacturers:
    - a) Advance Products & Systems, Inc.
    - b) Calpico, Inc.
    - c) Central Plastics Company.
    - d) Pipeline Seal and Insulator, Inc.
  - 2) Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig minimum working pressure where required to suit system pressures.
  
- f. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.

- 1) Manufacturers:
  - a) Calpico, Inc.
  - b) Lochinvar Corp.
- g. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 deg F.
  - 1) Manufacturers:
    - a) Perfection Corp.
    - b) Precision Plumbing Products, Inc.
    - c) Sioux Chief Manufacturing Co., Inc.
    - d) Victaulic Co. of America.

## 2.5 MECHANICAL SLEEVE SEALS

- a. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
  - 1) Manufacturers:
    - a) Advance Products & Systems, Inc.
    - b) Calpico, Inc.
    - c) Metraflex Co.
    - d) Pipeline Seal and Insulator, Inc.
  - 2) Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
  - 3) Pressure Plates: Stainless steel. Include two for each sealing element.
  - 4) Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

## 2.6 SLEEVES

- a. Galvanized-Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.
- b. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.

- c. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
- d. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
  - 1) Underdeck Clamp: Clamping ring with set screws.
- e. Molded PVC: Permanent, with nailing flange for attaching to wooden forms.
- f. PVC Pipe: ASTM D 1785, Schedule 40.
- g. Molded PE: Reusable, PE, tapered-cup shaped, and smooth-outer surface with nailing flange for attaching to wooden forms.

## 2.7 ESCUTCHEONS

- a. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.
- b. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chrome-plated finish.
- c. One-Piece, Cast-Brass Type: With set screw.
  - 1) Finish: Polished chrome-plated.
- d. Split-Casting, Cast-Brass Type: With concealed hinge and set screw.
  - 1) Finish: Polished chrome-plated.
- e. One-Piece, Stamped-Steel Type: With set screw or spring clips and chrome-plated finish.
- f. Split-Plate, Stamped-Steel Type: With concealed hinge, set screw, and chrome-plated finish.
- g. One-Piece, Floor-Plate Type: Cast-iron floor plate.
- h. Split-Casting, Floor-Plate Type: Cast brass with concealed hinge and set screw.

## 2.8 GROUT

- a. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.
  - 1) Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
  - 2) Design Mix: 5000-psi, 28-day compressive strength.

- 3) Packaging: Premixed and factory packaged.

## **PART 3 EXECUTION**

### **3.1 HVAC DEMOLITION**

- a. Refer to Division 01 Section "Cutting and Patching" and Division 02 Section "Selective Structure Demolition" for general demolition requirements and procedures.
- b. Disconnect, demolish, and remove HVAC systems, equipment, and components indicated to be removed.
  - 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 with same or compatible piping material.
  - 3) Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug 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: Disconnect and cap 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.

### **3.2 PIPING SYSTEMS - COMMON REQUIREMENTS**

- a. Install piping according to the following requirements and Division 23 Sections specifying piping systems.
- b. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- c. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

- d. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- e. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- f. Install piping to permit valve servicing.
- g. Install piping at indicated slopes.
- h. Install piping free of sags and bends.
- i. Install fittings for changes in direction and branch connections.
- j. Install piping to allow application of insulation.
- k. Select system components with pressure rating equal to or greater than system operating pressure.
- l. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:
  - 1) New Piping:
    - a) Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
    - b) Chrome-Plated Piping: One-piece, cast-brass type with polished chrome-plated finish.
    - c) Insulated Piping: One-piece, stamped-steel type with spring clips.
    - d) Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
    - e) Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
    - f) Bare Piping in Unfinished Service Spaces: One-piece, stamped-steel type with concealed hinge and set screw or spring clips.
    - g) Bare Piping in Equipment Rooms: One-piece, cast-brass type.
    - h) Bare Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.
- m. Permanent sleeves are not required for holes formed by removable PE sleeves.
- n. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.

- 1) Cut sleeves to length for mounting flush with both surfaces.
    - a) Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
  - 2) Install sleeves in new walls and slabs as new walls and slabs are constructed.
  - 3) Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
    - a) PVC Pipe Sleeves: For pipes smaller than NPS 6.
    - b) Steel Sheet Sleeves: For pipes NPS 6 and larger, penetrating gypsum-board partitions.
    - c) Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level. Refer to Division 07 Section "Sheet Metal Flashing and Trim" for flashing.
- 1) Seal space outside of sleeve fittings with grout.
- 4) Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Refer to Division 07 Section "Joint Sealants" for materials and installation.
- o. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
    - 1) Install steel pipe for sleeves smaller than 6 inches in diameter.
    - 2) Install cast-iron "wall pipes" for sleeves 6 inches and larger in diameter.
    - 3) Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
  - p. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
    - 1) Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in

center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

- q. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 07 Section "Penetration Firestopping" for materials.
- r. Verify final equipment locations for roughing-in.
- s. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

### 3.3 PIPING JOINT CONSTRUCTION

- a. Join pipe and fittings according to the following requirements and Division 23 Sections specifying piping systems.
- b. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- c. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- d. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.
- e. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.
- f. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
  - 1) Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
  - 2) Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- g. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.
- h. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

- i. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
  - 1) Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
  - 2) CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
  - 3) PVC Pressure Piping: Join schedule number ASTM D 1785, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D 2855.
  - 4) PVC Nonpressure Piping: Join according to ASTM D 2855.
- j. Plastic Pressure Piping Gasketed Joints: Join according to ASTM D 3139.
- k. Plastic Nonpressure Piping Gasketed Joints: Join according to ASTM D 3212.
- l. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657.
  - 1) Plain-End Pipe and Fittings: Use butt fusion.
  - 2) Plain-End Pipe and Socket Fittings: Use socket fusion.
- m. Fiberglass Bonded Joints: Prepare pipe ends and fittings, apply adhesive, and join according to pipe manufacturer's written instructions.

### 3.4 PIPING CONNECTIONS

- a. Make connections according to the following, unless otherwise indicated:
  - 1) Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
  - 2) Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.
  - 3) Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.
  - 4) Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

### 3.5 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

- a. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.
- b. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.

- c. Install HVAC equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.
- d. Install equipment to allow right of way for piping installed at required slope.

### 3.6 PAINTING

- a. Painting of HVAC systems, equipment, and components is specified in Division 09 Sections "Interior Painting" and "Exterior Painting."
- b. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

### 3.7 CONCRETE BASES

- a. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.
  - 1) Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.
  - 2) Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.
  - 3) Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
  - 4) Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
  - 5) Install anchor bolts to elevations required for proper attachment to supported equipment.
  - 6) Install anchor bolts according to anchor-bolt manufacturer's written instructions.
  - 7) Use 3000-psi, 28-day compressive-strength concrete and reinforcement as specified in Division 03 Section "Cast-in-Place Concrete."

### 3.8 ERECTION OF METAL SUPPORTS AND ANCHORAGES

- a. Refer to Division 05 Section "Metal Fabrications" for structural steel.
- b. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor HVAC materials and equipment.
- c. Field Welding: Comply with AWS D1.1.

### 3.9 ERECTION OF WOOD SUPPORTS AND ANCHORAGES

- a. Cut, fit, and place wood grounds, nailers, blocking, and anchorages to support, and anchor HVAC materials and equipment.
- b. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.
- c. Attach to substrates as required to support applied loads.

### 3.10 GROUTING

- a. Mix and install grout for HVAC equipment base bearing surfaces, pump and other equipment base plates, and anchors.
- b. Clean surfaces that will come into contact with grout.
- c. Provide forms as required for placement of grout.
- d. Avoid air entrapment during placement of grout.
- e. Place grout, completely filling equipment bases.
- f. Place grout on concrete bases and provide smooth bearing surface for equipment.
- g. Place grout around anchors.
- h. Cure placed grout.

END OF SECTION 23 05 00

## SECTION 23 05 13

### COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

#### PART 1 GENERAL

##### 1.1 RELATED DOCUMENTS

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

##### 1.2 SUMMARY

- a. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on ac power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

##### 1.3 COORDINATION

- a. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:
  - 1) Motor controllers.
  - 2) Torque, speed, and horsepower requirements of the load.
  - 3) Ratings and characteristics of supply circuit and required control sequence.
  - 4) Ambient and environmental conditions of installation location.

#### PART 2 PRODUCTS

##### 2.1 GENERAL MOTOR REQUIREMENTS

- a. Comply with requirements in this Section except when stricter requirements are specified in HVAC equipment schedules or Sections.
- b. Comply with NEMA MG 1 unless otherwise indicated.
- c. Comply with IEEE 841 for severe-duty motors.

##### 2.2 MOTOR CHARACTERISTICS

- a. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet above sea level.
- b. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

## 2.3 SINGLE-PHASE MOTORS

- a. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:
  - 1) Permanent-split capacitor.
  - 2) Split phase.
  - 3) Capacitor start, inductor run.
  - 4) Capacitor start, capacitor run.
- b. Multispeed Motors: Variable-torque, permanent-split-capacitor type.
- c. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.
- d. Motors 1/20 HP and Smaller: Shaded-pole type.
- e. 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.

### **PART 3 EXECUTION (Not Applicable)**

END OF SECTION 23 05 13

## SECTION 23 05 29

### HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

#### PART 1 GENERAL

##### 1.1 RELATED DOCUMENTS

- a. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

##### 1.2 SUMMARY

- a. This Section includes the following hangers and supports for HVAC system piping and equipment:
  - 1) Steel pipe hangers and supports.
  - 2) Trapeze pipe hangers.
  - 3) Metal framing systems.
  - 4) Thermal-hanger shield inserts.
  - 5) Fastener systems.
  - 6) Pipe stands.
  - 7) Equipment supports.
- b. Related Sections include the following:
  - 1) Division 05 Section "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
  - 2) Division 21 Section "Water-Based Fire-Suppression Systems" for pipe hangers for fire-protection piping.
  - 3) Division 23 Section "Expansion Fittings and Loops for HVAC Piping" for pipe guides and anchors.
  - 4) Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment" for vibration isolation devices.
  - 5) Division 23 Section(s) "Metal Ducts" for duct hangers and supports.

##### 1.3 DEFINITIONS

- a. MSS: Manufacturers Standardization Society for The Valve and Fittings Industry Inc.
- b. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

#### 1.4 PERFORMANCE REQUIREMENTS

- a. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
- b. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
- c. Design seismic-restraint hangers and supports for piping and equipment and obtain approval from authorities having jurisdiction.

#### 1.5 SUBMITTALS

- a. Product Data: For the following:
  - 1) Steel pipe hangers and supports.
  - 2) Fiberglass pipe hangers.
  - 3) Thermal-hanger shield inserts.
  - 4) Powder-actuated fastener systems.
- b. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following:
  - 1) Trapeze pipe hangers. Include Product Data for components.
  - 2) Metal framing systems. Include Product Data for components.
  - 3) Fiberglass strut systems. Include Product Data for components.
  - 4) Pipe stands. Include Product Data for components.
  - 5) Equipment supports.
- c. Welding certificates.

#### 1.6 QUALITY ASSURANCE

- a. Welding: Qualify procedures and personnel according to the following:
  - 1) AWS D1.1, "Structural Welding Code--Steel."
  - 2) AWS D1.3, "Structural Welding Code--Sheet Steel."
  - 3) AWS D1.4, "Structural Welding Code--Reinforcing Steel."
  - 4) ASME Boiler and Pressure Vessel Code: Section IX.

## **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 STEEL PIPE HANGERS AND SUPPORTS**

- a. Description: MSS SP-58, Types 1 through 58, factory-fabricated components. Refer to Part 3 "Hanger and Support Applications" Article for where to use specific hanger and support types.
- b. Manufacturers:
  - 1) AAA Technology & Specialties Co., Inc.
  - 2) Bergen-Power Pipe Supports.
  - 3) B-Line Systems, Inc.; a division of Cooper Industries.
  - 4) Carpenter & Paterson, Inc.
  - 5) Empire Industries, Inc.
  - 6) ERICO/Michigan Hanger Co.
  - 7) Globe Pipe Hanger Products, Inc.
  - 8) Grinnell Corp.
  - 9) GS Metals Corp.
  - 10) National Pipe Hanger Corporation.
  - 11) PHD Manufacturing, Inc.
  - 12) PHS Industries, Inc.
  - 13) Piping Technology & Products, Inc.
  - 14) Tolco Inc.
- c. Galvanized, Metallic Coatings: Pregalvanized or hot dipped.
- d. Nonmetallic Coatings: Plastic coating, jacket, or liner.
- e. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion for support of bearing surface of piping.

### 2.3 TRAPEZE PIPE HANGERS

- a. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural-steel shapes with MSS SP-58 hanger rods, nuts, saddles, and U-bolts.

### 2.4 METAL FRAMING SYSTEMS

- a. Description: MFMA-3, shop- or field-fabricated pipe-support assembly made of steel channels and other components.
- b. Manufacturers:
  - 1) B-Line Systems, Inc.; a division of Cooper Industries.
  - 2) ERICO/Michigan Hanger Co.; ERISTRUT Div.
  - 3) GS Metals Corp.
  - 4) Power-Strut Div.; Tyco International, Ltd.
  - 5) Thomas & Betts Corporation.
  - 6) Tolco Inc.
  - 7) Unistrut Corp.; Tyco International, Ltd.
- c. Coatings: Manufacturer's standard finish, unless bare metal surfaces are indicated.
- d. Nonmetallic Coatings: Plastic coating, jacket, or liner.

### 2.5 THERMAL-HANGER SHIELD INSERTS

- a. Description: 100-psig- minimum, compressive-strength insulation insert encased in sheet metal shield.
- b. Manufacturers:
  - 1) Carpenter & Paterson, Inc.
  - 2) ERICO/Michigan Hanger Co.
  - 3) PHS Industries, Inc.
  - 4) Pipe Shields, Inc.
  - 5) Rilco Manufacturing Company, Inc.
  - 6) Value Engineered Products, Inc.
- c. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate or ASTM C 552, Type II cellular glass.
- d. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.

- e. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
- f. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

## 2.6 FASTENER SYSTEMS

- a. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
  - 1) Manufacturers:
    - a) Hilti, Inc.
    - b) ITW Ramset/Red Head.
    - c) Masterset Fastening Systems, Inc.
    - d) MKT Fastening, LLC.
    - e) Powers Fasteners.
- b. Mechanical-Expansion Anchors: Insert-wedge-type stainless steel, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
  - 1) Manufacturers:
    - a) B-Line Systems, Inc.; a division of Cooper Industries.
    - b) Empire Industries, Inc.
    - c) Hilti, Inc.
    - d) ITW Ramset/Red Head.
    - e) MKT Fastening, LLC.
    - f) Powers Fasteners.

## 2.7 PIPE STAND FABRICATION

- a. Pipe Stands, General: Shop or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.
- b. Compact Pipe Stand: One-piece plastic unit with integral-rod-roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.
  - 1) Manufacturers:
    - a) ERICO/Michigan Hanger Co.
    - b) MIRO Industries.

- c. Low-Type, Single-Pipe Stand: One-piece stainless-steel base unit with plastic roller, for roof installation without membrane penetration.
  - 1) Manufacturers:
    - a) MIRO Industries.
- d. High-Type, Single-Pipe Stand: Assembly of base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.
  - 1) Manufacturers:
    - a) ERICO/Michigan Hanger Co.
    - b) MIRO Industries.
    - c) Portable Pipe Hangers.
  - 2) Base: Stainless steel.
  - 3) Vertical Members: Two or more cadmium-plated-steel or stainless-steel, continuous-thread rods.
  - 4) Horizontal Member: Cadmium-plated-steel or stainless-steel rod with plastic or stainless-steel, roller-type pipe support.
- e. High-Type, Multiple-Pipe Stand: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.
  - 1) Manufacturers:
    - a) Portable Pipe Hangers.
  - 2) Bases: One or more plastic.
  - 3) Vertical Members: Two or more protective-coated-steel channels.
  - 4) Horizontal Member: Protective-coated-steel channel.
  - 5) Pipe Supports: Galvanized-steel, clevis-type pipe hangers.
- f. Curb-Mounting-Type Pipe Stands: Shop- or field-fabricated pipe support made from structural-steel shape, continuous-thread rods, and rollers for mounting on permanent stationary roof curb.

## 2.8 EQUIPMENT SUPPORTS

- a. Description: Welded, shop- or field-fabricated equipment support made from structural-steel shapes.

## 2.9 MISCELLANEOUS MATERIALS

- a. Structural Steel: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

- b. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
  - 1) Properties: Nonstaining, noncorrosive, and nongaseous.
  - 2) Design Mix: 5000-psi, 28-day compressive strength.

### **PART 3 EXECUTION**

#### **3.1 HANGER AND SUPPORT APPLICATIONS**

- a. Specific hanger and support requirements are specified in Sections specifying piping systems and equipment.
- b. Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping system Sections.
- c. Use hangers and supports with galvanized, metallic coatings for piping and equipment that will not have field-applied finish.
- d. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- e. Use padded hangers for piping that is subject to scratching.
- f. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
  - 1) Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated stationary pipes, NPS 1/2 to NPS 30.
  - 2) Yoke-Type Pipe Clamps (MSS Type 2): For suspension of 120 to 450 deg F pipes, NPS 4 to NPS 16, requiring up to 4 inches of insulation.
  - 3) Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes, NPS 3/4 to NPS 24, requiring clamp flexibility and up to 4 inches of insulation.
  - 4) Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes, NPS 1/2 to NPS 24, if little or no insulation is required.
  - 5) Pipe Hangers (MSS Type 5): For suspension of pipes, NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
  - 6) Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated stationary pipes, NPS 3/4 to NPS 8.
  - 7) Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8.
  - 8) Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8.
  - 9) Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 2.

- 10) Split Pipe-Ring with or without Turnbuckle-Adjustment Hangers (MSS Type 11): For suspension of noninsulated stationary pipes, NPS 3/8 to NPS 8.
  - 11) Extension Hinged or 2-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated stationary pipes, NPS 3/8 to NPS 3.
  - 12) U-Bolts (MSS Type 24): For support of heavy pipes, NPS 1/2 to NPS 30.
  - 13) Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
  - 14) Pipe Saddle Supports (MSS Type 36): For support of pipes, NPS 4 to NPS 36, with steel pipe base stanchion support and cast-iron floor flange.
  - 15) Pipe Stanchion Saddles (MSS Type 37): For support of pipes, NPS 4 to NPS 36, with steel pipe base stanchion support and cast-iron floor flange and with U-bolt to retain pipe.
  - 16) Adjustable, Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes, NPS 2-1/2 to NPS 36, if vertical adjustment is required, with steel pipe base stanchion support and cast-iron floor flange.
  - 17) Single Pipe Rolls (MSS Type 41): For suspension of pipes, NPS 1 to NPS 30, from 2 rods if longitudinal movement caused by expansion and contraction might occur.
  - 18) Adjustable Roller Hangers (MSS Type 43): For suspension of pipes, NPS 2-1/2 to NPS 20, from single rod if horizontal movement caused by expansion and contraction might occur.
  - 19) Complete Pipe Rolls (MSS Type 44): For support of pipes, NPS 2 to NPS 42, if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
  - 20) Pipe Roll and Plate Units (MSS Type 45): For support of pipes, NPS 2 to NPS 24, if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.
  - 21) Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes, NPS 2 to NPS 30, if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.
- g. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
- 1) Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers, NPS 3/4 to NPS 20.
  - 2) Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers, NPS 3/4 to NPS 20, if longer ends are required for riser clamps.
- h. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

- 1) Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
  - 2) Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
  - 3) Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
  - 4) Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
  - 5) Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.
- i. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
- 1) Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
  - 2) Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction to attach to top flange of structural shape.
  - 3) Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
  - 4) Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
  - 5) Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
  - 6) C-Clamps (MSS Type 23): For structural shapes.
  - 7) Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
  - 8) Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
  - 9) Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
  - 10) Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
  - 11) Malleable Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
  - 12) Welded-Steel Brackets: For support of pipes from below, or for suspending from above by using clip and rod. Use one of the following for indicated loads:
    - a) Light (MSS Type 31): 750 lb.
    - b) Medium (MSS Type 32): 1500 lb.

- c) Heavy (MSS Type 33): 3000 lb.
- 13) Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
- 14) Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
- 15) Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.
- j. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
  - 1) Steel Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
  - 2) Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
  - 3) Thermal-Hanger Shield Inserts: For supporting insulated pipe.
- k. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
  - 1) Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
  - 2) Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
  - 3) Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41 roll hanger with springs.
  - 4) Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
  - 5) Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from hanger.
  - 6) Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from base support.
  - 7) Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from trapeze support.
  - 8) Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:
    - a) Horizontal (MSS Type 54): Mounted horizontally.
    - b) Vertical (MSS Type 55): Mounted vertically.

- c) Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.
- l. Comply with MSS SP-69 for trapeze pipe hanger selections and applications that are not specified in piping system Sections.
- m. Comply with MFMA-102 for metal framing system selections and applications that are not specified in piping system Sections.
- n. Use powder-actuated fasteners instead of building attachments where required in concrete construction.

### 3.2 HANGER AND SUPPORT INSTALLATION

- a. Steel Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.
- b. Trapeze Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping and support together on field-fabricated trapeze pipe hangers.
  - 1) Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified above for individual pipe hangers.
  - 2) Field fabricate from ASTM A 36/A 36M, steel shapes selected for loads being supported. Weld steel according to AWS D1.1.
- c. Fiberglass Pipe Hanger Installation: Comply with applicable portions of MSS SP-69 and MSS SP-89. Install hangers and attachments as required to properly support piping from building structure.
- d. Metal Framing System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled metal framing systems.
- e. Fiberglass Strut System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled fiberglass struts.
- f. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.
- g. Fastener System Installation:
  - 1) Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
  - 2) Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- h. Pipe Stand Installation:

- 1) Pipe Stand Types except Curb-Mounting Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
  - 2) Curb-Mounting-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. Refer to Division 07 Section "Roof Accessories" for curbs.
- i. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.
  - j. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
  - k. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
  - l. Install lateral bracing with pipe hangers and supports to prevent swaying.
  - m. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.
  - n. Load Distribution: Install hangers and supports so piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
  - o. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.1 (for power piping) and ASME B31.9 (for building services piping) are not exceeded.
  - p. Insulated Piping: Comply with the following:
    - 1) Attach clamps and spacers to piping.
      - a) Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
      - b) Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
      - c) Do not exceed pipe stress limits according to ASME B31.1 for power piping and ASME B31.9 for building services piping.
    - 2) Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
      - a) Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
    - 3) Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.

- a) Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
- 4) Shield Dimensions for Pipe: Not less than the following:
  - a) NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
  - b) NPS 4: 12 inches long and 0.06 inch thick.
  - c) NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
  - d) NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
  - e) NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.
- 5) Pipes NPS 8 and Larger: Include wood inserts.
- 6) Insert Material: Length at least as long as protective shield.
- 7) Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

### 3.3 EQUIPMENT SUPPORTS

- a. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.
- b. Grouting: Place grout under supports for equipment and make smooth bearing surface.
- c. Provide lateral bracing, to prevent swaying, for equipment supports.

### 3.4 METAL FABRICATIONS

- a. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.
- b. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
- c. Field Welding: Comply with AWS D1.1 procedures for shielded metal arc welding, appearance and quality of welds, and methods used in correcting welding work, and with the following:
  - 1) Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
  - 2) Obtain fusion without undercut or overlap.
  - 3) Remove welding flux immediately.
  - 4) Finish welds at exposed connections so no roughness shows after finishing and contours of welded surfaces match adjacent contours.

### 3.5 ADJUSTING

- a. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- b. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches

### 3.6 PAINTING

- a. Touch Up: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
  - 1) Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.
- b. Touch Up: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 09 painting Sections.
- c. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 23 05 29

## SECTION 23 05 48

### VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT

#### PART 1 GENERAL

##### 1.1 RELATED DOCUMENTS

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

##### 1.2 SUMMARY

- a. This Section includes the following:
  - 1) Isolation pads.
  - 2) Isolation mounts.
  - 3) Restrained elastomeric isolation mounts.
  - 4) Freestanding and restrained spring isolators.
  - 5) Housed spring mounts.
  - 6) Elastomeric hangers.
  - 7) Spring hangers.
  - 8) Spring hangers with vertical-limit stops.
  - 9) Pipe riser resilient supports.
  - 10) Resilient pipe guides.
  - 11) Seismic snubbers.
  - 12) Restraining braces and cables.
  - 13) Steel vibration isolation equipment bases.

##### 1.3 DEFINITIONS

- a. IBC: International Building Code.
- b. ICC-ES: ICC-Evaluation Service.
- c. OSHPD: Office of Statewide Health Planning and Development for the State of California.

##### 1.4 PERFORMANCE REQUIREMENTS

- a. Seismic-Restraint Loading:

- 1) Site Class as Defined in the CBC.

## 1.5 SUBMITTALS

- a. Product Data: For the following:
  - 1) Include rated load, rated deflection, and overload capacity for each vibration isolation device.
  - 2) Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of seismic-restraint component used.
    - a) Tabulate types and sizes of seismic restraints, complete with report numbers and rated strength in tension and shear as evaluated by an agency acceptable to authorities having jurisdiction.
    - b) Annotate to indicate application of each product submitted and compliance with requirements.
  - 3) Interlocking Snubbers: Include ratings for horizontal, vertical, and combined loads.
- b. Delegated-Design Submittal: For vibration isolation and seismic-restraint details indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
  - 1) Design Calculations: Calculate static and dynamic loading due to equipment weight and operation, seismic forces required to select vibration isolators, seismic restraints, and for designing vibration isolation bases.
    - a) Coordinate design calculations with wind load calculations required for equipment mounted outdoors.
  - 2) Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, spring deflection changes, and seismic loads. Include certification that riser system has been examined for excessive stress and that none will exist.
  - 3) Vibration Isolation Base Details: Detail overall dimensions, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, base weights, equipment static loads, power transmission, component misalignment, and cantilever loads.
  - 4) Seismic-Restraint Details:
    - a) Design Analysis: To support selection and arrangement of seismic restraints. Include calculations of combined tensile and shear loads.
    - b) Details: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices.

- c) Preapproval and Evaluation Documentation: By an agency acceptable to authorities having jurisdiction, showing maximum ratings of restraint items and the basis for approval (tests or calculations).
- c. Coordination Drawings: Show coordination of seismic bracing for HVAC piping and equipment with other systems and equipment in the vicinity, including other supports and seismic restraints.
- d. Welding certificates.
- e. Qualification Data: For testing agency.
- f. Field quality-control test reports.
- g. Operation and Maintenance Data: For air-mounting systems to include in operation and maintenance manuals.

## 1.6 QUALITY ASSURANCE

- a. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
- b. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.
- c. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- d. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear anchorage preapproval OPA number from OSHPD, preapproval by ICC-ES, or preapproval by another agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are not available, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by a qualified professional engineer.

## PART 2 PRODUCTS

### 2.1 VIBRATION ISOLATORS

- a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1) Ace Mountings Co., Inc.
  - 2) Amber/Booth Company, Inc.
  - 3) California Dynamics Corporation.
  - 4) Isolation Technology, Inc.
  - 5) Kinetics Noise Control.

- 6) Mason Industries.
  - 7) Vibration Eliminator Co., Inc.
  - 8) Vibration Isolation.
  - 9) Vibration Mountings & Controls, Inc.
  - 10) M.W. Sausse & Co., Inc.
- b. Pads: Arranged in single or multiple layers of sufficient stiffness for uniform loading over pad area, molded with a nonslip pattern and galvanized-steel baseplates, and factory cut to sizes that match requirements of supported equipment.
- 1) Resilient Material: Oil- and water-resistant neoprene.
- c. Mounts: Double-deflection type, with molded, oil-resistant rubber, hermetically sealed compressed fiberglass, or neoprene isolator elements with factory-drilled, encapsulated top plate for bolting to equipment and with baseplate for bolting to structure. Color-code or otherwise identify to indicate capacity range.
- 1) Materials: Cast-ductile-iron or welded steel housing containing two separate and opposing, oil-resistant rubber or neoprene elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.
  - 2) Neoprene: Shock-absorbing materials compounded according to the standard for bridge-bearing neoprene as defined by AASHTO.
- d. Restrained: All-directional mountings with seismic restraint.
- 1) Materials: Cast-ductile-iron or welded steel housing containing two separate and opposing, oil-resistant rubber or neoprene elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.
  - 2) Neoprene: Shock-absorbing materials compounded according to the standard for bridge-bearing neoprene as defined by AASHTO.
- e. Spring: Freestanding, laterally stable, open-spring isolators.
- 1) Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
  - 2) Minimum Additional Travel: 50 percent of the required deflection at rated load.
  - 3) Lateral Stiffness: More than 80 percent of rated vertical stiffness.
  - 4) Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
  - 5) Baseplates: Factory drilled for bolting to structure and bonded to 1/4-inch-thick, rubber isolator pad attached to baseplate underside. Baseplates shall limit floor load to 500 psig.

- 6) Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.
- f. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic or limit-stop restraint.
- 1) Housing: Steel with resilient vertical-limit stops to prevent spring extension due to weight being removed; factory-drilled baseplate bonded to 1/4-inch-thick, neoprene or rubber isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.
  - 2) Restraint: Seismic or limit stop as required for equipment and authorities having jurisdiction.
  - 3) Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
  - 4) Minimum Additional Travel: 50 percent of the required deflection at rated load.
  - 5) Lateral Stiffness: More than 80 percent of rated vertical stiffness.
  - 6) Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
- g. Housed Spring Mounts: Housed spring isolator with integral seismic snubbers.
- 1) Housing: Ductile-iron or steel housing to provide all-directional seismic restraint.
  - 2) Base: Factory drilled for bolting to structure.
  - 3) Snubbers: Vertically adjustable to allow a maximum of 1/4-inch travel up or down before contacting a resilient collar.
- h. Elastomeric Hangers: Single or double-deflection type, fitted with molded, oil-resistant elastomeric isolator elements bonded to steel housings with threaded connections for hanger rods. Color-code or otherwise identify to indicate capacity range.
- i. Spring Hangers: Combination coil-spring and elastomeric-insert hanger with spring and insert in compression.
- 1) Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
  - 2) Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
  - 3) Minimum Additional Travel: 50 percent of the required deflection at rated load.
  - 4) Lateral Stiffness: More than 80 percent of rated vertical stiffness.

- 5) Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
  - 6) Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
  - 7) Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.
- j. Spring Hangers with Vertical-Limit Stop: Combination coil-spring and elastomeric-insert hanger with spring and insert in compression and with a vertical-limit stop.
- 1) Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
  - 2) Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
  - 3) Minimum Additional Travel: 50 percent of the required deflection at rated load.
  - 4) Lateral Stiffness: More than 80 percent of rated vertical stiffness.
  - 5) Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
  - 6) Elastomeric Element: Molded, oil-resistant rubber or neoprene.
  - 7) Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.
  - 8) Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.
- k. Pipe Riser Resilient Support: All-directional, acoustical pipe anchor consisting of 2 steel tubes separated by a minimum of 1/2-inch- thick neoprene. Include steel and neoprene vertical-limit stops arranged to prevent vertical travel in both directions. Design support for a maximum load on the isolation material of 500 psig and for equal resistance in all directions.
- l. Resilient Pipe Guides: Telescopic arrangement of 2 steel tubes or post and sleeve arrangement separated by a minimum of 1/2-inch- thick neoprene. Where clearances are not readily visible, a factory-set guide height with a shear pin to allow vertical motion due to pipe expansion and contraction shall be fitted. Shear pin shall be removable and reinsertable to allow for selection of pipe movement. Guides shall be capable of motion to meet location requirements.

## 2.2 VIBRATION ISOLATION EQUIPMENT BASES

- a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1) Amber/Booth Company, Inc.

- 2) California Dynamics Corporation.
  - 3) Isolation Technology, Inc.
  - 4) Kinetics Noise Control.
  - 5) Mason Industries.
  - 6) Vibration Eliminator Co., Inc.
  - 7) Vibration Isolation.
  - 8) Vibration Mountings & Controls, Inc.
  - 9) M.W. Sausse & Co., Inc.
- b. Steel Base: Factory-fabricated, welded, structural-steel bases and rails.
- 1) Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.
    - a) Include supports for suction and discharge elbows for pumps.
  - 2) Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Bases shall have shape to accommodate supported equipment.
  - 3) Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.

### 2.3 SEISMIC-RESTRAINT DEVICES

- a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- 1) Amber/Booth Company, Inc.
  - 2) California Dynamics Corporation.
  - 3) Cooper B-Line, Inc.; a division of Cooper Industries.
  - 4) Hilti, Inc.
  - 5) Kinetics Noise Control.
  - 6) Loos & Co.; Cableware Division.
  - 7) Mason Industries.
  - 8) TOLCO Incorporated; a brand of NIBCO INC.
  - 9) Unistrut; Tyco International, Ltd.
  - 10) M.W. Sausse & Co., Inc.

- b. General Requirements for Restraint Components: Rated strengths, features, and applications shall be as defined in reports by an agency acceptable to authorities having jurisdiction.
  - 1) Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least four times the maximum seismic forces to which they will be subjected.
- c. Snubbers: Factory fabricated using welded structural-steel shapes and plates, anchor bolts, and replaceable resilient isolation washers and bushings.
  - 1) Anchor bolts for attaching to concrete shall be seismic-rated, drill-in, and stud-wedge or female-wedge type.
  - 2) Resilient Isolation Washers and Bushings: Oil- and water-resistant neoprene.
  - 3) Maximum 1/4-inch air gap, and minimum 1/4-inch- thick resilient cushion.
- d. Channel Support System: MFMA-3, shop- or field-fabricated support assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; and rated in tension, compression, and torsion forces.
- e. Restraint Cables: ASTM A 492 stainless-steel cables with end connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for restraining cable service; and with a minimum of two clamping bolts for cable engagement.
- f. Hanger Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections to hanger rod.
- g. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchor bolts and studs.
- h. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings, and matched to type and size of attachment devices used.
- i. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.
- j. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488. Minimum length of eight times diameter.
- k. Adhesive Anchor Bolts: Drilled-in and capsule anchor system containing polyvinyl or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

## 2.4 FACTORY FINISHES

- a. Finish: Manufacturer's standard paint applied to factory-assembled and -tested equipment before shipping.
  - 1) Powder coating on springs and housings.
  - 2) All hardware shall be galvanized. Hot-dip galvanize metal components for exterior use.
  - 3) Baked enamel or powder coat for metal components on isolators for interior use.
  - 4) Color-code or otherwise mark vibration isolation and seismic-control devices to indicate capacity range.

## PART 3 EXECUTION

### 3.1 EXAMINATION

- a. Examine areas and equipment to receive vibration isolation and seismic-control devices for compliance with requirements for installation tolerances and other conditions affecting performance.
- b. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.
- c. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 APPLICATIONS

- a. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by an agency acceptable to authorities having jurisdiction.
- b. Hanger Rod Stiffeners: Install hanger rod stiffeners where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to seismic forces.
- c. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static and seismic loads within specified loading limits.

### 3.3 VIBRATION-CONTROL AND SEISMIC-RESTRAINT DEVICE INSTALLATION

- a. Comply with requirements in Division 07 Section "Roof Accessories" for installation of roof curbs, equipment supports, and roof penetrations.
- b. Equipment Restraints:
  - 1) Install seismic snubbers on HVAC equipment mounted on vibration isolators. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure.
  - 2) Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.

- 3) Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction providing required submittals for component.
- c. Piping Restraints:
- 1) Comply with requirements in MSS SP-127.
  - 2) Space lateral supports a maximum of 40 feet o.c., and longitudinal supports a maximum of 80 feet o.c.
  - 3) Brace a change of direction longer than 12 feet.
- d. Install cables so they do not bend across edges of adjacent equipment or building structure.
- e. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction providing required submittals for component.
- f. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.
- g. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.
- h. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.
- i. Drilled-in Anchors:
- 1) Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
  - 2) Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
  - 3) Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
  - 4) Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
  - 5) Set anchors to manufacturer's recommended torque, using a torque wrench.
  - 6) Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

### 3.4 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

- a. Install flexible connections in piping where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where the connections terminate with connection to equipment that is anchored to a different structural element from the one supporting the connections as they approach equipment.

### 3.5 FIELD QUALITY CONTROL

- a. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- b. Tests and Inspections:
  - 1) Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
  - 2) Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless postconnection testing has been approved), and with at least seven days' advance notice.
  - 3) Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
  - 4) Test at least four of each type and size of installed anchors and fasteners selected by Architect.
  - 5) Test to 90 percent of rated proof load of device.
  - 6) Measure isolator restraint clearance.
  - 7) Measure isolator deflection.
  - 8) Verify snubber minimum clearances.
  - 9) Air-Mounting System Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
  - 10) Air-Mounting System Operational Test: Test the compressed-air leveling system.
  - 11) Test and adjust air-mounting system controls and safeties.
  - 12) If a device fails test, modify all installations of same type and retest until satisfactory results are achieved.
- c. Remove and replace malfunctioning units and retest as specified above.
- d. Prepare test and inspection reports.

### 3.7 ADJUSTING

- a. Adjust isolators after piping system is at operating weight.

- b. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.
- c. Adjust air-spring leveling mechanism.
- d. Adjust active height of spring isolators.
- e. Adjust restraints to permit free movement of equipment within normal mode of operation.

### 3.8 DEMONSTRATION

- a. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air-mounting systems. Refer to Division 01 Section "Demonstration And Training."

END OF SECTION 23 05 48

## SECTION 23 05 53

### IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

#### PART 1 GENERAL

##### 1.1 RELATED DOCUMENTS

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

##### 1.2 SUMMARY

- a. Section Includes:
  - 1) Equipment labels.
  - 2) Warning signs and labels.
  - 3) Pipe labels.
  - 4) Duct labels.
  - 5) Stencils.
  - 6) Valve tags.
  - 7) Warning tags.

##### 1.3 SUBMITTALS

- a. Product Data: For each type of product indicated.
- b. Samples: For color, letter style, and graphic representation required for each identification material and device.
- c. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.
- d. Valve numbering scheme.
- e. Valve Schedules: For each piping system to include in maintenance manuals.

##### 1.4 COORDINATION

- a. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- b. Coordinate installation of identifying devices with locations of access panels and doors.
- c. Install identifying devices before installing acoustical ceilings and similar concealment.

## **PART 2 PRODUCTS**

### **2.1 EQUIPMENT LABELS**

a. Metal Labels for Equipment:

- 1) Material and Thickness: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
- 2) Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
- 3) Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
- 4) Fasteners: Stainless-steel rivets or self-tapping screws.
- 5) Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- 6) Each piece of HVAC equipment should have a physical equipment tag 2" high, Arial font, black background with white engraved letters.
- 7) All tanks in the HVAC enclosures shall also be labeled with a physical equipment tag 2" high, Arial font, black background with white engraved letters.

b. Plastic Labels for Equipment:

- 1) Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
- 2) Maximum Temperature: Able to withstand temperatures up to 160 deg F.
- 3) Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
- 4) Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
- 5) Fasteners: Stainless-steel rivets or self-tapping screws.
- 6) Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- 7) Each piece of HVAC equipment should have a physical equipment tag 2" high, Arial font, black background with white engraved letters.
- 8) All tanks in the HVAC enclosures shall also be labeled with a physical equipment tag 2" high, Arial font, black background with white engraved letters.

- 9) HVAC equipment tag shall be adhered to the ceiling access panel, or onto the t-bar.
  - 10) The filter location should be noted on the ceiling (t-bar or access panel or hard lid) with a label stating "filter access".
- c. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified.
  - d. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

## 2.2 WARNING SIGNS AND LABELS

- a. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
- b. Letter Color: White.
- c. Background Color: Red.
- d. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
- e. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
- f. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
- g. Fasteners: Stainless-steel rivets or self-tapping screws.
- h. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- i. Label Content: Include caution and warning information, plus emergency notification instructions.

## 2.3 PIPE LABELS

- a. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.
- b. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.
- c. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

- d. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.
  - 1) Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
  - 2) Lettering Size: At least 1-1/2 inches high.

## 2.4 DUCT LABELS

- a. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
- b. Letter Color: White.
- c. Background Color: Blue.
- d. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
- e. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
- f. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
- g. Fasteners: Stainless-steel rivets or self-tapping screws.
- h. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- i. Duct Label Contents: Include identification of duct service using same designations or abbreviations as used on Drawings, duct size, and an arrow indicating flow direction.
  - 1) Flow-Direction Arrows: Integral with duct system service lettering to accommodate both directions, or as separate unit on each duct label to indicate flow direction.
  - 2) Lettering Size: At least 1-1/2 inches high.

## 2.5 STENCILS

- a. Stencils: Prepared with letter sizes according to ASME A13.1 for piping; minimum letter height of 1-1/4 inches for ducts; and minimum letter height of 3/4 inch for access panel and door labels, equipment labels, and similar operational instructions.
  - 1) Stencil Material: Brass.
  - 2) Stencil Paint: Exterior, gloss, alkyd enamel black unless otherwise indicated. Paint may be in pressurized spray-can form.

- 3) Identification Paint: Exterior, alkyd enamel in colors according to ASME A13.1 unless otherwise indicated.

## 2.6 VALVE TAGS

- a. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.
  - 1) Tag Material: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
  - 2) Fasteners: Brass wire-link or beaded chain; or S-hook.
- b. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
  - 1) Valve-tag schedule shall be included in operation and maintenance data.

## 2.7 WARNING TAGS

- a. Warning Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.
  - 1) Size: Approximately 4 by 7 inches.
  - 2) Fasteners: Brass grommet and wire.
  - 3) Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."
  - 4) Color: Yellow background with black lettering.

## PART 3 EXECUTION

### 3.1 PREPARATION

- a. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

### 3.2 EQUIPMENT LABEL INSTALLATION

- a. Install or permanently fasten labels on each major item of mechanical equipment.
- b. Locate equipment labels where accessible and visible.

### 3.3 PIPE LABEL INSTALLATION

- a. Piping Color-Coding: Painting of piping is specified in Division 09 Section "Interior Painting."

- b. Stenciled Pipe Label Option: Stenciled labels may be provided instead of manufactured pipe labels, at Installer's option. Install stenciled pipe labels, complying with ASME A13.1, on each piping system.
  - 1) Identification Paint: Use for contrasting background.
  - 2) Stencil Paint: Use for pipe marking.
- c. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
  - 1) Near each valve and control device.
  - 2) Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
  - 3) Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
  - 4) At access doors, manholes, and similar access points that permit view of concealed piping.
  - 5) Near major equipment items and other points of origination and termination.
  - 6) Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
  - 7) On piping above removable acoustical ceilings. Omit intermediately spaced labels.
- d. Pipe Label Color Schedule:
  - 1) Heating Water Piping:
    - a) Background Color: White.
    - b) Letter Color: Red.

### 3.4 DUCT LABEL INSTALLATION

- a. Install plastic-laminated duct labels with permanent adhesive on air ducts in the following color codes:
  - 1) Green: For exhaust-, outside-, relief-, return-, and mixed-air ducts.
  - 2) ASME A13.1 Colors and Designs: For hazardous material exhaust.
- b. Stenciled Duct Label Option: Stenciled labels, showing service and flow direction, may be provided instead of plastic-laminated duct labels, at Installer's option, if lettering larger than 1 inch high is needed for proper identification because of distance from normal location of required identification.
- c. Locate labels near points where ducts enter into concealed spaces and at maximum intervals of 50 feet in each space where ducts are exposed or concealed by removable ceiling system.

### 3.5 VALVE-TAG INSTALLATION

- a. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; shutoff valves; faucets; convenience and lawn-watering hose connections; and HVAC terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.
- b. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:
  - 1) Valve-Tag Size and Shape:
    - a) Hot Water: 1-1/2 inches, square.
  - 2) Valve-Tag Color:
    - a) Hot Water: Green.
  - 3) Letter Color:
    - a) Hot Water: White.

### 3.6 WARNING-TAG INSTALLATION

- a. Write required message on, and attach warning tags to, equipment and other items where required.

END OF SECTION 23 05 53

## SECTION 23 05 93

### TESTING, ADJUSTING, AND BALANCING FOR HVAC

#### PART 1 GENERAL

##### 1.1 RELATED DOCUMENTS

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

##### 1.2 SUMMARY

- a. This Section includes TAB to produce design objectives for the following:
  - 1) Vibration measuring.
  - 2) Verifying that automatic control devices are functioning properly.
  - 3) Reporting results of activities and procedures specified in this Section.

##### 1.3 DEFINITIONS

- a. Adjust: To regulate fluid flow rate and air patterns at the terminal equipment, such as to reduce fan speed or adjust a damper.
- b. Balance: To proportion flows within the distribution system, including submains, branches, and terminals, according to indicated quantities.
- c. Barrier or Boundary: Construction, either vertical or horizontal, such as walls, floors, and ceilings that are designed and constructed to restrict the movement of airflow, smoke, odors, and other pollutants.
- d. Draft: A current of air, when referring to localized effect caused by one or more factors of high air velocity, low ambient temperature, or direction of airflow, whereby more heat is withdrawn from a person's skin than is normally dissipated.
- e. NC: Noise criteria.
- f. Procedure: An approach to and execution of a sequence of work operations to yield repeatable results.
- g. RC: Room criteria.
- h. Report Forms: Test data sheets for recording test data in logical order.
- i. Smoke-Control System: An engineered system that uses fans to produce airflow and pressure differences across barriers to limit smoke movement.
- j. Smoke-Control Zone: A space within a building that is enclosed by smoke barriers and is a part of a zoned smoke-control system.

- k. Stair Pressurization System: A type of smoke-control system that is intended to positively pressurize stair towers with outdoor air by using fans to keep smoke from contaminating the stair towers during an alarm condition.
- l. Static Head: The pressure due to the weight of the fluid above the point of measurement. In a closed system, static head is equal on both sides of the pump.
- m. Suction Head: The height of fluid surface above the centerline of the pump on the suction side.
- n. System Effect: A phenomenon that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
- o. System Effect Factors: Allowances used to calculate a reduction of the performance ratings of a fan when installed under conditions different from those presented when the fan was performance tested.
- p. TAB: Testing, adjusting, and balancing.
- q. Terminal: A point where the controlled medium, such as fluid or energy, enters or leaves the distribution system.
- r. Test: A procedure to determine quantitative performance of systems or equipment.
- s. Testing, Adjusting, and Balancing (TAB) Firm: The entity responsible for performing and reporting TAB procedures.

#### 1.4 SUBMITTALS

- a. Qualification Data: Within 30 days from Contractor's Notice to Proceed, submit 4 copies of evidence that TAB firm and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.
- b. Contract Documents Examination Report: Within 30 days from Contractor's Notice to Proceed, submit 4 copies of the Contract Documents review report as specified in Part 3.
- c. Strategies and Procedures Plan: Within 60 days from Contractor's Notice to Proceed, submit 4 copies of TAB strategies and step-by-step procedures as specified in Part 3 "Preparation" Article. Include a complete set of report forms intended for use on this Project.
- d. Certified TAB Reports: Submit two copies of reports prepared, as specified in this Section, on approved forms certified by TAB firm.
- e. Sample Report Forms: Submit two sets of sample TAB report forms.
- f. Warranties specified in this Section.

#### 1.5 QUALITY ASSURANCE

- a. TAB Firm Qualifications: Engage a TAB firm certified by AABC.
- b. TAB Conference: Meet with Owner's and Architect's representatives on approval of TAB strategies and procedures plan to develop a mutual understanding of the details. Ensure the participation of TAB team members, equipment manufacturers'

authorized service representatives, HVAC controls installers, and other support personnel. Provide seven days' advance notice of scheduled meeting time and location.

- 1) Agenda Items: Include at least the following:
  - a) Submittal distribution requirements.
  - b) The Contract Documents examination report.
  - c) TAB plan.
  - d) Work schedule and Project-site access requirements.
  - e) Coordination and cooperation of trades and subcontractors.
  - f) Coordination of documentation and communication flow.
- c. Certification of TAB Reports: Certify TAB field data reports. This certification includes the following:
  - 1) Review field data reports to validate accuracy of data and to prepare certified TAB reports.
  - 2) Certify that TAB team complied with approved TAB plan and the procedures specified and referenced in this Specification.
- d. TAB Report Forms: Use standard forms from AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems."
- e. Instrumentation Type, Quantity, and Accuracy: As described in AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems."
- f. Instrumentation Calibration: Calibrate instruments at least every six months or more frequently if required by instrument manufacturer.
  - 1) Keep an updated record of instrument calibration that indicates date of calibration and the name of party performing instrument calibration.

## 1.6 PROJECT CONDITIONS

- a. Full Owner Occupancy: Owner will occupy the site and existing building during entire TAB period. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

## 1.7 COORDINATION

- a. Coordinate the efforts of factory-authorized service representatives for systems and equipment, HVAC controls installers, and other mechanics to operate HVAC systems and equipment to support and assist TAB activities.
- b. Notice: Provide seven days' advance notice for each test. Include scheduled test dates and times.

- c. Perform TAB after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

## 1.8 WARRANTY

- a. National Project Performance Guarantee: Provide a guarantee on AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems" forms stating that AABC will assist in completing requirements of the Contract Documents if TAB firm fails to comply with the Contract Documents. Guarantee includes the following provisions:
  - 1) The certified TAB firm has tested and balanced systems according to the Contract Documents.
  - 2) Systems are balanced to optimum performance capabilities within design and installation limits.

## **PART 2 PRODUCTS (Not Applicable)**

## **PART 3 EXECUTION**

### 3.1 EXAMINATION

- a. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment.
  - 1) Contract Documents are defined in the General and Supplementary Conditions of Contract.
  - 2) Verify that balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are required by the Contract Documents. Verify that quantities and locations of these balancing devices are accessible and appropriate for effective balancing and for efficient system and equipment operation.
- b. Examine approved submittal data of HVAC systems and equipment.
- c. Examine Project Record Documents described in Division 01 Section "Project Record Documents."
- 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. 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. Calculate system effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from those presented when the equipment was performance tested at the factory. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," Sections 7 through 10; or in SMACNA's "HVAC Systems--Duct Design," Sections 5 and 6. Compare this data with the design data and installed conditions.

- f. Examine system and equipment installations to verify that they are complete and that testing, cleaning, adjusting, and commissioning specified in individual Sections have been performed.
- g. Examine system and equipment test reports.
- h. Examine HVAC system and equipment installations to verify that indicated balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are properly installed, and that their locations are accessible and appropriate for effective balancing and for efficient system and equipment operation.
- i. Examine systems for functional deficiencies that cannot be corrected by adjusting and balancing.
- j. Examine HVAC equipment to ensure that clean filters have been installed, bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.
- k. Examine terminal units, such as variable-air-volume boxes, to verify that they are accessible and their controls are connected and functioning.
- l. Examine plenum ceilings used for supply air to verify that they are airtight. Verify that pipe penetrations and other holes are sealed.
- m. Examine strainers for clean screens and proper perforations.
- n. Examine three-way valves for proper installation for their intended function of diverting or mixing fluid flows.
- o. Examine heat-transfer coils for correct piping connections and for clean and straight fins.
- p. Examine system pumps to ensure absence of entrained air in the suction piping.
- q. Examine equipment for installation and for properly operating safety interlocks and controls.
- r. Examine automatic temperature system components to verify the following:
  - 1) Dampers, valves, and other controlled devices are operated by the intended controller.
  - 2) Dampers and valves are in the position indicated by the controller.
  - 3) Integrity of valves and dampers for free and full operation and for tightness of fully closed and fully open positions. This includes dampers in multizone units, mixing boxes, and variable-air-volume terminals.
  - 4) Automatic modulating and shutoff valves, including two-way valves and three-way mixing and diverting valves, are properly connected.
  - 5) Thermostats and humidistats are located to avoid adverse effects of sunlight, drafts, and cold walls.
  - 6) Sensors are located to sense only the intended conditions.

- 7) Sequence of operation for control modes is according to the Contract Documents.
  - 8) Controller set points are set at indicated values.
  - 9) Interlocked systems are operating.
  - 10) Changeover from heating to cooling mode occurs according to indicated values.
- s. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

### 3.2 PREPARATION

- a. Prepare a TAB plan that includes strategies and step-by-step procedures.
- b. Complete system readiness checks and prepare system readiness reports. Verify the following:
  - 1) Permanent electrical power wiring is complete.
  - 2) Automatic temperature-control systems are operational.
  - 3) Equipment and duct access doors are securely closed.
  - 4) Balance, smoke, and fire dampers are open.
  - 5) Isolating and balancing valves are open and control valves are operational.
  - 6) Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
  - 7) Windows and doors can be closed so indicated conditions for system operations can be met.

### 3.3 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 Testing and Balancing Heating, Ventilating, and Air Conditioning Systems" and this Section.
- b. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. After testing and balancing, close probe holes and patch insulation with new materials identical to those removed. Restore vapor barrier and finish according to insulation Specifications for this Project.
- c. Mark equipment and balancing device settings with paint or other suitable, permanent identification material, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, to show final settings.
- d. Take and report testing and balancing measurements in inch-pound (IP) units.

### 3.4 PROCEDURES FOR MOTORS

- a. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:
  - 1) Manufacturer, model, and serial numbers.
  - 2) Motor horsepower rating.
  - 3) Motor rpm.
  - 4) Efficiency rating.
  - 5) Nameplate and measured voltage, each phase.
  - 6) Nameplate and measured amperage, each phase.
  - 7) Starter thermal-protection-element rating.
- b. Motors Driven by Variable-Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum. Test the manual bypass for the controller to prove proper operation. Record observations, including controller manufacturer, model and serial numbers, and nameplate data.

### 3.5 PROCEDURES FOR TEMPERATURE MEASUREMENTS

- a. During TAB, report the need for adjustment in temperature regulation within the automatic temperature-control system.
- b. Measure indoor wet- and dry-bulb temperatures every other hour for a period of two successive eight-hour days, in each separately controlled zone, to prove correctness of final temperature settings. Measure when the building or zone is occupied.
- c. Measure outside-air, wet- and dry-bulb temperatures.

### 3.6 PROCEDURES FOR VIBRATION MEASUREMENTS

- a. Use a vibration meter meeting the following criteria:
  - 1) Solid-state circuitry with a piezoelectric accelerometer.
  - 2) Velocity range of 0.1 to 10 inches per second.
  - 3) Displacement range of 1 to 100 mils.
  - 4) Frequency range of at least 0 to 1000 Hz.
  - 5) Capable of filtering unwanted frequencies.
- b. Calibrate the vibration meter before each day of testing.
  - 1) Use a calibrator provided with the vibration meter.
  - 2) Follow vibration meter and calibrator manufacturer's calibration procedures.

- c. Perform vibration measurements when other building and outdoor vibration sources are at a minimum level and will not influence measurements of equipment being tested.
  - 1) Turn off equipment in the building that might interfere with testing.
  - 2) Clear the space of people.
- d. Perform vibration measurements after air and water balancing and equipment testing is complete.
- e. Clean equipment surfaces in contact with the vibration transducer.
- f. Position the vibration transducer according to manufacturer's written instructions and to avoid interference with the operation of the equipment being tested.
- g. Measure and record vibration on rotating equipment over 3 hp.
- h. Measure and record equipment vibration, bearing vibration, equipment base vibration, and building structure vibration. Record velocity and displacement readings in the horizontal, vertical, and axial planes.
  - 1) Pumps:
    - a) Pump Bearing: Drive end and opposite end.
    - b) Motor Bearing: Drive end and opposite end.
    - c) Pump Base: Top and side.
    - d) Building: Floor.
    - e) Piping: To and from the pump after flexible connections.
- i. For equipment with vibration isolation, take floor measurements with the vibration isolation blocked solid to the floor and with the vibration isolation floating. Calculate and report the differences.
- j. Inspect, measure, and record vibration isolation.
  - 1) Verify that vibration isolation is installed in the required locations.
  - 2) Verify that installation is level and plumb.
  - 3) Verify that isolators are properly anchored.
  - 4) For spring isolators, measure the compressed spring height, the spring OD, and the travel-to-solid distance.
  - 5) Measure the operating clearance between each inertia base and the floor or concrete base below. Verify that there is unobstructed clearance between the bottom of the inertia base and the floor.

### 3.7 TEMPERATURE-CONTROL VERIFICATION

- a. Verify that controllers are calibrated and commissioned.

- b. Check transmitter and controller locations and note conditions that would adversely affect control functions.
- c. Record controller settings and note variances between set points and actual measurements.
- d. Check the operation of limiting controllers (i.e., high- and low-temperature controllers).
- e. Check free travel and proper operation of control devices such as damper and valve operators.
- f. Check the sequence of operation of control devices. Note air pressures and device positions and correlate with airflow and water flow measurements. Note the speed of response to input changes.
- g. Check the interaction of electrically operated switch transducers.
- h. Check the interaction of interlock and lockout systems.
- i. Check main control supply-air pressure and observe compressor and dryer operations.
- j. Record voltages of power supply and controller output. Determine whether the system operates on a grounded or nongrounded power supply.
- k. Note operation of electric actuators using spring return for proper fail-safe operations.

### 3.8 TOLERANCES

- a. Set HVAC system airflow and water flow rates within the following tolerances:
  - 1) Supply, Return, and Exhaust Fans and Equipment with Fans: Plus 5 to plus 10 percent.
  - 2) Air Outlets and Inlets: 0 to minus 10 percent.

### 3.9 REPORTING

- a. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for systems' balancing devices. Recommend changes and additions to systems' balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.
- b. Status Reports: As Work progresses, prepare reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

### 3.10 FINAL REPORT

- a. General: Typewritten, or computer printout in letter-quality font, on standard bond paper, in three-ring binder, tabulated and divided into sections by tested and balanced systems.
- b. Include a certification sheet in front of binder signed and sealed by the certified testing and balancing engineer.
  - 1) Include a list of instruments used for procedures, along with proof of calibration.
- c. Final Report Contents: In addition to certified field report data, include the following:
  - 1) Pump curves.
  - 2) Manufacturers' test data.
  - 3) Field test reports prepared by system and equipment installers.
  - 4) Other information relative to equipment performance, but do not include Shop Drawings and Product Data.
- d. General Report Data: In addition to form titles and entries, include the following data in the final report, as applicable:
  - 1) Title page.
  - 2) Name and address of TAB firm.
  - 3) Project name.
  - 4) Project location.
  - 5) Architect's name and address.
  - 6) Engineer's name and address.
  - 7) Contractor's name and address.
  - 8) Report date.
  - 9) Signature of TAB firm who certifies the report.
  - 10) Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
  - 11) Summary of contents including the following:
    - a) Indicated versus final performance.
    - b) Notable characteristics of systems.
    - c) Description of system operation sequence if it varies from the Contract Documents.

- 12) Nomenclature sheets for each item of equipment.
  - 13) Data for terminal units, including manufacturer, type size, and fittings.
  - 14) Notes to explain why certain final data in the body of reports varies from indicated values.
  - 15) Test conditions for fans and pump performance forms including the following:
    - a) Settings for outside-, return-, and exhaust-air dampers.
    - b) Conditions of filters.
    - c) Cooling coil, wet- and dry-bulb conditions.
    - d) Face and bypass damper settings at coils.
    - e) Fan drive settings including settings and percentage of maximum pitch diameter.
    - f) Inlet vane settings for variable-air-volume systems.
    - g) Settings for supply-air, static-pressure controller.
    - h) Other system operating conditions that affect performance.
- e. Vibration Measurement Reports:
- 1) Date and time of test.
  - 2) Vibration meter manufacturer, model number, and serial number.
  - 3) Equipment designation, location, equipment, speed, motor speed, and motor horsepower.
  - 4) Diagram of equipment showing the vibration measurement locations.
  - 5) Measurement readings for each measurement location.
  - 6) Calculate isolator efficiency using measurements taken.
  - 7) Description of predominant vibration source.
- f. Instrument Calibration Reports:
- 1) Report Data:
    - a) Instrument type and make.
    - b) Serial number.
    - c) Application.
    - d) Dates of use.
    - e) Dates of calibration.

### 3.11 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) Randomly check the following for each system:
    - a) Measure airflow of at least 10 percent of air outlets.
    - b) Measure water flow of at least 5 percent of terminals.
    - c) Measure room temperature at each thermostat/temperature sensor. Compare the reading to the set point.
    - d) Measure sound levels at two locations.
    - e) Measure space pressure of at least 10 percent of locations.
    - f) Verify that balancing devices are marked with final balance position.
    - g) Note deviations to the Contract Documents in the Final Report.
- b. Final Inspection:
  - 1) After initial inspection is complete and evidence 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 Owner.
  - 2) TAB firm test and balance engineer shall conduct the inspection in the presence of Owner.
  - 3) Owner shall randomly select measurements documented in the final report to be rechecked. The 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 the rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."
  - 5) If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.
  - 6) TAB firm shall recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes and resubmit the final report.
  - 7) Request a second final inspection. If the second final inspection also fails, Owner shall contract the services of another TAB firm to complete the testing and balancing in accordance with the Contract Documents and deduct the cost of the services from the final payment.

END OF SECTION 23 05 93

NEW HVAC SYSTEM AT  
RANCHO CAMPANA HIGH SCHOOL  
OXNARD UNION HIGH SCHOOL DISTRICT  
FLEWELLING & MOODY PROJECT NO. 2841.0100

TESTING, ADJUSTING AND BALANCING FOR HVAC  
23 05 93 - 13

**SECTION 23 0700**

**HVAC INSULATION**

**PART 1 – GENERAL**

1.01 SUMMARY

A. Section Includes:

1. Condensate drain piping from air conditioning equipment.
2. Vacuum and condensate pump discharge lines over 50 feet in length.
3. High and low temperature equipment.
4. Heating hot water supply and return piping.
5. Chilled water supply and return piping.
6. Supply and return air ducts for heating and cooling systems air ducts.

B. Related Requirements:

1. Division 01: General Requirements.
2. Section 23 0500: Common Work Results for HVAC.
3. Section 23 0513: Basic HVAC Materials and Methods.
4. Section 23 0553: Mechanical Identification.
5. Section 23 2013: HVAC Piping.
6. Section 23 2016: Underground HVAC Piping.
7. Section 23 3000: Air Distribution.
8. Section 23 5000: Central Heating Equipment.
9. Section 23 8000: Heating, Ventilating and Air Conditioning Equipment.

1.02 REFERENCES

A. American Society for Testing and Materials International (ASTM):

1. ASTM C167 - Standard Test Methods for Thickness and Density of Blanket or Batt Thermal Insulations.
2. ASTM C209 - Standard Test Methods for Cellulosic Fiber Insulating Board.

3. ASTM C302 - Standard Test Method for Density and Dimensions of Preformed Pipe-Covering-Type Thermal Insulation.
4. ASTM C411 - Standard Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation.
5. ASTM C518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
6. ASTM C533 - Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation.
7. ASTM C534 - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
8. ASTM C547 - Standard Specification for Mineral Fiber Pipe Insulation.
9. ASTM D5116 - Standard Guide for Small-Scale Environmental Chamber Determinations of Organic Emissions from Indoor Materials/Products.
10. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
11. ASTM E96 - Standard Test Methods for Water Vapor Transmission of Materials.
12. ASTM G21 - Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.
13. ASTM G22 - Standard Practice for Determining Resistance of Plastics to Bacteria.

B. Underwriters Laboratories Inc.:

1. UL 181 - Standard for Factory-Made Air Ducts and Air Connectors.
2. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials.

C. National Fire Protection Association:

1. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems .
2. NFPA 90B - Standard for the Installation of Warm Air Heating and Air-Conditioning Systems.
3. NFPA 255 - Standard Method of Test of Surface Burning Characteristics of Building Materials.

1.03 SUBMITTALS

- A. Submit in accordance with Division 01 and Section 23 0500: Common Work Results for HVAC.

1. Complete material list of items to be furnished and installed under this Section.
2. Manufacturer's specifications and other data required demonstrating compliance with the specified requirements.
3. Shop Drawings, catalog cuts and manufacturer's data indicating insulation, jacketing, adhesives, and coating. Insulating materials shall be certified by manufacturer to comply with the California quality standards for insulating materials.
4. Display sample cutaway sections.
5. Manufacturer's recommended method of installation procedures, which will become part of this Section.

1.04 QUALITY ASSURANCE

- A. Qualifications of Manufacturer and Installer, Materials, Fabrication, Execution, and Standard of Quality: Comply with provisions stated under Section 23 0500: Common Work Results for HVAC and Section 23 0513: Basic HVAC Materials and Methods.
- B. Test Ratings:
  1. Comply with provisions stated under Section 23 0500 and 23 0513 with emphasis on ASTM E84, NFPA 255, or UL 723. ASTM C167, ASTM C302, UL label or listing of satisfactory test results from the National Institute of Standards and Technology, or a satisfactory certified test report from an acceptable testing laboratory. Approval by the State Fire Marshal is required.
  2. Furnish labels, legibly printed with the name of the manufacturer or listings indicate that fire hazard ratings do not exceed those specified for materials proposed for installation. Flame spread index of not more than 25 and smoke developed rating not exceeding 50.
  3. Tests shall be performed on each item individually when insulation, vapor barrier covering, wrapping materials, or adhesives are installed separately at the Project site.
  4. Test insulation, vapor barrier covering, wrapping materials and adhesives as an assembly when they are factory composite systems.
- C. Regulatory Requirements: Insulation furnished and installed under this Section shall conform to the requirements of the California Building Code Parts 4, Mechanical Code, Part 5, Plumbing Code and Part 6, Energy Code.
- D. All chemically based products such as sealers, primers, fillers, adhesives, etc. shall meet the California air quality regulations.

1.05 PRODUCT HANDLING

- A. Protection, Replacement, Delivery and Storage: Comply with provisions stated under Sections 23 0500: Common Work Results for HVAC and 23 0513: Basic HVAC Materials and Methods.

**PART 2 – PRODUCTS**

2.01 MATERIALS

A. General:

1. Piping insulating material shall be fire resistant, non-corrosive, shall not break, settle, sag, pack or disintegrate under vibration, nor absorb more than 1 percent moisture by weight.
2. Piping insulating material shall be furnished with thickness indicated in Table 1, unless otherwise noted on the drawings, and shall furnish thermal resistance in the range of R-4.0 to 4.6 in accordance with inch at 75 degrees F. For any other value of R, insulation thickness shall be calculated accordingly and submitted for review.
3. Asbestos in any quantity in insulating material is not permitted.
4. Provide insulation materials, adhesives, coatings, sealants, fitting covers, and other accessories with a fire hazard rating not to exceed 25 for flame spread, 25 for fuel contributed and 50 for smoke developed, except for materials listed as follows:
  - a. Nylon anchors for installing insulation to ducts or equipment.
  - b. Treated wood blocks.
5. Flame-proofing treatments subject to moisture damage are not permitted.

TABLE 1 - MINIMUM PIPING INSULATION THICKNESS (1)

Insulation Thickness Required (in inches)  
Space Heating Systems (Steam, Steam Condensate and Hot Water)

Piping System Type	Temp. Range (degrees F)	Run-outs up to 2 (2)	1 and less	1.25 to 2	2.5 to 4	5 to 6	8 and larger
Hi Pres Temp	Above 350	1.5	2.5	2.5	3.0	3.5	3.5
Med Pres Temp	251 to 305	1.5	2.0	2.5	2.5	3.5	3.5
Low Pres Temp	201 to 250	1.0	1.5	1.5	2.0	2.0	3.5
Hot Water	Up to 200	0.5	1.5	1.5	1.5	1.5	1.5
Steam Cond.	-	0.5	1.0	1.0	1.0	1.5	1.5

Service Water Heating Systems (recirculating, piping supply and return)

Hot Water	Up to 180	0.5	1.0	1.0	1.5	1.5	1.5
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Space Cooling Systems (Chilled water, Brine and

Chilled Water	40-60	0.5	0.5	0.75	1.0	1.0	1.0
/Brine	Below 40	1.0	1.0	1.5	1.5	1.5	1.5

Condensate Drain	½-inch Minimum insulation thickness.	0.5	0.5	0.5	0.5	0.5	0.5
From Air Conditioning Equipment:	Insulate condensate drain lines within building, in room, inside walls and above ceilings.	0.5	0.5	0.5	0.5	0.5	0.5

NOTES:

- (1) For Underground HVAC Piping refer to section 23 2016 Underground HVAC Piping.
  - (2) For piping exposed to ambient temperatures, increase thickness by 0.5 inch.
  - (3) Run-outs to individual terminal units, not exceeding 12 feet in length.
- B. Lagging Adhesives: Shall be nonflammable and fire-resistant and shall have a maximum flame spread index of 25 and a maximum smoke developed index of 50 when tested in accordance with ASTM E84. Insulation finished with canvas shall be provided with laps adhered in accordance to manufacturer's recommendation. A finish coat of same material shall be applied to entire outer surface of lagging cloth at coverage specified by manufacturer.
- C. Canvas Jackets: Furnish 6 ounce in accordance with square foot minimum, 48 by 48 thread count canvas jacketing.
- D. Insulation Jackets:
1. Exterior insulation exposed to weather shall be weatherproofed with Childers aluminum jacketing as basis of design, or Pabco, RPR, or equal. Jacketing shall be manufactured from 1100, 3105 or 5010 aluminum alloy with 3/16-inch corrugations. Smooth or embossed jackets may be permitted in special situations to match an existing installation. Jacketing shall be furnished with an integrally bonded moisture barrier over entire surface in contact with insulation. A minimum thickness of 0.016 aluminum jacketing is to be provided on ducts and piping. A minimum thickness of 0.020 shall be provided on tanks, equipment, and heat exchangers.
  2. Insulated elbows, of 90 degrees and 45 degrees, with a nominal iron pipe size of ½-inch to 8-inch shall be provided with Childers aluminum Ell-Jacs insulation covers as basis of design, or Pabco, RPR, or equal, manufactured from 1100 aluminum alloy of 0.024-inch thickness. Insulated elbows with a nominal pipe size of 10 inches to 18 inches shall be provided with Childers 4-piece aluminum Ell-Jacs as basis of design, or Pabco, RPR, or equal.
  3. Tees, Flanges, and Valve Insulation in Conjunction with Aluminum Jacketing: Furnish Childers Aluminum Special Fabrications Insulation Covers as manufactured by Childers Products Company, Pabco, RPR, or equal.
- E. Adhesives: Adhesives shall be water based, UL Classified, meet the requirements of NFPA 90A and NFPA 90B, have been tested according to relevant ASTM requirements, and be acceptable to the State Fire Marshal. Name, type and method of installation shall be submitted for review.

- F. Valve and Fitting Cover: When installed in conjunction with PVC jacketing, furnish Zeston 25/50 rated polyvinyl chloride fitting covers as manufactured by Johns Manville, Knauf Insulation, Speedline, or equal.

2.02 SPACE HEATING PIPING SYSTEM

- A. General: Insulate steam, steam condensate return, and hot water space heating supply and return, including valves, strainers and fittings with insulation thickness as indicated on Table 1.

B. Materials:

1. Classes of Insulation:

- a. Class A: Calcium silicate molded pipe insulation, suitable for service temperature up to 1200 degrees F, ASTM C533; Johns Manville Thermo-12 Gold, or equal. Fittings: diatomaceous silica thermal insulating cement.
- b. Class B: Glass fiber molded pipe insulation suitable for service temperatures up to 850 degrees F. Pipe insulation shall be one piece, preformed, and provide a minimum R factor of 4.0 at 75 degrees F mean temperature. Insulation shall be faced with all-purpose fire-retardant vapor barrier jacket. Pipe insulation shall be Johns Manville Micro-Lok, Knauf Redi-Klad 1000, Owens Corning FIBERGLAS Pipe Insulation SSL II-ASJ, or equal.
- c. Class C: Flexible open-cell melamine (foam insulation) suitable for service temperature -150 degrees F to 400 degrees F. Thermal conductivity at 75 degrees F, K = 0.26. Pipe insulation, one-piece pre-formed, laminated to heavy non-reinforced PVC jacket, with locking track, factory installed to jacket, to snap insulation and jacket onto pipe. Similar to TechLite 079 Series as manufactured by Accessible Products Co., or equal. Installation shall comply with manufacturers recommendations.
- d. Class D: Mineral fiber pipe insulation suitable for service temperatures up to 1,200 degrees F. Pipe insulation shall be one-piece, preformed up to 3 inches thickness, and provide a minimum R factor of 4.0 at 75 degrees F mean temperature. Insulation shall be faced with all-purpose fire-retardant vapor barrier jacket. Pipe insulation shall be 8 pounds in accordance with cubic foot density by Roxul Tehton 1200, Fibrex COREPLUS 1200, Industrial Insulation Group, LLC (IIG) MinWool-1200, or equal.

2. Locations and Class of Insulation Required:

TABLE 2 – LOCATIONS AND CLASS OF INSULATION REQUIRED

<u>LOCATION</u>	<u>CLASS OF INSULATION</u>
Mechanical Equipment Room	A, B, C, or D
All Other Locations	A, B, C, or D

3. Fittings on indoor piping shall be covered with flush, hand-wrapped Class A, B, C, or D insulation, to match the adjoining pipe insulation and covered with polyvinyl chloride fitting covers: Zeston 2000 25/50 by Johns Manville, Knauf Insulation Proto PVC Fitting Cover, Speedline Polyco Smoke Safe, or equal.
4. Adhesive: Fibrous Adhesive to bond calcium silicate to itself and non-porous surfaces.

2.03 COOLING PIPING SYSTEM INSULATION

- A. General: Insulate chilled water supply and return piping..
- B. Materials:
  1. Classes of Insulation:
    - a. Class A: Expanded polystyrene pipe insulation, self-extinguishing type, either molded or extruded; Dow Chemical Co. STYROFOAM, ITW Insulation Systems XPS PIB, Foam-Control EPS, or equal.
    - b. Class B: Glass fiber molded pipe insulation ASTM C547. Pipe insulation shall be one piece, preformed, and provide a minimum R factor of 4 at 75 degrees F mean temperature. Insulation shall be faced with all-purpose fire-retardant vapor barrier jacket. Pipe insulation shall be Johns Manville Micro-Lok, CertainTeed Snap-On, Owens Corning FIBERGLAS SSL II-ASJ, or equal.
    - c. Class C: Expanded (foamed) urethane (polyurethane) or polyisocyanurate pipe insulation of self-extinguishing type molded or fabricated, Dyplast Products, LLC ISO-C1/2.0, ITW Trymer, Specialty Products & Insulation Co. Polyisocyanurate Pipe Insulation, Armacell Armalok, or equal.
    - d. Class D: Foamed plastic pipe insulation, self-extinguishing type, ASTM C534 Type 1 - tubular. Pipe insulation shall be one-piece preformed, flexible tubing type and provide a maximum K factor of 0.28 at 75 degrees F mean temperature. Pipe insulation shall be Armacell Armaflex, Aeroflex Aerocel, Rubatex INSUL-TUBE 180, or equal.
  2. Locations and Class of Insulation Required: For thickness required, refer to Table 1 of this Section.

TABLE 3 – SERVICE, LOCATION AND CLASS OF INSULATION REQUIRED

<u>SERVICE</u>	<u>LOCATION</u>	<u>CLASS OF INSULATION</u>
Condensate drains from air conditioning equipment	Indoors at all locations including above ceilings and between stud walls	D
Refrigerant suction Liquid line as required	All locations except underground	D

All other piping, except underground	All locations except underground	A, B, C
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3. Adhesives:
  - a. Polystyrene adhesives: Synthetic rubber and resin adhesives specifically designed to adhere extruded and expanded rigid polystyrene and urethane insulation to themselves and to other porous and non-porous substrates.
  - b. Vapor barrier laps and penetrations: Furnish protective coating and lagging adhesive on butt joints of foil-faced vapor barriers, and where pins and staples puncture facings.

## 2.04 HIGH TEMPERATURE EQUIPMENT INSULATION

- A. General:
  1. Insulate heat exchangers, hot water storage tanks, flash tanks, boiler breechings, and similar equipment operating at elevated temperatures up to 450 degrees F or 850 degrees F with high temperature insulation, jacket and material.
  2. Do not insulate condensate receivers, hot water expansion tanks, hot water pump casings, chemical feeders, and factory insulated boilers.
- B. Materials:
  1. Equipment insulation shall be 1½-inch minimum fiberglass board or insulating blocks, or molded calcium silicate, ASTM C533-Type I, Johns Manville Thermo-12 Gold or 1000 Series Spin-Glas, Knauf Insulation Board, Owens Corning Fiberglas Series 700 or Fiberglas Insul-Quick, or equal.
  2. Boiler breeching insulation shall be same as above except 2-inch thick minimum.
  3. Adhesive: For calcium silicate, furnish fibrous adhesive of sodium silicate base.

## 2.05 LOW TEMPERATURE EQUIPMENT INSULATION

- A. General:
  1. Insulate water chillers, heat exchangers, air eliminators and similar equipment operating at reduced surface temperatures.
  2. Do not insulate chilled water expansion tanks, and chemical feeders.
- B. Materials:
  1. Expanded polystyrene, 2-inch thick, self-extinguishing type, Dow Chemical Co.'s STYROFOAM, Owens Corning FOAMULAR, Foam-Control EPS, or equal, or 1½-inch thick expanded urethane (polyurethane) or polyisocyanurate, self-extinguishing type, Dyplast Products, LLC ISO-C1/2.0, ITW Trymer, Specialty Products & Insulation Co. Polyisocyanurate Pipe Insulation, or equal.

2. Canvas Jackets: 6 ounce in accordance with square foot minimum.
3. Vapor Barrier Laps and Penetrations: Furnish protective coating and lagging adhesive on butt joints of foil-faced vapor barriers and where pins and staples puncture facings.

2.06 DUCTWORK AND PLENUM INSULATION

A. General: Insulate ductwork and plenums with not less than the amount of insulation tabulated in Table 4, unless noted otherwise on the drawings. Insulation may be omitted under the following conditions:

1. Exposed return air ductwork in conditioned space.
2. Return air ductwork between wall studs inside an interior wall.

TABLE 4 - INSULATION OF DUCTS AND PLENUM

<u>Duct Location</u>	<u>Insulation Type</u>
Exposed interior round and oval supply air ductwork	DW-1
Exposed interior rectangular supply air ductwork	L-1
Exterior locations other than Health Units and Clinics	L-2
In walls, within floor/ ceiling spaces	F-1 or L-1 See note 3
Hot and cold plenums	F-2, DW-1 or L-2 See note 3

B. Insulation Types:

1. DW-1: 1-inch thick internal duct lining.
2. F-1: 1½-inch blanket fiberglass, factory-laminated with all-service jacket vapor barrier.
3. F-2: 2-inch blanket fiberglass, factory-laminated with all-service jacket vapor barrier.
4. L-1: 1½-inch Internal duct lining.
5. L-2: 2-inch Internal duct lining.

C. Notes:

1. Minimum insulation provided shall be as required by the current California Mechanical Code Title 24 for the most restrictive condition.

2. Refer to the materials indicated in this section for external insulation & Internal Lining.
3. External insulation shall be replaced with internal duct lining (of equivalent thermal resistance value unless noted otherwise) where indicated on the drawings or specified elsewhere for sound attenuation.
4. Provide internal duct lining (1 ½-inch unless noted otherwise) where indicated on the drawings or specified elsewhere for sound attenuation.
5. All exterior insulated ductworks shall be water proofed at joints, seams and duct penetrations.

D. Materials:

1. Fire-Resistive Insulation Materials and Coatings: Submit State Fire Marshal pre-approved materials only.
2. Adhesives: See Paragraph 2.01.E for applicable products.
3. External Insulation: Provide glass fiber blankets that are factory-laminated with Foil Reinforced Kraft (FRK) vapor barrier facing; Johns Manville Microlite, Owens-Corning SOFTR Duct Wrap, Knauf Insulation Friendly Feel Duct Wrap, or equal. Provide a minimum installed R value as required by the CEC Building Energy Efficiency Standards; but not less than scheduled on Table 5:

TABLE 5  
INSULATION OF DUCTS AND PLENUM INSTALLED  
THERMAL RESISTANCE "R" VALUES

Type	Labeled Thickness (in inches)	Installed R Value (hr.ft <sup>2</sup> .°F/Btu)
F-1	1 ½	4.2
F-2	2	5.6
DW-1	1	4.2
L1	1 ½	6.0
L2	2	8.0

4. Internal Lining: Internal Lining shall be of the type that inhibits the growth of mold, mildew and fungi and shall not contain harmful VOC's or contain glass fiber.  
Approved Material:
  - a. Polyester Duct Liner:
    - 1) Polyester duct liner shall be an engineered nonwoven, thermally bonded Polyester with a smooth and durable FSK facing.

- 2) Polyester duct liner must be able to withstand a constant internal temperature up to 250°F must be compliant with Greenguard Environmental Institute and contain zero VOCs per ASTM D5116. Liner must comply with all applicable standards including ASTM E84, ASTM C411, ASTM C518, ASTM G21, NFPA 90A and 90B, and UL 181.
  - 3) Approved Manufacturer: Ductmate Industries “PolyArmor” duct liner or approved equal.
- b. Elastomeric duct liner:
- 1) Closed-cell, sponge- or expanded-rubber materials. Elastomeric liner must be able to withstand a constant internal temperature up to 300°F and must comply with all applicable standards including ASTM E84, ASTM E96, ASTM C209, ASTM C534 - Type II sheet materials, ASTM C411, ASTM C518, ASTM G21, ASTM G22, NFPA 90A and 90B, and UL 181.
  - 2) Approved Manufacturer: Armacell LLC “AP Armaflex FS” duct liner or approved equal.
- c. Duct liner must be attached per manufacturer’s requirements using a non-flammable, low VOC water-based adhesive. When applicable, apply a non-flammable, low VOC water-based lagging adhesive to the exposed leading edge of the insulation. Install fasteners per SMACNA HVAC Duct Liner installation instructions.
- d. Duct liner must be installed per SMACNA Manual, “HVAC Duct Construction Standards, Metal and Flexible,” Third Edition unless otherwise specified.

### **PART 3 – EXECUTION**

#### **3.01 INSTALLATION**

- A. Except as specified herein, install material in accordance with recommendations of manufacturer. Do not install insulation materials until tests specified in other sections are completed. Remove foreign material such as rust, scale, or dirt. Surfaces shall be clean and dry. Maintain insulation clean and dry at all times.
- B. On cold surfaces where a vapor barrier must be provided and maintained, insulation shall be installed with a continuous, unbroken moisture and vapor seal. Hangers, supports, anchors, or other projections that are fastened to cold surfaces shall be insulated and vapor sealed to prevent condensation.
- C. Surface finishes shall be extended in such a manner as to protect raw edges, ends, and surfaces of insulation.

- D. Pipe or duct insulation shall be continuous through walls, ceiling or floor openings, or sleeves; except where fire-stop or fire-safing materials are required.
- E. Metal shields shall be installed between hangers or supports and the piping insulation. Rigid insulation inserts shall be installed between the pipe and the insulation shields. Inserts shall be of equal thickness to adjacent insulation and shall be vapor sealed accordingly.
- F. Insulation shall not be installed in the following locations unless otherwise noted:
  - 1. On vacuum return lines less than 50 feet long.
  - 2. On unions, flanged connections or valve handles.
  - 3. Over edges of any manhole, clean-out hole, clean-out plug, access door or opening to a fire damper, so as to restrict opening or identification of access.
  - 4. Over any label or stamp indicating make, approval, rating, inspection, or similar data, unless provision is made for identification and access to label or stamp.

### 3.02 INSTALLATION OF HEATING PIPING SYSTEM INSULATION

- A. General: Space heating hot water, domestic hot water, tempered water supply and return piping and condensate return piping, after having been tested, shall be cleaned and insulated.
- B. Application: Insulate condensate return piping, hot water heating supply and return piping, steam and steam condensate piping, domestic hot water supply and return, including tempered supply and return piping in accordance with manufacturer's instructions and as specified herein.
  - 1. Install insulation on valve bodies up to valve bonnet. Fill void in saddles, in accordance with Section 23 0513: Basic HVAC Materials and Methods, with insulation and seal joints.
  - 2. Install insulating material to fittings, valves, and strainers and smooth to thickness of adjacent covering. Leave strainer clean-out plugs accessible. Covers fabricated from polyvinyl chloride shall be furnished.
- C. Insulation Jackets in Exposed Indoor Locations:
  - 1. Cover completed insulation with canvas jacket tightly pasted to covering with lagging adhesive. Lap jacket seams 1-1/2-inch minimum. Finish entire jacket with coating of undiluted adhesive.
  - 2. Equivalent factory applied pre-sized, glass fiber reinforced, or glass fiber jackets may be furnished. Seal jacket seams with adhesive in accordance with manufacturer's instructions.
  - 3. Johns Manville Zeston 2000, Knauf Insulation Proto PVC Fitting Cover, Speedline Polyco Smoke Safe, or equal, fitting covers may be furnished, with

molded or segmented insulation equal to specified insulation applied to fittings. Secure covers in accordance with manufacturer's instructions.

4. In addition to above requirements, cover exposed insulated piping within a distance of 8 feet above floors with 26 gage galvanized steel jacket. Omit jacket in areas accessible only to maintenance personnel, such as mechanical equipment rooms, utility corridors, accessible pipe tunnels and manholes.

D. Concealed Indoor Locations: Cover insulation over fittings, valves, and strainers with canvas. Provide pipe insulation with factory or field applied standard jacket of 4-ounce minimum canvas, fiberglass cloth, or glass fiber reinforced jacket. Seal jacket laps with adhesive in accordance with manufacturer's instructions.

E. Exposed Outdoors: In addition to canvas or fiberglass cloth cover, pipe insulation exposed to weather shall be provided with an additional 0.016-inch thick aluminum jacket with 2-inches lap connected with 1-inch hem overlap joint located on side of pipe and turned down to shed water. Jacket shall be strapped 12-inch on center with ½-inch wide stainless-steel strapping and wing seals. Aluminum jacket shall be mitered to fit fittings.

### 3.03 INSTALLATION OF COOLING PIPING SYSTEM INSULATION

A. General: Chilled water supply and return piping, refrigerant piping and condensate drain lines, after having been tested, shall be cleaned and insulated.

B. Application: Insulation on chilled water lines, refrigerant suction lines and liquid lines, if indicated, and air conditioner interior drain lines shall be jacketed with fire-resistant vapor barrier of laminated aluminum foil consisting of 2 plies with glass-yarn reinforcing. Jacket joints shall be lapped and sealed with an approved adhesive. Insulation shall be secured with aluminum bands not less than 0.005-inch thick by ¾-inches wide, spaced not over 12-inch on centers, or as recommended by manufacturer.

1. Longitudinal Seams: Butt hinged sections of covering tightly together and seal down jacket flap with adhesive, or with factory-applied, self-sealing lap with pressure-sensitive sealer protected with release paper.

2. End Joints: Wrap joint with a 3-inch wide (minimum) self-sealing tape.

3. Fittings and Valves: Fittings and valves shall be covered with same material of same thickness as pipe insulation, sealed with an approved, vapor-sealing tape or compound and covered with Johns Manville Zeston polyvinyl-chloride cover, Knauf Insulation Proto PVC Fitting Cover, Speedline Polyco Smoke Safe, or equal.

4. Pipe hangers shall be insulated or attached to pipe by an insulating insert, butted between adjoining insulation sections.

C. Additional Jackets:

1. Exposed Indoor Insulation: Cover with 26 gage galvanized sheet metal jacket to 8 feet above floors, except in mechanical equipment rooms and accessible pipe tunnels.

2. Exposed Outdoor Insulation: In addition to canvas or fiberglass cloth cover, provide 0.016-inch thick aluminum jacket with 1-inch wide aluminum bands and seals. Install appropriate jackets on valves and fittings.

### 3.04 INSTALLATION OF HIGH TEMPERATURE EQUIPMENT INSULATION

- A. General: Provide insulation over parts of heat exchangers and similar equipment requiring insulation having removable head or sections.
- B. Application:
  1. Equipment: Securely tie insulation on with copper clad wire. Install tack coat weather barrier coating at a thickness specified by manufacturer. While tack coat is still wet, a layer of 10 open weave glass cloth membrane shall be embedded with fabric seams overlapped a minimum of 2-inch. Install a finish coat fully covering membrane at coverage rate specified by manufacturer.
  2. Boiler Breechings: Wire securely V-rib wire lath,  $\frac{3}{4}$ -inch minimum depth to boiler breechings, connections and stacks inside boiler rooms, and cover with insulation and jacket as specified above.
  3. Manholes and Hand Holes: Maintain accessible by beveling off permanent insulation around manhole and cover manhole plate with removable blanket.

### 3.05 INSTALLATION OF LOW-TEMPERATURE EQUIPMENT INSULATION

- A. General: Provide removable sections of insulation over parts of chillers and similar equipment requiring insulation and having removable heads or sections.
- B. Exterior surfaces of chilled water system expansion tanks and chilled water pumps shall be insulated with not less than 2-inch thick expanded polystyrene or fiberglass, as specified. Fill spaces between insulation and equipment with granulated polystyrene or urethane to eliminate voids. Insulation shall be secured with metal band, and covered with one inch, 20 gage hexagon galvanized mesh and  $\frac{1}{4}$ -inch thick insulating cement troweled smooth. Cement surface shall then be covered with 0.002-inch aluminum foil applied smoothly and secured with suitable adhesive, and a layer of 6-oz. canvas.
- C. Coat joints of polyurethane insulation with neoprene based contact adhesive. Adhesives furnished shall be approved by insulation manufacturer. Fill and seal external voids and seams with non-shrinking sealant.
- D. Canvas Jacket: Cover completed insulation with canvas jacket tightly pasted to covering with lagging adhesive. Lap jacket seams a minimum of 1  $\frac{1}{2}$ -inch. Finish entire surface of canvas jacket with one brush coat of diluted lagging adhesive, Childers CP-50A, Foster 30-36, Mon-Eco Industries (MEI) Eco-Lag Adhesive, or equal, and heavy final coat of undiluted adhesive.

### 3.06 INSTALLATION OF DUCTWORK AND PLENUM INSULATION

- A. External Covering:

1. Before installing duct insulation, sheet metal ducts shall be clean, dry, and tightly sealed at joints and seams, inspected pressure tested, and accepted by District OAR/ Inspector.
  2. Duct exterior insulation shall be firmly wrapped around ductwork with joints lapped a minimum of 2-inch. Insulation shall be securely fastened with 18 gage copper-lined steel wire, or 16 gage soft-annealed galvanized wire spaced approximately 12-inch on centers and at loose ends, presenting a neat and workmanlike appearance. Where duct width is such that wiring will not fasten insulation firmly against duct an adhesive shall be furnished to fasten insulation to duct with wiring being installed at ends of insulation segment.
  3. Insulation on ductwork transporting conditioned air, both supply and return, and outside air intake ducts when pre-conditioned, shall be furnished with a factory-applied, fire-resistant vapor barrier.
  4. Exposed Ducts or Plenum:
    - a. Install insulation to ducts or plenum furnished with butt joints, without voids and with adhesive over entire surface of duct. Cover insulation with canvas jacket, fastened tightly to insulation with lagging adhesive. Install 2 finish coats of undiluted adhesive.
    - b. When installing jacket, finished covering shall be even and level, without humps, with constant diameters on round ducts maintained.
- B. Interior insulation - lining:
1. Dimensions of ducts indicated are net inside dimensions and must include thickness of duct liners to obtain the required duct size.
  2. Install insulation in square turns, where required, to cover interior surfaces before duct turns are installed.
  3. Install lining material during fabrication of duct with sealed face only exposed to air stream.
  4. Interior insulation in ducts or plenums shall not have exposed edges. Edges open to entering or leaving air streams shall be covered, secured in place and sealed with approved duct liner edge sealers.
  5. Insulation shall be fastened to sheet metal with an approved fire-retardant adhesive, with minimum 90 percent coverage and edges firmly adhered.
  6. Mechanical fasteners shall supplement the adhesive on top sections of ducts more than 12-inch wide and on sides of ducts more than 24-inch high and shall be spaced on 16-inch centers maximum. Fastener posts shall be cut off approximately ¼-inch from metal disc.

### 3.07 CLEANUP

- A. Remove rubbish, debris, and waste materials and legally dispose of off the Project site.

3.08 PROTECTION

- A. Protect the Work of this Section until Substantial Completion.

END OF SECTION

## SECTION 23 08 13

### ENVIRONMENTAL CONTROLS AND ENERGY MANAGEMENT SYSTEMS COMMISSIONING

#### PART 1 – GENERAL

##### 1.1 SUMMARY

###### A. Section Includes:

1. General requirements for the Commissioning (Cx) of the Environmental Controls and Energy Management System (ECEMS), and interfacing with other systems such as, lighting controls and HVAC systems interconnection, including installation, start-up, testing and documentation according to Construction Documents and Commissioning Plan (CxP).
2. Standard procedures for the execution of commissioning work shall be in conformance with Division 01, Section 01 91 13: General Commissioning Requirements. Coordinate work with the Commissioning Agent (CxA).

###### B. Related Requirements:

1. Division 01: General Requirements.
2. Section 01 45 23: Testing and Inspection.
3. Section 01 77 00: Contract Closeout.
4. Section 01 79 00: Maintenance and Operations Staff Demonstration and Training.
5. Section 01 91 13: General Commissioning Requirements.
6. Section 23 05 00: Common Work Results for HVAC.
7. Section 23 05 13: Basic HVAC Materials and Methods.
8. Section 23 08 00: HVAC Systems Commissioning.
9. Section 23 09 00: Instrumentation and Controls.
10. Section 23 09 23: Environmental Controls and Energy Management Systems.
11. Section 23 25 00: HVAC Water Treatment.
12. Section 23 30 00: Air Distribution.
13. Section 23 70 00: Air Handling Units.
14. Section 23 80 00: Heating, Ventilating and Air Conditioning Equipment.
15. Section 26 05 00: Common Work Results for Electrical.

16. Section 26 05 13: Basic Electrical Materials and Methods.
17. Section 26 05 19: Low Voltage Wires (600 Volt AC).
18. Section 26 05 26: Grounding and Bonding.
19. Section 26 05 86: Motors and Drives.
20. Section 26 08 00: Electrical Systems Commissioning.
21. Section 26 24 19: Motor Control Centers and Motor Control Devices.
22. Section 26 29 13: Adjustable Frequency Drives.
23. Project Commissioning Plan.

## 1.2 REFERENCES

- A. The latest version of applicable codes, standards, and references: Inspections and tests shall be in accordance with the following applicable codes and standards, except as provided otherwise herein:
  1. National Electrical Manufacturers Association – NEMA.
  2. American Society for Testing and Materials – ASTM.
  3. American National Standards Institute – ANSI.
  4. California Electrical Code – CEC.
  5. Occupational Safety and Health Administration – OSHA.
  6. National Institute of Standards and Technology – NIST.
  7. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE). – Building Management and Energy Management Systems Commissioning, ASHRAE Guideline.
  8. California Building Code – CBC.
  9. California Mechanical Code – CMC.
  10. InterNational Electrical Testing Association (NETA) Acceptance Testing.

## 1.3 SUBMITTALS

- A. Submittals shall include the following:
  1. Required Cx submittals in accordance with Division 01 Specifications.
  2. Copy of the Architect's reviewed and accepted submittals to the CxA via the OAR.

3. List of team members who will represent the Contractor in the Pre-functional and Functional Performance Testing, at least two weeks prior to the start of Pre-functional Equipment Checks.
4. Detailed manufacturer installation and start-up, operating, troubleshooting and maintenance procedures, checklist documentation and field checklist forms to be used by factory or field technicians, and a copy of full details of Owner-contracted tests, full factory testing reports, if any, and Warranty information, including responsibilities of Owner to keep Warranty in force, clearly defined.
5. Detailed manufacturer's recommended procedures and schedules for Pre-functional Equipment Checks, supplemented by Contractor's specific procedures, and Functional Performance Tests, at least four weeks prior to the start of Pre-functional Performance Tests.
6. System logic documentation and sequence of operations for review and approval.
7. Provide Level 1 passwords.
8. After facility's commission is complete, submit completed Pre-functional Equipment Checklists and Functional Performance Test checklists organized by system and by subsystem. Bind information in a single package. The results of failed tests shall be included along with a description of the corrective actions taken.

#### 1.4 MEETINGS, SEQUENCING AND SCHEDULING

- A. Meetings: Attend Cx meetings as required under Section 01 91 13, any other related Sections and the CxP.
- B. Sequencing and Scheduling: The work described in this Section shall begin only after work required in related Division 23 and 26 Sections have been successfully completed, and tests, inspection reports and Operation & Maintenance manuals required have been submitted and reviewed. The start-up and Pre-functional Equipment Checklists shall be completed and submitted to the Owner's Authorized Representative (OAR) prior to the Functional Performance Tests.
  1. Coordinate electrical work with the work of other trades prior to scheduling of any Cx procedures.
  2. Coordinate the completion of electrical testing, inspection, and calibration prior to start of Cx activities.
  3. Cx activities shall be scheduled in accordance with project's Section 01 91 13 and Cx plan.

#### 1.5 QUALITY CONTROL

- A. Comply with Owner's Quality Control Specifications.
- B. Incorporate manufacturer's recommended Cx procedures for the systems and equipment to be commissioned under this Section.

- C. Typical quality control procedures include but are not limited to the following:
  - 1. Attend CxA progress and coordination meetings.
  - 2. Establish trend logs of system schedules as required in Section 23 09 23.
  - 3. Demonstrate system operation and compliance with contract documents.
  - 4. Manipulate systems and equipment to facilitate testing.
  - 5. Provide instrumentation necessary for verification and performance testing.
- D. Provide ECEMS technician(s) to work at the direction of the CxA for software optimization assistance for a minimum of 8 hours. Refer to Part 3 for a description of the software optimization.
- E. Compensation for Retesting: Compensate Owner for site time necessitated by incompleteness of systems or equipment at time of Functional Performance Testing (FPT). Testing failures, which require on-site time for retesting, will be considered actual damages to the Owner. Parties under contract with the Owner who are affected by the retesting shall be included in the contract modification.
- F. Allow sufficient time before final commissioning dates to complete electrical testing, inspection, and calibration to avoid delays in the commissioning process.
- G. During the commissioning activities, provide labor and materials to make corrections when required, without undue delay.

#### 1.6 COORDINATION

- A. Coordinate the completion of electrical testing, inspection, programming and calibration prior to start of commissioning activities.
- B. Coordinate factory field-testing per the requirements of this Section.
- C. Coordinate commissioning efforts with CxA prior to commencing any activities.

### **PART 2 – PRODUCTS**

#### 2.1 TEST EQUIPMENT

- A. Equipment to be used in the commissioning process shall meet the following requirements.
  - 1. Provide test equipment as necessary for start-up and commissioning of the EMS system.
  - 2. Provide testing equipment and accessories that are free of defects and are certified for use.
  - 3. Provide testing equipment with current calibration labels as per NIST Standards; Equipment shall be calibrated on the manufacturer's recommended intervals with calibration tags affixed to the instrument. In the absence of calibration tags,

calibration documentation shall be submitted to the CxA at least thirty days prior to use; this documentation shall include description and serial number of instrument and calibration date and time.

4. Testing equipment shall be maintained in good operating condition for the duration of the project.
  5. Testing equipment shall be UL Listed.
- B. Instrumentation required to verify readings and test the system and equipment performance shall be provided by the Contractor and made available to CxA. Generally, no testing equipment will be required beyond that required to perform Contractor's work under contract documents.

## 2.2 TESTING AND AIR BALANCING AND COMMISSIONING

- A. Provide a portable operator's terminal or hand-held device to facilitate testing, adjusting, and calibration of controls. This device shall support functions and allow querying and editing of parameters required for proper calibration and start up.
- B. Connections shall be provided local to the device being calibrated. For instance, for VAV boxes, connection of the operator's terminal shall be either at the sensor or at the terminal box. Otherwise, a wireless system shall be provided to facilitate this local functionality.

## PART 3 – EXECUTION

### 3.1 COMMISSIONING PROCESS REQUIREMENTS

- A. Work prior to commissioning:
1. Complete phases of the work so the system(s) can be started, tested, adjusted, balanced, and otherwise commissioned.
  2. If contractual modifications are required to bring the system(s) to acceptance levels, such modifications shall be made at no additional cost to the owner.
  3. Normal start-up services required to bring each system into full operational state:
    - a. Testing, motor rotation check, control sequences of operation, full and part load performance.
    - b. Commissioning will not start until each system is complete and start-up has been performed.
- B. Pre-Commissioning responsibilities:
1. Inspection, calibration and testing of the equipment required to commission the following systems:
    - a. Environmental Controls and Energy Management Systems.

- b. Interface and connections of EMS system with lighting controls, electric utility meter, gas meter, photo voltaic system, or as otherwise indicated in contract documents.
- C. Commissioning Process Requirements:
  - 1. Refer to Section 01 91 13: General Commissioning Requirements and related Sections for information on meetings, start-up plans, Functional Performance Testing (FPT), operations and maintenance data, training requirements, and other Commissioning activities.

### 3.2 PREPARATION

- A. Provide certified EMS technicians as required, with tools and equipment necessary to perform Cx activities specified.
- B. Provide certified testing agency personnel and equipment factory representatives as required in the Cx plan and other related Sections.
- C. Verify that work required in this Section and in Section 01 91 13 is complete prior to starting of FPT.
- D. Verify that complete operational manuals have been reviewed and accepted by the CxA as specified before starting FPT.

### 3.3 START-UP, TESTING, ADJUSTING, AND CALIBRATION

- A. Work or systems installed shall be fully functioning prior to Demonstration and Acceptance Phase. Start, test, adjust, and calibrate work as described below:
  - 1. Inspect the installation of devices. Review the manufacturer's installation instructions and validate that the device is installed in accordance with them.
  - 2. Verify proper electrical voltages and amperages, and verify that circuits are free from faults.
  - 3. Verify integrity/safety of electrical connections.
  - 4. For AHUs that use a throttled outside air damper position when minimum outside air is required, mark the minimum outside air damper position.
  - 5. Coordinate with testing and air balance (TAB) subcontractor to obtain, Cx and fine-tune control settings that are determined from balancing procedures. Record the following control settings as obtained from TAB Contractor, and note any TAB deficiencies in the ECEMS Start-up report:
    - a. Optimum duct static pressure setpoints for VAV air handling units.
    - b. Minimum outside air damper settings for air handling units.
    - c. Optimum differential pressure setpoints for variable speed pumping systems.

- d. Calibration parameters for flow control devices such as VAV boxes and flow measuring stations.
6. Test, calibrate, and set digital and analog sensing and actuating devices. Test equipment shall be 50 percent more accurate than the field device over the same range. Calibrate each instrumentation device by making a comparison between the ECEMS display and the reading at the device. (e.g., if field device is plus or minus 0.5 percent accurate, test equipment shall be plus or minus 0.25 percent accurate over the same range). Record the measured value and displayed value for each device in the ECEMS start-up report.
7. Check and set zero and span adjustments for transducers and transmitters.
8. Dampers and Valves:
  - a. Check for adequate installation including free travel throughout range and adequate seal.
  - b. Where loops are sequenced, check for proper control with overlap.
9. Actuators:
  - a. Check to insure that device seals tightly when the appropriate signal is applied to the operator.
  - b. Check for appropriate fail position, and that the stroke and range is as required.
10. Check each digital control point by making a comparison between the control command at the central command unit and the status of the controlled device. Check each digital input point by making a comparison of the state of the sensing device and the ECEMS display. Record the results for each device in the ECEMS start-up report.
11. For outputs to reset other manufacturer's devices (for example, VSDs) and for feedback from them, calibrate ranges to establish proper parameters. Coordinate with representative of the respective manufacturer and obtain their approval of the installation.
12. Verify proper sequences by using the checklists to record results and submit with ECEMS start-up report. Verify proper sequence and operation of specified functions.
13. Verify that safety devices trip at appropriate conditions. Adjust setpoints accordingly.
14. Tune control loops to obtain the fastest stable response without hunting, offset or overshoot. Record tuning parameters and response test results for each control loop in the ECEMS start-up report. Except from a startup, maximum allowable variance from setpoint for controlled variables under normal load fluctuations shall be as follows. Within 3 minutes of any upset (for which the system has the capability to respond) in the control loop, tolerances shall be maintained (exceptions noted):

- a. Duct air temperature: plus or minus 1 degree F.
- b. Space temperature: plus or minus 2 degrees F.
- c. Hot water temperature: plus or minus 3 degrees F
- d. Duct pressure: plus or minus 0.25 inches w.g.
- e. Water pressure: plus or minus 1 psid.
- f. Air flow control: plus or minus 5 percent of setpoint velocity.
- g. Space pressurization: plus or minus 0.05 inches w.g.

15. For interface and DDC control panels:

- a. Ensure devices are properly installed with adequate clearance for maintenance and with clear labels in accordance with the record drawings.
- b. Ensure that terminations are safe, secure and labeled in accordance with the record drawings.
- c. Check power supplies for proper voltage ranges and loading.
- d. Ensure that wiring and tubing are run in a neat and workman-like manner, either bound or enclosed in trough.
- e. Check for adequate signal strength on communication networks.
- f. Check for standalone performance of controllers by disconnecting the controller from the LAN. Verify that the controlling LAN reconfigures as specified in the event of a LAN disconnection.
- g. Ensure that outputs and devices fail to their proper positions/states.
- h. Ensure that buffered or volatile information is held through power outage.
- i. With system and communications operating normally, sample and record update/annunciation times for critical alarms fed from the panel to the Operator Interface.
- j. Check for adequate grounding of DDC panels and devices.

16. Operator Interfaces:

- a. Verify that elements on the graphics are functional and are properly bound to physical devices or virtual points, and that hot links or page jumps are functional and logical.
- b. Output specified ECEMS reports for review and approval.

- c. Verify that the alarm printing and logging is functional and per requirements.
  - d. Verify that trends are archiving to disk and provide a sample to the CxA and owner for review.
  - e. Verify that e-mail alarm annunciation is functional.
  - f. Verify that functionality of remote operator interfaces.
  - g. Verify that required third party software applications required with the bid are installed and are functional.
  - h. Verify proper interface with fire alarm, lighting control system, photo voltaic system, gas and electrical meters.
- B. Submit start-up test report: Report shall be completed, submitted, and reviewed prior to Substantial Completion.

### 3.4 SENSOR CHECKOUT AND CALIBRATION

- A. General Checkout: Verify that sensor locations are appropriate and are away from causes of erratic operation. Verify that sensor with shielded cable are grounded only at one end.
- B. Calibration: Calibrate sensors using one of the following procedures:
  - 1. Sensors Without Transmitters – Standard Application: Make a reading with a calibrated test instrument within 6 inches of the site sensor at various points across the range. Verify that the sensor reading (via the permanent thermostat, gage, or ECEMS) is within the tolerances specified for the sensor. Where sensors are subject to wide variations in the sensed variable, calibrate sensor within the highest and lowest 20 percent for the expected range.
- C. Sensor Tolerance: Sensors shall be within the tolerances specified for the device.

### 3.5 COIL VALVE LEAK CHECK

- A. Verify proper close off of the valves. Ensure that valve seats properly by simulating the maximum anticipated pressure difference across the circuit. Calibrate air temperature sensor on each side of coil to be within 0.5 degrees F of each other. Via the Operator Interface, command the valve to close. Energize fans. After five minutes observe air temperature difference across coil. If a temperature difference is indicated, and the piping surface temperature entering the coil is within 3 degrees F of the water supply temperature, leakage is probably occurring. If it appears that it is occurring, close the isolation valve to the coil to ensure the conditions change. If they do, this validates that the valve is not closing. Remedy the condition by adjusting the stroke and range, increasing the actuator size/torque, replacing the seat, or replacing the valve as applicable.

### 3.6 VALVE STROKE SETUP AND CHECK

- A. For valve and actuator positions check, verify the actual position against the ECEMS display.
- B. Set pumps to normal operating mode. Command valve closed, verify that valve is closed, and adjust output zero signal as required. Command valve open, verify position is full open and adjust output signal as required. Command the valve to various few intermediate positions. If actual valve position does not reasonably correspond, replace actuator.

### 3.7 ECEMS DEMONSTRATION

- A. Demonstrate the operation of the ECEMS hardware, software, and related components and systems to the satisfaction of the CxA and Owner. Schedule the demonstration with the Owner's representative two weeks in advance. Demonstration shall not be scheduled until hardware and software submittals and the start-up test report are reviewed. If the work fails to be demonstrated to conform with contract specifications, so as to require scheduling of additional site visits by the CxA and Owner's representative for re-demonstration, reimburse owner for reasonable local costs of subsequent CxA site visits as detailed elsewhere in these specifications.
- B. Supply personnel and equipment for the demonstration, including, but not limited to, instruments, ladders, etcetera. Contractor-supplied personnel shall be competent with and knowledgeable of project-specific hardware, software, and the HVAC systems. Training documentation and submittals shall be at the job site.
- C. Demonstration shall typically involve small representative samples of systems and equipment randomly selected by the owner and CxA.
- D. The system shall be demonstrated following the same procedures used in the start-up test by using the Commissioning checklist. Demonstration shall include, but not necessarily be limited to, the following:
  - 1. Demonstrate that required software is installed on ECEMS workstations. Demonstrate that graphic screens, alarms, trends, and reports are installed as submitted. Demonstrate directory structure and file system matches that submitted.
  - 2. Demonstrate that points specified and shown can be interrogated or commanded (as applicable) from workstations, as specified, in less than the maximum response time.
  - 3. Demonstrate correct calibration of input/output devices using the same methods specified for the start-up tests. A maximum of 10 percent of I/O points shall be selected at random by the CxA or owner for demonstration. Upon failure of any device to meet the specified end-to-end accuracy, an additional 10 percent of I/O points shall be selected at random by CxA for demonstration. This process shall be repeated until 100 percent of randomly selected I/O points have been demonstrated to meet specified end-to-end accuracy.
  - 4. Demonstrate that DDC and other software programs exist at respective field panels. The DDC programming and point database shall be as submitted.

5. Demonstrate that DDC programs accomplish the specified sequences of operation including failure sequences.
  6. Demonstrate that the panels automatically recover from power failure, as specified. Demonstrate alarms as specified.
  7. Demonstrate that the stand-alone operation of panels meets the requirements of these Specifications. Demonstrate that the panels' response to LAN communication failures meets the requirements of these Specifications.
  8. Identify access to equipment selected by CxA or by the owner. Demonstrate that access is sufficient to perform required maintenance.
  9. Demonstrate that required trend graphs and trend logs are set up per the requirements. Provide a sample of the data archive. Indicate the file names and locations.
- E. ECEMS demonstration shall be completed and prior to Substantial Completion.
- F. Tests successfully completed during the demonstration will be recorded as passed for the Functional Performance Testing (FPT) and will not have to be retested.

### 3.8 RESOLUTION OF DEFICIENCIES

- A. Maladjustments, misapplied equipment, or deficient Contractors performance may result in additional work being required for Cx acceptance.
1. Perform work required to correct the installations not meeting contract requirements at no additional cost to the Owner.
- B. Corrective work shall be completed in a timely manner to permit completion of the Cx process.
1. Refer to Article 3.07 above, Section 01 91 13, and Cx plan for retesting requirements necessary to achieve required system performance.
  2. If the system's Cx deadline, as defined in the CxP, goes beyond the scheduled completion of Cx without resolution of the problem, the Owner reserves the right to obtain supplementary services or equipment to resolve the problem.

### 3.9 ECEMS ACCEPTANCE PERIOD

- A. After approval of the ECEMS demonstration and prior to contract close-out acceptance phase shall commence. Acceptance period shall not be scheduled until HVAC systems are in operation and have been accepted, required cleaning and lubrication has been completed (i.e., filters changed, piping flushed, strainers cleaned, and the like), and Testing and Balancing report has been submitted and reviewed. Acceptance Period and its approval will be performed on a system-by-system basis if mutually agreed upon by the Contractor and the owner.
- B. Operational Test: At the beginning of the Acceptance Phase, the system shall operate properly for two weeks without malfunction, without alarm caused by control action or device failure, and with smooth and stable control of systems and equipment in

conformance with these specifications. At the end of the two weeks, forward the trend logs to the CxA for review and acceptance. CxA shall determine if the system is ready for Functional Performance Testing (FPT) and document any problems requiring Contractor attention.

1. If the systems are not ready for Functional Performance Testing (FPT), correct problems and provide notification to the owner's representative that problems have been corrected. The acceptance period shall be restarted at the mutually scheduled time for an additional one-week period. This process shall be repeated until CxA issues notice that the ECEMS is ready for Functional Performance Testing (FPT).
- C. During the acceptance period, maintain a hard copy log of alarms generated by the ECEMS. For each alarm received, diagnose the cause of the alarm, and list on the log for each alarm the diagnosed cause of the alarm, and the corrective action taken.
- 3.10 TREND LOGS
- A. Configure and analyze trends required under Section 23 09 23.
- 3.11 TREND GRAPHS
- A. Trend graphs as specified in Section 23 09 23 shall generally be used during the acceptance phase to facilitate and document testing. Prepare controller and workstation software to display graphical format trends during the acceptance period. Trend graphs shall demonstrate compliance with contract documents.
- B. Each graph shall be clearly labeled with HVAC subsystem title, date, and times.
- 3.12 WARRANTY PHASE
- A. Trending: Throughout the Warranty phase, trend logs shall be maintained as required for the acceptance period. Forward archive trend logs to the CxA and Owner for review. CxA or Owner will review these and notify Contractor of Warranty work required.
- 3.13 SOFTWARE OPTIMIZATION ASSISTANCE
- A. Provide the services of an ECEMS technician at the project site to be at the disposal of the CxA and Owner. The technician is to make changes, enhancements, and additions to control unit or workstation software that has been identified by the CxA or Owner during the Construction and Commissioning of the project and that are beyond the specified contract requirements. The cost for this service to include a total of 40 hour will be included with the bid. Request for assistance shall be for contiguous or non-contiguous 8 hour days, unless otherwise mutually agreed upon by the Contractor, CxA, and OAR. The Owner Authorized Representative (OAR) shall notify Contractor two days in advance of each day of requested assistance.
- B. The ECEMS technician provided shall be trained in the programming and operation of the controller and workstation software. If the ECEMS technician provided cannot perform every software task requested by the CxA or Owner in a timely fashion, provide additional qualified personnel at the project site as requested by the CxA or Owner.

**END OF SECTION 23 08 13**

## SECTION 23 0900

### HVAC INSTRUMENTATION AND CONTROLS

#### PART 1 – GENERAL

##### 1.01 SUMMARY

- A. Section Includes: Temperature controls for air conditioning, heating, and ventilating systems as indicated. Work includes, but is not be limited to, the following:
1. Automatic control valves and automatically operated dampers.
  2. Pneumatic or electric relays (magnetic starters excluded), electric or mechanical linkages, duct sensors, thermostats, dampers and motorized valves, and appurtenances and accessories.
  3. Wiring outlet boxes and conduits for control systems, including wiring to connect magnetic starters to control systems.
  4. Air compressor and receiver tank for pneumatic control systems, with appurtenances and air piping, including pressure regulator, automatic moisture eliminators, air line filters, relief valves, pressure gages and shut-off valves, drains, pneumatic piping distribution to control equipment, etcetera.
  5. Testing and adjusting temperature control system.
  6. Furnishing record drawings and operational data of systems as installed and finally adjusted.
  7. Formal instruction of Owner personnel in operation of equipment.
- B. Following items are specified in other Sections:
1. Magnetic starters, contacts, power relays and variable resistors or controllers for motors, and other electrical devices.
  2. Load carrying wiring for above listed devices and wiring for starting switches not interconnected with temperature control system. (Division 26: Electrical).
  3. Electrical power to control panels and other equipment. (Division 26: Electrical).
  4. Installing automatic valves in pipelines.
  5. Installing automatic dampers.
  6. Automatic controls and valves not connected with comfort heating, ventilating, and air conditioning systems.
  7. Packaged self contained equipment specified complete with temperature controls.
  8. DDC control equipment specified in Section 23 0923: Environmental Control and Energy Management Systems.

C. Related Requirements:

1. Division 01: General Requirements.
2. Division 26: Electrical.
3. Section 23 0500: Common Work Results for HVAC.
4. Section 23 0513: Basic HVAC Materials and Methods.
5. Section 23 0800: HVAC Systems Commissioning.
6. Section 23 0923: Environmental Control and Energy Management Systems.
7. Section 23 2013: HVAC Piping.
8. Section 23 3000: Air Distribution.
9. Section 23 3813: Kitchen Ventilation System.
10. Section 23 5000: Central Heating Equipment.
11. Section 23 6416: Oil Lubricated Centrifugal Water Chillers.
12. Section 23 6418: Oil Free Centrifugal Water Chillers.
13. Section 23 6423: Scroll Water Chillers.
14. Section 23 6426: Rotary-Screw Water Chillers.
15. Section 23 6428: Air-Cooled Rotary Screw Chillers.
16. Section 23 6500: Cooling Towers.
17. Section 23 7000: Air Handling Units.
18. Section 23 8000: Heating, Ventilating and Air Conditioning Equipment.

1.02 SUBMITTALS

A. Provide in accordance with Division 01 and Section 23 0500: Common Work Results for HVAC.

1. Complete list of items proposed to be furnished and installed under this Section.
2. Manufacturer's specifications and other data required to demonstrate compliance with specified requirements.
3. Manufacturer's printed installation procedures.

B. Shop Drawings: Provide Shop Drawings, in the same size as the Drawings, prepared, signed and sealed by a mechanical engineer licensed in the State of California. Shop Drawings shall indicate temperature control diagrams, complete with equipment appurtenances required for system. Include sequence of operation description for each system. Submit in accordance with of Division 01.

- C. Sequence of Operation: Provide complete, detailed, step-by-step sequence of operation for each item of equipment.
- D. Operating Instructions: Comply with provisions of Section 23 0500: Common Work Results for HVAC. Explain and demonstrate operation of system to Owner representatives as required.
- E. Guarantee: Refer to Section 23 0500: Common Work Results for HVAC.

1.03 QUALITY ASSURANCE

- A. Manufacturer and Installer Qualifications: Comply with provisions stated under Section 23 0500: Common Work Results for HVAC.

1.04 PRODUCT HANDLING

- A. Production, Replacement, Delivery and Storage: Refer to Section 23 0500: Common Work Results for HVAC and Section 23 0513: Basic HVAC Materials and Methods.

**PART 2 – PRODUCTS**

2.01 TEMPERATURE CONTROLS

- A. Provide temperature controls of pneumatic, electric, electronic microprocessor - DDC type, or a combination thereof, as indicated on Drawings, to provide required sequences or operational control.

2.02 MANUFACTURERS

- A. Equipment in system shall be of same manufacturer or their standard furnished items. Testing, initial start-up, and adjusting of control system shall be under continuous observation of the mechanical engineer responsible for Shop Drawing preparation.

- B. Pneumatic, electric, electronic, or direct digital microprocessor based control equipment shall be one of following manufacturers, unless otherwise noted:

1. Carrier
2. No known Equal
3. No known Equal
4. No known Equal

2.03 PNEUMATIC EQUIPMENT AND ACCESSORIES

- A. Pneumatic equipment and accessories shall include, but not be limited to following:
  1. Pneumatic control devices as indicated on Drawings and as described including sensors, switches, relays, thermostats, control panels for instruments, temperature controllers, automatic valves, automatic dampers, and damper operators as required to provide a complete and operable system.
  2. Pneumatic distribution tubing for temperature control systems.
  3. Local control panels.

4. Complete instrument air system including air compressor and receiver, refrigerated air dryer, and appropriate accessories.
- B. Control Panels:
1. Controllers, relays, switches, etcetera, for equipment located within equipment rooms shall be installed in enclosed control panel, with hinged locking doors. Pneumatic indicating devices and pressure differential devices shall be mounted on face of control panel door. Control devices, including pneumatic indicators, for equipment located in exposed areas subject to outside weather conditions, shall be mounted inside weatherproof enclosures. Location of each panel shall be convenient for adjustment service. Nameplates shall be provided beneath each panel-mounted control device describing function of device.
  2. Pneumatic devices within panel shall be factory pre-piped. A pneumatic terminal numbering system shall be installed on pneumatic lines within a panel with aforementioned numbers matching pneumatic terminals indicated on control diagrams. This feature is required to assist system checkout and service.
  3. Electrical devices within panel shall be pre-wired to terminal strips with inter-device wiring within panel completed before installation of the system.
- C. Room Type Instruments: Room thermostats and transmitters shall be miniature type, two-pipe with pneumatic relay, pneumatic feedback, and adjustable sensitivity. A cover with tamperproof screws shall be provided on room type instruments, unless indicated otherwise.
1. Single pipe non-relay bleed type instruments may be furnished if indicated on Drawings.
  2. Deadband Thermostat: Thermostat shall be furnished with dual movement, one for cooling control and one for heating. An adjustable dead-band shall be provided centered approximately at nominal comfort temperature of 73 degrees F. For any particular dead-band selected, thermostat shall react to temperatures above and below that band while within that band shall maintain a signal that produces neither cooling nor heating.
- D. Damper Operators:
1. Damper operators shall be synthetic elastomer diaphragm piston-type and shall be fully proportioning unless otherwise specified. Damper operators shall be furnished with metal bodies. Operators shall provide ample power to overcome friction of damper linkage and air pressure acting on damper blades. Damper operator mounting arrangement shall be outside airstream wherever possible. Operators shall be furnished with external adjustable stops to limit stroke. Operator linkage arrangement shall be such as to permit normally open or normally closed positions of damper as indicated.
  2. Damper operators on modulating dampers that are to be sequenced with other control devices, shall, where indicated on Drawings or required to meet sequencing needs, be provided with a pilot positioner of full relay type with an interconnecting linkage to provide mechanical feedback so as to accurately position and control damper.
- E. Receiver Controllers:
1. Modulating temperature, pressure, and humidity receiver controllers shall be fluid type furnished with adjustable gain with an amplification ratio up to 40 to 1. Dual input (submaster) instruments shall provide adjustable ratio or reset range. Instruments shall be furnished with dials for setpoint, gain, and where applicable ratio or reset range. Such receiver controllers shall be mounted inside local control panels. A pressure gage shall be mounted on

instrument indicating the output air pressure supplied to controlled device. Test probe points shall be furnished to permit analysis of input signals without interrupting controller functionally.

2. Applications requiring offset compensation shall include a proportional integral controller. The device shall be fluid in design to minimize internal hysteresis and be furnished with either integral or remote setpoint adjustment and integral time constant adjustment. Device shall function as an integral feedback device with an output that varies progressively depending on degree of offset and time since transient was detected.

F. Pneumatic Transmitters:

1. Pneumatic duct and immersion temperature transmitters shall be furnished and shall be liquid filled capillary type, incorporating a pneumatic feedback signal to ensure an exact and proportional relation between measured temperature and transmitted signal. Where transmitter is provided for sensing of mixed air temperature or coil discharge temperatures, or duct area is more than 14 square feet, instrument shall incorporate an averaging element. This element shall be a minimum of 96 inches long. Outside air sensing shall be accomplished with a transmitter and a bulb element either duct mounted or shielded from effects of solar radiation.

2. To limit total control loop error and provide closer control, transmitters shall be furnished in following ranges:

	<u>Degrees F</u>
a. Chilled water	0 to 100
b. Condenser water	50 to 100
c. Cold plenum	40 to 65
d. Hot plenum	50 to 150
e. Mixed air	50 to 100
f. Outside air (temperate climate)	0 to 100
g. Outside air (severe climate) minus	0 to 160
h. Hot water	40 to 240
i. High temperature hot water	200 to 400
j. Room temperature	60 to 85

3. Manufacturers not furnishing the above ranges shall provide industrial transmitters bench calibrated for particular range. Calibration certificate shall be furnished with each device.
4. Where transmitters are provided for sensing liquid temperatures, they shall be furnished with brass separable wells. Pressure and pressure differential transmitters shall be provided in conjunction with calibrated sensing arrangements to provide a linear 3 to 15 psi signal across operating range.

G. Economizer Control System:

1. Economizer controller shall consist of either a single instrument or a number of components, as indicated on reviewed submittals, to provide performance characteristics described.

2. When air handling equipment is started, a signal shall be provided to switch on economizer control system.
  3. Unless overridden by a warm-up cycle signal, center shall, upon verification that air handling unit is running, open outside air damper to provide minimum required ventilation. An adjustment shall be provided for minimum outside air setting.
  4. A cooling demand signal shall be furnished to economizer controller from other temperature controllers as indicated on Drawings. An adjustment shall be provided to override economy cycle upon either an outside air or, if indicated on Drawings, an enthalpy stimulus. The economizer shall react to this signal as follows:
    - a. Outside air temperature or enthalpy above setting or economizer override. No benefit is derived from use of outside air for free cooling. Outside, return, and exhaust dampers shall be positioned for minimum ventilation. Cooling demand shall be satisfied by modulating chilled water valve (for DX equipment as applicable).
    - b. Outside air temperature above cooling demand controller set point but below economizer switch over. Outside, return, and exhaust dampers shall be positioned for maximum free cooling using outside air with shortfall capacity made up by modulating chilled water valve.
    - c. Outside air temperature below cooling demand controller. Cooling demand shall be satisfied by modulating outside, return and exhaust dampers. Chilled water valve shall be closed to flow of water through coil (DX equipment off).
  5. A target gage will indicate if system is operating on economy cycle or has been switched to minimum ventilation.
  6. An indicator shall be provided indicating outside air temperature at which economy override occurs.
- H. Pneumatic Indication:
1. Pneumatic indicator gages shall be provided for each transmitter. Indicators shall be temperature, humidity, or pressure according to type of transmitter. Indicators shall be dial type, a minimum of 2 ½-inch in diameter.
  2. Control panels shall have a 0-30 psi pressure gage of 1 ½-inch minimum diameter to indicate input control air pressure and output of controllers contained within panel.
  3. Accessory pneumatic and pneumatic electric devices shall be furnished with a pneumatic test point on device output, which will allow output signal to be measured without interruption of control function.
- I. Direct Reading Pressure Differential Gages: Gages shall be panel or equipment installed with appropriate sensing tubes located on the equipment being measured. Differential pressure gages shall be of high sensitivity bellows actuated variety. Range of differential pressure gage shall be appropriate for pressure drop being measured. Refer to Drawings for location of gages.
- J. Solenoid Air (E.P.) Valves: Solenoid air valves shall be two-position electric to pneumatic devices capable of feeding a pneumatic signal through a common port from either a normally closed port or a normally open port.

- K. Signal Discriminators: Signal discriminators shall be a pneumatic device capable of simultaneously limiting high and low signals to predetermined levels to limit amount of reset applied to a submaster receiver controller. Setting shall be completely and infinitely variably adjustable. Mechanical stops on controllers that are subject to vibration errors are not permitted.
- L. Relays and Signal Transmitters: Necessary relays and signal boosters shall be furnished to provide a full and operable system as required by sequence of operation.
- M. Square Root Extractors: Square root extractors shall be furnished where indicated on Drawings. Device shall obtain a parabolic input signal, such as that obtained from a velocity pressure transmitter, and linearize it to provide a signal proportional to square root of original signal.
- N. Multi-Port Summing Cumulators: Summing cumulators shall process input signals to provide an output signal proportional to actual value of input parameters. Different spans of input signals shall be accommodated by provision of ratio adjustments for inputs referenced to largest input.
- O. Selector Switches, Two-Position: For applications where two signals need to be switched manually, selector switches shall be furnished. Switches shall be designed for panel face mounting with position graphics located behind a knob.
- P. Gradual Switches: Gradual switches shall provide a proportional output signal that increases and decreases according to position of a knob. Device shall be designed for panel mounting and be provided with a graduated backplate.
- Q. Pressure Electric (P.E.) Switches:
1. Pressure electric switches shall convert a pneumatic control signal into an electric contact closing. Action may be to open a contact on rise in pressure or to close a contact on rise in pressure as required by sequence of operation. Single-pole double-throw switches may be provided for either action.
  2. Differential shall be adjustable where required to stage correct sequences of on/off and to prevent rapid cycling of equipment.
  3. Narrow differential switches may provide fixed differential where close tolerance of on/off point is required.
  4. Double pole single throw switches furnished for duplicate functions shall be constructed such that both contact sets close simultaneously.
  5. Contact rating shall be suitable for application with necessary approvals from such agencies as Underwriters Laboratories.
- R. Automatic Control Valves:
1. Automatic control valves shall be fully proportioning with modulating plugs for equal percentage of linear flow characteristics. Valves shall be sized by control manufacturer and be provided with actuators of sufficient power for duty intended. Valve body and actuator selection shall be sufficient to handle system pressure and shall close against differential pressures encountered on the Work.
  2. Where required by sequence of operation, valves shall be capable of being sequenced either with other valves or other pneumatically actuated devices. Where such sequencing is required, actual spring range, when adjusted for spring shift, shall be such that no

overlapping occurs. In event that spring shift causes an overlap, a pilot positioning operator shall be furnished.

3. Small Valves, ½ to 1 inch: Valves shall be constructed with a cast brass body and screwed ends. Trim shall consist of a removable cage providing valve plug guiding throughout entire travel range. A stainless steel stem shall be provided. Bonnet, cage, and stem and plug assembly shall be removable for servicing. Actuator shall be cast aluminum with spring return piston operated by synthetic rubber diaphragm. Body rating shall be 400 psi at 150 degrees F.
  4. Valves, 1 ½ to 2-inch: Valves shall be constructed with a cast brass body and screwed ends. For special duty, valves may be selected by control manufacturer to have either bronze or cast iron bodies with screwed or flanged ends. Valves shall be provided with either piston or diaphragm actuators as required.
  5. Valves, 2 ½-inch and Above: Valves shall be constructed with a cast iron body and be furnished with flanged connections. Actuators shall be synthetic rubber, spring return, diaphragm type sized for the duty.
- S. Dampers: Modulating dampers shall be single or multiple blade type as required. Damper frames shall be constructed of 13 gage galvanized sheet metal and shall be furnished with flanges for duct mounting. Blade-to-blade linkage on each section shall be concealed within damper frame. Section linkage shall not be exposed to airstream. Damper blades shall not exceed 6 inches in width. Blades shall be corrugated type construction, fabricated from two sheets of 22 gage galvanized sheet steel, spot welded together. Blades shall be suitable for high velocity performance. Dampers furnished for outside, return, or exhaust air and those provided for zone mixing dampers shall be furnished with seals to provide tight shut-off along edges of blades. Seals shall be synthetic elastomer, spring stainless steel or combinations of both. Seals shall provide a tight closing, low leakage damper of less than one percent at 3 inches static pressure. Bearing shall be oil-impregnated sintered bronze or bearing grade nylon.
- T. Instrument Air Supply:
1. Instrument air supply shall be furnished to provide clean, dry control quality instrument air to temperature control system.
  2. A single or duplex air compressor shall be installed as indicated on Drawings. Each air compressor shall be sized by the temperature control manufacturer to provide adequate air for system without operating more than 50 percent of the time. Air compressor and after cooler sizing indicated on Drawings shall represent minimums only. Air compressor shall be instrument air quality, operating at low piston speeds and low temperature to minimize oil vaporization and carry-over.
  3. A receiver tank shall be furnished complete with ASME label, pressure gage, relief valve, automatic drain trap piped to convenient drain, and necessary openings. Compressor receiver tank shall be sized to require no more than 10 starts per hour of an individual compressor. Receiver tank shall comply with applicable state and local codes as well as OSHA standards.
- U. Driers:
1. A drier shall be furnished to remove condensable contaminants from air such as oil and water. After cooler drier shall be mechanical refrigeration type rated at not less than 1/6 horsepower with a refrigeration capacity to assure a dewpoint of 39 degrees F for 10 CFM of

air at 100 psi, with inlet air at 100 degrees F, operating at 100 degrees F ambient temperature.

2. Drier shall be provided for full system capacity.
3. Assembly shall be furnished with the following:
  - a. Integral 40 micron particulate afterfilter.
  - b. Automatic condensate drain trap.
  - c. Power on green pilot light.
  - d. High air temperature red warning pilot light.
  - e. Provision for connection of a remote alarm.

V. Following instrument air accessories shall be provided:

1. Submicron filter assembly including replaceable cartridge type filter with transparent bowl and metal bowl guard. Filter element shall be effective in removing 98 percent of any oil leaving after cooler and solid particles as small as 0.6 microns. A trap shall be provided to automatically discharge any liquid contaminants retained in the filter bowl.
2. Pressure reducing stations shall be provided at locations to ensure adequate quantity and pressure of instrument air to controls furnished herein. Pressure gage shall indicate output of PRV. For systems operating at 20 psig a pop safety shall be furnished to protect instruments from excess air pressures.

W. For duplex air compressors, provide an electric alternator system that will:

1. Automatically alternate lead/lag compressor on each start.
2. Energize lag compressor in event that lead compressor either fails to start or fails to deliver sufficient air capacity.
3. Alternator system shall include combination starters or fused disconnect starters as indicated on Drawings.

## 2.04 ELECTRIC EQUIPMENT AND ACCESSORIES

A. Electric control equipment and accessories include, but are not limited to, the following:

1. Electric control devices as indicated on Drawings and described herein, including thermostats, temperature controllers, valve and damper operators, switches, relays, and control panels for instruments as required to provide a complete and operable system.
2. Wiring and conduit, unless otherwise noted, or control systems including wiring required, to connect magnetic starters, specified in other sections, to control systems.

B. Room Thermostats:

1. Thermostats for unitary air conditioning units shall be as specified in Section 23 8000: Heating, Ventilating and Air Conditioning Equipment. Thermostats located on outside walls shall be installed on insulated backplates or as specified by unit manufacturer.

2. Provide the following room thermostats for each specific application as follows, where manufacturer's thermostats are not specified in Section 23 8000:
  - a. Carrier or no known equal, for Carrier or no known equal equal, for cooling only.
  - b. Carrier or no knownequal, microelectronic commercial thermostat with sub-base for electronic control of 18 to 30 VAC single zone HVAC equipment. Thermostat is either stand alone, or arranged in a temperature averaging network consisting of 2, 3, 4, 5, or 9 sensors for corresponding rooms or zones.
  - c. Carrier or no known equal, proportional thermostat, low-voltage, 3-wire controller for valve, damper motors and balancing relays. Unit manufacturer may specify or recommend optional thermostat.
  - d. Provide tamper-proof locking thermostat guards for items specified above. Covers shall be opaque beige plastic in student occupied areas, clear plastic cover in administrative areas. Provide Carrier or no known equal, universal thermostat guards or as recommended by thermostat manufacturer.
- C. Duct-Mounted Thermostats: Duct-mounted thermostats shall be modulating or 2-position as required to accomplish sequence of operation.
- D. Valve and Damper Motors: Damper motors shall be furnished with oil-immersed gear trains and ample capacity to handle required loads under normal operating conditions. Where indicated, spring return type motors are to be provided. Valve motors to be 2-position or proportional, spring return or now spring return.
- E. Time Clocks:
  1. TC-1: Time clock shall be solid-state digital electronic type capable of 28 on/off set points to be distributed through the week, complete with a day repeat feature, time and set points to be adjustable to nearest minute with a minimum on duration of one minute and a maximum of 7 days. UL Listed, enclosed in standard case NEMA Type 1, Intermatic, Tork, Paragon, or equal, with battery operated carry-over.
  2. TC-2: Interval timer (bypass), except for window units, shall be manually set and spring operated type, 0 to 6 hours, and without hold feature. Provide Intermatic, M.H. Rhodes, Paragon, or equal.
  3. TC-3: Bypass timer for window type air conditioner units shall be DPDT switch configuration, 12 hours, and without hold feature. Provide M.H. Rhodes, Intermatic, Tork, or equal. Provide double gang box as specified in Division 26: Electrical.
- F. Wiring: Wiring in connection with control systems regardless of voltage, except power supply circuits, is part of the Work of this Section. Wiring shall comply with Division 26: Electrical.
- G. See Section 23 0923 for DDC/Electronic controls.

### **PART 3 – EXECUTION**

#### **3.01 TEMPERATURE CONTROL SYSTEM INSTALLATION**

- A. Control system shall be installed in accordance with control manufacturer's instructions and reviewed Shop Drawings.

### 3.02 PNEUMATIC SYSTEM

- A. Compressor and receiver unit shall be installed inside building, unless otherwise required.
- B. Compressor unit installed on roof or exposed to weather shall be provided with weatherproof enclosure with access to components. Include in the Shop Drawings the enclosure details.
- C. An ASME high-pressure safety valve shall be installed on receiver. A low-pressure safety valve shall be located downstream of each regulator for instrument protection.
- D. Pneumatic copper control piping shall be installed concealed in finished rooms. Pipe shall be properly supported from building structure. Hanging to pipes is not permitted. Provision shall be provided to allow for movement in pipes passing through separation joints, between sections of a building, among two buildings, or between arcades and buildings where movement may occur. Tubing shall pitch toward receiver from first downstream moisture eliminator, and shall be not less than one pipe size larger than pipe leaving eliminator.
- E. Suitable drip-legs and drains shall be installed at low points in air mains. At least one drip point shall be provided for each building. Drip leg at each drip point and moisture eliminator shall be not less than 6 inches long; one inch tubing, with brass drain petcock.
- F. Pressure Testing: Piping system shall be tested by placing it under 30 psi air pressure for 24 hours. Total pressure drop during this period shall not exceed 3 psi.

### 3.03 CONTROL PANELS OR CABINETS

- A. Switches, clocks, temperature control instruments, and remote bulb thermometers, whose capillary tubes are less than 25 feet in length, shall be mounted in control panels with required wiring, piping, and tubing behind panel. Control panels shall be galvanized steel sheet metal, with light gray hammertone enamel finish, not lighter than 14 gage. Control panels shall be UL Listed. Panels shall be attached to wall at locations indicated, or as required. Adjustable apparatus shall be provided with P-Touch, or equal, labels to indicate function. A clear space of 30 inches in front shall be maintained.
- B. Control cabinets shall be provided with door locks. Door locks shall be the flush type, latched, 5/8 inch for metal door, keyed to a Corbin Cat. No. 60 key. Cabinet shall be prime coated and finish painted as specified in Section 09 9000: Painting and Coating. Cabinet shall be flush mounted.

### 3.04 ROOM THERMOSTAT

- A. Room thermostats shall be wall mounted at a height of approximately 4 feet. Room thermostats are not permitted on outside walls, at marker boards, between shelving, in recesses or above heat producing equipment. Units shall be installed as close to edge of tack board as possible. Room thermostats shall be furnished with tamperproof cover. Thermostats shall be furnished with set point windows and integral thermometers. Office thermostats shall be furnished with extended adjustment knobs; others shall have key adjustments. Room thermostats shall be furnished with non-switching sub-bases.

### 3.05 COORDINATION

- A. Coordinate this Work with other aspects of system balancing to obtain a complete operating mechanical system in accordance with design intent, including coordinating with balancing of the system.
- B. Coordinate this Work with all aspects of alarm, fire alarm, and smoke detector, specified in Division 26: Electrical.

3.06 SEQUENCE OF OPERATION

- A. Each system, pneumatic, electric, electronic, or direct digital control shall operate as graphically and described on Drawings and in accordance with reviewed sequence of operation.

3.07 CONTROL SYSTEM ADJUSTMENTS

- A. Perform adjustments under operating conditions to provide sequence of operation for controls indicated. If required operating conditions cannot be obtained before Substantial Completion, due to outdoor seasonal temperatures, return to the Project site when requested by the Owner and readjust control system when outdoor temperatures will permit proper operating conditions. Start readjustment within seven calendar days after notification. Final settings of controls and pressure ranges indicated by gages shall be indicated on project record documents.

3.08 RUNNING TIME METERS

- A. A digital type, non-reset meter, shall be furnished to read cumulative operating time (in hours) for each of following equipment:
  - 1. Refrigeration Compressors: 10 HP or larger.
  - 2. Cooling Towers.
  - 3. Condenser Water Pumps: 2 HP or larger.
  - 4. Circulating Water Pumps: 2 HP or larger.
  - 5. Heaters and Boilers: 400,000 BTUH or larger.
  - 6. Air Compressors: 5 HP or larger.
- B. Meters shall be marked to identify equipment being served. Meters shall be mounted in control panels serving their equipment or, for a pump, on an adjacent wall or structure. Meters may be located in central motor centers, when so provided, instead of adjacent to equipment.
- C. Meters shall be non-resettable, totalizing reading 99,999.9 hours as a minimum for wiring in parallel with equipment served.

3.09 PROTECTION

- A. Protect the Work of this Section until Substantial Completion.

3.10 CLEANUP

- A. Remove rubbish, debris, and waste materials and legally dispose of off the Project site.

END OF SECTION

## SECTION 23 09 23

### ENVIRONMENTAL CONTROLS AND ENERGY MANAGEMENT SYSTEMS

#### PART 1 – GENERAL

##### 1.1 SUMMARY

- A. Section Includes: Environmental controls and energy management systems, including equipment, materials, installation, start-up, testing, documentation and training according to construction documents. The project drawings establish the scope of HVAC controls work in conjunction with the scope of work indicated in Section 23 09 00: HVAC Instrumentation and Controls. This Section complements the requirements of Section 23 09 00, and construction drawings for controls and system communications.
- B. Related Requirements:
1. Division 01: General Requirements.
  2. Section 01 45 23: Testing and Inspection.
  3. Section 01 79 00: Maintenance and Operations Staff Demonstration and Training.
  4. Section 01 91 13: General Commissioning Requirements.
  5. Section 23 05 00: Common Work Results for HVAC.
  6. Section 23 05 13: Basic HVAC Materials and Methods.
  7. Section 23 08 00: HVAC Systems Commissioning.
  8. Section 23 08 13: Environmental Controls and Energy Management Systems Commissioning.
  9. Section 23 30 00: Air Distribution.
  10. Section 23 70 00: Air Handling Units.
  11. Section 23 80 00: Heating, Ventilating and Air Conditioning Equipment.
  12. Section 26 05 00: Common Work Results for Electrical.
  13. Section 26 05 13: Basic Electrical Materials and Methods.
  14. Section 26 05 19: Low-Voltage Wires (600 Volt AC).
  15. Section 26 05 26: Grounding and Bonding.
  16. Section 26 09 23: Lighting Control Systems.
  17. Section 28 31 49: Carbon Monoxide Detection and Alarm Systems.
  18. Project Commissioning Plan (CxP).

##### 1.2 REFERENCES

NEW HVAC SYSTEM AT  
RANCHO CAMPANA HIGH SCHOOL  
OXNARD UNION HIGH SCHOOL DISTRICT  
FLEWELLING & MOODY PROJECT NO. 2841.0100

ENVIRONMENTAL CONTROLS AND  
ENERGY MANAGEMENT SYSTEMS  
23 09 23-1

- A. The latest version of applicable codes, standards, and references. Inspections and tests shall be in accordance with the following applicable codes and standards, except as provided otherwise herein.
1. International Electrical Testing Association – NETA.
  2. National Electrical Manufacturers Association – NEMA.
  3. American Society for Testing and Materials – ASTM.
  4. Institute of Electrical and Electronics Engineers – IEEE.
  5. American National Standards Institute – ANSI.
  6. National Electrical Safety Code – NESC.
  7. California Building Code – CBC.
  8. California Electrical Code – CEC.
  9. California Mechanical Code – CMC.
  10. Insulated Cables Engineers Association – ICEA.
  11. Occupational Safety and Health Administration – OSHA.
  12. National Institute of Standards and Technology – NIST.
  13. National Fire Protection Association – NFPA.
  14. American Society of Heating, Refrigerating, and Air-Conditioning Engineers – ASHRAE  
(The HVAC Commissioning Process, ASHRAE Guideline).
  15. International Building Code – IBC.
  16. International Mechanical Code – IMC.
  17. InterNational Electrical Testing Association (NETA) Acceptance Testing.

### 1.3 SUBMITTALS

- A. Provide in accordance with Division 01 and Section 23 05 00: Common Work Results for HVAC.
- B. Shop Drawings shall include but not limited to:
1. Cover page with legend, common notes, symbol schedule, and drawing index.
  2. Complete point to point environmental controls and energy management network communication diagram(s) for Direct Digital Controls (DDC) of each system:
    - a. Identify all components.
    - b. Indicate conduit and wire characteristics, sizes and quantities.

- c. Provide bill of materials.
- 3. Floor plans showing control panels and intercommunication wiring.
  - a. Show system(s) interface connections.
- 4. Valve Schedules where required.
- 5. Operations and Maintenance Manuals.
- 6. As-built submittal drawings.
- 7. Installation Instructions of each control device.
- 8. PC Workstation.
- 9. Software flow diagram of each unique system sequence of operation.
- 10. Software licenses and electronic keys.
- 11. Supplemental local or factory training schedule for post warranty support.
- 12. A complete list of recommended spare parts with pricing for the OWNER's use in keeping the environmental control system downtime to a minimum.
- 13. Composite CD-ROM with AutoCAD drawings in a ".dwg" format.

#### 1.4 QUALITY CONTROL

- A. CONTRACTOR shall have adequate experience installing systems of similar size and complexity with the control product line proposed for this project.
  - 1. Qualifications of Installer: Minimum five years experience installing products and systems of similar scope and complexity.
  - 2. Installer shall submit certification from the equipment manufacturer indicating that installer is an authorized representative of the equipment manufacturer and is trained on network applications.
  - 3. Installer shall maintain a fully equipped service organization capable of furnishing repair service to the equipment and shall maintain a spare set of major parts for the system at all times.
  - 4. Installer shall furnish a letter from manufacturer of equipment certifying equipment has been installed according to factory standards and that system is operating properly.
  - 5. CONTRACTOR shall have participated in the commissioning of a minimum of 10 projects of similar magnitude to those needed for this project.
  - 6. System startup and testing shall be performed under the direct observation of the Project Inspector and OAR.
- B. Materials and equipment installed shall be new.
- C. System installation shall not begin until Shop Drawings are submitted and reviewed by the Architect or Engineer of Record.

- D. Components for Direct Digital Control (DDC) shall comply with ASHRAE standards.
- E. The installer shall provide the system components required by code and for the life safety of the service personnel.
- F. System shall be able to interface with open protocol BACnet systems.
- G. Provide all ancillary components for the system to perform the required sequence of operations. Install, test and adjust the system accordingly.
- H. System components shall operate per industry standards. The standards shall be as defined by ASHRAE, SMACNA, AABC, NEBB, TABB, and the literature of the manufacturers listed in this Section.
- I. Provide field engineering tools including software and hardware needed for programming and/or modifying system controller and devices.

#### 1.5 WARRANTY

- A. Components, system hardware and software, and parts and labor shall be guaranteed against defects in materials, fabrication, and execution for three years from date of system acceptance. Provide labor and materials to repair, reprogram, or replace defective components at no charge to the OWNER during the warranty period.
- B. Provide a list of applicable warranties for equipment and components, this list shall include warranty information, names, addresses, telephone numbers, and procedures for filing a claim and obtaining warranty services.
- C. CONTRACTOR shall respond to OWNER's request for warranty service within four hours of initial call to schedule a mutually agreeable time for service. Submit records of the nature of the call, the work performed, and the parts replaced or service rendered.

#### 1.6 TRAINING

- A. Provide a competent instructor who is factory trained and has comprehensive knowledge of system components and operations to provide full instructions to designated personnel in the system operation, maintenance, and programming. Training shall be specifically oriented to installed equipment and systems.
  - 1. Provide four hours of onsite OWNER familiarization and training for the installed system. Training shall include system overview, time schedules, override commands, emergency operation, and programming and report generation. OWNER employees attending this training session shall be provided with the following documentation:
    - a. As-built drawings of System layouts and point to point connection diagrams.
    - b. System components cut sheets.
    - c. Operations and maintenance data.
  - 2. Programmer and maintenance training shall include database entry; trend logs application programs, diagnostic routines, reporting, failure recovery and calibration.
    - a. Provide 24 hours of training as follows:

- 1) Training session shall accommodate a minimum of 20 persons and be facilitated at CONTRACTOR's training facility, which should be no more than 50 miles from the Project Site.
  - a) Training shall be delivered in 6 hours per session increments.
  - b) Obtain OWNER's approval for training locations exceeding 50 miles. In such cases, the CONTRACTOR shall be responsible for transportation expenses.
  - c) CONTRACTOR shall provide training computers for all attendees. Computers shall be ready for live training sessions.
- 2) Training shall cover instruction, theory, and expose the trainees to system's features, components, architecture, operations, programming, report generation, communications, and any other pertinent information required for the operations and maintenance of the system.
- 3) Each training session shall have an itemized agenda covering all aspects of the training to be covered in the sessions. CONTRACTOR shall obtain agendas approval from OWNER and Commissioning Agent.
- 3) Instructor(s) shall give the trainees the opportunity to practice on simulated and actual (installed) systems.
- 4) The training session shall cover, but not be limited to the following instruction modules or sessions:
  - a) System Architecture:
    - (1) System layout and components interrelations and hierarchical structure.
    - (2) Controllers interfacing and functions.
    - (3) Server functionality and data management, error messages, and alarm conditions.
    - (4) Connectivity and communication losses.
    - (5) Replacement procedures for system components.
  - b) User Operations:
    - (1) Familiarization and navigation with the EMS operating System.
    - (2) Windowpanes, menus, navigation buttons, alarm response windows, system passwords and accessibility features and options, monitoring and managing data points (inputs, outputs, numeric values, time and date, strings).

- (3) Views: Provide sufficient information as to train staff on how and where to access programs, functions, adjust or alter diagnostic points and related data, override messages, reports and actions taken.
- c) Trending: Setting trend(s) intervals, accessing data trends and history logs for diagnosis points or groups, and reporting. Working with trended data graphical displays, including but not limited to hiding points, setting display types and colors, viewing and setting scales.
- d) Graphics: Standard symbols and color codes, graphics customization, how and where to access and manage the system with the graphic displays, including changing points and values, using HOA switches and viewing results, mapping to or with other graphic sources and functions, including groups, navigation, sequence of operations, and displays and reports.
- e) Alarms: Reading and interpreting alarms, acknowledging and silencing alarms, routing and setting priorities, viewing and responding e-mailed and paged alarms.

## PART 2 – PRODUCTS

### 2.1 ACCEPTABLE MANUFACTURERS

- A. Environmental controls and energy management systems shall be approved products of **Carrier**, or no known equal.
- B. Basis of Design: Carrier iVu

### 2.2 SYSTEM ARCHITECTURE

- A. The system shall be capable of providing a peer-to-peer network of distributed stand-alone DDC controllers that meet ANSI/ASHRAE Standard 135 for open protocol communications.
- B. A maximum of 32 controllers shall be connected to any one MS/TP bus. Minimum Speed of 38kb and can support 127 devices per COM port. Provide a minimum of 2 ports.
  - 1. Provide a Building Automation System (BAS) that consists of Network Server/Controllers (NSCs), a family of Standalone Digital Control Units (SDCUs), Administration and Programming Workstations (APWs), and Web-based Operator Workstations (WOWs). The BAS shall provide control, alarm detection, scheduling, reporting and information management for the entire facility, WEB enable capabilities, and Wide Area Network (WAN).
  - 2. The Enterprise Level BAS shall consist of an Enterprise Server, which enables multiple NSCs (including all graphics, alarms, schedules, trends, programming, and configuration) to be accessible from a single Workstation simultaneously for operations and engineering tasks. The Enterprise Level BAS shall be able to host up to 250 servers, or NSCs, beneath it.
  - 3. For Enterprise and robust reporting capability outside of the trend chart and listing ability of the Workstation, a Reports Server shall be provided and installed on a

Microsoft Windows based computer. The Reports Server can be installed on the same computer as the Enterprise Server.

4. The system shall be a top-level 100/1000bT Ethernet network that utilizes BACnet/IP.
  - a. A sub-network of SDCUs using the BACnet MS/TP protocol shall connect the local, and stand-alone controllers with Ethernet-level Network Server Controllers/IP Routers.
5. The system shall match the existing LonWorks IP, and/or Modbus TCP protocol.
  - a. Integration to existing Modbus RTU/ASCII (and J-bus), Modbus TCP, LonTalk FTT-10A, and Web Services shall be native to the NSCs. There shall not be a need to provide multiple NSCs or additional software to allow all three protocols to be natively supported.
  - b. A sub-network of SDCUs using LonTalk FTT-10A, and/or Modbus RTU protocol shall connect the local, stand-alone controllers with Ethernet-level Network Server Controllers/IP Routers.
- C. Only systems that use HTML 5 structured language are allowed.
- D. The supplied computer software shall employ object-oriented technology (OOT) for representation of data and control devices within the system. For each global, system or unitary controller, provide a PICS document showing the installed device's compliance level. Minimum compliance is Level 3 with the ability to support data read and write functionality.
- E. Maximum acceptable response time from any alarm occurrence (at the point of origin) to the point of annunciation shall not exceed three seconds for network connected controllers or user interfaces.
  1. For each system point, alarms can be created based on high/low limits or in comparison to other point values.
  2. There is no limit to the number of alarms that can be created or stored in system hardware for any point, up to the system capacity.
  3. System shall generate configured alarms from single or multiple system conditions.
  4. Alarms will be generated from an evaluation of the alarm condition, and presented to the user in a fully configurable order, by priority, time, and category,
    - a. Alarm views shall be presented to the user upon logging into the system WorkStation and/or Webstation.
  5. Program the alarm management system to create and report alarm events history; the alarm events history data base shall provide the option to select alarm cause and action notes associated with an alarm event. The alarm management system shall also generate checklists for operators' use when utilizing a suggested mode of troubleshooting.
  6. Provide alarm event history for a feature use to permit assigning of events for resolution to OWNER staff. The system shall notify the user and assigned resolution personnel.
  7. Alarms shall be capable of being routed to any BACnet workstation that conforms to the B-OWS device profile and uses the BACnet/IP protocol.

- F. The system shall be able to interface with subsystems that utilize ANSI/CEA-709.1: Control Network Protocol Specification.

## 2.3 EMS SERVER AND USER INTERFACE WORKSTATION

- A. EMS Server: The EMS Server shall include a tower or rack mounted server with an Intel Xeon E5 2600 processor, 8 Gb RAM, RAID 1 configuration with two hot swap 2TB 7200 RPM SATA drive, DVDRW drive, keyboard, mouse, 27 inch LCD color display and the latest version of Microsoft Windows Server operating system software. The workstation shall connect to the network through an internal 1Gbps Ethernet interface card.
  - 1. Software licensing shall be provided for local or remote unlimited simultaneous users of the system, unlimited future point expansion, user graphical display generation and non-vendor controllers. Licenses and electronic keys shall be included with the M&O manuals for project acceptance. Conditional Licenses will not be acceptable.
  - 2. The system shall be programmed to email selected alarms to designated response personnel.
    - a. The ability to utilize email paging of alarms shall be a standard feature of the operating system's mail application interface (MAPI). No special software and no email client software must be running in order for the system to distribute emails.
    - b. The email notification shall be able to be sent to an individual user or a user group.
    - c. The NSC shall support the use of Web Services based on open standards, such as SOAP and REST. Use incoming third-party data (temperature forecast, energy cost) over the Web to determine site modes, scheduling, and programming.
  - 3. Web-based operation shall be supported directly by the NSCs and shall not require additional software.
  - 4. The supplied system shall incorporate the ability to access all data using HTML5 enabled browsers without requiring proprietary operator interface and configuration programs.
  - 5. Programming of SDCUs shall be capable of being done either off-line or on-line from any operator workstation. All information shall be available in graphic or text displays stored at the NSC. Graphic displays shall 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.
  - 6. Programming in the NSC shall be either in graphical block format or line-programming format or both.
  - 7. Programming of the NSC shall be available offline from system prior to deployment into the field. All engineering tasks shall be possible, except the viewing of live tasks or values.
  - 8. The programmer's environment shall include access to a superset of the same programming language supported in the SDCUs.

9. Provided NSC devices shall support both script programming language as well as the graphical function block programming language. For both languages, the programmer will be able to configure application software for custom program development and write global control programs. Both languages will have debugging capabilities in their editors.
10. The system shall be able to save custom programs as libraries for reuse throughout the system. A wizard tool shall be available for loading programs from a library file in the program editor.
11. The system shall be capable providing views of graphical programming in live and real-time from Workstation(s).
12. The system shall be capable of creating 'binding templates' allowing the user to bind multiple points to multiple objects all at once.
13. Automatic detecting zone that may be excessively driving the reset logic and generate an alarm.
14. Readily allow operator removal of zones from reset algorithm.
15. Applications shall be able to be assigned different priorities and cycle times for a prioritized execution of different function.
16. The provided system shall be able to create objects that allow common objects such as power meters, VFD drives, etc. to be integrated into the system with simple import actions without the need of complicated programming or configuration setups.
17. The BAS workstation software shall allow the creation of a custom, browser-style interface linked to the user when logging into any workstation. Additionally, it shall be possible to create customized workspaces that can be assigned to user groups. 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 shall 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 user security capabilities, shall 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 shut down the active alarm viewer and/or unable to load software onto the PC.
18. 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.
19. Provide a Web Server to automatically convert system displays on the workstation to an Internet page. Internet page shall be readable from standard PC browsers. Acceptable browsers shall be latest version of internet explorer, Chrome, or Firefox. No additional plug-ins, programs, software, hardware, etc. shall be needed to access the Internet page. The server shall be a separate device to provide security protection for the building system from outside hackers.
  - a. Coordinate individual system components IP addresses, switch port assignments, security settings such as but not limited to SNMP alarm

delivery, HTTPS/SSL settings, VLAN assignment and authorized IP address ranges with the OWNER's Information Technology Division. Coordination activities with ITD shall be executed through the OAR.

- b. Provide IP address label on the interior of each cabinet door or equipment.
  - c. The system shall support the ability to notify school or OWNER designated personnel by SMS or Email messages, utilizing the OWNER's mail server when problems or situations that require immediate attention arise.
20. Operator Workstation shall display data associated with the project as called out on drawings or object type list supplied. Graphic files shall be created using digital, full color photographs of system installation, AutoCAD or Visio drawing files of field installation drawings and wiring diagrams from as-built drawings. Operator's workstation shall display data using three-dimensional graphic representations of mechanical equipment. System shall be capable of displaying graphic files, text, trend data and dynamic object data together on each display screen with animation of equipment operation.
21. Controllers shall be programmed using graphical software tools that allow connection of function blocks for visual sequencing of control logic. Function blocks shall display real time data and be animated to show status of data inputs and outputs when in real time operation. Animation shall also show change of status on logic devices and countdown of timer devices in a graphical format.
22. Operator Tracking Log shall record operator changes to the system for future review. This shall include, but not be limited to setpoint changes, time schedule overrides, alarm limits, etc.
23. The system shall be equipped with a battery back-up source capable of providing 30 minutes of operation (computer and monitor) in the absence of normal power, to allow for an orderly shutdown and data back-up.
- B. EMS Workstation: The EMS Workstation shall be an enterprise level tower with an Intel Core™ i7 or better processor, 16GB of RAM, 256 GB solid state drive, DVD drive, keyboard, mouse, 27 inch LCD color display and the latest version of Microsoft Windows professional operating system software. The workstation shall connect to the network through an internal 1Gbps Ethernet interface card.

#### 2.4 GLOBAL CONTROLLER

- A. Building controllers shall incorporate the functions of a 3-way BACnet router. Controller shall route BACnet messages between the high-speed LAN (Ethernet 100MHz), master slave token passing (MS/TP) LANs, a point-to-point (PTP/RS-232) connection and telephone modem.
- B. Provide global control strategies for the system based on information from any point objects in the system. Programming shall be object-oriented using graphical control function blocks. Global strategies shall include, but not limited to unit scheduling, electrical demand limiting, optimized start-stop of equipment, central plan reset control, etc.
- C. Battery shall retain static RAM memory and real-time clock functions for a minimum of 1.5 years (cumulative). Battery shall provide up to five minutes of powerless operation for orderly shutdown and data backup.
- D. Each building controller shall support a minimum of 250 BACnet Schedule Objects and 250 BACnet Calendar Objects.

- E. Each building controller shall log a minimum 1,000 trend logs. Any point object in the system (real or calculated) may be logged. Sample time interval shall be adjustable at the operator's workstation. Building controller shall periodically upload trended data to networked operator's workstation for long term archiving if desired. Archived data shall be available for use in third-party spreadsheet or database programs.
- F. Alarms may be generated within the system for any object change of value or state either real or calculated. This includes events such as analog object value changes, binary object state changes and various controller communication failures. Each alarm may be automatically dialed out to a telephone pager or emailed to any Internet PC computer.
- G. Provide a 1.5 KVA UPS with battery back-up capability to provide a minimum of 30 minutes of operation (computer and monitor) for orderly shutdown and data backup. Make connections and test the system for proper operation in the presence of the Project Inspector.
- H. The global controller shall be equipped with ADR demand limiting capacity interface.
  - 1. The system shall include 5 DI for interfacing to local utility ADR program. The 5 DI shall be located in a 24 X 24 X 6 NEMA 12 cabinet mounted in the MDF or IDF room. Upon closer of each DI the control system shall raise or lower (depend on system mode) global room temperature set point 1 degree (user adjustable).
  - 2. The system shall also include a demand-limiting program that utilizes data from site utility meter. Features indicated below shall be available via a switchable graphical user interface in all operating stations:
    - a. Shed/Restore equipment in digital format shall include 5 data input points for interface to future ADR web appliance located in an MDF/IDF room. System server shall accept ADR command from utility service via web interface and shall include at least 5 priority levels of equipment shedding. Load shedding on a given priority level shall include two methods. In one the loads shall be shed and restored in a "first-off/first-on" mode and in the other; the loads shall be shed/restored in a linear fashion.
    - b. Adjust operator selected control setpoints in analog format based on energy usage when compared to shed and restore settings.
    - c. Shedding may be implemented independently on each and every zone or piece of equipment connected to the system.
    - d. Status of every load shed shall be capable of being displayed on every operator terminal connected to the system. Statuses shall be displayed along with the English description of each load.

## 2.5 APPLICATION (system and unitary) DDC CONTROLLERS.

- A. Application controllers shall include universal inputs with 10-bit resolution that accept 3K and 10K thermistors, 0 to 10VDC, 0 to 5 VDC, 4 to 20 mA and dry contact signals. Any input on a controller may be either analog or digital with a minimum of three inputs that accept pulses. Controller shall include support and modifiable programming for interface to intelligent room sensor with digital display, and set point adjustment and override button. Controller shall include binary and analog outputs on board. Analog outputs shall be switch selectable as either 0–10VDC or 0–20mA. Software shall include scaling features for analog outputs. Application controller shall include a supply voltage to power external sensors.

- B. Program sequences shall be stored in EEPROM or flash memory. No batteries shall be needed to retain logic program. Controller shall execute program sequences 10 times per second and be capable of multiple PID loops for control of multiple devices. Calculations shall be completed using floating-point math. Programming of application controller shall be completely modifiable in the field over the installed BACnet LANs or remotely via modem interface.
- C. Central Plant Controllers shall interface to chiller gateways. Point objects shall reside in the central plant controller. Hand-Off-Auto switches shall be provided for direct wired output control circuits.
- D. CONTRACTOR shall provide a laminated wiring diagram for each control panel. Locate diagrams on interior side of control panel's doors.

## 2.6 TEMPERATURE SENSORS

- A. Temperature sensors shall be 10K ohm thermistor factory-calibrated to within 0.5 degrees F, totally interchangeable with housings appropriate for the application.
- B. Wall sensors shall be installed 48 inches above finished floor. Duct sensors to be installed such that the sensing element is in the main air stream. Immersion sensors to be installed in wells filled with thermal compound. Outside air sensors shall be installed away from exhaust or relief vents, not in an outside air intake and in a location that is in the shade most of the day.
- C. Intelligent room sensors shall be equipped with digital display, set point adjustment and override button. Smart room temperature sensor/thermostat shall incorporate PIR motion sensor, temperature display, set point adjustment and override button. Acceptable Manufacturers: Schneider Electric SE8600 series, Viconics VT8600 series, Sigler 8600 series or equal.
- D. Room thermostat shall be BACnet capable, Acceptable manufacturers: Schneider Electric SE8600 series, Viconics VT8600 series, Sigler VT8600 series or equal.

## 2.7 CARBON DIOXIDE (CO<sub>2</sub>) SENSORS

- A. Sensors shall be wall mounted at a height of approximately 4 feet. Locate sensors adjacent to room thermostat.
- B. Sensors are not permitted on marker boards, between shelving, in recesses or above heat producing equipment.
- C. Sensors shall be furnished with a display window that provides continuous monitoring and sensor status readings, and with tamperproof cover.
- D. Sensors shall be gold plated for long-calibration stability, be factory calibrated and certified for a minimum of five years.
- E. CO<sub>2</sub> sensors shall be BACnet capable, acceptable manufacturers: Honeywell C7232A, Telaire Ventostat Wall Mount, Johnson Control CD-WRD-00-0, or equal.

## 2.8 PRESSURE SENSORS

- A. Differential and pressure sensors shall have a tensioned stainless steel diaphragm to form a variable capacitor that produces a linear output with an accuracy of 1.0 percent of full scale. The unit shall be able to withstand 10 PSIG over pressurization.

- B. Differential pressure switches shall utilize a diaphragm operated snap-acting switch with a setpoint range of 0.05 to 2.0 inches WC.
- C. Steam pressure sensors shall be mounted on a pigtail siphon with manual shutoff ball valve.

## 2.9 CARBON DIOXIDE (CO<sub>2</sub>) SENSORS

- A. Carbon dioxide concentration levels shall be sensed by non-dispersive infrared technology. A corrosion-free sensing chamber shall be used for accurate, stable CO<sub>2</sub> sensing. An LCD shall display sensed CO<sub>2</sub> concentration.
- B. Sensor shall be gold plated and have a range of 0-2000 PPM at +/- 5 percent accuracy for long-term calibration stability. Both analog and binary relay output circuits shall be available on the sensor. An automatic background calibration algorithm shall reduce required maintenance.
- C. Acceptable Manufacturers: Telaire, Honeywell, Johnson Controls, or equal.

## 2.10 ELECTRONIC VALVES

- A. Control Valves ½ inch to 2-inch shall be characterized stainless steel ball valves with actuators sized to close off against twice the maximum fluid pressure. Valve body shall be NPT screwed for 2-way or 3-way application. A push button release shall be provided for manual operation.
- B. Control Valves 2 ½-inch and larger shall be butterfly type with actuators sized to close off against twice the maximum fluid pressure. Valve body shall be flanged for 2-way or 3-way application. Contacts shall be provided to mechanically indicate the full open and full closed position of the valve.
- C. Steam Valves shall be globe valves suitable for 35-PSI inlet steam service. Valve bodies shall be NPT screwed or flanged with spring-return normally closed valve actuators.
- D. Valve control shall be accomplish with 2-10 VDC. All valve shall provide feedback signal to EMS/BMS for monitoring on GUI.
- E. Acceptable Manufacturers: Belimo, Honeywell, Johnson Controls, Schneider Electric or equal.

## 2.11 DAMPER ACTUATORS

- A. Electric damper actuators (including VAV box actuators) shall be direct shaft mounted and use a V-bolt and toothed V-clamp. The actuator mounting arrangement and spring return feature shall permit normally open or normally closed positions of the damper as required.
- B. Actuators shall be sized for 200 percent of the design torque requirements.
- C. Damper actuators shall incorporate a release mechanism to manually position the damper for maintenance or emergency override.
- D. Damper Actuators located outdoors shall have a clear plastic weather shield specifically designed for the application.
- E. Damper motor control shall be with 2-10 VDC
- F. Acceptable Manufacturers: Belimo, Honeywell, Johnson Controls, Schneider Electric, or equal.

## 2.12 CURRENT SWITCH

- A. Current sensing switch shall be self-powered with solid-state circuitry and a dry contact output. A multi-turn setpoint adjustment shall set the trip point status. An LED shall indicate the on or off status.

## 2.13 CONTROL RELAY

- A. The relay shall be contained in a plenum rated NEMA 12 enclosure with a ¾" NPT conduit fitting. Coil voltage shall be 24 or 120 VAC with a contact rating of 10A. An LED on the enclosure cover shall indicate the relay is energized.

## 2.14 POWER SUPPLIES

Power supplies and panel assemblies shall be UL or NRTL listed.

## 2.15 ENCLOSURES

- A. Controllers, power supplies and relays shall be mounted in Hoffman A-LP NEMA 12 enclosures or equal when located in an indoor environment.
- B. Enclosures for outdoor applications shall be metal NEMA 4, Hoffman A-ALP, A-BLP or equal, and be mounted on the north exposure of the controlled unit.
- C. Enclosures shall have hinged, locking doors with common keying (CAT-60) for control panel on the Project Site.
- D. Enclosures shall have permanently affixed to the door an engraved nametag identifying the equipment served. The nametag shall be a minimum 1 inch by 3-inch with ½ inch lettering.

## PART 3 – EXECUTION

### 3.1 CONTROLS INSTALLATION

- A. Wiring methods for control system shall be as defined in the Division 26 specifications. Wire types shall conform to manufacturers' recommendations.
- B. Mount control panels adjacent to associated equipment on vibration-free walls or freestanding angle iron supports. One cabinet may accommodate more than one system in same equipment room. Control panel assemblies must be UL listed.
- C. Provide software and hardware required to provide controls and monitoring of diagnostic points indicated in specification Section 23 80 00.
- D. Coordinate with Division 26 electrical installer so that "Hand/Off/Auto" selector switches are installed to override automatic interlock controls when switch is in the "Hand" position. Safety shutdown interlock wiring shall disable the equipment regardless of the position of the H-O-A switch.

### 3.2 ROOM SENSORS INSTALLATION

- A. Room sensors shall be wall mounted at a 48-inch height above finished floor. Room sensors are not permitted on outside walls, at chalkboards, between shelving, in recesses or above heat producing equipment. Coordinate with Division 26 for sensor or thermostat mounting adjacent to light switches.

### 3.3 COORDINATION

- A. Coordinate the work with other aspects of mechanical, electrical, fire-life safety and security systems, controls, and photo voltaic systems to obtain a complete and operating system in accordance with the contract documents.
- B. Meet with the OAR and school principal and other school staff to determine when each zone or building will be occupied, and to determine programming and scheduling of the heating, ventilating and air conditioning equipment.
- C. CONTRACTOR shall contact OAR to coordinate for timely availability of VPN access point(s) form OWNER's Information Technology Division.

### 3.4 DDC CONTROL SYSTEM ADJUSTMENTS

- A. Make adjustments under operating conditions to provide sequence of operation for each control system per design intent. If required operating conditions cannot be obtained prior to completion date of the contract due to outdoor seasonal temperatures, return to the job site when requested by the OWNER and re-adjust control system when outdoor temperatures will permit proper operating conditions. Start re-adjustment within seven calendar days after notification.

### 3.5 PERFORMANCE AND ACCEPTANCE:

- A. Test and calibrate each device including but not limited to the following for proper operation, connection, signal value or response.
  - 1. Building Controllers.
  - 2. Custom Application Controllers.
  - 3. Application Specific Controllers.
  - 4. Input / Output Devices. (Sensors, actuators and monitoring devices)
  - 5. Operator Interfaces.
- B. Verify that systems are standalone and operable upon network failure.
- C. Verify that systems return to normal operation automatically upon resumption of network operation or return of power.
- D. Test each system for functions of the required control sequence of operation either by normal control operation or forced operation as required. Log and submit results.
- E. Test the network for connectivity, data transmission rates, input/output responses, and other appropriate parameters Failure modes, including network failure, individual control system failure, and power outages, shall be simulated and responses logged, with any effects on network operation noted and corrected.
- F. Test each preprogrammed time and holiday schedule.
- G. Commissioning requirements of Divisions 01, 23, and 26 apply to this Section.
- H. Schedule of Responsibilities: Refer to Appendix A. The schedule identifies the responsibilities of the CONTRACTOR for the installation of the environmental controls and energy

management system. Deviations and clarifications of this schedule only if allowed by the OAR, provided trade CONTRACTOR coordination and schedule requirements are met. Submit a record copy of the Schedule of Responsibilities to the OAR at the commencement of this Section's Work.

### 3.6 WIRING AND INFRASTRUCTURE

- A. Provide necessary wiring, terminations, connections and conduit infrastructure for the complete system as indicated in the construction documents.
- B. Exterior cables whether above or below ground level shall be rated for exterior applications. When entering a building provide a code sized pull box with necessary hardware to transition exterior rated cables to interior applications.
- C. Underground EMS cables are permitted to be installed with lighting control wiring in underground applications. Provide innerduct to separate EMS cables from lighting control system cables.
- D. Provide both labeling and record documentation for all EMS system cabling. A cable management schedule and diagram shall be provided at each system panel or cabinet, in addition to a complete cabling diagram to be provided at the head end equipment location.
  - 1. The cable management spread file shall include the following:
    - a. Cable Schedule.
    - b. Cable Test Forms.
    - c. Cable Label sequence and nomenclature.
    - d. Network chart.
  - 2. Cable numbering shall be based on a defined format which readily identifies cable type and allows maintenance technicians to determine originating and terminating locations.
  - 3. Present the data in an Excel spreadsheet that will operate on the latest Windows platform. Information shall be presented in paper and electronic formats.
  - 4. A copy of the cable schedule in a transparent plastic sleeve shall be affixed in the interior side of the front door of each network cabinet or cables convergence hub points.

### 3.7 DATA LOGGING REQUIREMENTS

- A. The system must be capable of storing the system's collected and diagnosis data for a minimum of seven days.
- B. Program the system for a standard seven-day schedule including holydays.

### 3.8 CLEANUP

- A. Remove rubbish, debris and waste materials and legally dispose of off Project Site.

### 3.9 PROTECTION

A. Protect Work of this Section until Substantial Completion.

**END OF SECTION 23 09 23**

**APPENDIX A**

**SCHEDULE OF RESPONSIBILITIES**

	ITEM	FURNISH BY	INSTALL BY	POWER BY	CONTROL WIRING BY
1	Magnetic Motor Starters:				
	a. Automatic controlled, with or without HOA switches.	E	E	E	DDC
	b. Manually controlled	E	E	E	N/A
	c. Manually controlled furnished as factory wired unit equipment	M	M	E	E
	d. Special duty type (part winding, multi-speed, etc.)	M	See Note 1	E	See Note 1
	e. Adjustable frequency drives with or without manual bypass.	DDC	E	E	DDC See Note 2
	f. Domestic booster pump. Motor Controls	M	M	E	DDC
2	Line voltage contactors.	E	E	E	DDC
3	Control relay transformers (other than starters).	DDC	DDC	E	DDC
4	Control and Instrumentation panels	DDC	NI	E	DDC
5	Automatic control valves, automatic dampers and damper operators, solenoid valves, insertion temperature and pressure sensors including wells	DDC	M	E	DDC
6	Control interlock wiring between chillers, pumps, cooling towers, fans and air handling units and other miscellaneous mechanical equipment.	DDC	DDC	E	DDC
7	Duct Smoke Detectors	E	M	E	E
8	Dampers				
	a. Control Dampers	M	M	N/A	DDC
	b. Smoke Dampers and Combination Fire/Smoke Dampers	M	M	E	E
9	Airflow Stations with transmitter.	M	M	E	DDC

10	Air terminal devices (I.e., VAV and fan powered boxes).	M	M	E	DDC
11	Intelligent Devices and Control Units provided with packaged mechanical equipment such as: Large VAV and constant volume package units Boilers and Chillers.	M	M	E	NI
12	Intelligent Devices and Control Units not provided by equipment manufacturer such as: Air handling units, Heat pumps, AC units (small < 20 tons), Air terminal units (VAV boxes)	DDC	DDC	E	DDC
13	Intelligent Devices and Control Units provided with electrical systems such as: Occupancy / motion sensors, Lighting Control Panels, Switches and dimmers, Switch Multiplexing Control Units, Door Entry Control Units.	E	E	E	DDC
14	Gateways for proprietary non-BACnet equipment	M	M	E	DDC
15	Communications network devices such as Routers, Bridges and Repeaters.	DDC	DDC	DDC	DDC

Abbreviations

DD C	DDC CONTRACTOR (controls CONTRACTOR)
M	Mechanical CONTRACTOR
E	Electrical CONTRACTOR
N/A	Not Applicable

Notes:

1. Magnetic motor starters (special duty type) shall be set in place under electrical division except when part of factory wired equipment, in which case they shall be set in place under mechanical division.
2. Where a remote motor disconnect is required in addition to the one provided integral to a Variable Frequency Drive (VFD), controls CONTRACTOR shall provide the necessary control interlock between the disconnects.

## Section 23 20 15

### HVAC PIPING, SYSTEM

#### PART 1 - GENERAL

##### 1.1 DESCRIPTION

- a. This section describes piping, pipe fittings, and incidental related items as required for HVAC piping systems.

##### 1.2 RELATED WORK SPECIFIED ELSEWHERE

- a. Section 015713, Temporary Erosion, Sediment, and Pollution Control
- b. Section 230500, Common Work Results for HVAC
- c. Section 230529, Hangers and Supports for HVAC Piping and Equipment
- d. Section 230545, Seismic Restraints for HVAC Piping and Equipment
- e. Section 230548, Vibration, and Seismic Controls for HVAC Piping and Equipment
- f. Section 230553, Identification for HVAC Piping and Equipment
- g. Section 230590, Pressure Testing of HVAC Systems
- h. Section 230593, Testing, Adjusting, and Balancing
- i. Section 230719, HVAC Insulation
- j. Section 232500, HVAC Water Treatment
- k. Section 312000, Site Clearing and Earthwork
- l. Section 312300, Trenching, Backfilling, and Compacting
- m. Section 312319, Dewatering

##### 1.3 REFERENCES

- a. ANSI: American National Standards Institute
  1. ANSI B16.1: Gray Iron Pipe Fittings and Flanged Fittings: Classes 25, 125, and 250
  2. ANSI/NSF 14: Plastic Piping System Components and Related Materials
  3. ANSI/NSF 61: Potable Water System Components-Health Effects
- b. ASTM: American Society for Testing and Materials
  1. ASTM A47: Standard Specification for Ferritic Malleable Iron Castings
  2. ASTM A53 or A120: Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
  3. ASTM A135: Standard Specification for Electric-Resistance-Welded Steel Pipe
  4. ASTM A183: Standard Specification for Carbon Steel Track Bolts and Nuts
  5. ASTM A234: Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service
  6. ASTM A307: Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
  7. ASTM B88: Standard Specification for Seamless Copper Water Tube
  8. ASTM F2389-17A: Pressure-Rated Polypropylene (PP) Piping Systems

9. ASTM F2023-15: Chlorine Resistance testing for Plastic Piping
10. ASTM D2657-07: Heat Fusion for Polypropylene Pipe & Fittings
11. ASTM F1290-19: Electrofusion for Polypropylene Pipe & Fittings
12. ASTM D2774-12: Underground Installation of thermoplastic Pressure Piping
13. ASTM F1668-16: Construction Procedures for Buried Plastic Pipe

c. AWWA: American Water Works Association

1. AWWA C209: Cold-Applied Tape Coatings for Steel Water Pipe and Fittings
2. AWWA C214: Tape Coating Systems for the Exterior of Steel Water Pipelines

1.4 SUBMITTALS

- a. Product Data: Submit product data for products specified herein.
- b. Shop Drawings: Submit shop drawings of HVAC systems layout, coordinated with the work of other divisions and existing facilities, systems, equipment, and components.
- c. Test Reports and Certificates: Comply with any special requests from the AHJ for any certification.
- d. Other: Submit certified welders' certificates.

1.5 QUALITY ASSURANCE

- a. Regulatory Requirements: Piping material and installation shall meet requirements of the State and local building codes, and serving Utility's requirements.
- b. Pipe Cleaning: Should any pipe be plugged or should discoloration or foaming of water systems occur, disconnect piping sections as needed, re-clean the system, and reconnect and reinspect.
- c. Correct any damage to the building or systems resulting from failure to properly clean the system.

**PART 2 - PRODUCTS**

2.1 BLACK STEEL PIPE, SCHEDULE 40

- a. Pipe: Schedule 40, in accordance with ASTM A120 or A53.
- b. Fittings: 150-pound screwed malleable iron on 2 inches and below, Schedule 40 welded fittings in accordance with ASTM A234 for 2-1/2 inches and above or mechanical couplings on select piping as herein specified. Fittings below grade shall be welded fittings. All elbows on pumped systems shall be long radius type. Short radius elbows are not acceptable for use except when approved by the Port on a case-by-case basis.
- c. Service:
  1. Chilled and heating water piping.
  2. Miscellaneous drains and overflows.
  3. Emergency generator exhaust. Mechanical couplings not permitted.
  4. Safety and relief valve discharge. Mechanical couplings not permitted.
  5. Chemical treatment.
  6. High pressure steam. Mechanical couplings not permitted.
  7. Low pressure steam. Mechanical couplings not permitted.
  8. Steam vent. Mechanical couplings not permitted.

## 2.2 BLACK STEEL PIPE, SCHEDULE 80

- a. Pipe: Schedule 80, in accordance with ASTM A120 or A53.
- b. Fittings: Extra heavy Class 300 screwed cast iron on 2 inches and below, extra strong welding fittings in accordance with ASTM A234 for 2-1/2 inches and above.
- c. Service: Pumped and gravity steam condensate return.

## 2.3 COPPER PIPE

- a. Pipe: Hard drawn copper tubing, Class L or K, ASTM B88.
- b. Fittings: ASME B16.18 cast copper or ASME B16.22 solder wrought copper.
- c. Service:
  1. Chilled and heating water above grade (Type L hard drawn) on piping up to and including 2-1/2.
  2. Domestic Water Make-up Piping: ASTM B88, Type K or L, hard drawn copper tubing, and backflow protected from the potable water source with an RP device.
  3. Refrigerant piping (Type L, hard drawn, ACR cleaned). Soft drawn copper piping is permitted for use at points of equipment connection, with no kinks, and a maximum length of 6 inches.
  4. Cooling Coil Condensate Drain Piping

## 2.4 PVC or CPVC PIPE

- a. Pipe: PVC, SDR-26, Class 160, ASTM D-2241 and D-1784, rated for 160 psi at 73°F, or PVC SDR-21, Class 200, rated for 200 psi at 73°F, C900 or C905 DR rated pipe, Schedule 40 or Schedule 80 ASTM 2261-06 PVC piping, or Schedule 40 or Schedule 80 ASTM F441/F441M-15 CPVC piping.
- b. Fittings
  1. Schedule 40 & Schedule 80: socket type for solvent welding.
  2. Schedule 40 drain piping: Drainage pattern.
  3. Schedule 80 CPVC Chemical feed piping for condenser water treatment ASTM F439.
- c. Service:
  1. Chilled water piping, buried or outdoor above grade piping 4 inches and smaller, only where specified on plans.
  2. Special attention to pressure derating based on pipe size and temperature, thermal expansion, pipe support spacing, and thrust blocking.
  3. Condensate and waste water drainage.

## 2.5 PP-RCT or PP-RP Polypropylene PIPE

- a. Pipe: ASTM 2389-17A fiberglass reinforced pressure rated PP-RCT and PP-RP pipe. Having a fiberglass reinforced PP-RCT core and with PP-RCT material on the inside and the outside of the pipe wall, made in a single extrusion process resulting in a single homogenous pipe wall. Select SDR (wall thickness) sizes in SDR-7.3, SDR-9, SDR-11, or SDR-17, to meet the service temperature and pressure for each application. In compliance with ASTM F1290-19 ASTM D2657-07 for Electrofusion and Heat Fusion, and ANSI/NSF 14 and CSA B137.11.

**Basis of Design:** Niron Clima fiberglass reinforced PP-RCT pressure rated pipe and fittings.

- b. Fittings and Assembly-Joining Methods:
  1. Socket fusion molded fittings and couplings for 1/2" through 5".
  2. Butt fusion fittings and end-to-end pipe fusion for 2" through 24".

3. Electrofusion fittings for 1/2" through 10".
4. Electrofusion couplings for 1/2" through 24".

c. Service:

1. Chilled water piping, direct bury and above grade, use SDR 11 [ **and SDR 17** ]
2. Hot water piping, direct bury and above grade, use SDR 7.3 and SDR 9
3. Water Make-up piping, and backflow protected from the potable water source with an RP device.
4. Pipe and fittings for Potable water applications shall be NSF-61 certified.
5. Standard PP-RCT and PP-RP pipe and fittings shall be painted, insulated, or insulated and jacketed, or otherwise protected from UV exposure.

2.6 UV rated PP-RCT or PP-RP Polypropylene PIPE

- a. Pipe: ASTM 2389-17A Fiberglass reinforced pressure rated PP-RCT or PP-RP pipe. Having a single homogenous pipe wall with fiberglass reinforced core and with PP-RCT material on the inside and with a White UV barrier of PP-R material on the outside of the pipe wall, for use in areas subject to continuous UV exposure. Select SDR (wall thickness) sizes in SDR-11 or SDR-17, to meet the service temperature and pressure for each application. In compliance with ASTM F1290-19 ASTM D2657-07 for Electrofusion and Heat Fusion, and ANSI/NSF 14 and CSA B137.11

**Basis of Design:** Niron Clima 'Cool-Pro' UV rated PP-RCT pipe and fittings.

b. Fittings and Assembly-Joining Methods:

1. Electrofusion fittings for 1" through 8".
2. Electrofusion couplings for 1" through 16".
3. Butt fusion fittings and end-to-end pipe fusion for 10" through 16".

c. Service:

1. Chilled water piping above grade, use SDR 11 [ **and SDR 17** ]
2. Hot water piping above grade, use SDR 9 and SDR 7.3
3. Domestic Water Make-up piping, and backflow protected from the potable water source with an RP device.

2.7 PRE-INSULATED PP-RCT and PP-R Polypropylene PIPE

- a. Pipe: ASTM 2389-17A Fiberglass reinforced pressure rated PP-RCT or PP-RP pipe. Having a single homogenous pipe wall with fiberglass reinforced core and with PP-RCT material on the inside and outside of the pipe wall. Factory Pre-Insulated with CFC free rigid closed-cell Polyurethane insulation, and jacketed with a White UV barrier of PP-R material on the outside of the pipe insulation. Select SDR (wall thickness) sizes in SDR-7.3 (pipe sizes 1" through 6"), SDR-11 (pipe sizes 1-1/4" through 12"), or SDR-17 (pipe sizes 2" through 12"), to meet the service temperature and pressure for each application. In compliance with ASTM F1290-19 ASTM D2657-07 for Electrofusion and Heat Fusion, and ANSI/NSF 14 and CSA B137.11

1. Pre-Insulated with CFC free rigid polyurethane insulation that has a coefficient of thermal conductivity that is 0.14 BTU-inch/hr-ft<sup>2</sup>-°F calculated at a medium temperature of 122°F (50°C), with a closed cell structure that resists transformation caused by water absorption, compression, or loss of insulative value over time.
2. Jacketing shall be a one-piece extrusion of white UV protected Polypropylene (PP-R), having a minimum jacket wall thickness meeting schedule 40 pipe dimensions.

**Basis of Design:** Niron Clima 'All-Pro' Pre-Insulated PP-RCT or PP-RP pipe and fittings.

- b. Fittings and Assembly-Joining Methods:
  - 1 Electrofusion Pre-Insulated fittings for 1" through 8".
  - 2 Electrofusion Pre-Insulated couplings for 1" through 12".
  - 3 Butt fusion fittings and end-to-end pipe fusion for 1" through 12".
- c. Service:
  - 1. Chilled water piping buried and above grade, use SDR 11 [ **and SDR 17** ]
  - 2 Hot water piping buried and above grade, use SDR 7.3 and SDR 9 [ **and SDR 11** ]
  - 3 Domestic Hot Water piping in outdoor and rooftop applications

## 2.8 METALIC FLANGED CONNECTION JOINTS

- a. Flanges shall be cast iron or steel for screwed piping and forged steel welding neck for welded line sizes. Pressure rating and drilling shall match the apparatus, valve or fitting to which they are attached. Flanges shall be in accordance with ANSI B16.1; 150-pound for system pressures to 150 psig; 300-pound for system pressures 150 psig to 400 psig. Gaskets shall be 1/16-inch thick, Cranite or equal, ring type, coated with graphite and oil to facilitate making a tight joint. Make joint using American Standard hexagon head bolts, lock washers and nuts (in accordance with ASTM A307 GR.B) for service pressures to 150 psig; alloy steel stud bolts, lock washer and American Standard hexagon head nuts (in accordance with ASTM A307 GR.B) for service pressures 150 psig to 400 psig. Use length of bolt required for full nut engagement. Provide electro-cad plated bolts and nuts on cold and chilled water lines.

## 2.9 METALIC UNIONS

- a. Unions shall be 150 psi malleable iron or brass, brass to iron seat, ground joint, black or galvanized to match pipe. 200 psi WOG bronze, ground joint, solder type for copper tubing. Use of dielectric unions is not permitted.

## 2.10 DIELECTRIC NIPPLE

- a. Iron body with zinc plated external coating, 150 psi, plastic dielectric coating on inside of nipple, and NPT x NPT connections. Grooved ends are not permitted.

## 2.11 DIELECTRIC FLANGE

- a. Iron body with zinc plated coating and bronze body, 175 psi, Buna-N gasket for chilled water, optional EPDM gasket for hot water and any system with water above 150°F, bolted flange with bolt isolation gaskets and metal washers, and NPT iron pipe by soldered copper connections. Use Watts series 3100, or equal.

## 2.12 METALIC MECHANICAL PIPE COUPLINGS AND FITTINGS

- a. Acceptable Manufacturers: Victaulic, Gruvlok, or pre-bid approved equal.
- b. Flexible Couplings and Fittings:
  - 1. Coupling housing shall be zero flex rigid type coupling with angled bolt pad design. Similar to Victaulic Type 07. Only use flexible couplings when expansion contraction, deflection, or noise and vibration is to be dampened. Flexible coupling shall be similar to Victaulic Type 77. Coupling gasket shall be similar to Victaulic's Grade E molded synthetic rubber, Grade No. R615BZ. Flushseal gasket configuration on all applications. Coupling bolts shall be oval neck track head type with hexagonal heavy nuts in accordance with ASTM A183.
  - 2. Fittings used with pipe couplings shall be fabricated of malleable iron castings in accordance with ASTM A47. Where malleable fitting pattern is not available, fittings fabricated from Schedule 40 steel pipe or standard wall seamless welding fittings with grooved ends may be used. Elbows on pumped systems shall be long radius type.

- c. Service:
  - 3. Chilled water inside building and utility tunnels.
  - 4. Heating water below 230°F inside building and utility tunnels.

#### 2.13 SOLDER

- a. Copper Piping and Joints: Westinghouse Phos-Copper, Dyna-Flow by J.W. Harris Co. Inc., or equal.
- b. Valves, Cast Fittings, or Bronze Fittings: Harris Stay-Silv-15, Handy & Harmon Sil-Fos, or equal.
- c. Water Piping: All-State 430 with Duzall Flux, Engelhard Silvabrite with Engelhard General Purpose Flux, J.W. Harris Co. Stay-Safe 50 with Stay-Clean Flux, or equal, on 3 inches and smaller. On larger pipe, use Type "A" solder.

#### 2.14 UTILITY MARKERS

- a. Provide plastic utility warning tape and locate wire over all buried piping in accordance with Section 312300, Trenching, Backfilling, and Compacting.

#### 2.15 PIPE INSULATION

- a. Pipe insulation as indicated on the drawings or in specification Section 230719, shall provide both thermal insulation and a vapor barrier. The insulation thickness and R-value shall comply with ASHRAE 90.1 "Energy Efficient Design of New Buildings", and State "Building Energy Efficiency Standards", [Title 24, Part 6]. Pipe insulation, and insulation jacketing, or waterproof wraps shall be UV resistant, non-porous, and resist mold growth.
  - 1. For indoor systems operating at temperatures from 0°F (-18°C) to 200°F (93°C):
    - a. Owens Corning TM Fiberglas TM Insulation with SSL II® Positive Closure System, or approved equal.
  - 2. For systems operating below ambient (32°F (0°C) to +65°F (18°C)) temperature:
    - a. Owens Corning TM Vapor Wick® Pipe Insulation, or approved equal.
  - 3. Factory pre-insulated pipe and fittings suitable for buried or above ground installation, and for hot water or chilled water applications:
    - a. Niron Clima 'All-Pro' Pre-Insulated PP-RCT, or approved equal.

#### 2.16 PIPE WRAPPING

- a. For all below ground steel piping and fittings, provide complete covering of Scotchrap No. 51, or equal, 20 mil thickness, protective tape applied over Scotchrap pipe primer applied at 1 gallon per 800 square feet of pipe surface.
- b. At the Contractor's option, pipe may be furnished with factory applied jacket of "X-tru-coat" with Scotchrap as previously specified for field joints.

#### 2.17 FLEXIBLE CONNECTORS

- a. Expansion Joint/Seismic Connector:
  - 1 Annular corrugated [T316 stainless steel], [Bronze] metal hose with [T304 stainless steel], [bronze] braided cover, Schedule 40 radius elbows, flange, groove, MPT threaded, sweat or weld ends, for Schedule 40 fittings. FlexHose Tri-Flex or 'U' Loop, Metraflex Metraloop, or approved equal.
  - 2 Accept differential support displacement without damaging pipe, equipment connections, or support connections.
- b. Flexible Connectors to Air Terminal Units
  - 1 Annular corrugated [T316 stainless steel], [Bronze] metal hose with [T304 stainless steel], [bronze] braided cover, Schedule 40 radius elbows, flange, groove, MPT threaded, sweat or weld ends, for Schedule 40 fittings. FlexHose, Pumpsaver, Bellowsflex, or approved equal.

- 2 Accept differential support displacement without damaging pipe, equipment connections, or support connections.

## 2.18 EXPANSION COMPENSATOR FOR FINNED TUBE RADIATION

- a. Acceptable Manufacturers: FlexHose, Keflex, Flexonics, or equal.
- b. Single Expansion Joint: Type 300 stainless steel bellows, telescoping shrouds, flanged, weld-ends, threaded or female copper tubing ends, 2-inch traverse, 150 psig tested, 300°F maximum temperature, similar to FlexHose Bellowsflex.or approved equal.

## 2.19 PIPING, HANGERS, SUPPORTS, ANCHORAGE, AND SEISMIC RESTRAINTS

- a. Conform to the requirements of Section 230529, Hangers and Supports for HVAC Piping and Equipment; Section 230545, Seismic Restraints for HVAC Piping and Equipment; and Section 230548, Vibration, and Seismic Controls for HVAC Piping and Equipment.

# PART 3 - EXECUTION

## 3.1 PREPARATION

- a. Measurements, Lines, and Levels:
  1. Check dimensions at the building site and establish lines and levels for the work specified in this section.
  2. Establish all inverts, slopes and manhole elevations by instrument, working from an established datum point. Provide elevation markers for use in determining slopes and elevations in accordance with the drawings and specifications.
  3. Use established grid and area lines for locating trenches in relation to buildings and boundaries.

## 3.2 EXCAVATION AND BACKFILL

- a. Perform all necessary excavation and backfill required for the installation of mechanical work in accordance with Section 312000, Site Clearing and Earthwork, and Section 312300, Trenching, Backfilling, and Compacting. Repair pipelines or other work damaged during excavation and backfilling. Provide dewatering and temporary erosion control in accordance with Section 312319, Dewatering, and Section 015713, Temporary Erosion, Sediment, and Pollution Control.
- b. All cast iron, steel, and copper piping shall be full bedded on sand. Place a minimum 4-inch-deep layer on the leveled trench bottom, allowing for the necessary depth for piping bells and couplings to maintain contact of the pipe on the sand for its entire length. Lay all other piping on a smooth level trench bottom, so that contact shall be made for its entire length.
- c. Polypropylene piping shall be fully bedded on sand, with a minimum 6-inch-deep layer on the leveled trench bottom, allowing for the necessary depth for couplings to maintain contact of the pipe on the sand for its entire length. Sand and gravel containing a significant proportion of silt and clay shall be compacted by hand, by mechanical tamper. Provide a 12" or larger barrier of 1" Blue Board between hot and cold water piping or provide a distance of 3 times the pipe diameters between the hot and cold water piping. Underground installations shall conform to ASTM D2774-12 and ASTM F1668-16 for Buried Installation of Plastic Pressure Pipe, and shall comply with the piping manufacturer's installation instructions.
- d. Pipe embedment materials shall be stable, sufficiently granular to be readily worked under the sides of the pipe to provide satisfactory haunching, and readily compactable to achieve soil densities specified by contract documents. Reference Test Method ASTM D 2487-17 for gravels and sands classified as Soil Types GM, GC, SM, SC, GW, GP, SW, and SP, or by a dual soil classifications beginning with one of these symbols.

## 3.3 PIPING INSTALLATION

- a. Piping installed in areas of relative inaccessibility or in areas where leakage could cause significant damage shall not use mechanical couplings. Piping in these areas shall be soldered or welded. Areas

- include enclosed vertical shafts, above IT rooms, above electrical rooms, above hard lid ceilings, and as indicated on the drawings.
- b. Install unions in all non-flanged or non-mechanical coupling piping connections to apparatus and adjacent to all screwed valves, traps, and appurtenances requiring removal for servicing, located so that piping may be disconnected without disturbing the general system.
  - c. Mechanical Couplings:
    - 1. All galvanizing shall factory applied.
    - 2. Before assembly of metallic couplings, lightly coat pipe ends and outside of gaskets with approved lubricant.
    - 3. Pipe grooving shall be in accordance with manufacturer's specifications contained in latest published literature.
    - 4. Expansion and contraction allowance for chilled water piping: Allow 1/8 inch per coupling, with piping installed to allow 1/16-inch movement in either direction, and installation at 70°F. Make appropriate adjustments when installing at other temperatures.
    - 5. Expansion and contraction allowance for pumped condensate piping: Allow 1/4 inch per coupling, with piping installed to allow 3/4 inch of expansion and installation at 40°F. Make appropriate adjustments when installing at other temperatures.
  - d. Install all piping to vent and drain. Support all piping independently so that its weight is not be carried by the equipment.
  - e. Install hangers and supports at intervals specified in the applicable Plumbing or Mechanical Codes and/or as recommended by the piping manufacturer.
  - f. Support vertical piping at each floor and as specified in the applicable Plumbing or Mechanical Code. Piping 2" (63mm) or smaller shall be installed with mid-story guides.
  - g. Fire stopping shall be provided that is compatible with the piping material, and meets the requirements of ASTM E 814 or ULC S115, "Fire Tests of Through-Penetration Firestops".
  - h. Run piping clear of tube cleaning or removal/replacement access area on coils, etc.
  - i. Install utility warning tape and locate wire over the entire length of the underground piping utilities in accordance with Section 312300, Trenching, Backfilling, and Compacting.
  - j. Underground Water Systems: Provide mechanical joint restraints or concrete thrust blocks, prior to testing pipe, at changes in direction. Block size as required for types of fittings involved.
  - k. Dielectric Fittings: Provide dielectric nipples or flanges between dissimilar metals. Fittings shall be suitable for the pressure and temperature to be encountered. Dielectric unions are not permitted. Only install dielectric flanges in areas that are easily accessible.
  - l. Copper Grooved Piping System: Install in accordance with the manufacturer's latest published literature.
  - m. Expansion Joints/Seismic Connectors: Install where piping crosses building expansion joints and where indicated on drawings. Install in accordance with the manufacturer's instructions.
  - n. When installed in systems with pumps in excess of 7.5 HP, PP-RCT piping shall be protected from excessive heat generated by the pump operating at shut-off conditions. Where the possibility exists that the pump will operate with no flow, a temperature relief valve or comparable level of protection, set to a maximum temperature of 185°F shall be provided.
  - o. Where freeze protection heat tracing is specified for PP-RCT piping, it should be installed on the pipe exterior, it shall be self-regulating for even heat distribution, and shall limit the heating cable's surface temperature of the pipe to no more than 158° F (70° C).
  - q. Flexible Connectors to Air Terminal Units: Install where piping connects to air terminal units and where indicated on drawings. Install in accordance with the manufacturer's instructions.
  - r. High and Low Pressure Steam Piping: Slope piping in direction of flow, 1 inch in 40 feet.

3.4 PIPING JOINTS

- a. Join pipe and fittings using methods and materials recommended by the manufacturer, in accordance with standard practice and applicable codes. Clean, cut, ream, groove, etc., with proper tools and equipment. Hacksaw pipe cutting is prohibited. Peening of welds to stop leaks is not permitted.
- b. Copper Piping:
  - 1. Soldered Joints: Cut pipe evenly with cutter, ream to full inside diameter; end of pipe and inside of fitting thoroughly cleaned and polished. Joint shall be uniformly heated, and capillary space completely filled with solder, leaving full bead around entire circumference.
- c. Do not install couplings in floor, wall, or grade beam sleeves.
- d. Steel Piping:
  - 1. Screwed Joints: Cut pipes evenly with pipe cutter, and ream to full inside diameter, with all burrs and cuttings removed. Joints shall be made up with suitable lubricant or Teflon tape, applied to male threads only, leaving two threads bare. Tighten joints so not more than two threads are left showing. Make junctions between galvanized steel waste pipe and bell of cast iron pipe with tapped spigot or half coupling on steel pipe to form spigot end, and caulk.
  - 2. Flanged Joints: Pressure rating of flanges shall match valve or fitting joined. Joint gaskets shall be coated with graphite and oil.
- e. Welded Joints:
  - 1. Preparation for Welding: Bevel piping on both ends before welding.
    - a. Use following weld spacing on all butt-welds:

<u>Nominal Pipe Wall Thickness</u>	<u>Spacing</u>	<u>Bevel</u>
1/4" or less	1/8"	37 1/2"
Over 1/4", less than 3/4"	3/16"	27 1/2"

- b. Before welding, remove all corrosion products and foreign material from surfaces.
      - 2. Welded Joints: Joints shall be made by the arc-welding process using ASME certified welders. Port openings of fittings shall match the inside diameter of the pipe to which they are welded. Use full radius welding elbows for all turns; use welding tees for all tees. Use reducing fittings for size reduction. Weldolets may be used for branches up through one-half the pipe size of the main to which they are attached. Nipples will not be allowed.
      - 3. Welding Operation:
        - a. After deposition, clean each layer of weld metal to remove slag and scale by wire brushing or grinding. Chip where necessary to prepare for proper deposition of next layer.
        - b. Weld reinforcement no less than 1/16 inch nor more than 1/8 inch above normal surface of jointed sections. Reinforcement shall be crowned at center and tapered on each side to surfaces being joined. Exposed surface of weld shall be free of depressions below surface of jointed members.
        - c. Do not perform welding when temperature of base metal is lower than 0°F. Material to be welded during freezing temperatures shall be made warm and dry before welding is started. Metal shall be warm to the hand or approximately 60°F.
- f. Screwed Joints: Use Teflon tape or Teflon liquid dope applied to male threads only.
- g. PP-RCT piping systems shall be joined with piping manufacturer approved fittings, and shall be heat fused with Socket-weld, Butt-weld, or Electrofusion weld methods and practices in compliance with the manufacturer's installation recommendations, ASTM F1290-19, and ASTM D2657-07.

### 3.5 TESTING

- a. While still accessible all piping shall be pressure/leak tested to the manufacturer's standards. Tests shall be carried out using water, compressed air or a mixture of the two. The test pressure for a hydrostatic test shall be 150 psi, **[or a minimum of 1.5 times the design pressure]**, and for an air test shall be 1.1 times the design pressure or 150 psi, whichever is greater. Any leaks detected shall be repaired at the contractor's expense by removing the leaking part and replacing with new parts welded per the manufacturer's installation and repair instructions.
- b. The installing Contractor shall deliver to the OAR and the IOR valid pressure/leak test documentation indicating that the system was tested and passed the manufacturer's recommended pressure/leak testing
- c. Testing duration is 8 hours for polypropylene piping

### 3.6 INSTALLATION, PIPE WRAP

- a. Install in accordance with AWWA C209 and C214.
- b. Apply in accordance with the manufacturer's instructions.
- c. Apply wrapping to fittings in field after installation.

### 3.7 ADJUSTING AND CLEANING

- a. General:
  1. Clean interior of all piping before installation.
  2. Flush sediment out of all piping systems with a minimum velocity of 5 to 6 FPS.
  3. Prepare system for adjusting and balancing. If any system components, including control valves, balancing valves, automatic flow control valves, strainers, or other valves and specialties have sediment present, remove, clean and replace damaged or worn components.
- b. Closed loop chiller water and heating water system cleaning and water treatment: Comply with the additional requirements of Section 232500, HVAC Water Treatment.

### 3.8 INSTALLATION, RADIANT FLOOR HEATING SYSTEM PIPING

- a. Install piping in accordance with the manufacturer's instructions.

### 3.9 EXPANSION COMPENSATORS FOR FINNED TUBE RADIATION

- a. Install in accordance with the manufacturer's instructions.
- b. Furnish and install pipe guide as recommended by the manufacturer.

### 3.10 POLYPROPELYNE PIPING INSTALLATION AND EXECUTION

- a. The pipe and fittings manufacturer's representative shall provide the installing contractor with on-site training and installer certification in the fusion welding methods, and the operation of fusion machines, as well as the proper handling of pipe and fittings on site for quality control.

The contractor shall routinely monitor that handling, storage, and installation practices are being performed in accordance with manufacturer's installation instructions and recommendations.

### 3.11 POLYPROPYLENE CLOSING DOCUMENTATION

- a. The pipe and fittings manufacturer's representative shall provide the District with training and written installation instructions in the fusion welding methods necessary to affect repairs and to modify the piping system after installation as might be needed.

**END OF SECTION 23 20 15**

## SECTION 23 20 16

### UNDERGROUND HVAC PIPING

#### PART 1 – GENERAL

##### 1.1 SUMMARY

- A. Section Includes: Underground piping systems for heating, ventilating and air conditioning systems. Systems include, but are not limited to, the following:
  - 1. Chilled Water Piping System.
  - 2. Hot Water Heating Piping System.
  - 3. Condenser Water Piping.
- B. Related Requirements:
  - 1. Division 01: General Requirements.
  - 2. Section 23 05 00: Common Work Results for HVAC.
  - 3. Section 23 05 13: Basic HVAC Materials and Methods.
  - 4. Section 23 05 53: HVAC Identification.
  - 5. Section 23 20 13: HVAC Piping.
  - 6. Section 31 23 23: Excavation and Fill for Utilities.

##### 1.2 REFERENCES

- A. ASTM International:
  - 1. ASTM A47 – Standard Specification for Ferritic Malleable Iron Castings.
  - 2. ASTM A53 - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
  - 3. ASTM A105 - Standard Specification for Carbon Steel Forgings for Piping Applications.
  - 4. ASTM A126 - Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
  - 5. ASTM A181 - Standard Specification for Carbon Steel Forgings, for General-Purpose Piping.
  - 6. ASTM A234 - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.

7. ASTM A307 - Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60000 PSI Tensile Strength.
  8. ASTM B32 - Standard Specification for Solder Metal.
  9. ASTM B62 - Standard Specification for Composition Bronze or Ounce Metal Castings.
  10. ASTM B88 - Standard Specification for Seamless Copper Water Tube.
  11. ASTM F2389-17A: Pressure-Rated Polypropylene (PP) Piping Systems
  12. ASTM D2657-07: Heat Fusion for Polypropylene Pipe & Fittings
  13. ASTM D2774-12: Underground Installation of thermoplastic Pressure Piping
  14. ASTM F1668-16: Construction Procedures for Buried Plastic Pipe
- B. American National Standard Institute (ANSI) and The American Society for Mechanical Engineers (ASME):
1. ANSI/ASME B1.20.1 - Pipe Threads, General Purpose, Inch.
  2. ANSI/ASME B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard.
  3. ANSI/ASME B16.9 - Factory Made Wrought Butt-welding Fittings.
  4. ANSI/ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings.

### 1.3 SUBMITTALS

- A. Provide submittals in accordance with Division 01, Sections 23 05 00, and 23 05 13.
- B. Provide Shop Drawings with dimensioned piping layout and details of expansion loops, elbows, anchor points, building or manhole entry points and other pertinent information required to verify layout, intent and type of materials are in accordance with this Section. Prefabricated pipe units shall be dimensioned and numbered to fit actual Work with field verified conditions prior to start of factory fabrication.
- C. The CONTRACTOR shall indicate location and depth of all installed fittings, in addition to the as-built drawing content required in accordance with Section 01 77 00.

### 1.4 QUALITY ASSURANCE

- A. Refer to Sections 23 05 00 and 23 05 13.
- B. The Contractor shall be present to inspect delivered pipe and fittings, shall ensure that piping and associated jacketing is not damaged and shall verify that pipe and fittings are properly stored. The CONTRACTOR shall repair and/or replace damaged materials.

- C. The Pipe and fittings manufacturer's representative shall provide the installing Contractor with on-site training and installer certification in the fusion welding methods, and the operation of fusion machines, as well as the proper handling of pipe and fittings on site for quality control.
- D. The Contractor shall routinely monitor that welding and installation practices are being performed in accordance with manufacturer's installation instructions and recommendations.
- E. Welding of Pipe and Qualifications of Welder shall be in accordance with Section 23 05 13: Basic HVAC Materials and Methods.
- F. Welding performed as part of this Division may be subject to radiographic inspections at random in accordance with requirements specified in Section 23 05 13: Basic HVAC Materials and Methods.

#### 1.5 PRODUCT HANDLING

- A. Comply with the requirements of Section 23 05 13.
- B. Verify that materials delivered to the site are undamaged.

Deliver piping with factory applied packaging or end caps. Packaging or end caps shall remain in place until piping is installed to prevent entrance of dirt, debris and moisture.

- C. Handle and store materials on site in accordance to manufacturer recommendations.
- D. Protect stored piping from moisture and dirt by elevating above grade.

#### 1.6 COORDINATION

- A. Coordinate installation and related procedures with provisions of Section 23 05 00.

#### 1.7 WARRANTY

- A. Manufacturer shall warrant materials for a period of five years starting at Substantial Completion.
- B. Polypropylene PP-RCT piping and preinsulated PP-RCT piping shall be warranted by the manufacturer for minimum of 30 years.
- C. CONTRACTOR shall remedy defects due to faulty material or workmanship and pay for any damage to other work resulting therefrom within a period of three years from Substantial Completion.

### **PART 2 – PRODUCTS**

#### 2.1 MATERIALS

- A. Chilled Water, Condenser Water and Heating Hot Water, 1-1/4" inch and Larger Pipe and Fittings: Underground chilled water, condenser water and hot water supply and return piping that are pre-insulated, pre-fabricated type, composed of integral sealed units of outer jacket, polyurethane foam insulation, and fiberglass reinforced PP-RCT polypropylene carrier pipe.

1. Carrier Pipe and Fittings: Seamless fiberglass reinforced Polypropylene PP-RCT pipe and fittings. ANSI/NSF 14, ANSI/NSF 61, ASTM F2389, ASTM F2023, CSA B137.11, in SDR (wall thickness) sizes SDR 7.3, SDR 11, or SDR17, selected to meet the service temperature and pressure for each application.
  2. Outer Jacket: Seamless Polypropylene PP-R having a minimum wall thickness meeting schedule 40 pipe dimensions..
  3. Insulation: CFC free, rigid closed cell Polyurethane foam completely filling annular space between carrier pipe and outer jacket, having a "K" factor of 0.14 BTU/ (hour) (square foot) (degrees F/in) at 122 degrees F. Exposed insulation at unit ends shall be sealed with a factory-supplied fittings.
  4. Fittings: Insulated fittings shall be factory preassembled or assembled from factory kits in the field, made up of PP-RCT fittings with PP-R polypropylene jacketing.
  5. Field Joining Pipe and Fittings: Joining methods for preinsulated pipe and fittings may include butt-fusion, socket-fusion, and electrofusion methods in compliance with ASTM F1290-19 and ASTM D2657-07.
  6. Preparation and installation of all field joints shall comply with the preinsulated piping manufacturer's approved installation instructions.
  7. Thrust Blocks: Shall be sized and installed as recommended by the preinsulated pipe manufacturer.
  8. Expansion Joints: Where indicated on Drawings, expansion joints and seismic connectors shall consist of annular corrugated [T316 stainless steel], or [Bronze] with a [T304 stainless steel], or [Bronze] braided cover, have a flanged connection to PP-RCT to the piping system.
- B. Chilled Water, Condenser Water and Heating Hot Water, 2-inch and Smaller Pipe and Fittings: Underground chilled water, condenser water and hot water supply and return piping shall be pre-insulated, pre-fabricated type, composed of integral sealed units of HDPE (2" Size) and PVC (1-1/2" or smaller) outer jacket, polyurethane foam insulation, and seamless copper carrier pipe Type K manufactured by: Perma-Pipe Rovanco Copper Pipe System, Thermal Pipe Systems, Thermacore Copper-Therm, or equal.
9. Carrier Pipe: ASTM B88, Type "K" seamless Copper tubing.
  10. Outer Jacket (1-1/2" and Smaller Pipe): Seamless PVC plastic outer jacket extruded from Type I, Grade I, polyvinyl chloride, per ASTM D1784. See Table 1 for minimum wall thickness.
  11. Outer Jacket (2" Pipe): Seamless High Density Polyethylene (HDPE) per ASTM D1248 and D3350. Type III, Category 5, Class C. No overwrap or sprayed jacketing will be allowed. See Table 1 for minimum jacket thickness.
  12. Insulation: Polyurethane foam completely filling annular space between carrier pipe and outer jacket. In-place density shall be 1.9 to 2.1 pcf, with a "K" factor of 0.1 BTU/ (hour) (square foot) (degrees F/in) at 73 degrees F, and a closed cell content of 90 percent. Exposed insulation at unit ends shall be sealed with a factory-applied end seal. Minimum 1-inch thick insulation (nominal).

13. End Seals: Factory installed water tight end seals by the fitting and pipe manufacturer. Suitable for service ad pressure of the system. Surfaces shall be smooth and free of voids. "Painted on" end seals are not allowed.
  14. Fittings: ANSI B16.22 wrought copper fittings. Soldered joints shall be provided with silver solder or brazing alloys with melting points at or above 1,100 °F. Tin-lead solders, with melting points less than 1,100 °F, are not permitted.
  15. Field Joints: Carrier pipe ends shall be brazed, and insulated with pre-fabricated rigid insulating half shells covered by insulating jacket or injected insulation after installation of jacket. O-Ring fittings are not allowed.
  16. Preparation and installation of all field joints shall be observed and approved by pre-insulated pipe manufacturer's authorized representative and Project Inspector.
  17. Thrust Blocks: Suitably sized concrete thrust blocks shall be installed at changes in direction, both vertical and horizontal, changes in pipe size, dead ends, and valves.
  18. Anchors: Where indicated on Drawings, install anchor plates attached to the carrier pipe and sealed to pipe jacketing per pipe manufacturer's recommendations.
- A. Chilled Water, Condenser Water and Hot Water, 2-½-inch and Larger Pipe and Fittings: Underground chilled water, condenser water and hot water supply and return piping that are pre-insulated, prefabricated-pipe type, composed of integral sealed units of HDPE outer jacket, polyurethane foam insulation and schedule 40 seamless black steel carrier pipe manufactured by: Perma Pipe, Rovanco, Thermal Pipe Systems "Heat-Tite", Thermacor "Ferro-Therm", or equal.
1. Carrier Pipe: ASTM A53, Grade B, Schedule 40, seamless black steel pipe.
  2. Outer Jacket: Seamless High Density Polyethylene (HDPE) per ASTM D1248 and D3350. Type III, Category 5, Class C. No overwrap or sprayed jacketing will be allowed. Tape shall not be allowed to serve as a jacket. The HDPE jacket shall be pressure tested for watertight integrity. See Table 1 for minimum jacket thickness.
  3. Insulation: Polyurethane foam completely filling annular space between carrier pipe and outer jacket to a minimum thickness of 1 inch. In-place density shall be 1.9 to 2.1 0.14 BTU/ (hour) (square foot) degrees F/in) at 73 degrees F, and a closed cell content of 90 to 95 percent. Exposed insulation at unit ends shall be sealed with factory-applied end seal.
  4. End Seals: Furnish factory installed watertight end seals by the jacket and carrier pipe manufacturer suitable for services and pressure of the system. Surfaces shall be smooth and free of voids. "Painted on" end seals are not be allowed.
  5. Fittings: Factory fabricated and pre-insulated with polyurethane foam insulation. Insulation shall be protected with a HDPE jacket of same thickness and quality as that of straight units of pre-insulated pipe. Miters on HDPE jacket at fittings shall be as strong as pipe outer jacket.
  6. Joints: Standard weight, seamless steel; welding fittings ASTM A234 and ANSI/ASME B16.9.

7. Expansion Elbows and Loops: Prefabricated elbows, expansion loops and tees shall be furnished where expansion compensation is indicated on the Drawings. Pre-insulated fittings that must provide compensation for pipe expansion or contraction shall be installed in a suitably sized jacket and insulated with flexible polyurethane foam insulation. Straight units adjoining expansion fittings shall also be insulated with flexible polyurethane foam insulation to compensate for lateral pipe movement. Expansion loops and elbows shall be properly designed in accordance with stress limits indicated by ANSI B31.1 Code for Pressure Piping.
  8. Thrust Blocks: Suitably sized concrete thrust blocks shall be installed, when indicated on Drawings.
  9. Anchors: Prefabricated plate anchors shall be furnished where indicated on Drawings and shall consist of a steel plate welded to carrier pipe and sealed to outer jacket.
  10. Field Joints: Field joints between prefabricated units shall be installed in the following manner:
    - a. Split or full round HDPE sleeve shall be slid over end of unit before connection of carrier pipe. Connect carrier pipe and hydrostatically test as specified.
    - b. Center HDPE sleeves over joint area and hold in position with fiberglass tape, mix polyurethane foam components and pour into cavity according to instructions provided by manufacturer.
    - c. Trim cured polyurethane foam flush with jacket sleeve. Center heat-actuated shrink blanket over jacket sleeve and jacket of adjoining units to provide double layer protection. Using a soft orange flame from a propane torch, work flame from center toward one end, moving rapidly back and forth and around shrink blanket. Air pockets shall be removed and worked out from under shrink blanket. At field joints with expansion provisions, wrap pipe with flexible polyurethane foam insulation and hold in place with tape and complete joint in same manner per prior instructions.
    - d. Preparation and installation of field joints shall be observed and approved by the pre-insulated pipe manufacturer's authorized representative and the Project Inspector.
  11. Valves: Refer to Section 23 05 13: Basic HVAC Materials and Methods. Provide valve stem extension and valve boxes.
- B. Condensate Pipe and Fittings: Underground condensate return piping shall be pre-insulated, pre-fabricated pipe composed of integral sealed units of steel outer jacket, cellular glass or mineral wool insulation, and schedule 40 seamless black steel carrier pipe with welded joints as specified: Perma-Pipe MULTI-THERM 500, Rovanco Rhinocoat High Temp Conduit, Thermacor DUO-THERM "505", or equal.1. Outer Conduit: Welded steel casing. See Table 2 for minimum required wall thickness.
1. Outer Conduit Protection / Insulation:
    - a. 20 Mil Fusion bonded epoxy per ASTM D1763.

- b. Interior surface of the outer conduit shall be corrosion resistant. Epoxy coating or other similar coating shall be installed.
  - c. One-inch Polyurethane Foam Insulation with 20 mil Fiberglass (FRP) Filament wound directly onto the foam insulation. The urethane foam shall meet ASTM C591, K = 0.14, density of 2 PCF and closed cell content of 90 to 95 percent.
  - d. Cellular glass, mineral wool, or calcium silicate banded on carrier pipe with stainless steel band, K factor = 0.31 at 200 degrees F. Exposed insulation at unit ends shall be sealed with a factory-applied vapor barrier. Minimum 1 inch thick insulation (nominal).
2. Carrier Pipe:
- a. ASTM A53, Grade B, schedule 40, seamless black steel pipe with beveled ends for welding.
3. End Seals: Shall consist of a steel bulkhead plated, welded to the outer jacket where there is no anchor within 5 feet of a thermal end, provide gland seals with packed stuffing box and gland follower mounted on a steel plate, welded to the end of the exposed jacket.
4. Fittings: Shall be factory fabricated and pre-insulated. Insulation shall be protected with a jacket of same thickness and quality as that of straight units of pre-insulated pipe.
5. Expansion Elbows and Loops: Prefabricated elbows, expansion loops and tees shall be furnished where expansion is required on the Drawings. Pre-insulated fittings that must provide compensation for pipe expansion or contraction shall be installed in a suitably sized jacket and insulated with flexible insulation to compensate for lateral pipe movement.
6. Thrust Blocks: Expansion loops and elbows shall be properly designed in accordance with stress limits indicated by ANSI B31.1 Code for Pressure Piping.
7. Anchors: Prefabricated plate anchors shall be furnished and shall consist of a steel plate welded to carrier pipe and to outer jacket.
8. Field Joints: Field joints shall be furnished only at straight sections. Preparation and installation of field joints shall be observed and approved by the pre-insulated pipe manufacturer's authorized representative and the Project Inspector.
- a. Weld carrier pipe and hydrostatically test as specified.
  - b. Weld in place the outer jacket closure sleeve. Install the outer jacket protection/insulation. Seal the entire joint with a heat shrinkable sleeve.
  - c. Trim insulation flush with jacket sleeve.

2.2 MINIMUM THICKNESS OF HDPE JACKETS

TABLE 1
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Pipe Size (Inches)	Jacket Thickness (Inches)
2	0.070
2-1/2	0.070
3	0.080
4	0.080
5	0.100
6	0.100
8	0.120
10	0.120
12	0.170
14	0.200

2.3 MINIMUM WALL THICKNESS OF STEEL OUTER JACKET

TABLE 2	
Jacket Size (Inches)	Jacket Thickness (Gage)
6-26	10
28-36	6
38-42	4

**PART 3 – EXECUTION**

3.1 INSTALLATION

- A. Refer to Section 23 05 13: Basic HVAC Materials and Methods.
- B. Refer to Section 23 20 13: HVAC Piping.
- C. Installation shall be in accordance with manufacturer's instructions.
- D. Manufacturer's technical representative shall provide the installing Contractor with on-site training and installer certification in the fusion welding methods, and the operation of fusion machines, as well as the proper handling of pipe and fittings.
- E. Individuals installing and welding or fusing pipe and fittings shall have been trained by the manufacturer, and shall certification documentation of that training.

- F. Inspections and Tests:
1. Welding Inspection: In accordance with Section 23 05 13.
  2. Pressure Testing: In accordance with Section 23 05 13 and following:
    - a. Test at 200 psi. Maintain test pressure for at least 4 hours, observed by the Project Inspector, to prove tightness without leaks.
    - b. Testing of fiberglass reinforced Polypropylene PP-RCT piping systems shall in accordance with the manufacturer's instruction.
  3. Field Joint Inspection:
    - a. Verify installation of insulation at all field joints. Installation of field applied insulation and jackets shall be observed by the Project Inspector.
  4. Video Recording of Underground Installation:
    - a. Prior to backfill, the CONTRACTOR shall video record the entire extent of the underground piping installation. The video recording shall also note depths, and locations of fittings.
    - b. The video recording shall be developed on a 12 cm, DVD disk, or Flash Drive. Provide three copies of the recording to the Project Inspector for approval by the ARCHITECT, prior to backfill.
    - c. Provide one copy of the recording within the underground piping "as-built" drawing submittal package.
- G. Backfill: For excavation, fill, import and export of materials refer to Section 31 23 23, Excavation and Fill for Utilities.
1. Immediately after piping is installed in trench, a partial backfill shall be provided in middle of each unit leaving joints exposed for inspection before hydrostatic tests. After all thrust blocks are installed, a hydrostatic test shall be performed.
  2. After hydrostatic testing, final backfill of selected earth shall be hand-packed and hand-tamped to 12-inch minimum over top of jacket. Remainder of backfill shall be free of large boulders, rocks over 6-inch in diameter, frozen earth, or foreign matter. Do not furnish wheeled or tracked vehicles for tamping of backfill.
- H. Detectable Warning Tape: Provide and install detectable marking tape along buried piping per Section 23 05 53, HVAC Identification.

### 3.2 CLEANUP

- A. Remove rubbish, debris and waste materials and legally dispose off of Project site.

### 3.3 PROTECTION

- A. Protect the Work of this Section until Substantial Completion.

### 3.4 DEMONSTRATION AND TRAINING

- A. The CONTRACTOR shall provide a minimum of two (2) hours of demonstration and training to District Maintenance and Operations Personnel covering the following items:
1. Field joint preparation and installation.
  2. Installation of field applied insulation.
  3. Installation and repair of Polypropylene PP-RCT pipe and fittings, and HDPE & PVC jackets.
  4. Testing of installed field joints to ensure water tight installation.

**END OF SECTION 23 20 16**

## SECTION 23 31 13

### METAL DUCTS

#### PART 1 GENERAL

##### 1.1 RELATED DOCUMENTS

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

##### 1.2 SUMMARY

- a. Section Includes:
  - 1) Single-wall round ducts and fittings.
  - 2) Sheet metal materials.
  - 3) Sealants and gaskets.
  - 4) Hangers and supports.
- b. Related Sections:
  - 1) Division 23 Section "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing requirements for metal ducts.
  - 2) Division 23 Section "Nonmetal Ducts" for fibrous-glass ducts, thermoset fiber-reinforced plastic ducts, thermoplastic ducts, PVC ducts, and concrete ducts.
  - 3) Division 23 Section "HVAC Casings" for factory- and field-fabricated casings for mechanical equipment.
  - 4) Division 23 Section "Air Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.

##### 1.3 PERFORMANCE REQUIREMENTS

- a. Delegated Duct Design: Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and performance requirements and design criteria indicated.
  - 1) Static-Pressure Classes:
    - a) Exhaust Ducts (Negative Pressure): 1-inch wg.
- b. Structural Performance: Duct hangers and supports and seismic restraints shall withstand the effects of gravity and seismic loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems."

- 1) Seismic Hazard Level A: Seismic force to weight ratio, 0.48.
- 2) Seismic Hazard Level B: Seismic force to weight ratio, 0.30.
- 3) Seismic Hazard Level C: Seismic force to weight ratio, 0.15.

#### 1.4 SUBMITTALS

- a. Product Data: For each type of the following products:
  - 1) Sealants and gaskets.
- b. Shop Drawings:
  - 1) Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
  - 2) Factory- and shop-fabricated ducts and fittings.
  - 3) Duct layout indicating sizes, configuration, liner material, and static-pressure classes.
  - 4) Elevation of top of ducts.
  - 5) Dimensions of main duct runs from building grid lines.
  - 6) Fittings.
  - 7) Reinforcement and spacing.
  - 8) Seam and joint construction.
  - 9) Equipment installation based on equipment being used on Project.
  - 10) Locations for duct accessories, including dampers, turning vanes, and access doors and panels.
  - 11) Hangers and supports, including methods for duct and building attachment, seismic restraints, and vibration isolation.
- c. Delegated-Design Submittal:
  - 1) Sheet metal thicknesses.
  - 2) Joint and seam construction and sealing.
  - 3) Reinforcement details and spacing.
  - 4) Materials, fabrication, assembly, and spacing of hangers and supports.
  - 5) Design Calculations: Calculations, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation for selecting hangers and supports and seismic restraints.
- d. Coordination Drawings: Plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

- 1) Duct installation in congested spaces, indicating coordination with general construction, building components, and other building services. Indicate proposed changes to duct layout.
- 2) Suspended ceiling components.
- 3) Structural members to which duct will be attached.
- 4) Size and location of initial access modules for acoustical tile.
- 5) Penetrations of smoke barriers and fire-rated construction.
- 6) Items penetrating finished ceiling including the following:
  - a) Lighting fixtures.
  - b) Air outlets and inlets.
  - c) Sprinklers.
  - d) Access panels.
  - e) Perimeter moldings.
- e. Welding certificates.
- f. Field quality-control reports.

#### 1.5 QUALITY ASSURANCE

- a. Welding Qualifications: Qualify procedures and personnel according to AWS D9.1M/D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.
- b. Welding Qualifications: Qualify procedures and personnel according to the following:
  - 1) AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports.
  - 2) AWS D1.2/D1.2M, "Structural Welding Code - Aluminum," for aluminum supports.
  - 3) AWS D9.1M/D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.
- c. Mockups:
  - 1) Before installing duct systems, build mockups representing static-pressure classes in excess of 3-inch wg. Build mockups to comply with the following requirements, using materials indicated for the completed Work:
    - a) Five transverse joints.
    - b) One access door(s).
    - c) Two typical branch connections, each with at least one elbow.

- d) Perform leakage tests specified in "Field Quality Control" Article. Revise mockup construction and perform additional tests as required to achieve specified minimum acceptable results.
- 2) Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

## **PART 2 PRODUCTS**

### **2.1 SINGLE-WALL ROUND DUCTS AND FITTINGS**

- a. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.
  - 1) Manufacturers: Subject to compliance with requirements, provide products by one of the following
    - a) Lindab Inc.
    - b) McGill AirFlow LLC.
    - c) SEMCO Incorporated.
    - d) Sheet Metal Connectors, Inc.
    - e) Spiral Manufacturing Co., Inc.
    - f) Or Equal.
- b. Flat-Oval Ducts: Indicated dimensions are the duct width (major dimension) and diameter (diameter of the round sides connecting the flat portions of the duct).
- c. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Transverse Joints - Round Duct," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
  - 1) Transverse Joints in Ducts Larger Than 60 Inches in Diameter: Flanged.
- d. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Seams - Round Duct and Fittings," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
  - 1) Fabricate round ducts larger than 90 inches in diameter with butt-welded longitudinal seams.
  - 2) Fabricate flat-oval ducts larger than 72 inches in width (major dimension) with butt-welded longitudinal seams.
- e. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "90 Degree Tees and Laterals," and Figure 3-5, "Conical Tees," for static-pressure class, applicable

sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

## 2.2 SHEET METAL MATERIALS

- a. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
- b. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304 or 316, as indicated in the "Duct Schedule" Article; cold rolled, annealed, sheet. Exposed surface finish shall be No. 2B, No. 2D, No. 3, or No. 4 as indicated in the "Duct Schedule" Article.
- c. Aluminum Sheets: Comply with ASTM B 209 Alloy 3003, H14 temper; with mill finish for concealed ducts, and standard, one-side bright finish for duct surfaces exposed to view.
- d. Factory- or Shop-Applied Antimicrobial Coating:
  - 1) Apply to the surface of sheet metal that will form the interior surface of the duct. An untreated clear coating shall be applied to the exterior surface.
  - 2) Antimicrobial compound shall be tested for efficacy by an NRTL and registered by the EPA for use in HVAC systems.
  - 3) Coating containing the antimicrobial compound shall have a hardness of 2H, minimum, when tested according to ASTM D 3363.
  - 4) Surface-Burning Characteristics: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.
  - 5) Shop-Applied Coating Color: Black.
  - 6) Antimicrobial coating on sheet metal is not required for duct containing liner treated with antimicrobial coating.
- e. Reinforcement Shapes and Plates: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
  - 1) Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.
- f. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

## 2.3 SEALANT AND GASKETS

- a. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.

b. Two-Part Tape Sealing System:

- 1) Tape: Woven cotton fiber impregnated with mineral gypsum and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.
- 2) Tape Width: 6 inches.
- 3) Sealant: Modified styrene acrylic.
- 4) Water resistant.
- 5) Mold and mildew resistant.
- 6) Maximum Static-Pressure Class: 10-inch wg, positive and negative.
- 7) Service: Indoor and outdoor.
- 8) Service Temperature: Minus 40 to plus 200 deg F.
- 9) Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum.

c. Water-Based Joint and Seam Sealant:

- 1) Application Method: Brush on.
- 2) Solids Content: Minimum 65 percent.
- 3) Shore A Hardness: Minimum 20.
- 4) Water resistant.
- 5) Mold and mildew resistant.
- 6) VOC: Maximum 75 g/L (less water).
- 7) Maximum Static-Pressure Class: 10-inch wg, positive and negative.
- 8) Service: Indoor or outdoor.
- 9) Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

d. Solvent-Based Joint and Seam Sealant:

- 1) Application Method: Brush on.
- 2) Base: Synthetic rubber resin.
- 3) Solvent: Toluene and heptane.
- 4) Solids Content: Minimum 60 percent.
- 5) Shore A Hardness: Minimum 60.
- 6) Water resistant.

- 7) Mold and mildew resistant.
  - 8) VOC: Maximum 395 g/L.
  - 9) Maximum Static-Pressure Class: 10-inch wg, positive or negative.
  - 10) Service: Indoor or outdoor.
  - 11) Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.
- e. Flanged Joint Sealant: Comply with ASTM C 920.
- 1) General: Single-component, acid-curing, silicone, elastomeric.
  - 2) Type: S.
  - 3) Grade: NS.
  - 4) Class: 25.
  - 5) Use: O.
- f. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.
- g. Round Duct Joint O-Ring Seals:
- 1) Seal shall provide maximum leakage class of 3 cfm/100 sq. ft. at 1-inch wg and shall be rated for 10-inch wg static-pressure class, positive or negative.
  - 2) EPDM O-ring to seal in concave bead in coupling or fitting spigot.
  - 3) Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.

## 2.4 HANGERS AND SUPPORTS

- a. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.
- b. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.
- c. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 4-1, "Rectangular Duct Hangers Minimum Size," and Table 4-2, "Minimum Hanger Sizes for Round Duct."
- d. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.
- e. Steel Cables for Stainless-Steel Ducts: Stainless steel complying with ASTM A 492.
- f. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.

- g. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.
- h. Trapeze and Riser Supports:
  - 1) Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
  - 2) Supports for Stainless-Steel Ducts: Stainless-steel shapes and plates.
  - 3) Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.

## 2.5 SEISMIC-RESTRAINT DEVICES

- a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1) Cooper B-Line, Inc.; a division of Cooper Industries.
  - 2) Ductmate Industries, Inc.
  - 3) Hilti Corp.
  - 4) Kinetics Noise Control.
  - 5) Loos & Co.; Cableware Division.
  - 6) Mason Industries.
  - 7) TOLCO; a brand of NIBCO INC.
  - 8) Unistrut Corporation; Tyco International, Ltd.
  - 9) Or Equal.
- b. General Requirements for Restraint Components: Rated strengths, features, and applications shall be as defined in reports by an agency acceptable to authorities having jurisdiction.
  - 1) Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least four times the maximum seismic forces to which they will be subjected.
- c. Channel Support System: Shop- or field-fabricated support assembly made of slotted steel channels rated in tension, compression, and torsion forces and with accessories for attachment to braced component at one end and to building structure at the other end. Include matching components and corrosion-resistant coating.
- d. Restraint Cables: ASTM A 603, galvanized-steel cables with end connections made of cadmium-plated steel assemblies with brackets, swivel, and bolts designed for restraining cable service; and with an automatic-locking and clamping device or double-cable clips.
- e. Hanger Rod Stiffener: Reinforcing steel angle clamped to hanger rod.

- f. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

## **PART 3 EXECUTION**

### **3.1 DUCT INSTALLATION**

- a. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.
- b. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.
- c. Install round ducts in maximum practical lengths.
- d. Install ducts with fewest possible joints.
- e. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.
- f. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.
- g. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
- h. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.
- i. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.
- j. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches.
- k. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers. Comply with requirements in Division 23 Section "Air Duct Accessories" for fire and smoke dampers.
- l. Protect duct interiors from moisture, construction debris and dust, and other foreign materials. Comply with SMACNA's "Duct Cleanliness for New Construction Guidelines."

### **3.2 SEAM AND JOINT SEALING**

- a. Seal duct seams and joints for duct static-pressure and leakage classes specified in "Performance Requirements" Article, according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 1-2, "Standard Duct Sealing Requirements," unless otherwise indicated.

- 1) For static-pressure classes 1- and 1/2-inch wg, comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Seal Class C, except as follows:
  - a) Systems for residential occupancy.
  - b) Ducts that are located directly in zones they serve.
- b. Seal Classes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 1-2, "Standard Duct Sealing Requirements."
  - 1) For static-pressure classes 1- and 1/2-inch wg, comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Seal Class C, except as follows:
    - a) Systems for residential occupancy.
    - b) Ducts that are located directly in zones they serve.

### 3.3 HANGER AND SUPPORT INSTALLATION

- a. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Hangers and Supports."
- b. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
  - 1) Where practical, install concrete inserts before placing concrete.
  - 2) Install powder-actuated concrete fasteners after concrete is placed and completely cured.
  - 3) Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.
  - 4) Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.
  - 5) Do not use powder-actuated concrete fasteners for seismic restraints.
- c. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 4-1, "Rectangular Duct Hangers Minimum Size," and Table 4-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.
- d. Hangers Exposed to View: Threaded rod and angle or channel supports.
- e. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet.
- f. 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.

### 3.4 SEISMIC-RESTRAINT-DEVICE INSTALLATION

- a. Install ducts with hangers and braces designed to support the duct and to restrain against seismic forces required by applicable building codes. Comply with SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems."
  - 1) Space lateral supports a maximum of 40 feet o.c., and longitudinal supports a maximum of 80 feet o.c.
  - 2) Brace a change of direction longer than 12 feet.
- b. Select seismic-restraint devices with capacities adequate to carry present and future static and seismic loads.
- c. Install cables so they do not bend across edges of adjacent equipment or building structure.
- d. Install cable restraints on ducts that are suspended with vibration isolators.
- e. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction.
- f. Attachment to Structure: If specific attachment is not indicated, anchor bracing and restraints to structure, to flanges of beams, to upper truss chords of bar joists, or to concrete members.
- g. Drilling for and Setting Anchors:
  - 1) Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcement or embedded items during drilling. Notify the Architect if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
  - 2) Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
  - 3) Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
  - 4) Set anchors to manufacturer's recommended torque, using a torque wrench.
  - 5) Install zinc-coated steel anchors for interior applications and stainless-steel anchors for applications exposed to weather.

### 3.5 CONNECTIONS

- a. Make connections to equipment with flexible connectors complying with Division 23 Section "Air Duct Accessories."
- b. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

### 3.6 PAINTING

- a. Paint interior of metal ducts that are visible through registers and grilles and that do not have duct liner. Apply one coat of flat, black, latex paint over a compatible galvanized-steel primer. Paint materials and application requirements are specified in Division 09 painting Sections.

### 3.7 FIELD QUALITY CONTROL

- a. Perform tests and inspections.
- b. Leakage Tests:
  - 1) Comply with SMACNA's "HVAC Air Duct Leakage Test Manual."
  - 2) Test the following systems:
    - a) Exhaust air.
  - 3) Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
  - 4) Test for leaks before insulation application.
  - 5) Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If static-pressure classes are not indicated, test entire system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure. Give seven days' advance notice for testing.
- c. Duct System Cleanliness Tests:
  - 1) Visually inspect duct system to ensure that no visible contaminants are present.
  - 2) Test sections of metal duct system, chosen randomly by Owner, for cleanliness according to "Vacuum Test" in NADCA ACR, "Assessment, Cleaning and Restoration of HVAC Systems."
    - a) Acceptable Cleanliness Level: Net weight of debris collected on the filter media shall not exceed 0.75 mg/100 sq. cm.
- d. Duct system will be considered defective if it does not pass tests and inspections.
- e. Prepare test and inspection reports.

### 3.8 DUCT CLEANING

- a. Clean new and existing duct system(s) before testing, adjusting, and balancing.
- b. Use service openings for entry and inspection.
  - 1) Create new openings and install access panels appropriate for duct static-pressure class if required for cleaning access. Provide insulated panels for insulated or lined duct. Patch insulation and liner as recommended by duct liner manufacturer. Comply with Division 23 Section "Air Duct Accessories" for access panels and doors.

- 2) Disconnect and reconnect flexible ducts as needed for cleaning and inspection.
  - 3) Remove and reinstall ceiling to gain access during the cleaning process.
- c. Particulate Collection and Odor Control:
- 1) When venting vacuuming system inside the building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron-size (or larger) particles.
  - 2) When venting vacuuming system to outdoors, use filter to collect debris removed from HVAC system, and locate exhaust downwind and away from air intakes and other points of entry into building.
- d. Clean the following components by removing surface contaminants and deposits:
- 1) Air outlets and inlets (registers, grilles, and diffusers).
  - 2) Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
  - 3) Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.
  - 4) Coils and related components.
  - 5) Return-air ducts, dampers, actuators, and turning vanes except in ceiling plenums and mechanical equipment rooms.
  - 6) Supply-air ducts, dampers, actuators, and turning vanes.
  - 7) Dedicated exhaust and ventilation components and makeup air systems.
- e. Mechanical Cleaning Methodology:
- 1) Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.
  - 2) Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.
  - 3) Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts, duct liner, or duct accessories.
  - 4) Clean fibrous-glass duct liner with HEPA vacuuming equipment; do not permit duct liner to get wet. Replace fibrous-glass duct liner that is damaged, deteriorated, or delaminated or that has friable material, mold, or fungus growth.
  - 5) Clean coils and coil drain pans according to NADCA 1992. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.

- 6) Provide drainage and cleanup for wash-down procedures.
- 7) Antimicrobial Agents and Coatings: Apply EPA-registered antimicrobial agents if fungus is present. Apply antimicrobial agents according to manufacturer's written instructions after removal of surface deposits and debris.

### 3.9 DUCT SCHEDULE

- a. Fabricate ducts with galvanized sheet steel except as follows:
  - 1) Moist Environment Ducts: Aluminum.
- b. Intermediate Reinforcement:
  - 1) Galvanized-Steel Ducts: Galvanized steel.
  - 2) Stainless-Steel Ducts: Galvanized steel.
  - 3) Aluminum Ducts: Aluminum or galvanized sheet steel coated with zinc chromate.
- c. Elbow Configuration:
  - 1) Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-3, "Round Duct Elbows."
    - a) Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 3-1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.
      - 1) Velocity 1000 fpm or Lower: 0.5 radius-to-diameter ratio and three segments for 90-degree elbow.
      - 2) Velocity 1000 to 1500 fpm: 1.0 radius-to-diameter ratio and four segments for 90-degree elbow.
      - 3) Velocity 1500 fpm or Higher: 1.5 radius-to-diameter ratio and five segments for 90-degree elbow.
    - b) Round Elbows, 12 Inches and Smaller in Diameter: Stamped or pleated.
- d. Branch Configuration:
  - 1) Round and Flat Oval: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "90 Degree Tees and Laterals," and Figure 3-5, "Conical Tees." Saddle taps are permitted in existing duct.
    - a) Velocity 1000 fpm or Lower: 90-degree tap.
    - b) Velocity 1000 to 1500 fpm: Conical tap.
    - c) Velocity 1500 fpm or Higher: 45-degree lateral.

END OF SECTION 23 31 13

## SECTION 23 33 00

### AIR DUCT ACCESSORIES

#### PART 1 GENERAL

##### 1.1 RELATED DOCUMENTS

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

##### 1.2 SUMMARY

- a. Section Includes:
  - 1) Backdraft dampers (factory installed with exhaust fan).
  - 2) Flange connectors.
  - 3) Duct accessory hardware.
- b. Related Sections:
  - 1) Division 23 Section "HVAC Gravity Ventilators" for roof-mounted ventilator caps.

##### 1.3 SUBMITTALS

- a. Product Data: For each type of product indicated.
  - 1) For duct silencers, include pressure drop and dynamic insertion loss data. Include breakout noise calculations for high transmission loss casings.
- b. Shop Drawings: For duct accessories. Include plans, elevations, sections, details and attachments to other work.
  - 1) Detail duct accessories fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances; and method of field assembly into duct systems and other construction. Include the following:
    - a) Special fittings.
    - b) Wiring Diagrams: For power, signal, and control wiring.
- c. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which ceiling-mounted access panels and access doors required for access to duct accessories are shown and coordinated with each other, using input from Installers of the items involved.
- d. Source quality-control reports.
- e. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.

#### 1.4 QUALITY ASSURANCE

- a. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."
- b. Comply with AMCA 500-D testing for damper rating.

### **PART 2 PRODUCTS**

#### 2.1 MATERIALS

- a. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
- b. Aluminum Sheets: Comply with ASTM B 209, Alloy 3003, Temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.
- c. Extruded Aluminum: Comply with ASTM B 221, Alloy 6063, Temper T6.
- d. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.
- e. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

#### 2.2 BACKDRAFT AND PRESSURE RELIEF DAMPERS

- a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1) Broan
  - 2) Greenheck Fan Corporation.
  - 3) Loren Cook.
  - 4) Or Equal
- b. Description: Factory installed with ceiling exhaust fan..

#### 2.3 DUCT-MOUNTED ACCESS DOORS

- a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1) American Warming and Ventilating; a division of Mestek, Inc.
  - 2) Cesco Products; a division of Mestek, Inc.
  - 3) Ductmate Industries, Inc.
  - 4) Flexmaster U.S.A., Inc.

- 5) Greenheck Fan Corporation.
  - 6) McGill AirFlow LLC.
  - 7) Nailor Industries Inc.
  - 8) Pottorff; a division of PCI Industries, Inc.
  - 9) Ventfabrics, Inc.
  - 10) Ward Industries, Inc.; a division of Hart & Cooley, Inc.
  - 11) Or Equal
- b. Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 2-10, "Duct Access Doors and Panels," and 2-11, "Access Panels - Round Duct."
- 1) Door:
    - a) Double wall, rectangular.
    - b) Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
    - c) Vision panel.
    - d) Hinges and Latches: 1-by-1-inch butt or piano hinge and cam latches.
    - e) Fabricate doors airtight and suitable for duct pressure class.
  - 2) Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
  - 3) Number of Hinges and Locks:
    - a) Access Doors Less Than 12 Inches Square: No hinges and two sash locks.
    - b) Access Doors up to 18 Inches Square: Two hinges and two sash locks.
    - c) Access Doors up to 24 by 48 Inches: Three hinges and two compression latches with outside and inside handles.
    - d) Access Doors Larger Than 24 by 48 Inches: Four hinges and two compression latches with outside and inside handles.
- c. Pressure Relief Access Door:
- 1) Door and Frame Material: Galvanized sheet steel.
  - 2) Door: Double wall with insulation fill with metal thickness applicable for duct pressure class.
  - 3) Operation: Open outward for positive-pressure ducts and inward for negative-pressure ducts.

- 4) Factory set at 10-inch wg.
- 5) Doors close when pressures are within set-point range.
- 6) Hinge: Continuous piano.
- 7) Latches: Cam.
- 8) Seal: Neoprene or foam rubber.
- 9) Insulation Fill: 1-inch- thick, fibrous-glass or polystyrene-foam board.

#### 2.4 DUCT ACCESS PANEL ASSEMBLIES

- a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1) Ductmate Industries, Inc.
  - 2) Flame Gard, Inc.
  - 3) 3M.
  - 4) Or Equal.
- b. Labeled according to UL 1978 by an NRTL.
- c. Panel and Frame: Minimum thickness 0.0428-inch stainless steel.
- d. Fasteners: Stainless steel. Panel fasteners shall not penetrate duct wall.
- e. Gasket: Comply with NFPA 96; grease-tight, high-temperature ceramic fiber, rated for minimum 2000 deg F.
- f. Minimum Pressure Rating: 10-inch wg, positive or negative.

#### 2.5 FLEXIBLE CONNECTORS

- a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1) Ductmate Industries, Inc.
  - 2) Duro Dyne Inc.
  - 3) Ventfabrics, Inc.
  - 4) Ward Industries, Inc.; a division of Hart & Cooley, Inc.
  - 5) Or Equal.
- b. Materials: Flame-retardant or noncombustible fabrics.
- c. Coatings and Adhesives: Comply with UL 181, Class 1.

- d. Metal-Edged Connectors: Factory fabricated with a fabric strip 5-3/4 inches wide attached to 2 strips of 2-3/4-inch- wide, 0.028-inch- thick, galvanized sheet steel or 0.032-inch- thick aluminum sheets. Provide metal compatible with connected ducts.
- e. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.
  - 1) Minimum Weight: 26 oz./sq. yd..
  - 2) Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
  - 3) Service Temperature: Minus 40 to plus 200 deg F.
- f. Thrust Limits: Combination coil spring and elastomeric insert with spring and insert in compression, and with a load stop. Include rod and angle-iron brackets for attaching to fan discharge and duct.
  - 1) Frame: Steel, fabricated for connection to threaded rods and to allow for a maximum of 30 degrees of angular rod misalignment without binding or reducing isolation efficiency.
  - 2) Outdoor Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
  - 3) Minimum Additional Travel: 50 percent of the required deflection at rated load.
  - 4) Lateral Stiffness: More than 80 percent of rated vertical stiffness.
  - 5) Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
  - 6) Elastomeric Element: Molded, oil-resistant rubber or neoprene.
  - 7) Coil Spring: Factory set and field adjustable for a maximum of 1/4-inch movement at start and stop.

## 2.6 DUCT ACCESSORY HARDWARE

- a. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.
- b. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

## **PART 3 EXECUTION**

### 3.1 INSTALLATION

- a. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.

- b. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.
- c. Install backdraft dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.
- d. Set dampers to fully open position before testing, adjusting, and balancing.
- e. Install test holes at fan inlets and outlets and elsewhere as indicated.
- f. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:
  - 1) On both sides of duct coils.
  - 2) Downstream from manual volume dampers, control dampers, and equipment.
  - 3) Adjacent to and close enough to fire or smoke dampers, to reset or reinstall fusible links. Access doors for access to fire or smoke dampers having fusible links shall be pressure relief access doors and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.
  - 4) At each change in direction and at maximum 50-foot spacing.
  - 5) Upstream of turning vanes.
  - 6) Elsewhere as indicated.
- g. Install access doors with swing against duct static pressure.
- h. Access Door Sizes:
  - 1) One-Hand or Inspection Access: 8 by 5 inches.
  - 2) Two-Hand Access: 12 by 6 inches.
  - 3) Head and Hand Access: 18 by 10 inches.
  - 4) Head and Shoulders Access: 21 by 14 inches.
  - 5) Body Access: 25 by 14 inches.
  - 6) Body plus Ladder Access: 25 by 17 inches.
- i. Label access doors according to Division 23 Section "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.
- j. Install flexible connectors to connect ducts to equipment.
- k. For fans developing static pressures of 5-inch wg and more, cover flexible connectors with loaded vinyl sheet held in place with metal straps.
- l. Install duct test holes where required for testing and balancing purposes.

- m. Install thrust limits at centerline of thrust, symmetrical on both sides of equipment. Attach thrust limits at centerline of thrust and adjust to a maximum of 1/4-inch movement during start and stop of fans.

### 3.2 FIELD QUALITY CONTROL

- a. Tests and Inspections:

- 1) Operate dampers to verify full range of movement.
- 2) Inspect locations of access doors and verify that purpose of access door can be performed.
- 3) Operate fire, smoke, and combination fire and smoke dampers to verify full range of movement and verify that proper heat-response device is installed.
- 4) Inspect turning vanes for proper and secure installation.
- 5) Operate remote damper operators to verify full range of movement of operator and damper.

END OF SECTION 23 33 00

## SECTION 23 34 23

### HVAC POWER VENTILATORS

#### PART 1 GENERAL

##### 1.1 RELATED DOCUMENTS

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

##### 1.2 SUMMARY

- a. This Section includes the following

- 1) Ceiling-mounting ventilators.

##### 1.3 PERFORMANCE REQUIREMENTS

- a. Project Altitude: Base fan-performance ratings on sea level.
- b. Operating Limits: Classify according to AMCA 99.

##### 1.4 SUBMITTALS

- a. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated and include the following:
  - 1) Certified fan performance curves with system operating conditions indicated.
  - 2) Certified fan sound-power ratings.
  - 3) Motor ratings and electrical characteristics, plus motor and electrical accessories.
  - 4) Material thickness and finishes, including color charts.
  - 5) Dampers, including housings, linkages, and operators.
  - 6) Roof curbs.
  - 7) Fan speed controllers.
- b. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  - 1) Wiring Diagrams: Power, signal, and control wiring.
  - 2) Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.

- 3) Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, and base weights.
- c. Coordination Drawings: Reflected ceiling plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
    - 1) Roof framing and support members relative to duct penetrations.
    - 2) Ceiling suspension assembly members.
    - 3) Size and location of initial access modules for acoustical tile.
    - 4) Ceiling-mounted items including light fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
  - d. Field quality-control test reports.
  - e. Operation and Maintenance Data: For power ventilators to include in emergency, operation, and maintenance manuals.

#### 1.5 QUALITY ASSURANCE

- a. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- b. AMCA Compliance: Products shall comply with performance requirements and shall be licensed to use the AMCA-Certified Ratings Seal.
- c. NEMA Compliance: Motors and electrical accessories shall comply with NEMA standards.
- d. UL Standard: Power ventilators shall comply with UL 705.

#### 1.6 DELIVERY, STORAGE, AND HANDLING

- a. Deliver fans as factory-assembled unit, to the extent allowable by shipping limitations, with protective crating and covering.
- b. Disassemble and reassemble units, as required for moving to final location, according to manufacturer's written instructions.
- c. Lift and support units with manufacturer's designated lifting or supporting points.

#### 1.7 COORDINATION

- a. Coordinate size and location of structural-steel support members.
- b. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

- c. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

## **PART 2 PRODUCTS**

### **2.1 CEILING-MOUNTING VENTILATORS**

- a. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
  - 1) American Coolair Corp.
  - 2) Ammerman; General Resource Corp.
  - 3) Breidert Air Products.
  - 4) Broan Mfg. Co., Inc.
  - 5) Carnes Company HVAC.
  - 6) Dayton Electric Manufacturing Co.; a division of W. W. Grainger, Inc.
  - 7) FloAire.
  - 8) Greenheck.
  - 9) JencoFan; Div. of Breidert Air Products.
  - 10) Loren Cook Company.
  - 11) NuTone Inc.
  - 12) Penn Ventilation.
  - 13) Panasonic
- b. Description: Centrifugal fans designed for installing in ceiling or wall or for concealed in-line applications.
- c. Housing: Steel, lined with acoustical insulation.
- d. Fan Wheel: Centrifugal wheels directly mounted on motor shaft. Fan shrouds, motor, and fan wheel shall be removable for service.
- e. Grille: Plastic, louvered grille with flange on intake and thumbscrew attachment to fan housing.
- f. Electrical Requirements: Junction box for electrical connection on housing and receptacle for motor plug-in.
- g. Accessories:
  - 1) Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.

- 2) Manual Starter Switch: Single-pole rocker switch assembly with cover and pilot light.
- 3) Time-Delay Switch: Assembly with single-pole rocker switch, timer, and cover plate.
- 4) Motion Sensor: Motion detector with adjustable shutoff timer.
- 5) Ceiling Radiation Damper: Fire-rated assembly with ceramic blanket, stainless-steel springs, and fusible link.
- 6) Filter: Washable aluminum to fit between fan and grille.
- 7) Isolation: Rubber-in-shear vibration isolators.
- 8) Manufacturer's standard roof jack or wall cap, and transition fittings.

## 2.2 MOTORS

- a. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."
- b. Enclosure Type: Totally enclosed, fan cooled.

## 2.3 SOURCE QUALITY CONTROL

- a. Sound-Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.
- b. Fan Performance Ratings: Establish flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests and ratings according to AMCA 210, "Laboratory Methods of Testing Fans for Rating."

## **PART 3 EXECUTION**

### 3.1 INSTALLATION

- a. Install power ventilators level and plumb.
- b. Ceiling Units: Suspend units from structure; use steel wire or metal straps.
- c. Support suspended units from structure using threaded steel rods and elastomeric hangers having a static deflection of 1 inch. Vibration-control devices are specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."
- d. Install units with clearances for service and maintenance.
- e. Label units according to requirements specified in Division 23 Section "Identification for HVAC Piping and Equipment."

### 3.2 CONNECTIONS

- a. Duct installation and connection requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Division 23 Section "Air Duct Accessories."
- b. Install ducts adjacent to power ventilators to allow service and maintenance.
- c. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- d. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

### 3.3 FIELD QUALITY CONTROL

- a. Perform the following field tests and inspections and prepare test reports:
  - 1) Verify that shipping, blocking, and bracing are removed.
  - 2) Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
  - 3) Verify that cleaning and adjusting are complete.
  - 4) Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
  - 5) Adjust belt tension.
  - 6) Adjust damper linkages for proper damper operation.
  - 7) Verify lubrication for bearings and other moving parts.
  - 8) Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
  - 9) Disable automatic temperature-control operators, energize motor and adjust fan to indicated rpm, and measure and record motor voltage and amperage.
  - 10) Shut unit down and reconnect automatic temperature-control operators.
  - 11) Remove and replace malfunctioning units and retest as specified above.
- b. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

### 3.4 ADJUSTING

- a. Adjust damper linkages for proper damper operation.
- b. Adjust belt tension.

- c. Refer to Division 23 Section "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing procedures.
- d. Replace fan and motor pulleys as required to achieve design airflow.
- e. Lubricate bearings.

END OF SECTION 23 34 23

## SECTION 23 37 13

### DIFFUSERS, REGISTERS, AND GRILLES

#### PART 1 GENERAL

##### 1.1 RELATED DOCUMENTS

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

##### 1.2 SUMMARY

- a. This Section includes ceiling- and wall-mounted diffusers, registers, and grilles.
- b. Related Sections include the following:
  - 1) Division 08 Section "Louvers and Vents" for fixed and adjustable louvers and wall vents, whether or not they are connected to ducts.
  - 2) Division 23 Section "Air Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to diffusers, registers, and grilles.

##### 1.3 SUBMITTALS

- a. Product Data: For each product indicated, include the following:
  - 1) Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
  - 2) Diffuser, Register, and Grille Schedule: Indicate Drawing designation, room location, quantity, model number, size, and accessories furnished.
- b. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
  - 1) Ceiling suspension assembly members.
  - 2) Method of attaching hangers to building structure.
  - 3) Size and location of initial access modules for acoustical tile.
  - 4) Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
  - 5) Duct access panels.
- c. Samples for Initial Selection: For diffusers, registers, and grilles with factory-applied color finishes.

- d. Samples for Verification: For diffusers, registers, and grilles, in manufacturer's standard sizes to verify color selected.

## **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) Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, products specified.
  - 2) Products: Subject to compliance with requirements, provide one of the products specified.
  - 3) Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
  - 4) Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

### **2.2 GRILLES AND REGISTERS**

- a. Adjustable Bar Grille:
  - 1) Manufacturers:
    - a) A-J Manufacturing Co., Inc.
    - b) Anemostat; a Mestek Company.
    - c) Carnes.
    - d) Dayus Register & Grille.
    - e) Hart & Cooley, Inc.; Hart & Cooley Div.
    - f) Krueger.
    - g) METALAIRE, Inc.; Metal Industries Inc.
    - h) Nailor Industries of Texas Inc.
    - i) Price Industries.
    - j) Titus.
    - k) Tuttle & Bailey.
  - 2) Material: Steel

- 3) Finish: Baked enamel, color selected by Architect
  - 4) Face Blade Arrangement: Fixed horizontal spaced 1/2 inch apart.
- b. Fixed Face Grille:
- 1) Manufacturers:
    - a) A-J Manufacturing Co., Inc.
    - b) Anemostat; a Mestek Company.
    - c) Carnes.
    - d) Dayus Register & Grille.
    - e) Hart & Cooley, Inc.; Hart & Cooley Div.
    - f) Krueger.
    - g) Nailor Industries of Texas Inc.
    - h) Price Industries.
    - i) Titus.
    - j) Tuttle & Bailey.
  - 2) Material: Steel.
  - 3) Finish: Baked enamel, color selected by Architect.

### 2.3 CEILING DIFFUSER OUTLETS

- a. Louver Face Diffuser:
- 1) Manufacturers:
    - a) A-J Manufacturing Co., Inc.
    - b) Anemostat; a Mestek Company.
    - c) Carnes.
    - d) METALAIRE, Inc.; Metal Industries Inc.
    - e) Nailor Industries of Texas Inc.
    - f) Price Industries.
    - g) Titus.
    - h) Tuttle & Bailey.

- 2) Material: Steel.
- 3) Finish: Baked enamel, color selected by Architect.
- 4) Mounting: Surface.
- 5) Pattern: Four-way core style.
- 6) Dampers: Radial opposed blade.
- 7) Accessories:
  - a) Square to round neck adaptor.
  - b) Adjustable pattern vanes.
  - c) Plaster ring.
  - d) Safety chain.
  - e) Wire guard.

## 2.4 SOURCE QUALITY CONTROL

- a. Verification of Performance: Rate diffusers, registers, and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

## **PART 3 EXECUTION**

### 3.1 EXAMINATION

- a. Examine areas where diffusers, registers, and grilles are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.
- b. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

- a. Install diffusers, registers, and grilles level and plumb.
- b. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practicable. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.
- c. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

### 3.3 ADJUSTING

- a. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION 23 37 13

## SECTION 23 41 00

### PARTICULATE AIR FILTRATION

#### PART 1 GENERAL

##### 1.1 RELATED DOCUMENTS

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

##### 1.2 SUMMARY

- a. This Section includes factory-fabricated air-filter devices and media used to remove particulate matter from air for HVAC applications.

##### 1.3 DEFINITIONS

- a. DOP: Dioctyl phthalate or bis-(2-ethylhexyl) phthalate.

##### 1.4 SUBMITTALS

- a. Product Data: Include dimensions; operating characteristics; required clearances and access; rated flow capacity, including initial and final pressure drop at rated airflow; efficiency and test method; fire classification; furnished specialties; and accessories for each model indicated.
- b. Shop Drawings: Include plans, elevations, sections, and details to illustrate component assemblies and attachments.
  - 1) Show filter rack assembly, dimensions, materials, and methods of assembly of components.
  - 2) Include setting drawings, templates, and requirements for installing anchor bolts and anchorages.
  - 3) Wiring Diagrams: Power, signal, and control wiring.
- c. Operation and Maintenance Data: For each type of filter and rack to include in emergency, operation, and maintenance manuals.

##### 1.5 QUALITY ASSURANCE

- a. Product Options: Drawings indicate size, profiles, and dimensional requirements of air filters and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."
- b. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- c. Comply with ARI 850.

- d. Comply with ASHRAE 52.1 ASHRAE 52.2 for method of testing and rating air-filter units.
- e. Comply with NFPA 70 for installing electrical components.
- f. Comply with NFPA 90A and NFPA 90B.

#### 1.6 COORDINATION

- a. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

#### 1.7 EXTRA MATERIALS

- a. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1) Provide one complete set of filters for each filter bank. If system includes prefilters, provide only prefilters.
  - 2) Provide one container of red oil for inclined manometer filter gage.

### **PART 2 PRODUCTS**

#### 2.1 MANUFACTURERS

- a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1) Air Filters, Electrostatic Air Cleaners, and Filter-Holding Systems:
    - a) AAF International.
    - b) Filtration Group.
    - c) Airguard Industries, Inc.
    - d) Barnebey & Sutcliffe Corp.
    - e) Columbus Industries, Inc.
    - f) CRS Industries, Inc.; CosaTron Div.
    - g) D Mark Inc.
    - h) Farr Co.
    - i) Flame Gard, Inc.
    - j) Flanders/CSC Corp.
    - k) Flanders Filters, Inc.

- l) General Filters Inc.
  - m) International Air Filtration Corporation.
  - n) Koch Filter Corporation.
  - o) LakeAir International, Inc.
  - p) NiCon Filter Corp.; Continental Air Filter Div.
  - q) Purafil, Inc.
  - r) Research Products Corp.
- 2) Filter Gages:
- a) Airguard Industries, Inc.
  - b) Dwyer Instruments, Inc.

## 2.2 DISPOSABLE PANEL FILTERS

- a. Description: Factory-fabricated, viscous-coated, flat-panel-type, disposable air filters with holding frames.
- b. Media: Interlaced glass fibers sprayed with nonflammable adhesive and anti-microbial agent.
- c. Frame: Cardboard frame with perforated metal retainer.
- d. Duct-Mounting Frames: Welded, galvanized steel with gaskets and fasteners and suitable for bolting together into built-up filter banks.

## 2.3 EXTENDED-SURFACE, DISPOSABLE PANEL FILTERS

- a. Description: Factory-fabricated, dry, extended-surface filters with holding frames.
- b. Media: Fibrous material formed into deep-V-shaped pleats and held by self-supporting wire grid.
- c. Media and Media-Grid Frame: Nonflammable cardboard, 3/4-inch.
- d. Duct-Mounting Frames: Welded, galvanized steel with gaskets and fasteners, and suitable for bolting together into built-up filter banks.

## 2.4 FRONT- AND REAR-ACCESS FILTER FRAMES

- a. Framing System: Aluminum framing members with access for either upstream (front) or downstream (rear) filter servicing, cut to size and prepunched for assembly into modules. Vertically support filters prevent deflection of horizontal members without interfering with either filter installation or operation.
- b. Prefilters: Incorporate a separate track, removable from front or back.

- c. Sealing: Factory-installed, positive-sealing device for each row of filters to ensure seal between gasketed filter elements to prevent bypass of unfiltered air.

## 2.5 SIDE-SERVICE HOUSINGS

- a. Description: Factory-assembled, side-service housings, constructed of galvanized steel, with flanges to connect to duct system.
- b. Prefilters: Integral tracks to accommodate 2-inch disposable or washable filters.
- c. Access Doors: Continuous gaskets on perimeter and positive-locking devices. Arrange so filter cartridges can be loaded from either access door.
- d. Sealing: Incorporate positive-sealing gasket material on channels to seal top and bottom of filter cartridge frames to prevent bypass of unfiltered air.

## 2.6 FILTER GAGES

- a. Description: Diaphragm type with dial and pointer in metal case, vent valves, black figures on white background, and front recalibration adjustment.
  - 1) Diameter: 4-1/2 inches.
  - 2) Range: 0- to 1.0-inch wg.
- b. Manometer-Type Filter Gage: Molded plastic with epoxy-coated aluminum scale, logarithmic-curve tube gage with integral leveling gage, graduated to read from 0- to 3.0-inch wg, and accurate within 3 percent of full scale range.
- c. Accessories: Static-pressure tips, tubing, gage connections, and mounting bracket.

## **PART 3 EXECUTION**

### 3.1 INSTALLATION

- a. Install filter frames according to manufacturer's written instructions.
- b. Position each filter unit with clearance for normal service and maintenance. Anchor filter holding frames to substrate.
- c. Install filters in position to prevent passage of unfiltered air.
- d. Install filter gage for each filter bank.
- e. Install filter gage static-pressure tips upstream and downstream from filters to measure pressure drop through filter. Mount filter gages on outside of filter housing or filter plenum in an accessible position. Adjust and level inclined gages.
- f. Coordinate filter installations with duct and air-handling unit installations.
- g. Electrical wiring and connections are specified in Division 26 Sections.
- h. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

### 3.2 FIELD QUALITY CONTROL

- a. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components, filter and filter-frame installation, and electrical wiring, and to assist in field testing. Report results in writing.
- b. Operate automatic roll filters to demonstrate compliance with requirements. Test for leakage of unfiltered air while system is operating. Correct malfunctioning units, then retest to demonstrate compliance. Remove and replace units that cannot be corrected with new units and retest.

### 3.3 CLEANING

- a. After completing system installation and testing, adjusting, and balancing air-handling and air-distribution systems, clean filter housings and install new filter media.

END OF SECTION 23 41 00

**SECTION 23 70 00**  
**AIR HANDLING UNITS**

**PART 1 – GENERAL**

1.1 SUMMARY

A. Section Includes:

1. Indoor and outdoor air handling units.

B. Related Requirements:

1. Division 01: General Requirements.
2. Section 23 05 00: Common Work Results for HVAC.
3. Section 23 05 13: Basic HVAC Materials and Methods.
4. Section 23 05 48: HVAC Sound, Vibration and Seismic Control.
5. Section 23 07 00: HVAC Insulation.
6. Section 23 09 00: HVAC Instrumentation and Controls.
7. Section 23 20 13: HVAC Piping.
8. Section 23 80 00: Heating, Ventilating and Air Conditioning Equipment.

1.2 REFERENCES

A. Air Movement and Control Association International, Inc. (AMCA):

1. AMCA 211 – Certified Ratings Program - Product Rating Manual for Fan Air Performance.
2. AMCA 300 – Reverberant Room Method for Sound Testing of Fans.
3. AMCA 301 – Methods for Calculating Fan Sound Ratings from Laboratory Test Data.

B. Air-Conditioning, Heating, and Refrigeration Institute (AHRI):

1. AHRI 410 – Forced Circulation Air-Cooling and Air-Heating Coils.

C. American Society for Testing and Materials International (ASTM):

1. ASTM B117 – Standard Practice for Operating Salt Spray (Fog) Apparatus.
2. ASTM D2247 – Standard Practice for Testing Water Resistance of Coatings in 100 Percent Relative Humidity.
3. ASTM E84 – Standard Test Method for Surface Burning Characteristics of Building Materials.

- D. National Fire Protection Association (NFPA):
  - 1. NFPA 90A – Standard for the Installation of Air-Conditioning and Ventilating Systems.
- E. Underwriters Laboratories, Inc. (UL):
  - 1. UL 181 – Standard for Factory-Made Air Ducts and Air Connectors.
  - 2. UL 723 – Standard for Test for Surface Burning Characteristics of Building Materials.
  - 3. UL 1995 –Heating and Cooling Equipment.
- F. Underwriters Laboratories of Canada (ULC):
  - 1. CAN/ULC-S102.2 – Standard Method of Test for Surface Burning Characteristics of Flooring, Floor Coverings, and Miscellaneous Materials and Assemblies.
- G. American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE):
  - 1. ASHRAE Standard 62.1 – Ventilation for Acceptable Indoor Air Quality.
- H. National Electrical Manufacturers Association (NEMA):
  - 1. NEMA – MG 1, Table 12-10: NEMA Threshold Full-Load Nominal Efficiency Values for Energy-Efficient Motors.

### 1.3 SUBMITTALS

- A. Comply with provisions of Division 01 and Section 23 05 00: Common Work Results for HVAC.
- B. Manufacturer's Data:
  - 1. Complete materials list of items proposed to be furnished and installed under this Section. Materials lists, which do not require performance data, shall include manufacturer's name, type, and model number for indicated installation.
  - 2. Manufacturer's specifications and other data required to demonstrate compliance with specified requirements. Literature shall include descriptions of equipment, types, models and sizes proposed, capacity tables or curves marked to indicate performance characteristics, electrical requirements, options selected, space requirements and other data necessary to ensure compliance with requirements of this Specification and performances indicated on Drawings.
  - 3. Provide data of filter media, filter performance data, filter assembly, and filter frames.
- C. Shop Drawings indicating methods of installation of equipment and materials, and details of supporting structures for items indicated. Items to be submitted shall include but not be limited to the following:
  - 1. Layout Drawings of Equipment: Include plans, elevations, and sections, of proposed equipment drawn to scale, to establish which equipment shall fit in

allotted spaces with clearance for installation and maintenance. Indicate proposed details for attachment. Indicate vibration isolation units, foundations, supports, and openings for passage of pipes and ducts.

2. Electrical interlock or control diagrams for electrically controlled components furnishing more than one automatic or manual control devices, which are not indicated on Drawings.
- D. Manufacturer's Recommended Installation Procedures: Manufacturer's recommended installation procedures, when reviewed by the Architect shall become basis for inspecting actual installation procedures provided.
- E. Acoustical Test Report: Submit complete acoustical test reports showing that proposed products have been tested in accordance with latest versions of AMCA Standard 300, Reverberant Room Method for Sound Testing of Fans, and AMCA Standard 301, Methods for Calculating Fan Sound Ratings from Laboratory Test Data.
- F. Submit test certification stating compliance with the maximum requirement of 1 percent cabinet leakage of the specified airflow.
- G. Operations and Maintenance Data: Include instructions for lubrication, filter replacement, motor and drive replacement, spare parts list and wiring diagrams.

#### 1.4 QUALITY ASSURANCE

- A. Qualifications of Manufacturers and Installers: Comply with provisions in Section 23 05 00: Common Work Results for HVAC.
- B. Sound Level Measurements and Calculations:
  1. Sound power level measurements and calculations shall be made in complete accordance with latest version of AMCA Standard 300, Methods for Calculating Fan Sound Ratings from Laboratory Test Data, and AMCA Standard 301, Methods for Calculating Fan Sound Ratings from Laboratory Test Data.
  2. The results of all testing shall be certified by independent testing agency or an AMCA-approved testing laboratory and submitted to architect for approval. The submittal shall include a complete description of test conditions, methods and procedures, including specific installation type used for measurements, as detailed in AMCA 300.
  3. Maximum Allowable Sound Power Levels: Maximum allowable sound power levels for supply discharge, return intake, and casing radiated noise shall not exceed values given in schedule below as indicated on drawings with equipment operating at design airflow and static pressure conditions.
- C. Factory Leak Testing: Manufacturer shall provide a factory leak test on units at design total static pressure across the cabinet exterior walls. Cabinet leakage shall not exceed 1 percent of specified airflow on the operating side of the unit. All panels shall be sealed with closed cell gasketing material. A written test report shall be prepared by the manufacturer and submitted to the Architect.

#### 1.5 PROJECT RECORD DOCUMENTS

- A. Provide Owner instructions on equipment operation and maintenance procedures, as indicated in Section 23 05 00: Common Work Results for HVAC.

## 1.6 PRODUCT HANDLING

- A. Protection, Replacements, Delivery and Storage: Comply with provisions stated under Section 23 05 00: Common Work Results for HVAC.

## 1.7 COORDINATION

- A. Coordinate related and adjacent activities in accordance with provisions of Section 01 31 13: Project Coordination.

## **PART 2 – PRODUCTS**

### 2.1 CUSTOM CENTRAL STATION AIR HANDLING UNIT (INDOOR OR OUTDOOR):

- A. General:
  - 1. Central station air-handling unit specially designed, fabricated and factory tested for the capacity, configuration, arrangement and components as indicated on Drawings.
  - 2. Units shall be UL or ETL approved to ensure compliance with electrical codes.
  - 3. Unit shall be serviceable through service clearances indicated on drawings.
  - 4. Unit dimensions shall not exceed dimensions indicated on drawings.
- B. Base Frame: Provide a full perimeter welded base frame capable of mounting to a curb and supporting unit during shipment, installation, and operation. Base frame shall be manufactured with structural steel tubing or C-Channel support members. Formed metal base rails with bolted or screwed support members are not acceptable. Base and unit frame shall be painted with a gray phenolic, corrosion inhibitive primer. Base rails shall be fitted with lifting lugs at corner of unit or section (if demounted). Base rail shall overhang curb to facilitate water run-off and protection of curb-to-base connection from water intrusion. Base shall include a formed pocket that seats on roof curb gasketing to provide a positive, weather-tight seal.
- C. Base: The base shall include 2-inch foam insulation or a 4-inch thick fiberglass insulated “double bottom” floor with minimum 20 gage G-90 galvanized outer and 14 gage G-90 galvanized inner walk-on surface. Subfloor is not required with 2-inch foam insulation unless the underfloor is being used as a return air plenum. All floor seams shall be sealed for an airtight unit. Where access is provided to unit interior, floor openings shall be covered with walk on steel safety grating. Single wall floors with glued and pined insulation are not acceptable. Base frame shall be attached to unit at factory.
- D. Casing:
  - 1. Sections of unit shall be of same construction and finish except for interior panels that are specified differently for individual sections.
  - 2. Exterior Panels: Exterior panels including cooling coil sections shall be minimum 2-inch thick formed 16 gage galvanized steel. Provide necessary support to limit casing deflection to 1/200 of narrowest panel dimension. If panels cannot meet

this deflection, add additional internal reinforcing. Panel seams shall be fully welded or sealed for an airtight unit. Leakage rates shall be less than 1 percent at design static pressure. The exterior panel finish shall have a polyurethane paint system that is designed for long term corrosion resistance meeting or exceeding ASTM B117, Salt Spray Resistance, at 95 degrees F, 1,000 hrs. and ASTM D2247, Humidity Resistance, at 95 degrees F, 1,000 hrs. The color shall be sterling gray.

3. Interior Panels: Casing shall be of double wall construction with 20 gage interior galvanized steel liner in all sections and 22 gage galvanized steel perforated liner in all fan sections.
4. Insulation: Casing shall have 2-inch minimum thickness fiberglass insulation with a density of not less than 3 pounds per cubic foot. The insulation shall have an effective thermal conductivity (C) of 0.24 BTU in./sq.ft.°F and a noise reduction coefficient (NRC) of 0.70 per inch thick (based on a type "A" mounting). Insulation and insulation adhesive shall be UL listed and shall meet NFPA 90A flame spread and smoke generation requirements. Insulation shall meet erosion requirements of UL 181 facing air stream and fire hazard classification of 25/50 (per ASTM E84 and UL 723 and CAN/ULC-S102.2). All insulation edges shall be encapsulated within exterior panel. Insulation facing air stream shall be provided with black acrylic coating.
5. Thermal Breaks: Casing construction downstream of the cooling coil shall consist of thermal break panels to prevent condensation from accumulating on outer walls
6. Access doors shall be of double wall construction and shall be installed on stainless steel hinges for outward opening applications. Multiple handles of no more than four, shall be provided to assure positive closure. Handles shall be zinc alloy or glass reinforced nylon and rated to meet 500 hour salt-spray requirements. Doors shall be furnished with 2 seals with an atmospheric break between two seals to ensure zero negative pressure. The outer seal shall shield water from inner seal. Doors shall open outward for negative pressure and inward for positive pressure applications. Operating pressure of unit shall ensure that door compresses gasket seal. Doors shall open against system pressure. Provide ETL, UL, and CAL/OSHA approved tool operated safety latch on all fan section access doors. Access doors downstream of the cooling coil shall be thermal break.
7. Roof for outdoor units shall be double wall, pitched away from motor side of unit at a minimum roof pitch of ¼ inch per foot across width of unit. No penetrations shall be permitted in pressure-sensitive panels. Roof shall incorporate a standing top seam. Seams in roof shall be gasketed and capped to prevent water infiltration into unit.
8. Floors shall be double wall. Insulation shall be capped to isolate floor insulation from both airstream and from potential water damage.
9. Units shall be provided with exterior paint.
10. Unit shall provide an integral base which is capable of curb, platform or pad mounting and supporting unit during shipment, installation, and operation.

11. Base shall overhang curb to facilitate water run-off and protection of curb-to-base connection from water intrusion.
12. Base shall include a formed pocket that seats on roof curb gasketing to provide a positive, weather-tight seal.

E. Fan Section:

1. General: Fan section shall be furnished with a structural steel base for integral mounting of fan assembly and casing panels. Fan scroll, wheel, shaft, bearings, drives, and motor shall be installed on a structural steel base frame assembly isolated from outer casing with factory-installed, spring isolators of deflection indicated on drawings. This base frame assembly shall be seismically braced. Flexible connectors shall be provided between fans and stationary part of unit. Wiring shall be in flexible conduit. Comply with Section 23 05 48: HVAC Sound, Vibration and Seismic Control. Hinged access door, as specified above, shall be provided on both sides of unit.
2. Fans: Each unit shall be furnished with one or more supply fans as required. Fans shall be double-width, double-inlet type with backward curved airfoil blades or shall be single width, single inlet, ARR. 1 or ARR. 4 plug type fans with backward curved airfoil blades as indicated on equipment schedule. Fans shall be AMCA Class II rated.
3. Fan Bearings: Bearings shall be selected for a minimum L10 life (200,000 hours) at maximum horsepower and operating speed for classification. Bearings shall have same bore, type and manufacturer. Rigid support for inlet bearing must be removable for access to wheel.
4. Fan Wheels: Fan wheels shall be painted with zinc chromate primer and an enamel finish coat, unless constructed of aluminum. Fan wheels shall be keyed to shaft and shall be designed for continuous operation at maximum rated fan speed and motor horsepower. Fan wheels and shafts shall be selected to operate at 25 percent below first critical speed, and shall be statically and dynamically balanced as an assembly at factory.
5. Fan shafts: Fan shafts shall be solid steel, turned, ground, polished, and coated with rust-preventive oil. Access doors shall be provided so fan shaft may be removed without removal of casing panels and to facilitate air balancing of system.
6. Fan Motor: The motor shall be installed within fan section casing on adjustable slide rails. Motor shall be open drip-proof, NEMA Design B with size and electrical characteristics as indicated on equipment schedule. Motors shall be mounted on a horizontal flat surface and shall not be supported by fan or its structural members. Each motor shall be tested to IEEE Standard 112, test method B, and NEMA MG 1 Article 12.58.2 and 12.59 Table 12-10 and bear a factory certification run test label to verify compliance. Motors shall be premium efficiency, inverter duty, with minimum 90 percent efficiency for motors greater than 3 horsepower.
7. Fan Drives: Fan drive shall be designed for a minimum 1.3 service factor, shall be constant-speed variable pitch for motors 15 hp or less, and shall be constant-speed fixed-pitch for 20 hp and larger. Drives shall be factory mounted, with belts aligned and tensioned.

8. Fan Sound Ratings: Fans shall be AMCA 211 rated for performance and AMCA 300 and 301 rated for sound.
9. Accessories: The fan section shall be furnished with double pane glass viewport with safety wire reinforcement, field wired service light with safety cage and extended lubrication lines to unit exterior for fan motor and fan bearings

F. Coil Section:

1. General: Coil sections shall be fabricated of insulated galvanized steel panels. Coils shall be easily removable from side of units. Where 2 or more coils are installed in a coil bank, 304 stainless steel intermediate drain pans that extend a minimum of 6 inches from coil face shall be provided and condensate shall be piped to bottom drain pan. The bottom coil shall not serve as a drain path for upper coil. Main drain pan shall be insulated double-wall 304 stainless steel, sloped toward drain fitting. Drain fitting shall be flush with bottom pan for side discharge, FPT 304 stainless steel connection and shall comply with ASHRAE Standard 62 recommendations. A maximum of one drain shall be furnished for each cooling coil section. Moisture shall not carry over past coil.
2. Coil Test and Standards: Coils shall be leak tested at 450 psig air pressure while submerged in water. Coil performance shall be certified in accordance with AHRI Standard 410. Coils shall be furnished with galvanized steel casing as standard.
3. Chilled Water Coils: Chilled water coils shall be aluminum sinusoidal plate fin type with belled collars and shall be bonded to 5/8 inch OD copper tubes by mechanical expansion. Coils shall be provided with headers for MPT or Victaulic connections. Working pressure shall be 300 psig at 200 degrees F. 0.008 inch thick aluminum-fin coils shall be provided with a wet-table finish to minimize water blow off. Coil casings and tube supports shall be 304 stainless steel. Coils shall be drainable and shall be provided with non-trapping circuits. Copper headers shall be provided with drain and vent connections external to unit.
4. Hot Water Coils: Hot water coils shall be 0.008 inch thick aluminum plate fin type with belled collars bonded to 5/8 inch OD Coils shall be provided with copper or red brass headers for MPT connections. Working pressures shall be 175 psig at 400 F. Headers shall be furnished with drain and vent connections external to unit.
- 5.
6. Coil Tubes: Tube wall thickness shall not be less than 0.02 inch. Tube diameter with 0.025 inch brazed return bends on water and refrigerant coils. Tubes shall be 5/8 inch OD to ensure high thermal performance with lower total flow and reduced pumping requirements. Intermediate tube support shall be provided for coils over 44-inch fin length with an additional support every 42 inches.
  - a. Coil options shall be furnished with 0.008 inch thick copper fin construction.
7. Coil Piping Roof Penetrations: Roof curbs shall be rectangular without any offsets for coil piping to ensure a watertight roof connection. Coil piping which penetrates roof must be externally located from primary unit curb.

8. Roof curbs shall be rectangular without any offsets for coil piping to ensure a watertight roof connection. Coil piping which penetrates roof must be externally located from primary unit curb.

G. Filter Section:

1. General: Each filter section shall be designed and constructed to house specific type of filter indicated on equipment schedule. Provide filters of type indicated on schedule. A double-walled hinged access door, as specified above, shall be provided on side of section. Internal blank-offs shall be provided to prevent air bypass around filters.
2. Filter tracks in flat or cartridge filter sections: Filter tracks in flat or cartridge filter sections shall be upstream loaded Type 8 constructed from galvanized steel to ensure rigidity and tight tolerances. Tracks must be field adjustable without tools and designed to accept standard-size filters with one inch, 2-inch, or 4-inch widths.
3. Filter tracks in angle filter sections: Filter tracks in angle filter sections shall be constructed from galvanized steel to ensure rigidity and tight tolerances. Angle filter sections shall be designed to hold 2-inch filters of standard sizes, arranged in horizontal V-formation.
4. Bag or cartridge filter sections: Bag or cartridge filter sections shall be capable of accepting standard size 12-inch deep rigid media or bag filters. When bag/cartridge filters are installed in a positive pressure application, section shall be furnished with upstream service filter access and doors shall open inward against pressure for safety and leak integrity. For filters with lengths longer than 12 inches, additional plenum sections shall be furnished. Filter sizes shall be 24 by 24-inch or 12 by 24-inch only.
5. Each filter bank shall be provided with a Dwyer Series 2000 Magnehelic Differential Pressure Gage, or equal.
6. Mixing boxes or Economizer Section: Combination exhaust mixing boxes and filter-mixing boxes shall be furnished with opposed blades, interconnecting outside-air and return-air low leak dampers. Mixing boxes and filter-mixing boxes shall be furnished with a double-walled hinged access door as specified. Floors of 16 gage galvanized steel shall be furnished for mixing boxes to protect insulation during installation and servicing of damper actuators. Non-ducted outside air intakes shall include stationary louvers to reduce opportunity for rain or snow to enter unit.

H. Damper Section:

1. Face and bypass sections shall be furnished with opposed-acting damper blades in face damper and opposed bypass damper. Blades shall be double-skin airfoil type.
2. Damper blades shall be extruded aluminum, housed in a galvanized steel frame and mechanically fastened to a hex axle rod rotating in stainless steel bearings. Dampers shall be sectionalized to limit blade length to no more than 48 inches so as to minimize blade warpage. Replaceable neoprene blade seals are to be provided to insure tight closure.

3. Dampers shall be rated for maximum leakage rate per square foot of 7 cf. at 1.0 inch wg. Optional premium dampers shall be available for maximum leakage rate per square foot of 5 cfm at 1.0 inch wg. Damper blades shall be double-skin extruded aluminum airfoil type with stainless steel jam seals.
- I. Plenum Sections:
1. General: Inlet, discharge, access, and plenum sections shall be installed where indicated on Drawings and shall be as specified on equipment schedule.
  2. Inlet section: Inlet section shall be provided with extruded aluminum stationary louvers. Louvers shall be drainable type with built in downspouts and furnished with birdscreen. Blades shall be vertical and housed inside an aluminum frame and mounted to unit exterior. Louvers shall be painted to match unit exterior.
  3. Access sections: Access sections shall be provided by a double-walled hinged door, as specified above and 16 gage galvanized steel floors to protect insulation.
  4. Downblast discharge section: Downblast discharge section, which provides an opening through roof, shall be furnished with a grating over duct opening of sufficient size and strength to support a minimum of 300 pounds.
  5. Diffuser sections: Diffuser sections shall consist of casings as specified with an integral perforated aluminum plate installed on discharge side of supply fan to ensure even and uniform air distribution over adjacent downstream component. Not required on plug fan applications.
    - a. Blow-thru coil sections shall be provided with diffuser as an integral part of coil section and shall not extend length of standard section.
    - b. Diffuser sections shall be available and required if a filter section is directly following fan.
    - c. Unit panels shall be constructed of 16 gage galvanized steel.
    - d. A hinged access door shall be provided down-stream of mixer if specified. It shall be full height, insulated double-wall, with full perimeter gasketing.
    - e. Unit shall mix two or more air streams of different temperatures to within a range of six degrees F standard deviation of theoretical mixed-air temperature and shall provide a more uniform air velocity contour entering a downstream filter or coil bank.
- J. Sound Attenuators: Sound attenuators as specified in Section 23 05 48 shall be provided as an integral part of unit when specified or indicated on drawings.
- K. Electrical: Provide electrical and automatic control devices that are listed below and on drawings:
1. The units shall be factory pre-wired for a single point electrical power connection for both power and control circuits. Manufacturer shall provide a factory furnished and wired step down transformer with a fused disconnect for 120 Volt service.

2. Provide a main disconnect for each unit.
  3. Each fan motor shall be wired to a non-fusible disconnect.
  4. The unit shall be equipped with vapor proof light fixtures with guard.
  5. Lights shall be controlled by one light switch mounted adjacent to supply air fan access door. Lights shall be provided in each accessible section.
  6. Furnish a 120 Volt duplex convenience outlet on exterior of unit. Locate outlet next to fan section access door.
  7. A separate Variable Frequency Drive and three contactor bypass is required for each motor in unit including factory mounting and wired to motor. Danfoss, ABB, Toshiba, or equal.
  8. VFDs shall be recessed or surface mounted as shown on the drawings.
- L. Acoustical Performance Requirements: The sound generating characteristics of air handling and multi-zone units shall be tested to, and comply with, all requirements of this specification. Representative samples shall be subjected to tests in accordance with applicable standards and procedures in order to demonstrate such compliance. A special test for this project is not required if manufacturer has previous certified test results that can be made applicable to this project.
- M. Manufacturer: Enviro-Tec, Energy Labs, Temtrol, Alliance Air Products, Scott Springfield Mfg. Inc., Seasons<sup>4</sup>, Team Air Inc., or equal.

### **PART 3 – EXECUTION**

#### **3.1 GENERAL**

- A. Examine areas under which Work of this Section will be performed. Correct conditions detrimental to proper and timely completion of Work. Do not proceed until unsatisfactory conditions have been corrected.

#### **3.2 EQUIPMENT FOUNDATIONS**

- A. Equipment foundations shall be of sufficient size and weight, and of proper design to preclude shifting of equipment under operating conditions, or under any abnormal conditions imposed upon equipment.
- B. Foundations shall meet requirements of equipment manufacturer and, when required by the Architect, obtain from equipment manufacturer, approval of foundation design and construction for equipment to be installed. Equipment vibration shall be maintained within design limits, and shall be dampened and isolated. Isolators shall be bolted to a steel member so as to be readily removable.

#### **3.3 EQUIPMENT INSTALLATION**

- A. Equipment Installation: Equipment installation shall be in strict accordance with these Specifications, and installation instructions of manufacturers. Equipment installed on concrete foundations shall be grouted before piping is installed. Piping shall be installed in such a manner as not to place a strain on any of the equipment. Flanged joints shall be adequately extended before installation.

1. Install equipment in a neat and skillful manner, properly aligned, leveled, and adjusted for satisfactory operation.
2. Install so connecting and disconnecting of piping and accessories can be readily accomplished, parts are readily accessible for inspection, service and repair. Space shall be provided to readily remove filters, coils, and fan wheels.

#### 3.4 NOISE AND VIBRATION

- A. Operation of Equipment: Mechanical equipment and piping systems shall operate without exceeding specified noise and/or vibration levels.
- B. Corrective Measures: If specified noise and/or vibration levels are exceeded, provide necessary changes to reduce noise and/or vibration levels to within specified levels.

#### 3.5 FIELD TESTS AND INSPECTION

- A. General: Perform field inspections, field tests, and trial operations as specified in Section 23 05 00: Common Work Results for HVAC. Provide labor, equipment and incidentals required for testing. The Project Inspector will witness field tests and trial operations as specified in Section 23 05 00: Common Work Results for HVAC.
- B. Equipment and Material: Equipment and material certified as being successfully tested by manufacturer, in accordance with referenced Specifications and standards, will not require re-testing before installation. Equipment and materials not tested at the place of manufacture will be tested before or after installation, as applicable or necessary, to determine compliance with reference Specifications and standards.
- C. Start-Up and Operational Test: System shall be started up and initially operated with components operating. During this test, filters shall be periodically cleaned until no further accumulation of foreign material occurs. Adjust safety and automatic control instruments as required to provide proper operation and control sequence. Refer to Section 23 05 00: Common Work Results for HVAC.
- D. Extent of Field Tests: After installation and before completion, Work of this Section shall be subjected to required field tests, including those specified here and in Section 23 05 00: Common Work Results for HVAC.
- E. Operation and Maintenance Data: Provide required operation and maintenance data as specified in Section 23 05 00: Common Work Results for HVAC.

#### 3.6 PROTECTION

- A. Protect the Work of this Section until Substantial Completion.

#### 3.7 CLEANUP

- A. Remove rubbish, debris, and waste materials and legally dispose of off the Project site.

**END OF SECTION 23 70 00**

## SECTION 23 80 00

### HEATING, VENTILATING AND AIR CONDITIONING EQUIPMENT

#### PART 1 – GENERAL

##### 1.1 SUMMARY

- A. Section Includes: Air conditioning and air handling equipment including but not limited to:
  - 1. Split System Units.
  - 2. Fans.
- B. Related Requirements:
  - 1. Division 01: General Requirements.
  - 2. Section 07 60 00: Flashing and Sheet Metal.
  - 3. Section 22 10 00: Plumbing.
  - 4. Section 23 05 00: Common Work Results for HVAC.
  - 5. Section 23 05 13: Basic HVAC Materials and Methods.
  - 6. Section 23 05 48: HVAC Sound, Vibration and Seismic Control.
  - 7. Section 23 09 00: HVAC Instrumentation and Controls.
  - 8. Section 23 09 23: Environmental Control and Energy Management System.
  - 9. Section 23 20 13: HVAC Piping.
  - 10. Section 23 30 00: Air Distribution.

##### 1.2 DESIGN REQUIREMENTS

- A. Work of this Section is based on HVAC equipment units indicated as Basis of Design in Part 2 of this Section. Products from different HVAC equipment manufacturers listed are never identical, although equivalent in capacity, performance and quality. In the cases where dimensions, weight, configuration and utility requirements differ from the products used as a basis of design, the Contractor, at no additional cost to the Owner, shall coordinate and submit, for Architect review, revisions to the design.

##### 1.3 SUBMITTALS

- A. Provide in accordance with Division 01 and Section 23 05 00: Common Work Results for HVAC.
- B. For products listed that are not the basis of design, submit the following in addition to above requirements:
  - 1. Title 24 Calculations: Replace HVAC unit values in calculation files provided by the Architect and submit for review.

#### 1.4 QUALITY ASSURANCE

- A. Provide submittals in accordance with Section 23 05 00: Common Work Results for HVAC.

#### 1.5 PROJECT RECORD DOCUMENTS

- A. Provide Owner instructions on equipment operation and maintenance procedures, as indicated in Section 23 05 00: Common Work Results for HVAC.

#### 1.6 WARRANTY

- A. Compressors shall be provided with manufacturer's five year warranty, replacement only.
- B. Manufacturer shall warrant parts, except heat exchangers, for a period of five years.
- C. Heat exchangers shall be provided with manufacturer's ten year warranty, replacement only.

### **PART 2 – PRODUCTS**

#### 2.1 EQUIPMENT

- A. Capacities of air conditioning equipment indicated on Drawings are net capacities actually required. Standard catalog ratings shall be adjusted to actual Project site environmental conditions.

#### 2.2 FAN COIL UNITS - MULTIAQUA

- A. Manufacturer: Enviro-Tec (Ducted), MultiAqua (Ductless Cassettes) or equal.
  - 1. Basis of Design: Enviro-Tec (Ducted), MultiAqua (Ductless Cassettes)
- B. Indoor fan coil unit and condenser unit: Indoor fan coil unit shall be furnished with horizontal discharge and will include evaporator coil, fan and motor, condensate pan with drain, hydronic coil, pre-wired control panel and remote thermostat control. Nominal unit cooling, heating capacities, electrical characteristics, and operating conditions shall be as indicated on Drawings. See 23 82 41 for hydronic piping requirements.
- C. Quality Assurance:
  - 1. Cooling capacity rated in accordance with current AHRI Standard 210/240 and 270. Units shall be listed in AHRI.
  - 2. Unit construction shall comply with ANSI/ASHRAE 15, latest revision, and with NEC.
  - 3. Units shall be constructed in accordance with UL standards and shall carry UL label of approval. Units shall have CSA approval.
  - 4. Units shall be listed in CEC directory.
  - 5. Unit cabinet shall be capable of withstanding ASTM B117 500 hour salt spray test.
  - 6. Unit shall provide an EER/SEER/COP complying with CCR, Title 24, Building Energy Efficiency Standards and per the drawings.

- D. Unit Cabinets:
1. Cabinets shall be fabricated of galvanized steel, bonderized and finished with baked enamel.
  2. Cabinet interior shall be insulated with minimum one inch thick foil face fiberglass.
- E. Filters:
1. Filters shall be 2-inch standard size high capacity replaceable media type, MERV 8, or equal, installed in an external 2-inch rack filter section and complete with an access door.
  2. An-line filter-drier shall be furnished with equipment and installed at Project site.
- F. Economizer: Provide on units with capacities equal to, or larger than 4.5 tons nominal capacity, when the Prescriptive Compliance approach is utilized to comply with Energy Efficiency Standards or where necessary to achieve CHPS pre-requisite and/or CHPS building flush-out compliance. Economizer shall be manufacturer's standard; factory furnished and field installed. Economizer control shall maintain a fixed supply air temperature during free cooling operation by providing full modulation of operable outside and return air dampers.
- G. Provide programmable digital thermostat with following features:
1. 7-day time clock.
  2. Heat, cool, automatic changeover.
  3. Occupied / Unoccupied modes.
  4. Dry contact switch for input from an external device such as a central time clock, occupancy sensor, or a telephone activated device.
  5. Robertshaw, Honeywell, Johnson Controls, Carrier, Schneider Electric, Viconics, or equal with built-in occupancy sensor. Refer to Section 23 09 00 for areas with zone damper controls.
  6. Remote sensors. School Areas that could be subject to vandalism or accidental impact damage such as Gymnasiums, Auditoriums, Multipurpose Rooms, Corridors and Lobbies shall be provided with thermostats with remote return air duct or room sensors. Verify remote location of sensors and thermostats with Architect.
- H. Demand Control Ventilation:
1. Units of 6.25 nominal tons and higher capacity shall be provided with Indoor Air Quality (CO<sub>2</sub>) Sensor and Accessory Electronic Expansion Boards.
  2. The unit shall have ability to provide demand ventilation indoor-air quality (IAQ) control through economizer when provided with an indoor air quality sensor and accessory expansion board.
  3. The IAQ sensor shall be duct mounted in return air main duct unless otherwise indicated on Drawings. The set point shall be adjustable.

4. The IAQ sensor shall be powered through unit. If not, required control transformer shall be provided by manufacturer. Coordinate power requirements and location with Division 26.
  5. The IAQ sensor shall provide a 4 to 20 mA signal to expansion board.
- I. Start-up: Factory test each unit before shipment to Project site. Performance test shall include full refrigeration start-up, fan and controls start-up. Each unit shall be provided with its own report with its own serial number. Non-tested units are not permitted to be delivered to Project site. Provide full start-up of units to include full refrigeration and provide a written report.
  - J. Parts Availability: Submit proof in writing that majority (minimum 80 percent) of replacements parts are commonly available and not proprietary. Also, submit proof in writing that a local parts sales and service facility exists, where replacement parts will be warehoused in quantity. Guarantee timely availability for parts that are proprietary.

### 2.3 FAN COIL UNITS – ENVIRO-TEC® Model HDD & VDD Blower Coil Units

#### A. General

1. Furnish and install ENVIRO-TEC® Model HDD & VDD Blower Coil Units where indicated on the plans and specifications. Units shall be completely factory assembled and tested and shipped as one piece except where noted.
2. All units shall be capable of meeting or exceeding the scheduled capacities for cooling, heating and air delivery. All unit dimensions for each model and size shall be considered maximums.
3. All units shall be of “draw-thru” design with coils, fans, motor, and drain pan completely contained within the unit cabinet.
4. Electric heat to be in the blow-thru configuration.
5. Units shall be cETL listed in compliance with UL/ANSI Std. 1995.
6. All unit coils shall meet or exceed the scheduled cooling and heating capacity, selected and rated in accordance with AHRI 410.

#### B. Construction

1. All units shall be fabricated of minimum 18 gauge galvanized steel, able to withstand a 125 hour salt spray test per ASTM B-117. Panels shall be die-formed “multibend” construction for optimum strength and rigidity.
2. All exterior panels shall be single wall insulated with 1 inch thick fiberglass insulation, rated for a maximum air velocity of 5000 f.p.m.
3. **Optional:** Single wall with 1” thick, 1.6 pound per cubic foot density scrim reinforced foil faced insulation.
4. **Optional:** Single wall with 1” thick closed cell foam insulation.
5. Insulation must meet all requirements of ASTM C1071 (including C665), UL181 for erosion, and carry a 25/50 rating for flame spread/smoke developed per ASTM E-84, UL723 and NFPA 90A. In addition to using adhesive complying with NFPA 90A, the

insulation shall incorporate a secondary mechanical fastener attached to the unit casing wall. Adhesive as the only method of fastening the insulation to the casing is not acceptable.

6. All access panels shall be fully insulated and attached with standard fasteners on at least two opposite sides. No single access panel shall be larger than 30" x 36" for safety and ease of handling. No coil or drain piping or electrical connections shall pass through any access panel.
7. Each unit shall be furnished with a one-piece heavy gauge G90 steel or optional IAQ stainless steel drain pan with welded corner construction. Drain pan shall be insulated with minimum 1/8" closed cell foam. All units shall be provided with 9/16" diameter hanger rod holes in the top and bottom panels for "through-bolt" type suspension installation.
8. **Optional:** Spring type unit mounting vibration isolators shall be provided by the unit manufacturer.
9. **Optional:** Rubber-in-shear type unit mounting vibration isolators shall be provided by the unit manufacturer.
10. **Optional:** Units to have factory assembled and installed dbase rails with rigging slots.
11. All units shall have a minimum 1" duct collar on both the discharge and return.

C. Fan & Motor Assembly

1. All units shall be furnished with double inlet forward curved centrifugal blowers statically and dynamically balanced for smooth operation. Blower wheels shall be mounted directly on the motor shaft. Belt driven blowers are not acceptable.
2. Fan motors shall be electronically commutated with thermal overload protection and a constant torque operation. RPM control shall not be acceptable. Motors shall feature permanently lubricated ball bearings and operate on three or single phase power.
3. All motors to be installed, factory programmed and wired to the control panel.
4. All motors shall be isolated, depending on motor size, via belly band or torsion flex mount to the blower housing.
5. All motor wiring is to be terminated in a junction box, external to the unit casing.
6. All motors to be operated by single-speed or multi-speed local or remote controller.

D. Coils

1. All unit coils shall be rated in accordance with AHRI 410.
2. All coils shall be 1/2" O.D. seamless copper tubes with collared aluminum fins. All tubes shall be mechanically expanded to provide an efficient bond between tube and fin. All water coils shall be provided with a manual air vent fitting to allow for coil venting. Valve core type vent fittings shall not be accepted.
3. All chilled water, hot water, and direct expansion (DX) coils shall have aluminum fins and 0.016" tube wall thickness.

4. All coils shall be hydrostatically tested with air under water at 450 PSIG minimum pressure and rated for a maximum of 450 PSIG working pressure at 200°F.
  5. All steam coils shall have 0.025" tube wall thickness.
  6. All steams coils shall be suitable for 15 PSIG maximum operating pressure.
  7. **Optional:** Provide automatic air vents, in lieu of manual air vents.
  8. **Optional:** Provide 0.025" tube wall thickness
- E. Filter Rack Assembly
1. All units shall be furnished with a flat filter rack with hinged access on both sides designed to accept a 2" nominal standard sized filters. All units shall be provided with nominal 2" throwaway filters factory installed. One complete set of spare throwaway filters shall be provided for each unit.
  2. **Optional:** Factory provided MERV 8 pleated filters.
  3. **Optional:** Unit shall have a High Efficiency filter rack suitable for a pleated 2" MERV 8 and a pleated 4" MERV 11, MERV 14 or MERV 15 filter.
- F. Inlet Damper Section
1. Where shown on the plans, the unit manufacturer shall furnish a fully insulated mixing box section (factory assembled and installed inlet damper section) to be mounted next to the unit on base rail (unit & mixing box).
  2. The mixing box section shall include heavy gauge formed steel blade dampers in a heavy gauge steel frame with extruded vinyl blade seals and flexible metal jamb seals. Damper drive linkage shall be factory furnished and installed by the unit manufacturer. A field furnished and installed damper actuator can be mounted directly to the damper shaft.
- G. Electrical Control
1. The unit fan motor shall be completely factory wired to an external electrical enclosure. Each unit shall include fan control package with 24 volt control voltage. Each unit shall include a motor control board, motor circuit fusing, control circuit transformer and terminal strip for connection of field wiring.
  2. **Motor Control Board Option 1:** Motor control shall be provided by a single speed or proportional speed controller mounted on the exterior surface of the control box. Opening the control box to adjust the fan speed shall not be required.
  3. **Motor Control Board Option 2:** Four speed motor control shall be provided with potentiometer type adjustment. Unit to be compatible with three speed control thermostat.
  4. Calibrated airflow curves shall be provided near the control box to aid in testing and balancing.

5. A main incoming power non-fused disconnect switch with lock-out-tag-out ready feature shall be factory furnished and wired by the unit manufacturer for single point power connection.

H. Electric Heat Section

1. Where shown on the plans, the unit manufacturer shall furnish an electric resistance heating assembly with the heating capacity, voltage and stages as shown in the schedule. The heater assembly shall be designed and rated for installation to the blower coil unit in the blow thru configuration without the use of duct extensions or transitions between the unit and the heater assembly. The heater assembly shall be factory assembled to the air handling unit and completely factory wired. The heater/unit assembly shall be listed for zero clearance meeting all N.E.C. requirements and be cETL listed in compliance with UL/ANSI Std. 1995.
2. All heating elements shall be open coil design using Ni-Chrome wire mounted in ceramic insulators and housed in an insulated heavy gauge galvanized steel housing. All elements shall terminate in a machine staked stainless steel terminal secured with stainless steel hardware. The element support brackets shall be spaced no greater than 3-1/2" on center. All internal wiring shall be rated for 105°C minimum.
3. All heaters shall include over temperature protection. All heaters shall include a non-adjustable airflow switch.
4. An incoming line power distribution block shall be provided. The power distribution block shall be designed to accept incoming power wiring capable of carrying 125% of the calculated load current.
5. In addition to the above, electric heaters shall include the following options:
  - a. Main incoming power disconnect (non-fused)
  - b. Main fusing
  - c. Magnetic contactors wired for disconnecting operation
6. Electric heat section available uninsulated or with insulated double wall construction.

2.4 FAN COIL UNITS – ENVIRO-TEC® Model HL Horizontal Direct Drive Fan Coil

A. General

1. Furnish and install ENVIRO-TEC® Model HL Horizontal Direct Drive Fan Coil Units where indicated on the plans and in the specifications. Units shall be completely factory assembled, tested and shipped as one piece. Units shall be capable of meeting or exceeding the scheduled capacities for cooling, heating and air delivery. Unit dimensions for each model and size shall be considered maximums. Units shall be cETLus listed in compliance with UL/ANSI Standard 1995, and be certified as complying with the latest edition of AHRI Standard 440.

B. Construction

1. Unit chassis shall be fabricated of galvanized steel panels. Exterior panels shall be insulated with 3/8" thick elastomeric closed cell foam insulation. Insulation shall conform to UL 181 for erosion and NFPA 90A for fire and smoke, and comply with a

25/50 Flame Spread and Smoke Developed Index per ASTM E-84 or UL 723. Additionally, insulation shall comply with Antimicrobial Performance Rating of 0, no observed growth, per ASTM G-21. Polyethylene insulation is not acceptable. Ducted units shall have a minimum 1-1/2" duct collar on the discharge. Plenum and exposed units shall have a minimum 3/4" duct collar on the return. Exposed units shall have exterior panels fabricated of galvanized steel. The fan and filter bottom access panel shall be attached with quarter turn quick open fasteners to allow for easy removal and access for service. Unit mounting shall be by hanger brackets provided at four locations.

C. Painted Finish

1. Painted cabinet exterior panels shall be finished with a heat cured anodic acrylic powder paint of the standard factory color.

D. Sound

1. Ducted units shall have published sound power level data tested in accordance with AHRI Standard 260-2012. Exposed units shall have published sound power level data tested in accordance with AHRI Standard 350-2015 (non-ducted equipment).

E. Fan Assembly

1. Unit fan shall be a dynamically balanced, forwardly curved, DWDI centrifugal type constructed of 18 gauge zinc coated galvanized steel for corrosion resistance. Motors shall be high efficiency, permanently lubricated sleeve bearing, permanent split-capacitor type with UL and CSA listed automatic reset thermal overload protection and three separate horsepower taps. Single speed motors are not acceptable. The fan assembly shall be easily removable for servicing the motor and blower at, or away from the unit. The entire fan assembly shall be able to come out of the unit by removing two screws and unplugging the motor. Plenum unit fan assemblies shall be easily serviced through an access panel in casing. Devices used to energize and de-energize (switch) fan speeds must be silent. Magnetic, mercury, and/or quiet relays and/or contactors are not acceptable.
2. Option: Provide Electronically Commutated (EC) Motor capable of operation with low voltage 3 speed thermostat. Motor shall come factory programmed and configured for 3 speed operation.
3. Option: Motor shall be capable of accepting a 2-10 VDC output from BAS.
4. Option: Provide an electronic (SCR) fan speed controller as an aid in balancing the fan capacity. The speed controller shall have a turn down stop to prevent the possibility of harming the motor bearings, and incorporate electrical noise suppression to minimize noise on the incoming power lines.

F. Coils

1. All cooling and heating coils shall optimize rows and fins per inch to meet the specified capacity. Coils shall have seamless copper tubes and shall be mechanically expanded to provide an efficient, permanent bond between the tube and fin. Fins shall have high efficiency aluminum surface optimized for heat transfer, air pressure drop and carryover.

2. Each coil shall be pressured to 450 PSIG and rated for a maximum of 450 PSIG working pressure.
3. Steam coils shall be standard steam type suitable for temperatures above 35°F and 15 PSIG maximum working pressure.
4. Option: Coil casing shall be fabricated from Stainless Steel. All coils shall be provided with a manual air vent fitting to allow for coil venting.
5. Option: Provide automatic air vents in lieu of manual air vents.
6. Heating coils shall be furnished in the reheat or preheat position on units with chilled water coils, or in the reheat position for DX coils.

G. Drain Pans

1. Primary condensate drain pans shall be single wall, heavy gauge galvanized steel for corrosion resistance, and extend under the entire cooling coil. Drain pans shall be of one-piece construction and be double sloped for condensate removal. Drain pans shall be fully removable without the use of any tools. The drain pan shall be externally insulated with a fire retardant, closed cell foam insulation. The insulation shall carry no more than a 25/50 Flame Spread and Smoke Developed Rating per ASTM E-84 and UL 723 and an Antimicrobial Performance Rating of 0, no observed growth, per ASTM G-21.
2. Option: Provide a single wall primary drain pan constructed entirely of heavy gauge stainless steel for superior corrosion resistance. Stainless steel drain pans shall be externally insulated.
3. Option: Provide a secondary drain connection on the primary drain pan for condensate overflow.

H. Filters

1. All plenum and exposed units shall be furnished with a minimum 1" nominal glass fiber throwaway filter. Filters shall be tight fitting to prevent air bypass. Plenum unit filters shall be easily removable from the bottom of the unit without the need for tools.
2. Option: Provide unit with 1" pleated filter (MERV 8).
3. Option: Provide unit with 1" pleated filter (MERV 13).

I. Electrical

1. Units shall be furnished with single point power connection. Provide an electrical junction box with terminal strip for motor and other electrical terminations.

J. Electric Heat

1. Furnish an electric resistance heating assembly as an integral part of the fan coil unit, with the heating capacity, voltage and kilowatts scheduled. The heater assembly shall be designed and rated for installation on the fan coil unit without the use of duct extensions or transitions, and be located in the unit as to not expose the fan assembly to excessive leaving air temperatures that could affect motor performance.

2. The heater and unit assembly shall be listed for zero clearance and meet all NEC requirements, and be cETLus listed with the unit as an assembly in compliance with UL/ANSI Standard 1995.
3. All heating elements shall be open coil type nichrome wire mounted in ceramic insulators and located in an insulated heavy gauge galvanized steel housing. All elements shall terminate in a machine staked stainless steel terminal secured with stainless steel hardware for corrosion resistance. The element support brackets shall be spaced no greater than 3-1/2" on center. All internal wiring shall be rated for 105°C minimum.
4. All heaters shall include over temperature protection consisting of an automatic reset primary thermal limit and back up secondary thermal limit. All heaters shall be single stage.
5. Option: Provide a manual reset secondary thermal limit.
6. Units with electric heat shall have an incoming line power distribution block shall be provided and designated to accept single point power wiring capable of carrying 125% of the calculated load current.
7. Option: Devices used to energize and de-energize (switch) electric heat must be silent. Magnetic, mercury, and/or quiet relays and/or contactors are not acceptable.

K. Piping Packages

1. Provide a standard factory assembled valve piping package to consist of a 2 or 3 way, on/off, motorized electric control valve and two ball isolation valves.
2. Control valves are piped normally closed to cold water coils and normally open to hot water coils. Maximum entering water temperature on the control valve is 200 °F.
3. Provide high pressure close-off actuators for 2-way or 3-way on/off control valves. Maximum close-off pressure is 125 PSIG.
4. Option: Valve package mounted from the factory with structural supports. Field mounted valves are not acceptable.
5. Option: Provide 3-wire floating point modulating control valve (fail-in-place) in lieu of standard 2-position control valve with factory assembled valve piping package.
6. Option: Provide 0-10V proportional control valve (fail-in-place) in lieu of standard 2-position control valve with factory assembled valve piping package.
7. Option: Provide a fixed flow control device with a removable cartridge or each piping package.
8. Option: Normally Open in lieu of Normally Closed on/off valves.
9. Option: Spring return (N.O. or N.C.) modulating control valve.
10. Option: Spring return (N.O. or N.C.) proportional control valve.
11. Option: Provide pressure-temperature ports for each piping package.

12. Piping package shall be completely factory assembled, including interconnecting pipe, and shipped separate from the unit for field installation on the coil, so as to minimize the risk of freight damage.

## 2.5 ROOF MOUNTED POWER EXHAUST VENTILATORS

### A. RMEV-1

#### 1. Manufacturer:

CARNES	GREENHECK	LOREN COOK	PENNBARRY	TWIN CITY & BLOWER	OR EQUAL
VEBK Series	GB Series	ACEB	Domex-Belt Drive	BCRD	

2. Spun aluminum, roof mounted, belt driven, downblast centrifugal exhaust ventilator, with components as indicated and specified. Sizes, performances, and accessories shall be as indicated on equipment schedules on Drawings. Provide required accessories for proper operation and balancing of fans in accordance with design intent and sequence of operation.
3. Certification: Fan shall be listed by Underwriters Laboratories Inc (UL 705). Fan shall bear AMCA Certified Ratings Seals for Fan Sound and Air Performance.
4. Housing: The fan shall be of bolted and welded construction utilizing corrosion resistant fasteners. The spun aluminum structural components shall be constructed of minimum 18 gage Aluminum, bolted to a rigid aluminum support structure. The aluminum base shall have continuously welded curb cap corners for maximum leak protection. The discharge baffle shall have a rolled bead for added strength. A two piece top cap shall have stainless steel, or galvanized quick release latches to provide access into motor compartment without use of tools, or screws. An integral conduit chase shall be provided through curb cap and into motor compartment to facilitate wiring connections. The motor, bearings and drives shall be mounted on a minimum 16 gage steel power assembly, isolated from unit structure with rubber vibration isolators. These components shall be enclosed in a weather-tight compartment, separated from exhaust airstream. Lifting lugs shall be provided to help prevent damage from improper lifting. Unit shall bear an engraved aluminum nameplate.
5. Wheel: Wheel shall be centrifugal backward inclined, constructed of 100 percent aluminum, including a precision machined cast aluminum hub. Wheel inlet shall overlap an aerodynamic aluminum inlet cone to provide maximum performance and efficiency. Wheel shall be balanced in accordance with AMCA Standard 204, Balance Quality and Vibration Levels for Fans.
6. Motor: Motor shall be heavy-duty ECM type with permanently lubricated sealed ball bearings and furnished at specified voltage, phase, and enclosure.
7. Bearing: Bearings shall be designed and individually tested specifically for use in air handling applications. Construction shall be heavy duty regreasable ball type in a cast iron pillow block housing selected for a minimum L50 life in excess of 200,000 hours at maximum cataloged operating speed.

8. Belts and Drives: Belts shall be oil and heat resistant, non-static type. Drives shall be precision-machined cast iron type, or heavy gauge galvanized steel, keyed and securely attached to wheel and motor shafts. Drives shall be sized for 150 percent of installed motor horsepower. The variable pitch motor drive must be factory set to specified fan RPM.

B. RMEV-2:

1. Manufacturer:

CARNES	GREENHECK	LOREN COOK	PENNBARRY	TWIN CITY & BLOWER	OR EQUAL
VEDK Series	G Series	ACED	Domex-Direct Drive	DCRD	

2. Spun aluminum, roof mounted, direct driven, downblast centrifugal exhaust ventilator, with components as indicated and specified. Sizes, performances, and accessories shall be as indicated on equipment schedules on Drawings. Also, provide accessories for proper operation and balancing of fans in accordance with design intent and sequence of operation.
3. Certification: Fan shall be listed by Underwriters Laboratories Inc. (UL 705). Fan shall bear AMCA Certified Ratings Seals for Fan Sound and Air Performance.
4. Housing: The fan shall be of bolted and welded construction utilizing corrosion resistant fasteners. The spun aluminum structural components shall be constructed of minimum 18 gage Aluminum, bolted to a rigid aluminum support structure. The aluminum base shall have continuously welded curb cap corners for maximum leak protection. The discharge baffle shall have a rolled bead for added strength. An integral conduit chase shall be provided through curb cap and into motor compartment to facilitate wiring connections. The motor shall be enclosed in a weather-tight compartment, separated from exhaust airstream. Unit shall bear an engraved aluminum nameplate.
5. Wheel: Wheel shall be centrifugal backward inclined, constructed of 100 percent aluminum, including a precision machined cast aluminum hub. An aerodynamic aluminum inlet cone shall be provided for maximum performance and efficiency. Wheel shall be balanced in accordance with AMCA Standard 204, Balance Quality and Vibration Levels for Fans.
6. Motor: Motor shall be heavy-duty ECM type with permanently lubricated sealed bearings and furnished at specified voltage, phase, and enclosure.

C. RMEV-3:

1. Manufacturer:

CARNES	GREENHECK	LOREN COOK	PENNBARRY	TWIN CITY & BLOWER	OR EQUAL
VUBK Series	CUBE Series	ACRUB	Fumex-Belt Drive	BCRU	

2. Spun aluminum, roof mounted, belt driven, upblast centrifugal exhaust ventilator, with components as indicated and specified. Sizes, performances, and accessories shall be as indicated on equipment schedules on Drawings. Also, provide accessories for proper operation and balancing of fans in accordance with design intent and sequence of operation.
3. Certification: Fan shall be listed by Underwriters Laboratories Inc. (UL 705). Fan shall bear AMCA Certified Ratings Seals for Fan Sound and Air Performance.
4. Housing: The fan shall be of bolted and welded construction utilizing corrosion resistant fasteners. The spun aluminum structural components shall be constructed of minimum 18 gage Aluminum, bolted to a rigid aluminum support structure. The aluminum base shall have a one piece inlet spinning and continuously welded curb cap corners for maximum leak protection. The windband shall have a rolled bead for added strength. A two piece top cap shall have stainless steel, or galvanized quick release latches to provide access into motor compartment without use of tools, or screws. An integral conduit chase shall be provided into motor compartment to facilitate wiring connections. The motor, bearings and drives shall be mounted on a minimum 16 gage steel power assembly, isolated from unit structure with rubber vibration isolators. These components shall be enclosed in a weather-tight compartment, separated from exhaust airstream. Lifting lugs shall be provided to help prevent damage from improper lifting. Unit shall bear an engraved aluminum nameplate.
5. Wheel: Wheel shall be centrifugal backward inclined, constructed of 100 percent aluminum, including a precision machined cast aluminum hub. Wheel inlet shall overlap an aerodynamic aluminum inlet cone to provide maximum performance and efficiency. Wheel shall be balanced in accordance with AMCA Standard 204, Balance Quality and Vibration Levels for Fans.
6. Motor: Motor shall be heavy-duty ECM type with permanently lubricated sealed ball bearings and furnished at specified voltage, phase, and enclosure.
7. Bearing: Bearings shall be designed and individually tested specifically for use in air handling applications. Construction shall be heavy-duty regreasable ball type in a cast iron pillow block housing selected for a minimum L50 life in excess of 200,000 hours at maximum cataloged operating speed.
8. Belts and Drives: Belts shall be oil and heat resistant, non-static type. Drives shall be precision machined cast iron, or galvanized steel type, keyed and securely attached to wheel and motor shafts. Drives shall be sized for 150 percent of installed motor horsepower. The variable pitch motor drive must be factory set to specified fan RPM.

D. RMEV-4:

1. Manufacturer:

CARNES	GREENHECK	LOREN COOK	PENNBARRY	TWIN CITY & BLOWER	OR EQUAL
VUDK Series	CUE Series	ACRUD	Fumex-Direct Drive	DCRU	

2. Spun aluminum, roof mounted, direct driven, upblast centrifugal exhaust ventilator, with components as indicated and specified. Sizes, performances, and accessories shall be as indicated on equipment schedules on Drawings. Also, provide accessories for proper operation and balancing of fans in accordance with design intent and sequence of operation.
3. Certification: Fan shall be listed by Underwriters Laboratories Inc. (UL 705). Fan shall bear AMCA Certified Ratings Seals for Fan Sound and Air Performance.
4. Housing: Fan shall be of bolted and welded construction utilizing corrosion resistant fasteners. The spun aluminum structural components shall be constructed of minimum 18 gage Aluminum, bolted to a rigid aluminum support structure. The aluminum base shall have a one piece inlet spinning and continuously welded curb cap corners for maximum leak protection. The windband shall have a rolled bead for added strength. An integral conduit chase shall be provided into motor compartment to facilitate wiring connections. The motor shall be enclosed in a weather-tight compartment, separated from exhaust airstream. Unit shall bear an engraved aluminum nameplate.
5. Wheel: Wheel shall be centrifugal backward inclined, constructed of 100 percent aluminum, including a precision machined cast aluminum hub. An aerodynamic aluminum inlet cone shall be provided for maximum performance and efficiency. Wheel shall be balanced in accordance with AMCA Standard 204, Balance Quality and Vibration Levels for Fans.
6. Motor: Motor shall be heavy-duty ECM type with permanently lubricated sealed bearings and furnished at specified voltage, phase, and enclosure.

2.6 CEILING CABINET FANS

A. CCF-1:

1. Manufacturer:

CARNES	GREENHECK	LOREN COOK	PENNBARRY	TWIN CITY & BLOWER	OR EQUAL
VCDK or VCDD Series	SP or CSP Series	GC 200 or 900 Series	Zephyr Fans	T or TL Series	

2. Provide ceiling, wall, or inline mounted, direct driven, centrifugal exhaust fans of sizes, capacities and configurations indicated on drawings, complete with accessories for installation of fans. Also, provide accessories for proper operation and balancing of fans in accordance with design intent and sequence of operation.
3. Certification: Fan shall be listed by Underwriters Laboratories (UL 507 & 705). Fan shall bear AMCA Certified Ratings Seal for Sound and Air Performance.
4. Housing: The fan housing shall be minimum 22 gage galvanized steel and acoustically insulated. Blower and motor assembly shall be mounted to a minimum 16 gage reinforcing channel and shall be easily removable from

housing. Motor shall be mounted on vibration isolators. Unit shall be supplied with integral wiring box and disconnect receptacle shall be standard. Discharge position shall be convertible from right angle to straight through by moving interchangeable panels. The outlet duct collar shall include a reinforced aluminum damper with continuous aluminum hinge rod and brass bushings. To accommodate different ceiling thickness, an adjustable prepunched mounting bracket shall be provided. A powder painted white steel grille shall be provided as standard.

5. Wheel: Wheel shall be centrifugal forward curved type, constructed of galvanized steel. Wheel shall be balanced in accordance with AMCA Standard 204, Balance Quality and Vibration Levels for Fans.
6. Motor: Motor shall be ECM type with permanently lubricated bearings, built-in thermal overload protection and disconnect plug. Motor shall be furnished at specified voltage.

B. CCF-2:

1. Manufacturer:

CARNES	GREENHECK	LOREN COOK	PENNBARRY	TWIN CITY & BLOWER	OR EQUAL
VCDK or VCDD Series	CSP Series	GN 200 or 900 Series	Zephyr Fans	TL Series	

2. Provide inline mounted, direct driven, centrifugal exhaust fans of sizes, capacities and configurations indicated on drawings, complete with accessories for installation of fans. Also, provide accessories for proper operation and balancing of fans in accordance with design intent and sequence of operation.
3. Certification: Fan shall be listed by Underwriters Laboratories (UL 507 & 705). Fan shall bear AMCA Certified Ratings Seal for Sound and Air Performance.
4. Housing: The fan housing shall be minimum 22 gage galvanized steel and acoustically insulated. Blower and motor assembly shall be mounted to a minimum 16 gage reinforcing channel and shall be easily removable from housing. Motor shall be mounted on vibration isolators. Unit shall be supplied with integral wiring box and disconnect receptacle shall be standard. Discharge position shall be convertible from right angle to straight through by moving interchangeable panels. The outlet duct collar shall include a reinforced aluminum damper with continuous aluminum hinge rod and brass bushings. To accommodate different mounting positions, an adjustable prepunched mounting bracket shall be provided.
5. Wheel: Wheel shall be centrifugal forward curved type, constructed of galvanized steel. Wheel shall be balanced in accordance with AMCA Standard 204, Balance Quality and Vibration Levels for Fans.
6. Motor: Motor shall be ECM type with permanently lubricated bearings, built-in thermal overload protection and disconnect plug. Motor shall be furnished at specified voltage.

C. CCF-3:

1. Manufacturer:

CARNES	GREENHEC K	LOREN COOK	PENNBARRY	TWIN CITY & BLOWER	OR EQUAL
VDBA or VGBA Series	BCF Series	DB	Zephyr Cabinet Fans	DBS or DBT	

2. Provide duct mounted, belt driven centrifugal cabinet fans of sizes, capacities and configurations indicated on drawings, complete with accessories for installation of fans. Also, provide accessories for proper operation and balancing of fans in accordance with design intent and sequence of operation.
3. Certification: Fan shall be listed by Underwriters Laboratories (UL 705). Fan shall bear AMCA Certified Ratings Seals for Fan Sound and Air Performance.
4. Housing: The fan shall be of bolted construction utilizing corrosion resistant fasteners. Housing shall be minimum 22 gage galvanized steel with two access doors and integral duct collars. Internal blower and motor assembly shall be mounted on rubber vibration isolators. Hanging brackets shall be provided for horizontal installation. Unit shall bear an engraved aluminum nameplate.
5. Wheel: Wheel shall be DWDI centrifugal forward curved type, constructed of painted steel. Wheel shall be balanced in accordance with AMCA Standard 204, Balance Quality and Vibration Levels for Fans.
6. Motor: Motor shall be heavy duty TEFC inverter duty type with permanently lubricated sealed ball bearings and furnished at specified voltage and phase.
7. Bearing: Bearings shall be permanently lubricated, sealed ball type selected for a minimum L50 life in excess of 200,000 hours at maximum cataloged operating speed.
8. Belts and Drives: Belts shall be oil and heat resistant, non-static type. Drives shall be precision machined cast iron type, keyed and securely attached to wheel and motor shafts. Drives shall be sized for 150 percent of installed motor horsepower. The variable pitch motor drive must be factory set to specified fan RPM.

2.7 GRAVITY EXHAUST/INTAKE VENTILATORS

A. GEIV-1:

1. Manufacturer:

CARNES	GREENHECK	LOREN COOK	PENNBARRY	TWIN CITY & BLOWER	OR EQUAL
GSAA Series	GRS Series	PR or TR	WCC	GRV	

2. Spun aluminum, roof mounted gravity ventilators of sizes, capacities and configurations indicated on drawings, complete with accessories for installation of ventilators. Also, provide accessories for proper operation of ventilators per code and in accordance with design intent and sequence of operation.
3. Housing: The unit shall be of bolted and welded construction utilizing corrosion resistant fasteners. The spun aluminum structural components shall be constructed of minimum 18 gage Aluminum, bolted to a rigid aluminum support structure. The aluminum base shall have continuously welded curb cap corners for maximum leak protection. The spun aluminum baffle shall have a rolled bead for added strength. Birdscreen constructed of 1/2" mesh shall be mounted across air opening. Unit shall bear an engraved aluminum nameplate.
4. Provide gravity type back-draft or relief dampers at relief or exhaust ventilators (with counterweights if required). Gravity relief dampers shall fully open at 0.01" static pressure.
5. Intake ventilators shall be provided with normally closed, motorized dampers that are interlocked with fan to open upon fan activation unless fan is provided with such a damper.

B. GEIV-2:

1. Manufacturer:

CARNES	GREENHECK	LOREN COOK	PENNBARRY	TWIN CITY & BLOWER	OR EQUAL
GEAB Series	FGR Series	GR	AEG Relief	MGR	

2. Provide hooded aluminum, roof mounted gravity relief ventilators of sizes, capacities and configurations indicated on drawings, complete with accessories for installation of ventilators. Also, provide accessories for proper operation and balancing of ventilators in accordance with design intent and sequence of operation.
3. Housing: The unit shall be of bolted and welded construction utilizing corrosion resistant fasteners. The hood interlocking panels shall be constructed of minimum 12 gage Aluminum 5052, hinged to a minimum 12 gage aluminum 5052 support structure. The aluminum base shall have continuously welded curb cap corners for maximum leak protection. Birdscreen constructed of 1/2 inch mesh shall be mounted across relief opening. Unit shall bear an engraved aluminum nameplate.
4. Provide gravity type back-draft or relief dampers at relief or exhaust ventilators (with counterweights if required). Gravity relief dampers shall fully open at 0.01 inch static pressure.
5. Intake ventilators shall be provided with normally closed, motorized dampers that are interlocked with fan to open upon fan activation unless fan is provided with such a damper.

C. GEIV-3:

1. Manufacturer:

CARNES	GREENHECK	LOREN COOK	PENNBARRY	TWIN CITY & BLOWER	OR EQUAL
GIAB Series	FGI Series	GI	AEG Intake	MGI	

2. Provide hooded aluminum, roof mounted gravity intake ventilators of sizes, capacities and configurations indicated on drawings, complete with accessories for installation of ventilators. Also, provide accessories for proper operation and balancing of ventilators in accordance with design intent and sequence of operation.
3. Housing: The unit shall be of bolted and welded construction utilizing corrosion resistant fasteners. The hood interlocking panels shall be constructed of minimum 18 gage Aluminum, bolted to a minimum 12 gage aluminum 5052 support structure. The aluminum base shall have continuously welded curb cap corners for maximum leak protection. Birdscreen constructed of ½ inch mesh shall be mounted across intake opening. Unit shall bear an engraved aluminum nameplate. Units shall be provided with bird screen and anti-condensate coating as standard.
4. Provide gravity type back-draft or relief dampers at relief or exhaust ventilators (with counterweights if required). Gravity relief dampers shall fully open at 0.01 inch static pressure.
5. Intake ventilators shall be provided with normally closed, motorized dampers that are interlocked with fan to open upon fan activation unless fan is provided with such a damper.

2.8 FILTERS

- A. Air filters shall be of pleated, high capacity, disposable type of efficiencies indicated on drawings. Each filter shall consist of a non-woven cotton fabric media, media support grid, and enclosing frame. Filter shall be UL 900 listed, Class 2.
- B. Filter media shall provide an average efficiency as specified on drawings per ASHRAE Standard 52.2.
- C. Initial resistance of air filters shall not exceed following limits for each efficiency level at face velocities indicated. Lower resistance requirements, if indicated on drawings shall have precedence.
  - 30 percent (MERV 8)                      0.27 inch water gage at 500 feet per minute
  - 75 percent (MERV 11) 0.28 inch water gage at 500 feet per minute
  - 85 percent (MERV 13) 0.30 inch water gage at 500 feet per minute
  - 95 percent (MERV 14) 0.38 inch water gage at 500 feet per minute
- D. Use standard size Filter Medias only.
- E. Media support shall be a welded wire grid or a rigid frame with an effective open area of not less than 96 percent.

1. Media support shall be bonded to filter media to eliminate possibility of media oscillation and media pull-away.
  2. Media support grid shall be formed in such a manner that it effectively forms a radial pleat design, providing total use of filter media.
- F. Enclosing frame shall be bonded to air entering and air exit side of each pleat, to ensure pleat stability. Inside periphery of enclosing frame shall be bonded to filter pack, thus eliminating possibility of air bypass.
- G. Holding frames shall be factory fabricated of 16 gage galvanized steel, or equivalent and shall be furnished with gaskets and spring type positive sealing fasteners. Fasteners shall be capable of being attached or removed without use of tools.
- H. Manufacturers: Camfil Farr, Koch, or AAF.

## 2.9 LOUVERS, AIR CONDITIONING (use in conjunction with relief damper)

- A. Standard steel louvers shall be furnished complete with frames, blades, finish and construction details per Drawings and manufacturer's recommendations.
- B. Louvers shall be furnished with horizontal blades, 2 inches deep for air through wall installation in conjunction with gravity relief damper for backdraft protection that will open at 0.01 inch wc room static pressure as indicated on Drawings. Blades shall be 16-gage steel, spaced at 1 7/8-inch at 30 degrees angle, and with baked epoxy coating. Panel size shall be as indicated but not less than 24 inches width by 18 inches in height.

## PART 3 – EXECUTION

### 3.1 GENERAL

- A. Examine areas under which Work of this Section will be performed. Correct conditions detrimental to proper and timely completion of Work. Do not proceed until unsatisfactory conditions have been corrected.

### 3.2 EQUIPMENT FOUNDATIONS

- A. Provide foundations (housekeeping pads, level platforms or curbs) for mechanical equipment whether indicated on drawings or not. Equipment foundations shall be of sufficient size and weight, and of proper design to preclude shifting of equipment under operating conditions, or under abnormal conditions imposed upon equipment.
- B. Provide foundations (housekeeping pads, level platforms or curbs) for mechanical equipment whether indicated on drawings or not. Foundations shall meet requirements of equipment manufacturer and, when required by Architect, obtain from equipment manufacturer, approval of foundation design and construction, for equipment to be installed. Equipment vibration shall be maintained within design limits, and shall be dampened and isolated. Isolators shall be bolted to a structural member so as to be readily removable.

### 3.3 EQUIPMENT DESIGN AND INSTALLATION

- A. Uniformity: Unless otherwise specified, equipment of same type or classification shall be product of same manufacturer.
- B. Application: Only provide equipment as reviewed by Architect.

- C. Equipment Installation: Equipment installation shall be in strict accordance with these Specifications, and installation instructions of manufacturers. Equipment installed on concrete foundations shall be grouted before piping is installed. Piping shall be installed in such a manner as not to place a strain on equipment. Flanged joints shall be adequately extended before installation. Piping shall be graded, anchored, guided and supported, without low pockets.
1. Install equipment in a neat and skillful manner, properly aligned, leveled, and adjusted for satisfactory operation.
  2. Install so connecting and disconnecting of piping and accessories can be readily accomplished, parts are readily accessible for inspection, service and repair. Space shall be provided to readily remove filters, coils, compressors and fan wheels. Access doors shall be hinged with cam lock door handles.
  3. Provide flexible connections for duct, pipe and conduit connections at moving equipment.

### 3.4 NOISE AND VIBRATION

- A. Operation of Equipment: Mechanical equipment and piping systems shall operate without exceeding specified noise and/or vibration levels.
- B. Corrective Measures: If specified noise and/or vibration levels are exceeded, provide necessary changes to reduce noise and/or vibration levels to within specified levels.

### 3.5 FIELD TESTS AND INSPECTION

- A. General: Perform field inspections, field tests, and trial operations as specified in Section 23 05 00: Common Work Results for HVAC. Provide labor, equipment and incidentals required for testing. The Project Inspector will witness field tests and trial operations as specified in Section 23 05 00: Common Work Results for HVAC.
- B. Equipment and Material: Equipment and material certified as being successfully tested by manufacturer, in accordance with referenced Specifications and standards, will not require re-testing before installation. Equipment and materials not tested at place of manufacture will be tested before or after installation, as applicable or necessary, to determine compliance with reference Specifications and standards.
- C. Start-Up and Operational Test: System shall be started up and initially operated with components operating. During this test, various strainers or filters shall be periodically cleaned until no further accumulation of foreign material occurs. Adjust safety and automatic control instruments as required to provide proper operation and control sequence. Refer to Section 23 05 00: Common Work Results for HVAC.
- D. Extent of Field Tests: After installation and before completion, Work of this Section shall be subjected to required field tests, including those specified here and in Section 23 05 00: Common Work Results for HVAC.
- E. Operation and Maintenance Data: Provide required operation and maintenance data as specified in Section 23 05 00: Common Work Results for HVAC.

### 3.6 CLEANUP

- A. Remove rubbish, debris and waste materials and legally dispose of off Project site.

3.7 PROTECTION

- A. Protect Work of this Section until Substantial Completion.

**END OF SECTION 23 80 00**

## SECTION 23 82 41

### WATER-TO-WATER HEAT PUMP

#### WITH AUXILIARY AIR-COOLED CONDENSER

#### PART 1 GENERAL

##### 1.1 SUMMARY

- A. Section Includes:
  - 1. Design
  - 2. Performance Criteria
  - 3. Refrigerants
  - 4. Controls
  - 5. Installation Requirements

##### 1.2 REFERENCES

- A. ARI 550/590-2003
- B. ANSI/ASHRAE 15
- C. ASME Section VIII
- D. NEC
- E. UL
- F. CSA
- G. OSHA as adopted by each individual State

##### 1.3 SUBMITTALS

- A. Chiller dimensional drawings with elevation overview. Drawings to include required service clearances, location of all field installed piping and electrical connections.
- B. A summary of all auxiliary utility requirements for normal system operation required. Auxiliary utility requirements include: electrical, water, and air. Summary of auxiliary equipment shall include quantity and quality of each specific auxiliary utility required.
- C. Chiller Control documentation to include: Chiller control hardware layout, wiring diagrams depicting factory installed wiring, field installed wiring with points of connection, and points of connection for BAS control/interface points.
- D. Sequence of operation depicting overview of control logic used.

- E. Installation and Operating Manuals.
- F. Manufacturer certified performance data at full load in addition to either IPLV or NPLV.

#### 1.4 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with the codes and standards as defined in Section 1.02 titled REFERENCES
- B. Chiller is required to be run tested at manufacturer's facility prior to shipment. Report available upon request.

#### 1.5 DELIVERY and HANDLING

- A. Chiller modules shall be delivered to the job site completely assembled and charged with complete refrigerant charge.
- B. Installing contractor to comply with the manufacturer's instructions for transporting, rigging, and assembly of modular chiller.

#### 1.6 WARRANTY

- A. The manufacturer's equipment warranty shall be for a period of (1) One year from date of equipment start up or 18 months from the date of shipment, whichever occurs first.
- B. Provide (1) One Year Labor Warranty and (1) One Year Refrigerant Warranty.
- C. Provide (5) Five Year Compressor Warranty (Parts Only).

#### 1.7 MAINTENANCE

- A. Maintenance of the chiller shall be the sole responsibility of the owner.

### **PART 2 PRODUCTS**

#### 2.1 Operating Conditions

- A. Provide outdoor packaged air-cooled liquid heat pump heat recovery chiller with the Hot water and Chilled Water capacities as scheduled on drawings at job site elevation of 177 feet.
- B. Chiller shall be designed to operate using R-410A Refrigerant.
- C. Chiller shall be designed for parallel water flow through both the chilled water and hot water piping supplies to each module.
- D. The liquid to be chilled will be water containing corrosion inhibitors and antifreeze solution as required.
- E. Chiller shall be designed to operate using **460** volt, 3 phase, **60 Hz** electrical power supply.

#### 2.2 Outdoor Packaged Water-to-Water Heat Pump Heat Recovery Chiller

- A. Approved manufacturer is AIRSTACK. No known equal.
- B. System Description: Chiller shall incorporate Scroll type compressors and can consist of multiple **20, 30, or 60** – ton modules. Each refrigerant circuit shall consist of a tandem compressor set, evaporator, refrigerant to hot water heat exchanger, air to refrigerant heat exchanger, electronic expansion valves, liquid line solenoid valves, filter driers, (4) 2-way motorized refrigerant valves, and control system. Each circuit shall be constructed to be independent of other circuits from a refrigeration and electrical stand-point. The multi-module chiller must be able to produce chilled water and hot water even in the event of a failure of one or more refrigerant circuits.
- C. General
  - 1. Chiller Modules shall be ETL listed in accordance with UL Standard 1995, CSA certified per Standard C22.2#236.
  - 2. Modules shall ship wired and charged with refrigerant. All modules shall be factory run tested prior to shipment on an AHRI certified or 3<sup>rd</sup> party verified test stand.
  - 3. Compressors, heat exchangers, condenser fans, piping and controls shall be mounted on a heavy gauge, powder coated steel frame. Electrical controls, contactors, and relays for each module shall be mounted within that module. Module shall be provided within a steel enclosure suitable for outdoor use. Exposed steel surfaces shall be provided with a powder coat paint finish.
- D. Piping:
  - 1. Chilled Water Mains: Each module shall include supply and return mains for chilled water. Cut grooved end connections are provided for interconnection with grooved type couplings. Rolled grooved shall be unacceptable.
  - 2. Hot Water Mains: Each module shall include supply and return mains for hot water. Cut grooved end connections are provided for interconnection with grooved type couplings. Rolled grooved shall be unacceptable.
- E. Refrigerant to Water Heat Exchangers:
  - 1. Evaporator: Each evaporator shall be a brazed plate heat exchanger constructed of 316 stainless steel; designed, tested, and stamped in accordance with UL 1995 code for 650 psig working pressure. The evaporator heat exchanger shall not be mounted above the compressor, to eliminate the effect of migration of refrigerant to the cold evaporator with consequent liquid slugging on start-up.
  - 2. Condenser: Each condenser shall be a brazed plate heat exchanger constructed of 316 stainless steel; designed, tested, and stamped in accordance with UL 1995 code for 650 psig working pressure.
- F. Compressor: Each module shall contain two hermetic scroll compressors in a tandem piping arrangement mounted to the module with rubber-in-shear isolators. Each system also includes high discharge pressure and low suction pressure safety cut-outs.
- G. Source/Sink Fans: Each module shall contain dual fans for each refrigerant circuit. Module shall utilize ECM Fans. Blades are aluminum construction owlet design 7-blade axial fan with integral EC motor (direct drives with external VFD driven motors are not acceptable).

Efficiency exceeds criteria set out in the ErP 2015 directive. Individual fans are factory tested. Encapsulation required. Encapsulation is a process of filling a complete electronic assembly with a solid compound for resistance to shock and vibration, and for exclusion of moisture and corrosive agents. Sound pressure reductions at 30 feet, as compared to standard fan option, ranges from 3-6 dBA.

H. Central Control System.

1. Scheduling of the various compressors shall be performed by a microprocessor based control system (Master Controller). A new lead compressor is selected every 24 hours to assure even distribution of compressor run time.
2. The Master Controller shall monitor and report the following on each refrigeration system:
  - a. Discharge Pressure Fault
  - b. Suction Pressure Fault
  - c. Compressor Winding Temperature
  - d. Suction Temperature
  - e. Evaporator Leaving Chilled Water Temp.
  - f. Condenser Leaving Hot Water Temp
3. The Master Controller shall be powered by the chillers single point power connection and shall monitor and report the following system parameters:
  - a. Chilled Water Entering and Leaving Temperature
  - b. Discharge Refrigerant Temperature
  - c. Proof of Chilled Water Flow
  - d. Hot Water Entering and Leaving Temperature
  - e. Discharge Refrigerant Temperature
  - f. Proof of Hot Water Flow
4. An out of tolerance indication from these controls or sensors shall cause a "fault" indication at the Master Controller and shutdown of that compressor with the transfer of load requirements to the next available compressor. In the case of a System Fault the entire chiller will be shut down. When a fault occurs, the Master Controller shall record conditions at the time of the fault and store the data for recall. This information shall be capable of being recalled through the keypad of the Master Controller and displayed on the Master Controller's 2 line by 40 character back-lit LCD. A history of faults shall be maintained including date and time of day of each fault (up to the last 20 occurrences).
5. Individual monitoring of leaving chilled water temperatures from each refrigeration system shall be programmed to protect against freeze-up. Individual monitoring

of leaving hot water temperatures from each refrigeration system shall be programmed to protect against hi head pressure conditions.

6. Operation:

a. The control system shall monitor entering and leaving chilled water and hot water temperatures to determine both the chilled water and hot water system demand. The control system will use the demand to make staging mode (cooling, heating, or simultaneous heat recovery) decisions and select the number of compressor circuits required to operate. Mode decisions shall be available from the controller as well as via remote input. Response times and set points shall be adjustable. The system shall provide for variable time between compressor sequencing and temperature sensing, so as to optimize the chiller performance to different existing building loads.

b. Modules shall be able to provide the following capabilities:

1. Full cooling capacity with zero need for hot water
2. Full simultaneous heat recovery, providing full heating and cooling capacities.
3. Full heating capacity with zero need for chilled water.

7. **INTEROPERABILITY**

The Chiller shall be capable of interfacing to a building automation system. Interface shall be accomplished using an Interoperability Web Portal and shall be capable of communication over **BACNet, Modbus or LON**.

I. Chiller shall have external inputs and outputs to be compatible with the building management system to include Remote Start/Stop capability and Cooling Alarm output.

J. Each refrigerant circuit shall include all refrigerant specialties including a properly sized dynamic receiver to provide reliable operation down to 40°F Ambient.

K. **SINGLE POINT POWER CONNECTION**

Chiller shall be provided with a single point power connection at a 35,000 amp SCCR. This will include pre-engineered wiring for field installation and connection to a factory mounted chiller junction box. Junction box shall include branch circuit protection for each module and provide a single point of connection to building power.

M. **VARIABLE FLOW OPERATION – CHILLED AND/OR CONDENSER WATER**

Butterfly type isolation valves shall incorporate appropriate accessories and controls to allow the chiller to operate efficiently in a variable primary flow system. Motorized valve per module shall operate for variable flow.

N. **PUMP MODULE**

Provide a Pump Module of size and capacity indicated on the drawings and schedules. The Pump Module shall be interconnected through the common chiller header system and require no additional water connections. Pump Module will become an integral part of the chiller system. The Pump Module will come factory insulated to the same specification as the Chiller Modules. Pump Module shall incorporate dual in-line centrifugal pumps in a Primary/Standby pumping arrangement. Pump starters and controls shall be provided to enable manual selection of lead pump. In addition, in the event of a loss-of-flow failure of the chilled water system, the Pump Module controls shall disable the lead pump and automatically start the standby pump. Module shall be completely factory assembled and tested prior to shipment. Pump Module shall include integral Variable Speed Drives for each Chilled Water and Hot Water Pump Motor in NEMA 3R Enclosure. VFD's shall be ABB ACH550. The following additional options shall be included in the Pump Modules:

- Expansion tanks for both Chilled Water and Hot Water.
- Auto lead/lag timer
- Pump suction and discharge water pressure gauges (4" glass lens)
- Integral isolation/check valves for servicing one pump while the other is in operation.

**O. LIFTING FRAME**

Optional six (W6X15) inch I-beam painted steel frame will be provided with all modules mounted upon it. Typically, all water and wiring connections will be made between the modules at the factory. Depending on chiller length or customer requests, larger I-beams can be furnished.

**2.3 SAFETIES, CONTROLS AND OPERATION**

A. The chiller safety controls shall be provided (minimum) as follows:

1. Low evaporator refrigerant pressure
2. Loss of water flow through the evaporator
3. High condenser refrigerant pressure
4. High compressor motor temperature
5. Low suction gas temperature
6. Low leaving evaporator water temperature

B. Failure of chiller to start or chiller shutdown due to any of the above safety cutouts shall be annunciated by display of the appropriate diagnostic description at the unit control panel. This annunciation will be in plain English. Alphanumeric codes shall be unacceptable.

C. The chiller shall be furnished with a Master Controller as an integral portion of the chiller control circuitry to provide the following functions:

1. Provide automatic chiller shutdown during periods when the load level decreases below the normal operating requirements of the chiller. Upon an increase in load, the chiller shall automatically restart.
  2. Provisions for connection to automatically enable the chiller from a remote energy management system.
  3. The control panel shall provide alphanumeric display showing all system parameters in the English language with numeric data in English units.
- D. Normal Chiller Operation
1. When chiller is enabled, the factory supplied Master Controller modulates the chiller capacity from minimum to maximum as required by building load.
  2. The Chiller control system shall respond to Entering Water Temperature and will have an integral reset based on entering water temperature to provide for efficient operation at part-load conditions.

### **PART 3      INSTALLATION**

#### **3.1      PIPING SYSTEM FLUSHING PROCEDURE**

- A. Prior to connecting the chiller to the building chilled water loop, the piping shall be flushed with a detergent and hot water (110-130° F) mixture to remove previously accumulated dirt and other organic residue. In old piping systems with heavy encrustation of inorganic materials consult a water treatment specialist for proper passivation and/or removal of these contaminants.
- B. During the flushing a 30 mesh (max.) Y-strainers (or acceptable equivalent) shall be in place in the system piping and examined periodically as necessary to remove collected residue. The use of on board chiller strainers shall not be acceptable. The flushing process shall take no less than 6 hours or until the strainers, when examined after each flushing, are clean. Old systems with heavy encrustation shall be flushed for a minimum of 24 hours and may take as long as 48 hours before the filters run clean. Detergent and acid concentrations shall be used in strict accordance with the respective chemical manufacturers instructions. After flushing with the detergent and/or dilute acid concentrations the system loop shall be purged with clean water for at least one hour to ensure that all residual cleaning chemicals have been flushed out.
- C. Prior to supplying water to the chiller the Water Treatment Specification shall be consulted for requirements regarding the water quality during chiller operation. The appropriate chiller manufacturer's service literature shall be available to the operator and/or service contractor and consulted for guidelines concerning preventative maintenance and off-season shutdown procedures.

#### **3.2      Water Treatment Requirements**

- A. Supply water for the chilled water circuit shall be analyzed and treated by a professional water treatment specialist who is familiar with the operating conditions and materials of construction specified for the chiller's heat exchangers, headers and associated piping. Cycles of concentration shall be controlled such that recirculated water quality for modular chillers using 316 stainless steel brazed plate heat exchangers and carbon steel headers is maintained within the following parameters:

1.	pH	Greater than 7 and less than 9
2.	Total Dissolved Solids (TDS)	Less than 1000 ppm
3.	Hardness as CaCO <sub>3</sub>	30 to 500 ppm
4.	Alkalinity as Ca CO <sub>3</sub>	30 to 500 ppm
5.	Chlorides	Less than 200 ppm
6.	Sulfates	Less than 200 ppm

### 3.3 Warranty and Start-Up

- A. **Manufacturer's Warranty:** Manufacturer shall provide full parts-only warranty coverage for entire chiller for a period of one year. All parts shall be warranted against defects in material and workmanship. Similar parts-only coverage shall be provided for the chillers compressors for a period of five years. The warranty period shall commence either on the equipment start-up date or six months after shipment, whichever is earlier.
- B. Manufacturer shall provide the services of a Factory Authorized Service: Engineer to provide complete start-up supervision. Factory Authorized Service Engineer shall also be responsible for assembly of the chillers cabinetry package and electrical bus bar system. After start-up a Manufacturer's Representative shall provide a minimum of 8-hours of operator training to the owner's designated representative(s).

**END OF SECTION 23 82 41**

## SECTION 26 05 00

### COMMON WORK RESULTS FOR ELECTRICAL

#### PART 1 - GENERAL

##### 1.1 SUMMARY

- A. This Section specifies the basic requirements for electrical installations and includes requirements common to more than one section of Division 26. It expands and supplements the requirements specified in sections of Division 01.
- B. Related Requirements:
  - 1. Division 01 - General Requirements.
  - 2. Section 09 90 00 - Painting and Coating.
  - 3. Section 31 23 00 - Excavating, backfilling and compacting for utilities.
  - 4. Division 23 - HVAC.
  - 5. Division 27 – Communications.
- C. Applicable Standards
  - 1. ASTM D 709 (2007) – Laminated Thermosetting materials.
  - 2. ANSI/NEMA FB-1 (2010) – Standard for Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable.
  - 3. ANSI/NEMA 250 (2008) – Enclosure for Electrical Equipment (1000 Volts Maximum).
  - 4. California Electrical Code (CEC).
  - 5. IEEE C57.12.28 (2005) – Standard for Pad-Mounted equipment (Enclosure Integrity).
  - 6. UL 1 (2005) – Standard for Flexible Metal Conduit.
  - 7. UL 1242 (2007) – Standard for Electrical Intermediate Metal Conduit.
  - 8. UL 506 (2008) – Specialty Transformers.
  - 9. UL 6 (2010) – Electrical Rigid Metal Conduit-Steel.
  - 10. UL 797 (2007) – Electrical Metallic Tubing-Steel.
  - 11. UL 870 (2008) – Standard for Wireways, Auxiliary Gutters, and Associated Fittings

## 1.2 BASIC ELECTRICAL REQUIREMENTS

### A. DESCRIPTION

- a) Provide all labor materials and equipment necessary for general electrical requirements where shown on the contract drawings and specified herein.
- b) Included Work:
  1. Provide all labor, materials, equipment, tools and appliances required to furnish and install all electrical work as shown on the Contract Drawing and the specifications. All systems must be constructed complete and operable. The scope includes but not limited to the following:
    - a. All construction power and lighting and power for testing equipment and systems through final acceptance of test.
    - b. Power, low voltage and lighting raceway(s) underground inside the property line boundaries.
    - c. All underground power and low voltage conduits on and off site per the utility company's requirements, plans and provisions.
  2. Complete lighting and power system(s) including branch circuits, fixtures, outlets, lamps, switches, controllers, and auxiliary equipment.
  3. Complete distribution system(s) including switchboards, panel boards, transformers, feeders, and auxiliary equipment.
  4. Complete system of exterior (vandal resistant) lighting.
  5. Complete Grounding System.
  6. Complete Alerting System(s), including service raceways, cabinets, backboards, grounding, AC power provisions, etc. Contractor shall coordinate with USDD, Owner's instructions for the placement of devices.
  7. Fire department Communication tower and all related raceways, cable trays, etc.
  8. Television antenna and coaxial cable distribution system.
  9. Complete Data, phone and TV distribution system with all raceways and wiring. All systems to be functional and tested.
  10. Distribution for emergency power system including but not limited to lighting panel boards and all branch circuit wiring.
  11. All control wiring and devices for equipment specified in Sections of Division 26 and other technical Sections, except where specifically indicated or noted otherwise on the Contract Drawings or in the Specifications.
  12. Complete, operable and certified fire alarm system.

13. All testing for all installed systems including all owner furnished items.

14. Applicable excavating, trenching and backfilling.

B. Quality Assurance:

1. Workers possessing the skills and experience obtained in performing work of similar scope and complexity shall perform the Work of this Division.
2. Refer to other sections of the Specifications for other qualification requirements.

C. Drawings and Specifications Coordination:

1. For purposes of clearness and legibility, Drawings are essentially diagrammatic and the size and location of equipment is indicated to scale whenever possible. Verify conditions, dimensions, indicated equipment sizes, and manufacturer's data and information as necessary to install the Work of this Division. Coordinate location and layout with other Work.
2. Verify final locations for rough-ins with field measurements and with the requirements of the equipment to be connected.
3. Drawings indicate required size and points of termination of conduits, number and size of conductors, and diagrammatic routing of conduit. Install conduits with minimum number of bends to conform to structure, avoid obstructions, preserve headroom, keep openings and passageways clear, and comply with applicable code requirements.
4. Routing of conduits may be changed provided that the length of any conduit run is not increased more than 10 percent of length indicated on the Drawings.
5. Outlet locations shall be coordinated with architectural elements prior to start of construction. Locations indicated on the Drawings may be distorted for clarity.
6. Coordinate electrical equipment and materials installation with building components and the Work of other trades
7. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations.
8. Coordinate connection of electrical systems with existing underground utilities and services.

D. Terminology:

1. Signal Systems: Applies to clock, bell, fire alarm, annunciator, sound, public address, buzzer, telephone, television, inter-communication, elevator access controls, lighting control systems and security systems.
2. Low Voltage: Applies to signal systems operating at 120 volts and less, and power systems operating at less than 600 volts. Medium voltage: Applies to power systems operating at more than 600 volts.

3. UL: Underwriter's Laboratories Inc, Nationally Recognized Testing Laboratory (NRTL), or equal.
- E. Regulations: Work shall comply with the requirements of authorities having jurisdiction and the California Electrical and Building Codes. Material shall conform to regulations of the National Board of Fire Underwriters for electrical wiring and apparatus. Materials shall be new and listed by UL, or another NRTL.
- F. Structural Considerations for Conduit Routing:
1. Where conduits pass through or interfere with any structural member, or where notching, boring or cutting of the structure is necessary, or where special openings are required through walls, floors, footings, or other buildings elements, conform to CBC, Part 2, Title 24, Section 1906.3 for conduits and pipes embedded in concrete and Sections 2308.9.10 and 2308.9.11 for notches and bored holes in wood; for steel, as detailed on the structural steel Shop Drawings.
  2. Where a concrete encasement for underground conduit abuts a foundation wall or underground structure which the conduits enter, encasement shall rest on a haunch integral with wall or structure, or shall extend down to footing projection, if any, or shall be doweled into structure unless otherwise indicated. Underground structures shall include maintenance holes; pull boxes, vaults, and buildings.
  3. Holes required for conduit entrances into speaker poles, floodlight poles or other poles, shall be drilled with the conduit nipple or coupling welded to poles. Welds shall be provided by the electric arc process and shall be continuous around nipple or coupling.
- G. Electrically Operated Equipment and Appliances:
1. Furnished Equipment and Appliances:
    - a. Work shall include furnishing and installing wiring enclosures for, and the complete connection of electrically operated equipment and appliances and electrical control devices which are specified to be furnished and installed in this or other sections of the Specifications, wiring enclosures shall be concealed except where exposed Work is indicated on the Drawings.
    - b. Connections shall be provided as necessary to install equipment ready for use. Equipment shall be tested for proper operation and, if motorized, for proper rotation. If outlets are of incorrect electrical characteristics or any specified equipment fails to operate properly, repair and/or replace the outlet and/or equipment.
  2. Equipment and Appliances Furnished by Others:
    - a. Equipment and appliances indicated on Drawings as "not in contract" (NIC), "furnished by others," or "furnished by the Owner," will be delivered to the Project site. Required electrical connections shall be performed for such equipment and appliances. Motorized equipment will be furnished factory-wired to a control panel or junction box unless otherwise indicated.

Appliances will be furnished equipped with portable cord and cap. Provide disconnect switches where required.

- b. Connections to equipment furnished under this Division shall be part of the Work of this section. Work shall include internal wiring, installation, connection and adjustment of bolted drive motors in which the motor is supplied as a separate unit, and connections only for equipment furnished with factory installed internal wiring, except as further limited by Drawings and this Specification. Work shall include furnishing and installing suitable outlets, disconnecting devices, starters, push-button stations, selector switches, conduit, junction boxes, and wiring necessary for a complete electrical installation. Work shall also include furnishing and installing conduit and boxes for HVAC control systems, furnished under Division 23. Devices and equipment furnished shall be of same type used elsewhere on the Work or as specified.
- c. Electrical equipment furnished under other sections, for installation and connection under Work of this section, will be delivered to the Project site ready for installation.
- d. Mechanical equipment furnished under other sections, and requiring electrical connection under this section, will be set in place as part of the Work of the section furnishing such equipment unless noted otherwise.
- e. Suitability and condition of equipment furnished under other sections shall be determined in advance of installation. Immediate notice of damage, unsuitability, or lack of parts shall be given to the entity providing such equipment.

H. Submittals:

1. Conform to applicable provisions of Division I of the General Requirements and as hereinafter specified.
2. Prepare, review and coordinate schedule of submittals, determining necessary lead time for preparation, submitting, checking, and ordering and delivering materials and equipment to the job-site for timely arrival and conformance with the overall Construction schedule.
3. All submittals will be checked for general compliance with Specifications only. Contractor will be responsible for deviations from the Drawings or Specifications and for errors or omissions of any sort in the Submittals.
4. All required submittals on electrical items and equipment shall include complete catalog information such as construction ratings, insulation systems, including manufacturer's certification that items or equipment meet or exceed and Trade Standards, and the Specifications. All items must be U.L. listed or listed per a recognized by code listing agency.
5. Equipment Floor Plans: Submit after approval of material and/or equipment is secured. Prepare for each electrical equipment room drawn to 2" = 1'-0" scale. Layout drawing shall be to exact scale.
6. Materials list of items and equipment proposed to be provided for the work of this Division and shall include at least the following as applicable:
  - a. Service and distribution switchboard.
  - b. Emergency generator set.
  - c. Lighting panel boards.
  - d. Lighting control panels.
  - e. Conduits.
  - f. Conductors.
  - g. Electrical equipment layout at scale indicating on drawings of equipment,
  - h. Clearances, housekeeping pads.
  - i. Disconnect switches, pull boxes and fuses.
  - j. Lighting fixtures.
  - k. Fire alarm and detection system.
  - l. Control devices, standard and special receptacles, switches and finish device plates.

- m. Cabinets for signal and telephone systems, special terminals and cabinets.
- n. Vibration isolators, including lateral and vertical seismic restraints.
- o. All fabricated equipment.
- p. Time clocks, contactors, control switches, etc. including wiring diagrams and sequence of operation.

7. Short Circuit, Arc flash and Coordination Study.

- a. Submit, along with switchgear and distribution equipment submittal, system short circuit study based on the per unit method or in accordance with the latest IEEE recommendations, Report to be submitted with the shop drawings of the main service and the distribution system, each copy bound with a stiff cover.
- b. Provide Arc flash calculations and provide a sticker with the value and the recommended protective gear.
- c. Submit, along with the short circuit study, a coordination study of all protective devices, including the utility company protective device through all feeder devices on the secondary of each transformer downstream to each panel board and motor control center. Settings shall be incorporated with the coordination study. Study both short circuit and coordination studies~ comprising the power systems study shall be signed by California Registered Electrical Engineer who shall determine the adjustable settings for protective devices. All switchgear and distribution equipment shall comply with the results and recommendations of the studies. The ampere interrupting capacity (A.I.C.) rating of devices shall be a minimum of at least ten percent greater than the calculated value of symmetrical three-phase fault current at that respective device. All circuit breakers shall be fully rated. Series rated breakers shall not be accepted. Feeder lengths and materials shall be determined independently by the installing contractor, and documented in the study. Studies shall include entire system from normal utility source, emergency source down to panel boards, and individual feeder loads serving specific equipment.
- d. Studies to be done by switchgear manufacturer and shall include a tabular form indicating calculated fault value, the A.I.C. value and the available arc flash energy and the recommended protective gear at each equipment.

8. Special Submissions:

I. Test Reports for the following:

- a. Ground fault devices.
- b. Megger Readings: Ground system, motors, feeders and switchgear.
- c. Voltage Readings: Distribution, service and motors.
- d. Fire alarm system.

I. Protection of Materials:

1. Protect materials and equipment from damage and provide adequate and proper storage facilities during progress of the Work. Damaged materials and/or equipment shall be replaced.

J. Cleaning:

1. Exposed parts of Work shall be left in a neat, clean, usable condition. Finished painted surfaces shall be unblemished and metal surfaces shall be polished.
2. Thoroughly clean parts of apparatus and equipment. Exposed parts to be painted shall be thoroughly cleaned of cement, plaster, and other materials. Remove grease and oil spots with solvent. Such surfaces shall be wiped and corners and cracks scraped out. Exposed rough metal shall be smooth, free of sharp edges, carefully steel brushed to remove rust and other spots, and left in proper condition to receive finish painting.
3. Remove rubbish, debris, and waste materials and legally dispose of off the Project site.

K. WARRANTIES

1. Provide one year warranty on all material and labor performed as a minimum, unless noted otherwise in specific sections.

**PART 2 - PRODUCTS - NOT USED**

**PART 3 - EXECUTION**

3.1 GENERAL REQUIREMENTS

- A. Advise the Inspector before starting the Work of this Division.
- B. Exposed conduits shall be painted to match the surfaces adjacent to installation.
- C. Salvaged materials removed from buildings shall be removed from the Project site as required by the OAR.

- D. Trenches outside of barricade limits shall be backfilled and paved within 24 hours after being inspected by the Inspector. Provide traffic plates during the time that trenches are open in traffic areas and in areas accessible to students and staff.
- E. Where existing structural walls are cored for new conduit runs, separation between cored holes shall be three inches edge to edge from new or existing holes, unless otherwise required by the Architect. All coring to be laid out and reviewed by Architect prior to drilling. Contractor to verify location of structural steel, rebar, stress cabling or similar prior to lay out.
- F. Electrical equipment shall be braced and anchored for CBC Seismic Design requirements, or as otherwise indicated on the Drawings.
- G. LEGAL REQUIREMENTS AND STANDARDS
  - a. Required: Comply with the latest, as applicable and effective, during the progress of Contracted Work.
    - 1. Latest Ventura County, Electrical, Fire and Building Codes and Supplemental addendums and requirements.
    - 2. California State Administrative Code, Title 24, State Building Standard.
    - 3. (CAUOSHA) California State Occupational Safety and Health Act.
    - 4. California State Fire Marshal Standards.
    - 5. Southern California Edison.
    - 6. U.L. - Underwriters Laboratories Inc.
    - 7. NEC - National Electric Code.
    - 8. ASTM - American Society of Testing and Materials.
    - 9. Current publications of the National Fire Protection Association.
    - 10. National and American Standards Association.
  - b. General compliance as applicable
    - 1. Drawings and specification requirements shall govern where they exceed Code requirements, in case of a conflict between the plans, the codes and the specifications, the more stringent shall apply.
    - 2. Where requirements between governing Codes and Regulations vary, the more restrictive provision shall apply.
    - 3. Nothing contained in Contract Documents shall be construed as authority or permission to disregard or violate legal requirements.

### 3.2 DELIVERY STORAGE AND HANDLING

- A. Deliver products to project site with proper identification, which shall include names, model numbers, types, grades, compliance labels, and similar information needed for District identification; all products and materials shall be adequately packaged and protected to prevent damage during shipment, storage, and handling.
- B. Coordinate deliveries of electrical materials and equipment to minimize construction site congestion.

### 3.3 CUTTING AND PATCHING

- A. Cutting and patching of electrical equipment, components, and materials shall include the removal and legal disposal of selected materials, components, and equipment.
- B. Do not endanger or damage installed Work through procedures and processes of cutting and patching.
- C. Repair or restore other work, or surfaces damaged as a result of the work performed under this contract.

### 3.4 PRELIMINARY OPERATIONS

- A. Required; Should the District require that any portion of the systems or equipment be operated prior to the final scheduled dates for completion and acceptance of the work, the Contractor shall consent. Such operation shall be under the direct supervision of, and at the expense of the Contractor, and shall not be construed as an acceptance of any of the work by the District.

### 3.5 CLEANUP

- B. Remove rubbish, debris and waste materials and legally dispose off the Project site.
- C. Remove equipment and implements of service, and leave entire work area neat and clean, to the satisfaction of the Owner Authorized Representative.

### 3.6 PROTECTION

- A. Protect the Work of this section until Substantial Completion.

### 3.7 COMPLETION

- A. Protect The work will not be reviewed for final acceptance until operating and maintenance data, manufacturer's literature, panel directories and nameplates specified herein have been approved and properly posted or installed and final cleaning of equipment and premises has been completed.
- B. When the installation is complete and all adjustments have been made, operate the systems for a period of one week, during which time demonstrate to the Engineer that the systems are completed and operating in conformance with the Specifications.

END OF SECTION

## SECTION 26 05 13

### BASIC ELECTRICAL MATERIALS AND METHODS

#### PART 1 - GENERAL

##### 1.1 SUMMARY

###### A. Section Includes:

1. Boxes, enclosures, keys and locks.
2. Receptacles and switches.
3. Identifications and signs.

###### B. Related Requirements:

1. Division 01 - General Requirements.
2. Division 26 – Electrical.
3. Division 27 – Communications.
4. Division 28 - Electronic Safety and Security.

#### PART 2 - PRODUCTS

##### 2.1 BOXES, ENCLOSURES, KEYS AND LOCKS

###### A. Outlet Boxes and Fittings:

1. Outlet boxes installed in concealed Work shall be galvanized steel, pressed, or welded type, with knockouts.
2. In exposed Work, where conduit runs change direction or size, outlet boxes and conduit fittings shall be cast metal with threaded hubs cast integral with box or fitting.
3. Fittings shall be cast metal and non-corrosive. Ferrous metal fittings shall be cadmium-plated or zinc galvanized. Castings shall be true to pattern, smooth, straight, with even edges and corners, of uniform thickness of metal, and shall be free of cracks, gas holes, flaws, excessive shrinkage, and burnt-out sand.
4. Covers for fittings shall be galvanized steel or non-corrosive aluminum and shall be designed for particular fitting installed.

5. Light fixture outlets shall be 4-inch octagon, 4-inch square, 2 1/8-inch deep or larger, depending upon number of conductors or conduits therein. Plaster rings shall be furnished with round opening with two ears drilled 2 23/32 inches center to center.
6. For local device outlets provide 4-inch square 2 1/8-inch deep, boxes for single gang, 5-inch square boxes for two-gang, and special solid gang boxes with gang plaster ring for more than two switches.
7. For TV outlets, and horns and strobes provide manufacturer's supplied back box as needed. For television outlets, provide 4-gang deep boxes and 4-gang plaster rings.
8. Plaster rings shall be provided on flush-mounted outlet boxes except where otherwise indicated or specified. Plaster rings shall be same depth as finished surface. Install approved ring extension to obtain depth to finish surface.
9. In existing plywood wall or drywall construction, and where flexible steel conduit is fished into walls, single-gang and 2-gang outlets for wiring devices may be sectional steel boxes with plaster ears. Boxes shall be fastened to plywood with flat-head screws in each plaster ear screw hole. Boxes fastened to gypsum board shall be Raco, Appleton, Cooper, Bowers, or equal.
10. Factory made knockout seals shall be installed to seal box knockouts, which are not intact.
11. Where flexible conduit is extended from flush outlet boxes, provide and install weatherproof universal box extension adapters.

**B. Junction and Pull boxes:**

1. Junction and pull boxes, in addition to those indicated, shall only be used in compliance with codes, recognized standards, and Contract Documents.
2. Interior and non-weatherproof boxes shall be constructed of blue or galvanized steel with ample laps, spot welded, and shall be rigid under torsion and deflecting forces. Boxes shall be furnished with auxiliary angle iron framing where necessary to ensure rigidity.
3. Covers shall be fastened to box with a sufficient number of machine screws to ensure continuous contact all around. Flush type boxes shall be drilled and tapped for cover screws if boxes are not installed plumb. Surfaces of pull and junction boxes and covers shall be labeled in black marker ink designating system, panelboard and circuit designation contained in box. In exposed Work, designation shall be installed on inside of pullbox or junction box cover.
4. Weatherproof NEMA 3R pull and junction boxes shall conform to foregoing for interior boxes with following modifications:
  - a. Cover of flush mounting boxes shall be furnished with a weather-tight gasket cemented to, and trimmed even with, cover all around.

- b. Surface or semi-flush mounting pull and junction boxes shall be UL, or another Nationally Recognized Testing Laboratory (NRTL) listed as rain-tight and shall be furnished complete with threaded conduit hubs.
  - c. Exposed portions of boxes shall be galvanized and finished with one prime coat and one coat of baked-on gray enamel, unless already furnished with factory baked-on finish.
5. Junction and pull boxes shall be rigidly fastened to structure and shall not depend on conduits for support.
6. Underground Concrete Pull Boxes:
- a. Pre-cast concrete pull boxes. Concrete pull boxes shall be traffic type, reinforced for H-20 wheel loading, pre-cast concrete. Pull boxes with inside dimensions of 2 feet by 3 feet by 3 feet deep shall consist of a base section, top ring, and cover. Base section shall be furnished with 2 knockouts measuring 10 inch by 10 inch in each 3 feet side, and one 20 inch by 20 inch knockout in each 2-foot side. Pull boxes with inside dimension 4 feet by 4 feet by 4 feet deep shall consist of a base section, midsection, topping, and cover. Base section shall be furnished with 2 knockouts measuring 8-inch by 16-inch on each of two opposite sides, and one 20-inch by 20-inch knockout on each of other two opposite sides. Pull boxes shall be furnished with a minimum of 6-inch diameter sump knockout and one inch diameter ground rod knockout. In pull boxes, furnish and install cable racks on walls. Racks shall be furnished with 3 porcelain cable holders on vertical steel mounting bars. Pull boxes shall be furnished with 3/4 inch diameter pull irons. Covers shall be traffic-type consisting of steel safety plate bolted to frame. Covers shall be marked as electrical, power, or signal as required. Pull boxes shall be as manufactured by Oldcastle Precast, Jensen Precast, Kistner, Western Precast, or equal.
  - b. Provide end bells in duct entrances. Terminate each metal conduit with insulated bushing provided with a grounding terminal.
  - c. Install pulling irons on opposite walls and below horizontal centerlines of ducts and bricked-up openings, and in bottom. Install pulling irons with each end hooked around a reinforcing bar.
  - d. Remove floor drain knockout and provide a depth of 24 inches of crushed rock below box extending a minimum of 12 inches beyond on all sides.
  - e. Permanently and effectively ground metal equipment cases, cable racks, and similar items in pull boxes to site grounding electrode system. Provide grounding conductor in compliance with CEC Article 250.
  - f. Provide 6-inch deep sand base under pull boxes.
  - g. Identify power and signal cables by tagging in manholes and pull boxes. Tie securely to cables with nylon cord.

- h. Top of steel plate shall provide a minimum coefficient of static friction of 0.5 for either wet or dry locations, when tested for any shoe sole material. Test shall comply with ASTM D 1047 or F 489 or F 609 standards. Submit manufacturer's test results for Architect's review as part of materials and equipment submittals.
  - i. The use of underground extension boxes shall be limited to not more than 1 times the original depth of pull box.
7. Underground utility boxes shall be reinforced concrete with non-setting shoulders to prevent settlement following installation. Boxes shall be furnished with cast iron cover with finger hole, size as indicated on Drawings. Utility boxes shall be as manufactured by Oldcastle, Jensen, Kistner, Western Precast, or equal.
  8. Manholes, vaults, and pull boxes required by a utility company, and installed as part of this Contract, shall meet requirements of servicing utility company.

C. Floor Outlets:

1. Provided floor outlets, except for extension outlets, shall be Harvey Hubbell Inc. B-2503, Thomas & Betts 640 series, Legrand Omnibox, or equal, adjustable, cast iron, watertight floor boxes with flush brass floor plates, and shall be set to finish flush with finish floor covering, whether it be carpeted, wood, resilient floor covering, or other finish materials. Floor boxes shall be used in office, classrooms, and in library areas only.
2. Telephones above floor outlets, where not subjected to water, shall be provided with Harvey Hubbell Inc. SC-3098 pedestals with SC309T plates, Legrand 525 series, Thomas & Betts FPT-400 Series, or equal. Refer to other Division 26 sections. Floor boxes shall be used in office, classrooms and in Library areas only.
3. Plugs above floor outlets where not subjected to water shall be provided with Legrand 525 series, Thomas & Betts FPT-400 Series, Harvey Hubbell Inc. SC-3098, or equal, pedestal and with SS309D, or equal, device plates. Refer to other Division 26 sections. Floor boxes shall be used in office, classrooms, and library areas only.
4. Plugs above floor outlets where subjected to water shall be provided with a Harvey Hubbell Inc. SA-6685 or equal, single-gang outlet box, or SA-6687 or equal, 2-gang outlet box. Provide required cover plate. Refer to other Division 26 sections. Floor outlets shall be used in Cafeteria, Cafeteria serving areas, or any areas where floors are subjected to water.
5. Furnished extension floor outlets shall be cast iron floor boxes with cast iron covers and 1/2 inch offset entries for above-floor conduit extensions; Harvey Hubbell F3186, or equal. Boxes shall be designed to permit access to wiring without disturbing above-floor extensions and shall be set flush with finish floor.
6. Furnished above floor service fittings for surge suppression receptacles shall be Hubbell SC3098 with cover plates SS309DS, Legrand 525 series, Thomas & Betts FPT-400 Series, or equal.

7. Furnished above floor service fittings for data outlets shall be Hubbell SC3098 with required cover plates, Legrand 525 Series, Thomas & Betts FPT-400 Series, or equal. Refer to other Division 26 sections.

D. Floor Pockets:

1. Three-Gang: Furnished three-gang floor lighting pockets shall be flush floor type, with cast iron floor plate and hinged cast iron door notched for cables. Three-gang floor pockets shall be owner approved Legrand or Hubbell Recessed Floor Boxes, C.W. Cole TLS-353-6, or equal, for wood floors and C.W. Cole TLS-353-6-C, or equal, for concrete slabs. Each floor pocket shall be provided with three 20 amp, 3 wire, 125 volt receptacles with matching caps.
2. Single Gang:
  - a. Receptacle floor pockets shall be single gang, flush floor type, with cast iron floor plate, hinged cast iron door notched for cable and cast iron box; C.W. Cole TLA-362-1-FE, or Owner approved Legrand or Hubbell recessed floor box or equal. Provide each pocket with a standard, single grounding type receptacle unless otherwise indicated. Provide C.W. Cole TLS-362-1, or equal, in wood floors.
  - b. Microphone or projector floor pockets shall be single gang flush floor type with cast iron floor plate, hinged cast iron door, notched for cable and cast iron box, or owner approved Legrand or Hubbell recessed floor box, C.W. Cole TLA-362-3-FE, C.W. Cole TLS-362-3, in wood floors, or equal.

E. Keys and Locks:

1. Provide two keys with furnished door locks, including cabinet door locks and switchboard locks, two keys for lock switches on switchboards or control panels, and two keys with interlocks or other furnished lock switches. Deliver keys to Owner.
2. Locks shall be keyed to Corbin No. 60 keys for access to operate equipment and Corbin 70 keys for service access. Special keys and locks shall only be provided where specified.

## 2.2 RECEPTACLES AND SWITCHES

A. Wireless Controlled Receptacles:

1. The Duplex Controller shall be the Echoflex ERNR Series Split Duplex Controller by Echoflex Solutions, Inc., or equal. (Compatible with the Occupancy sensor Echoflex MOS-21U Series Occupancy Sensor by Echoflex Solutions, Inc., or equal).

1. Mechanical

- a. The Controller shall mount in a standard single-gang wall box

- b. The Controller shall have learn and clear buttons for manual linking of switches and sensors
  - 1) The buttons shall be accessible when the Controller is mounted, prior to mounting the faceplate.
- c. The Controller shall have two LED indicators to display power and linked device information
- d. The Controller shall have LED arrows pointing to controlled side of receptacle so that controlled side is permanently marked and easily visible in dark locations
- e. The Controller shall have an embossed icon  so that the controlled side is permanently marked

## 2. Electrical

- a. The Controller shall support 120VAC power input
- b. The Controller shall provide a single normally open relay contact, fully rated for 15 amps to switch power to the controlled receptacle
  - 1) The Controller shall have an auxiliary output controlled from the internal relay for wiring directly to other duplex receptacles
- c. The Controller shall use a 902 MHz EnOcean radio. Systems that use other radio frequencies shall not be acceptable
- d. The internal radio shall have a range of at least 80 feet through walls (laterally), up to 300 feet in open space
- e. The Controller shall be ETL listed, conform to UL 508, and certified to CAN/CSA Standard C22.2 No.14
- f. The Controller shall comply with FCC Part 15.231 and IC RSS-210

## 3. Functional

- a. The Controller shall provide switching control for an individual load plugged into the controlled receptacle

- a. The Controller shall support wireless Echoflex switches and sensors for relay control
  - 1) The Controller shall support linking of at least 20 wireless devices in any combination of Echoflex stations and sensors. Systems that do not support at least 20 stations or sensors shall not be acceptable
- b. The Controller shall provide the option of single or dual-hop wireless signal repeating to other controllers. Systems that do not provide signal repeating shall not be acceptable
- c. The Controller shall support Central Command functions for use with integrated control systems
- d. The Controller shall support commissioning and linking through software and/or mechanical means. Controllers that do not support both shall not be acceptable
- e. The Controller shall provide configuration variables that allow customization of the controllers operation with linked sensors and switches
- f. The Controller shall provide the option of reporting relay status wirelessly
- g. The Controller shall save all configuration settings and linked device details in non-volatile memory
  - 1) The Controller shall provide the option of saving user-defined configuration settings as recoverable default settings

A1. Receptacles:

- 1. Duplex receptacles shall be heavy-duty specification grade, grounding type. Terminal screws shall be back and side wired with internal screw pressure plates. Mounting strap shall feature heavy-duty brass construction. Receptacle back body shall be PVC. Receptacle face shall be ivory, impact resistant nylon. Receptacles shall have triple wipe brass power contacts.

<u>NEMA #</u>	<u>Pass &amp; Seymour</u>	<u>Hubbell</u>	<u>Leviton</u>
(20 amps) NEMA 5-20	PS5362-I	HBL5362-I	5362-I
(15 amps) NEMA 5-15	PS5262-I	HBL5262-I	5262-I

- 2. Duplex receptacles on circuits supplied by panel boards with integral surge suppression shall be Pass & Seymour model number PS5262BL (blue), Hubbell DRUBTVSS15, Leviton 5262-SBU, 15 amps, 120 volts, or equal.
- 3. Single receptacles shall be heavy-duty specification grade, grounding type. Terminal screws shall be back and side wire with internal screw pressure plates. Mounting strap shall feature heavy-duty brass construction. Receptacle back body shall be thermoplastic. Receptacle face shall be ivory, impact resistant nylon.

Receptacles shall have triple wipe brass power contacts. For circuits consisting of one single receptacle only, ampere rating of receptacle shall be same as circuit breaker or fuse.

<u>NEMA #</u>	<u>Pass &amp; Seymour</u>	<u>Hubbell</u>	<u>Leviton</u>
(20 amps) NEMA 5-20R	5361-I	HBL5361-I	5361-I
(15 amps) NEMA 5-15R	5261-I	HBL5261-I	5261-I

4. 15 and 20 amps single receptacles on circuits supplied by panel boards with integral surge suppression shall be Pass & Seymour NEMA 5-20R model number 5361-BL (blue), and NEMA 5-15R model number 5261-BL (blue) respectively. Equal receptacles by other Owner approved manufactures are acceptable.
5. For kiln receptacles and range receptacles, provide 3-pole, 4-wire, grounding type, rated 50 amps at 125/250 volts NEMA 14-50R. Provide with 2-gang, stainless steel plates, SS 703, or equal.

<u>NEMA #</u>	<u>Pass &amp; Seymour</u>	<u>Hubbell</u>	<u>Leviton</u>
NEMA 14-50R	3894	HBL9450A	279
WALL PLATE	SS703	S703	84026

6. For dryer receptacles, provide 3-wire, non-grounding type, rated 30 amps at 125/250 volts, NEMA 10-30R, with 2-gang stainless steel plates. Coordinate location of junction box with the work of Section 10 28 15, Hand and Hair Dryers.

<u>NEMA #</u>	<u>Pass &amp; Seymour</u>	<u>Hubbell</u>	<u>Leviton</u>
NEMA 10-30R	3860	HBL9350	5207
WALL PLATE	SS703	S703	84026

7. Provide specification grade ground-fault circuit interrupter (GFCI) type receptacles in accordance with 2010 UL standards. GFCI receptacles shall have a trip indication light. Receptacle terminal screws shall be back and side wire with internal screw pressure plates. Test and reset buttons shall match device body and shall be ivory. GFCI receptacles shall be manufactured in standard configuration for installation with stainless steel smooth plates. Exterior mounted receptacles shall be mounted inside weatherproof enclosure.

<u>NEMA #</u>	<u>Pass &amp; Seymour</u>	<u>Hubbell</u>	<u>Leviton</u>
NEMA 5-20R	2095-I	GFR5352-IA	7899-I
NEMA 5-15R	1595-I	GFR5252-IA	8598-I

8. Provide weatherproof receptacles, except where otherwise indicated or specified, consisting of GFCI receptacles, as specified herein, and metal plates with die-cast lockable hinged lids and weatherproof mats;

9. Provide transient voltage surge suppression (TVSS) receptacles offering metal oxide varistors (MOVs) protecting normal and common modes, (L-N, L-G, N-G) with 500V suppressed voltage. TVSS devices shall offer 3-mode equal protection with 210 joules minimum per mode of energy absorption and 13,000 amp maximum surge capability. TVSS devices shall have 3 thermal fuses and two over-current protection fuses. TVSS devices shall have LED visual only surge status indicator to alert user to surge suppression circuit condition. Visual indicator will be illuminated (red) when power is on and surge suppression circuit is fully functional. Visual indicator will not be illuminated when power is off or unit experiences loss of surge suppression protection. Terminals shall be back and side wire including ground terminal. Color shall be blue.

<u>NEMA #</u>	<u>Pass&amp; Seymour</u>	<u>Hubbell</u>	<u>Leviton</u>
(20 amps) NEMA 5-20R	5352BLSP	HBL5360SA	5380B
(15 amps) NEMA 5-15R	5252BLSP	HBL5260SA	5280B

10. Receptacles within 6 feet of water fountains, counter tops, or any sources of water shall be GFCI type.

B. Switches:

1. Local Switches:

- a. Provide local switches, high strength thermoplastic toggle, specification industrial grade, rated 20 amps at 120-277 volts AC only, with plaster ears, external screw pressure plate back and side wired, and standard size composition cups which fully enclose mechanism. Switches shall be approved for installation at currents up to full rating on resistive, inductive, tungsten filament lamp and fluorescent lamp loads, and for up to 80 percent of rating for motor loads. Switches shall have oversized silver alloy contacts for long life and better heat dissipation. Provide switches as single pole, double pole, 3-way, 4-way, non-lock type. Provide non-lock type switches with ivory handles;

	<u>Pass &amp; Seymour</u>	<u>Hubbell</u> <u>Leviton</u>
Single pole	PS20AC1I 1221-2I	HBL1221I
Double pole	PS20AC2I 1222-2I	HBL1222I
Three way	PS20AC3I 1223-2I	HBL1223I
Four way	PS20AC4I 1224-2I	HBL1224I

- b. Provide lock type switches, specification industrial grade, 20 amp, 120-277 volts with metal or nylon key guides with on/off indication, and operable by same key. Key shall be Owner standardized vertically oriented, tamper resistant, forked key with two each 5/16-inch long forks, 5/32-inch spacing between forks and 5/16-inch width overall.

	<u>Pass &amp; Seymour</u>	<u>Arrow Hart</u>	
Single pole Key	PS20AC1L w/#500 Key-2L	1221L	w/1201LK
Double pole Key	PS20AC2Lw/#500 Key	1222L	w/1201LK
Three way Key	PS20AC3L w/#500 Key	1223L	w/1201LK
Four Way Key	PS20AC4L w/#500 Key	1224L	w/1201LK

- c. Rotary lock switches shall incorporate a tumbler type lock to prevent unauthorized operation. Lock shall be tumbler type by Corbin, keyed to a HH41 key. Lock switch to be installed with pin tumblers facing downward. Key shall be removable in all positions. Each device shall be complete with 2 keys. Keys shall be delivered only to the Owner. Switches shall be rated at 20 amps, 120-277 volt AC. Switch plates shall be of stainless steel, engraved with on and off positions indicated.

	<u>Arrow Hart</u>
Single pole	AH1191N
Double pole	AH1192N
Three way	AH1193N

- d. Pilot light switches shall be rated 20 amps and shall conform to specifications for local switches. Switches shall be furnished with red, Lexan handles that are lighted by long-lasting neon lamps. Pilot light shall light when load is on. Pilot light 120 volt switches

	<u>Pass&amp; Seymour</u>	<u>Hubbell</u>	<u>Leviton</u>
Single pole	PS20AC1-RPL	HBL1221-PL	1221-PLR
Double pole	PS20AC2-RPL	HBL1222-PL	1222-PLR
Three way	PS20AC3-RPL	HBL1223-PL	1223-PLR

Same as above except rated at 20 amps at 277 volts.

	<u>Pass &amp; Seymour</u>	<u>Leviton</u>	<u>Hubbell</u>
Single pole	PS20AC1-RPL	1221-7PR	HBL1221-PL7

- e. Provide remote control switches for mechanically held contactors arranged for 3-wire control, toggle type, momentary contact, single pole, 3-position with center off position, rated 20 amps at 120-277 volts AC only, with plaster ears, binding screws for side wiring, standard size composition cups which fully enclose mechanism, and ivory handles

<u>Pass &amp; Seymour</u>	<u>Hubbell</u>	<u>Leviton</u>
1251-I	HBL1557-I	1285-I

- f. Provide remote control switches for magnetically held contactors arranged for 3-wire control, toggle type, maintained contact, single pole, 3-position with center off position, rated 20 amps at 120-277 volts AC only, with plaster ears, binding screws for side wiring, standard size composition cups which fully enclosed mechanism, and ivory handles.

<u>Pass and Seymour</u>	<u>Hubbell</u>	<u>Leviton</u>
1225-I	HBL 1385	1285-I

- g. Momentary Contact locking key type switch. 20A 120/277V center off. Key shall be Owner standardized vertically oriented, tamper resistant, forked key with two each 5/16" long forks, 5/32" spacing between forks and 5/16" width overall.

Arrow Hart

AH1995L w/ AH2000 key

- h. Momentary Contact switch low voltage 1 pole 3A 24VAC 3 position center off. Key for locking switch shall be Owner standardized vertically oriented, tamper resistant, forked key with two each 5/16" long forks, 5/31" spacing between forks and 5/16" width overall.

Pass and Seymour

Toggle 1081I

Locking 1081KGRY w/#500 Key

2. Time Switches and Photoelectric Controls for existing construction; use section 26 09 23 for new construction.

- a. Provide time switches with a 7-day, solid-state, electronic type capable of fully automatic or manual operation and housed in a sheet steel enclosure unless built into a panel or switchboard. Contacts rated for 25 amps resistive or inductive, each pole 240 VAC; 5 amps tungsten or 277 VAC pilot duty, each pole 240 VAC. Time switches to contain a non-volatile clock and non-volatile memory with a built-in rechargeable super capacitor power carry-over system. Battery carryover is not acceptable. Provide a minimum of 15 on/off set points per week. Timing to be in one minute increments with a minimum on or off time of one minute. Time switch digital displays to indicate days of week, hours, and minutes. Display to contain a load status light to indicate when equipment is in operation. Time switches; Paragon Model EC7000 Series, Tork Model EW 101B series, Intermatic ET7000 series, or equal. Features required for application:
  - 1) Liquid crystal display panel.
  - 2) Holiday scheduling: Up to 40 dates may be assigned special holiday schedules, up to one year in advance.
  - 3) Automatically adjusts to and from daylight savings time and for leap year.
  - 4) Contact ratings: 10 amp at 240 VAC.
  - 5) Safety override switch for each circuit to either provide shut down of circuit or to override on.
  - 6) Selective review: All or part of schedule shall be displayed at touch of a key.
  - 7) Super Capacitor for power carry over system.
  - 8) Supply voltage: 120 V.
  - 9) 365-day advance scheduling.
- b. Photoelectric control: Shall be rated 2,000 watts, 120V with single pole, single throw, normally closed contact, enclosed in a die-cast aluminum gasketed enclosure with 1/2 inch conduit fitting, Tork series 2100, or equal.

### 3. Emergency Lighting Control Unit

- a. The Emergency Lighting control Unit shall provide all required functionality to allow an standard lighting control device to control emergency lighting in conjunction with normal lighting in any area within a building.
- b. The emergency lighting control unit shall allow control of emergency lighting fixture in tandem with normal lighting in an area while ensuring that emergency lighting will turn on immediately to full brightness upon loss of normal power supplying the control device. Emergency lighting operation shall be independent for each controlled area and shall not require a generalized power failure for proper operation.

- c. The device shall have normally closed dry contacts capable of switching 10 amp emergency ballast loads at 120-277 VAC, 60 Hz, or 2 amp tungsten loads at 120 VAC, 60Hz.
  - d. The device shall have universal rated voltage inputs provided for normal power sense and normal switched power at 120-277 VAC, 60 Hz.
  - e. The device shall provide separate LEDs to indicate the presence of normal and emergency power sources. The LEDs shall indicate the unit's current operational mode (normal or emergency)
  - f. The device's normal power input terminal shall be connected to the line side of the control device such that any upstream fault causing a loss of power, including the tripping of the branch circuit breaker, will force the unit into the emergency mode and turn on the emergency lighting.
  - g. The unit shall automatically switch emergency lighting on and off as normal lighting is switched. When normal power is not available, the unit shall force and hold emergency lighting on regardless of the state of any external control device until normal power is restored.
  - h. Device shall be WattStopper ELCU-100 Emergency Lighting Control Unit, LVS #EPC-PM Series, Lighting Control Design #GR 2001 series or Equal.
4. Station Main Entrance Intercom Station:
- a. Provide Panasonic video intercom system VL-SV30BX (or equal) . locate per plans and install per manufacturer recommendations.
5. Cords and Caps:
- A. Manufacturers:
    - 1. Rome Cable Corporation
    - 2. Hubbell
    - 3. Or equal

Attachment Plug Construction to Conform to NEMA WD 1 match receptacle configuration to outlet provided for equipment.
  - B. Cord Construction: ANSII/NFPA 70, Type SO multiconductor flexible cord with identified equipment -grounding conductor. Suitable for use in damp locations and Suitable for connected load of equipment, length of cord, and rating of branch circuit overcurrent protection.

## 2.3 IDENTIFICATION AND SIGNS

- A. Identification Plates:

1. Provide identification plates for the following unless otherwise specified, for switchboards, unit substations, motor control centers, control panels, push-button stations, time switches, contactors, motor starters, motor switches, panelboards, and terminal cabinets.
2. Identification plates shall be of plastic stock and shall adequately describe function, voltage and phase of identified equipment. Where identification plates are detailed or described on Drawings, inscription and size of letters shall be as indicated. For lighting and power panels, identification plates shall indicate panel designation, voltage, and phase of panel. For terminal cabinets, identification plates shall indicate system contained in terminal cabinet.
3. Identification plates shall be black-and-white nameplate stock of bakelite with characters cut through black exposing white. Plates shall be furnished with beveled edges and shall be securely fastened in place with No. 4 Phillips-head, cadmium-plated steel, self-tapping screws. Characters shall be 3/16 inch high, unless otherwise indicated.

**B. Markings:**

1. Install identification markings to surface-mounted starters, switches, disconnect switches, contactors, and other devices controlling motors and appliances. Provide abbreviations required along with an identifying number. Markings to be provided with locking type stencils using paint of a contrasting color. Figures shall be 3/8 inch high unless otherwise indicated. Dymo Industries Inc., self-sticking plastic labels, with embossed characters made with a typewriter may be installed instead of stencils and paint; p-touch self adhesive plastic, or Brother P-Touch self sticking laminated plastic labels may be installed.
2. High Voltage: High voltage switchboards, cabinets, boxes, and conduits exposed in accessible locations, including under buildings and in attics, are required to be marked "WARNING-HIGH VOLTAGE- ABOVE 600 VOLTS". Markings for switchboards shall consist of 18 gage steel, porcelain enamel sign of standard manufacture. Markings for boxes, cabinets, and conduits shall be by means of stenciling or printed self-adhesive markers, Westline Tel-A-Pipe, or equal. Provide letters of black on orange background and not less than 1-7/8 inches high. On conduit runs, install markings at intervals not exceeding 10 feet in any individual area. Markings shall be installed after other painting Work is complete.

**C. Warning Signs:**

1. Provide a warning sign on outside of each door or gate to rooms or enclosures containing high voltage equipment. Signs required reading, "WARNING - HIGH VOLTAGE - KEEP OUT". Provide 2-inch high lettering.
2. Provide a warning sign on each high-voltage non-load break disconnect and fused cutout (not oil filled). Signs required reading, "DO NOT OPEN UNDER LOAD". Provide 2 inch high lettering.
3. Provide signs of standard manufacture, 18 gage steel, with porcelain enamel finish. Provide red lettering on a white background.

**PART 3 - EXECUTION**

### 3.1 INSTALLATION AND SUPPORT OF BOXES

- A. Install outlet boxes flush with finished surface of wall or ceiling. Install plumb and securely fastened to structure, independent of conduit. Except where otherwise indicated, provide factory-fabricated adjustable attachment bar hangers between studs to support outlet boxes. When installation is performed in fire rated walls, maintain the wall's rating integrity by means of approved fire stop methods.
- B. Outlet boxes installed in suspended or furred ceilings with steel runner or furring channels shall be supported, except where otherwise indicated, by a Unistrut P-4000 Tessco A1200HS-10, Cooper B-Line B22s-HG, or equal channel spanning main ceiling runner channels. Each box shall be supported from its channel by a 3/8 inch 16 threaded steel rod with a Unistrut P-4008, Fastenal #48604, Cooper B-Line 78101140346 or equal nut and a Tomic No. 711-B Adapta-Stud, or equal. Rod shall be tightened to a jamb fit with channel and its nut. Box shall be locked to rod by means of a 1/2 inch locknut on stud and a 3/8 inch 16 hex nut locking stud to rod.
- C. Heights of outlets and equipment indicated on Drawings shall govern. In absence of such indications, following heights shall be maintained with heights measured to centerline unless otherwise noted:
  - 1. Install wall-mounted telephones, light switches, and other switches, 48 inches above finished floor. Refer to other Division 26, 27 and 28 Sections.
  - 2. Outlet boxes for fire alarm pull stations shall be mounted at 45 inches above finished floor to insure that the operating handle of the initiating device is no higher than 48 inches at finished floor. Under no circumstances shall operating handle of the device exceed 48 inches above finished floor regardless of indicated height on drawing.
  - 3. Wall mounted fire alarm strobe or horn/strobe devices shall be mounted such that the entire lens is not less than 80 inches above finished floor. If ceiling heights allow, wall mounted appliances shall have bottom of lens a minimum of 80 inches but not more than 96 inches to the top of lens.
  - 4. Install outdoor fire alarm audible devices or fire alarm sprinkler flow bells at least 10 feet but not more than 12 feet above finished floor to center. Provide STI or equal protective covers for devices when required.
  - 5. Voice evacuation speakers mounted indoors shall be mounted in ceiling space or if mounted on wall shall not be less than 10 feet to center above finished floor.
  - 6. Install clocks and speakers, in classrooms and offices, 8 feet above finished floor. Unless otherwise indicated.
  - 7. In rooms other than places of assembly such as, but not limited to, multipurpose rooms, auditoriums, and libraries, clock outlets and speakers in classrooms and offices shall be mounted 8 feet above finished floors. Other assembly areas such as gymnasiums shall be mounted 10 to 12 feet above finished floor. Provide STI, or equal protective covers for clocks when required.
  - 8. Install fire alarm strobe lights 80 inches to bottom of light above finished floor.

9. Install outside bells and yard light outlets 4 feet above second floor level for 2 or more story buildings, 12 inches below top plate level for one story buildings without covered porch or arcade, and 12 inches below covered porch and arcade ceilings.
10. Install desk telephones, power receptacle outlets, and data outlets 15 inches above finished floor.
11. Install panelboards and terminal cabinets 6 feet 6 inches from finish floor to top of cabinet.
12. Install television outlets at a height corresponding to location of television monitor, or a minimum of 15 inches above finished floor.
13. The use of extension boxes shall be limited to not more than 1 times the original depth of junction box.

### 3.2 COVER PLATES

- A. Provide a plate on each switch, plug, pilot light, data, interphone, public telephone, and television outlet, and on existing and reset outlets where so indicated or required. Plates shall be of stainless steel unless otherwise specified.
- B. Flush wiring device and signal system outlets indicated to be blank covered, shall be covered with blank stainless steel plates. Flush lighting outlets to be blanked shall be covered with Wiremold 5736 steel covers, or equal, painted to match surrounding finish. Provide stainless steel covers to blank indicated or required surface-mounted outlets.
- C. In the following cases, and at required locations. Switch and receptacle plates shall be engraved with the device(s), or fixtures being controlled, or as indicated:
  1. Three-gang and larger gang switches in locations other than classrooms.
  2. Lock switches.
  3. Pilot switches.
  4. Switches so located that operator cannot see fixtures, or items of equipment controlled while his hand is on the switch.
  5. Switches not in same room with fixtures or items of unit heaters, air curtains, fly fans, etcetera.
  6. Receptacles operating at other than 120 V shall be identified with the operating voltage.
  7. Switches operating on 277 V shall be identified with the operating voltage.
  8. Where indicated on Drawings.
- D. Designations shall be as indicated on Drawings or as specified by Architect.

- E. Standard GFI cover plates shall be Pass & Seymour 4600, Raco 5028-0, or equal. GFI cover plates shall be provided with a CAM lock mechanism with two keys or a padlock hasp that does not protrude through the face of the cover and will allow the shank of locks keyed Corbin No. 60 keys.

### 3.3 IDENTIFICATION OF CIRCUITS AND EQUIPMENT

- A. Provide descriptive nameplates or tags permanently attached to switchboards, motor control centers, transformers, panelboards, circuit breakers, disconnect switches, starters, pushbutton control stations and other apparatus installed for operation or control of circuits, appliances, fire alarm control panel(s), fire alarm annunciator(s), power supplies, terminal cabinets, energy management control units, and Information technology system backbone and distribution equipment points.
- B. Provide nameplates of engraved laminated plastic, or etched metal. Submit Shop Drawings denoting dimensions and format to Architect before installation. Fasten to equipment with escutcheon pins, rivets, self-tapping screws, or machine screws. Self-adhering or adhesive backed nameplates are not permitted.
- C. Fasten tags to feeder wiring in conduits at every point where runs are broken or terminated, including pull wires in empty conduits. Indicate circuit, phase, and function. Tag branch circuits in panel boards and motor control centers. Tags may be manufactured of pressure-sensitive plastic or embossed self-attached stainless steel or brass ribbon.
- D. Provide circuit identification cards and cardholders in all panel boards. Cardholders shall consist of metal frame retaining a clear plastic cover permanently attached to inside of panel door. List of circuits shall be typewritten on a card. Circuit description shall include name or number of circuit, area and connected load.
- E. Junction and pull boxes shall have covers stenciled with box number when indicated on Drawings, or circuit numbers according to panel schedules. Data shall be lettered in a conspicuous manner with a color contrasting with finish.
- F. Name shall be correctly engraved, with a legend indicating function or areas, when required by codes or indicated on Drawings.

### 3.4 PROTECTION

- A. Protect Work of this section until Substantial Completion.

### 3.5 CLEANUP

- A. Remove rubbish, debris, and waste materials and legally dispose of off Project site.

END OF SECTION

## SECTION 26 05 19

### LOW-VOLTAGE WIRES (600 VOLT AC)

#### PART 1 - GENERAL

##### 1.1 SUMMARY

- A. Provisions of Division 01 apply to this section.
- B. Section Includes: Low-voltage wire, splices, terminations and installation.

##### 1.2 SUBMITTALS

- A. Provide in accordance with Division 01.

#### PART 2 - PRODUCTS

##### 2.1 WIRES

- A. Wires shall be single conductor type THHN, THWN or THWN-2 insulated with polyvinyl chloride and covered with a protective sheath of nylon, rated at 600 volts. Wires may be operated at 90 degrees C. maximum continuous conductor temperature in dry locations, 90 degrees C. in wet locations for sizes 8 AWG and larger and 75 degrees C in wet locations for sizes 10 AWG and smaller, and shall be listed by UL Standard 83 for thermoplastic insulated wires, listed by Underwriter's Laboratories (UL) for installation in accordance with Article 310 of the California Electrical Code (CEC). Conductors shall be solid copper for 12 AWG and smaller conductors, and stranded copper for 10 AWG and larger conductors. Conductors shall be insulated with PVC and sheathed with nylon. Wires shall be identified by surface markings indicating manufacturer's identification, conductor size and metal, voltage rating, UL symbol, type designations and optional rating. Indentations for lettering are not permitted. Wires shall be tested in accordance with the requirements of UL standard for types THWN-2, THWN or THHN.
- B. Conductors shall be solid Class B or stranded Class C, annealed uncoated copper in accordance with UL standards, or another Nationally Recognized Testing Laboratory (NRTL).

##### 2.2 STANDARDS

- A. THWN/THHN and THWN-2/THHN wires shall comply with the following standards:
  - 1. UL 83 for thermoplastic insulated wires.
  - 2. UL 1063 for machine tool wires and cables.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Wires shall not be installed until debris and moisture is removed from conduits, boxes, and cabinets. Wires stored at the site shall be protected from physical damage until they are installed and walls are completed.
- B. Wire-pulling compounds furnished as lubricants for installation of conductors in raceways shall be compounds approved and listed by UL, NRTL, or equal. Oil, grease, graphite, or similar substances are not permitted. Pulling of 2 AWG or larger conductors shall be performed with a cable pull machine. Any runs shorter than 50 feet are exempt. When pulling conductors, do not exceed manufacturer's recommended values.
- C. The Project Inspector will observe installation of feeder cables. Notify the Project Inspector not less than two working days in advance of the proposed time of feeder installation.
- D. At outlets for light, power, and signal equipment, provide pigtail splices with 8-inch circuit conductor leads for connection to fixtures, equipment, and devices.
- E. Pressure cable connectors, pre-insulated 3M Scotchlok, Hubbell Power, O-Z/Gedney or equal, Y, R or B spring-loaded twist-on type, may be furnished in splicing number 8 AWG or smaller wires for wiring systems, except public address and telephone systems.
- F. Joints, splices, taps, and connections to switchboard neutral, bonding or grounding conductors, conductors to ground busses, and transformer connections for wires 6 gage and larger shall be performed with high-pressure cable connectors approved for installation with copper conductors. Connectors shall be insulated with heavy wall heat shrink WCSM, or cold-applied roll-on sleeve RVS. Insulation level shall be a minimum of 600V and joints, splices, and taps shall be qualified to ANSI C 119.1, UL, NRTL, or equal listed mechanical pressure connections.
- G. Connections to any bussing and high-pressure cable connectors shall be securely bolted together with corrosion-resistant plated carbon steel, minimum grade five machine screws secured with constant pressure-type locking devices.
- H. Connection of any bonding or grounding conductors shall be securely bolted together with corrosion-resistant plated carbon steel, minimum grade five machine screws secured with constant pressure-type locking devices.
- I. Wire switchboards, panel cabinets, pull boxes, and other cabinets except public address, shall be neatly grouped and tied in bundles with nylon ties at 10-inch intervals. In switchboards, panels and terminal blocks, wires shall be fanned out to terminals. If bundles are longer than 24 inches, a maximum of nine current carrying conductors may be bundled together.
- J. Install conductor lengths with a minimum length within the wiring space. Conductors must be long enough to reach the terminal location in a manner that avoids strain on the connecting lug.
- K. Maintain the conductor required bending radius.
- L. Neutral conductors larger than 6 gage, which are not color identified throughout their entire length, shall be taped, painted white or natural gray, or taped white where they appear in

switchboards, cabinet, gutters or pull boxes. Neutral conductors 6 gage and smaller shall be white color identified throughout their entire length.

- M. Fire alarm and clock wiring shall be continuous from terminal cabinets or from equipment to each device. Splices are not permitted between devices and/or terminal cabinets at junction and pull boxes. Wiring shall be terminated at terminal blocks or devices only.
- N. Wiring systems shall be free from short circuits and grounds, other than required grounds. The contractor shall be responsible for the testing of feeder and branch circuit conductor's insulation resistance. The insulation of the conductors shall be tested prior to connections to any panelboards, switchboards, variable frequency drives, lighting control systems, ballasts, and wiring devices such as but not limited to GFI receptacles, TVSS receptacles, or equipment. Insulation testing of panelboards and switchboards shall be independently performed from the insulation testing of any conductors as specified in other sections of this specification.
  - 1. Utilize the services of an approved independent testing laboratory to perform megger time-resistance insulation testing of feeder conductors. Tests must be conducted with wires disconnected at both ends.
    - a. Provide calibration program records to assure the testing instrument to be within rated accuracy. The test equipment accuracy shall be in accord with the requirements stated by the National Institute of Standards and Technology (NIST).
    - b. Test equipment shall be provided with a label stating the date of last calibration. As a minimum the equipment shall have been calibrated within the past 12 months.
    - c. Test reports shall include the following:
      - 1) Identification of the testing organization.
      - 2) Equipment identification.
      - 3) Ambient conditions.
      - 4) Identification of the testing technician.
      - 5) Summary of project.
      - 6) Description of equipment being tested.
      - 7) Description of tests.
      - 8) Test results.
      - 9) Analysis, interpretation and recommendations.
  - 2. Utilize the services of an approved independent testing laboratory or a qualified contractor's employee (Technician certified in accordance with ANSI/NETA ETT-2000 Standard for Certification of Electrical Testing Personnel) to perform megger time-resistance insulation testing of branch circuit conductors. Tests must be conducted with wires disconnected at both ends.

- a. Test equipment and report requirements stipulated under paragraph 3.01.N.1 apply to branch circuit testing.
- 3. Tests shall be performed in the presence of the Project Inspector.
- 4. Insulation resistance shall not be less than 100 mega-ohms.

3.2 COLOR CODES

A. General Wiring:

- 1. Color code conductor insulation as follows:

SYSTEM VOLTAGE		
Conductor	208Y/120	480Y/277
Phase A	Black	Brown
Phase B	Red	Orange
Phase C	Blue	Yellow
Neutral	White	Natural Gray

Neutrals shall be colored-distinguished if circuits of two voltage systems are used in the same raceway.

- 2. For phase and neutral conductors 6 gage or larger, permanent plastic-colored tape may be furnished to mark conductor end instead of coded insulation. Tape shall cover not less than 2 inches of conductor insulation within enclosure.

B. Signal Systems: Wires for signal systems shall be color-coded and installed under observation of the Project Inspector. Except where otherwise specified, color-coding shall be as follows:

- 1. Fire Alarm Systems:
  - a. Notification Devices (Signal Loop Circuits )  
Strobes: Red = Positive, Black = Negative  
Horns: Red = Positive, Black = Negative
  - b. Initiating Devices (Alarm Loop Circuits):  
Pull Stations: Yellow and Blue  
Smoke Detectors (Circuit): Orange and Brown  
Thermal Detectors (Circuit): Orange and Brown  
Air Duct Smoke Det. (Circuit): Purple and Gray
  - c. Initiating Device (Power Circuit): Red = Positive, Black = Negative.
  - d. Interlocks: Red = Positive, Black = Negative
  - e. AC Power: Black and White

All underground wiring to be XHHW insulation rated for wet location.

2. Program Clock Circuits:

- a. Clocks: Run Black (Label - CRUN)  
Reset Red (Label - CRST)  
Common = White (Label - - CC)
- b. Program Bells: Pink 1st Period (Label - PB1P)  
Pink 2nd Period (Label - PB2P)  
Pink 3rd Period (Label - PB3P)  
Pink 4th Period (Label - PB4P)  
Pink = 5th Period (Label - PB5P)  
Pink 6th Period (Label - PB6P)  
Common = White (Label - PBC)
- c. Night Lights: Brown = N.L. On (Label - NLON)  
Brown = N.L. Off (Label - NLOFF)  
Common White (Label - NLC)
- d. Heat: Purple Heat On (Label - HON)  
Purple Heat Off (Label - HOFF)  
Common White (Label - HC)
- e. Toilet Flush: Yellow Flush On (Label - TFON)  
Common White (Label - TFC)

3. Additional requirements:

- a. All existing outside bells to be identified and labeled on and at each terminal block.
- b. All existing classroom buzzers to be identified and labeled on and at each terminal block.
- c. All existing relays located at the master clock to be identified and labeled as to what it controls. Each relay shall be labeled by the use of a white label and black lettering.
- d. All wires shall be identified and labeled by the use of white shrink wrap, with black lettering on each end of each wire.
- e. All wires shall be placed neatly and tie wrapped into each terminal cabinet, and each terminal block shall be marked as to what circuits it has on it (i.e. Fire Alarm, Clock, program bells, etc.)

3.3 FEEDER IDENTIFICATION

- A. Feeder wires and cables shall be identified at each point the conduit run is broken by a cabinet, box, gutter, etc. Where terminal ends are available, identification shall be by means of heat shrink wire markers, which provide terminal strain relief. Markers shall be by Tyco Electronics, Panduit, Brady Perma-Sleeve, or equal. Identification in other areas shall be by means of wrap-around tape markers from Tyco Electronics, Panduit, Brady Perma-Code or equal. Markers shall include feeder designation, size, and description.

### 3.4

#### TAPE AND SPLICE KITS

- A. Splices, joints, and connectors joining conductors in dry and wet locations shall be covered with insulation equivalent to that provided on conductors. Free ends of conductors connected to energized sources shall be taped. Voids in irregular connectors shall be filled with insulating compound before taping. Thermoplastic insulating tape approved by UL, NRTL, or equal for installation as sole insulation of splices shall be furnished and shall be installed according to manufacturer's printed specifications.

3.5 TAGGING

- A. General: Install identification markers on ungrounded conductors of all circuits, in switchboards, panel boards, pull, junction and outlet boxes, lighting fixtures, switches, receptacles and other terminating enclosures. Grounded circuit conductors shall have identification markers in switchboards, panel boards, and all enclosures where more than one circuit grounded circuit conductor is installed. Identification shall include switchboard, panel board, or other source and circuit number. Tags shall be 3M Co. "Scotchcode" " write-on tape or shall be premarked with self-adhesive wraparound type EZ Code, Brady.
- B. Tagging: Conductors shall be lagged in each junction box, pull box, wireway or auxiliary gutter and at each device, motor outlet, panel board, switchboard or other conductor termination. Tag shall show feeder number, size. Phase and origin

3.6 MISCELLANEOUS (AS APPLICABLE)

- A. Make all branch circuit and fixture joints for #10 AWG and smaller wire with UL approved connectors, listed for 600 volts. Provide Minnesota Mining and Manufacturing Co. insulated "Scotchlocks,", Ideal Co. "Wing-Nut", or T & B Burndy Co. "Piggy" connectors.
- B. Make all branch circuit joints of #8 AWG and larger with screw pressure lugs, and insulate with electrical tape to 150% of the insulating value of the conductor insulation.
- C. Tape all connections made with non-insulated type connectors with half-lapped, rubber-type tape, to 1-1/2 times the thickness of the conductor insulation, then cover with Scotch #33 tape.
- D. Each circuit must correspond to the branch circuit number indicated on the panel schedule shown on the drawings except where departures are approved by the Engineer.
- E. Neatly group or tape together wiring within equipment enclosures.
- F. Where conductors in conduit pass through exterior walls, a sealing compound of moisture-resistant material shall be applied in the ends of the conduits to seal around the conductors.
- G. Megger tests shall be taken on all feeder conductors and on all conductors for motors over 15 HP. Tests shall be made in presence of the District's representative and prior to connection of equipment. Written reports of results shall be submitted to the Engineer. Conductors testing below manufacturers standard shall be replaced at no expense to the owner.

3.7 PROTECTION

- A. Protect the Work of this section until Substantial Completion.

3.8 CLEANUP

- A. Remove rubbish, debris and waste materials and legally dispose of off the Project site.

END OF SECTION

## SECTION 26 05 26

### GROUNDING AND BONDING

#### PART 1 - GENERAL

##### 1.1 SUMMARY

- A. Section Includes: Provide and install grounding system as indicated or required.
- B. Related Requirements:
  - 1. Refer to related sections for their system grounding requirements.
  - 2. Section 26 05 00: Common Work Results for Electrical.
  - 3. Division 27: Communications.

##### 1.2 QUALITY ASSURANCE

- A. Reference Standards:
  - 1. IEEE 142 Green Book.
  - 2. Underwriter's Laboratories (UL).
  - 3. California Electrical Code.
  - 4. Building Industry Consultant Services International (BICSI) (Signal).
  - 5. EIA/TIA (Signal and power).
  - 6. Nationally Recognized Testing Laboratory (NRTL) or equal.
  - 7. Motorola R56 Standards.

##### 1.3 SYSTEM DESCRIPTION

- A. Metallic objects on the Project site that enclose electrical conductors, or that are likely to be energized by electrical currents, shall be effectively grounded.
- B. Metal equipment parts, such as enclosures, raceways, and equipment grounding conductors, and earth grounding electrodes shall be solidly joined together into a continuous electrically conductive system.
- C. Metallic systems shall be effectively bonded to the main grounding electrode system.
- D. A separately derived AC source shall be grounded to the equipment grounding conductor, and to separate "made" electrode of building grounding electrode system.
- E. Electrical continuity to ground metal raceways and enclosures, isolated from equipment ground by installation of non-metallic conduit or fittings, shall be provided by a green insulated grounding conductor of required size within each raceway connected to isolated metallic

raceways, or enclosures at each end. Each flexible conduit shall be provided with a green insulated grounding conductor of required size.

- F. Cold water, UFER ground or other utility piping systems, shall not be utilized as grounding electrodes due to the installation of insulating couplings and non-metallic pipe in such installations. In addition to bonding to cold water pipe provide at least one of the following made grounding electrodes:
1. A dedicated "made" electrode, fabricated of at least 20 feet of galvanized 1/2 inch diameter rebar encased by at least two inches of concrete, and placed next to the bottom of a concrete foundation, or footing in direct contact with earth. A welded extended portion shall surface at the location of the common grounding electrode bus bar and be extended by a 3/0 CAD welded bare copper cable, or be CAD welded directly to the bus. The CAD weld shall be at least four inches above finished floor in a dry location. The main grounding electrode and associated grounding conductors shall be in an enclosure and in conduit.
  2. Grounding electrodes as specified hereafter in this section.
  3. Concrete enclosed electrode, fabricated of at least 20 feet of No. 2 AWG, minimum size, bare copper conductor, encased by at least two inches of concrete, located within or near bottom of a concrete foundation, or footing, which is in direct contact with earth. Footing rebar shall be connected to copper wire with approved connectors. An external electrode, as specified hereafter or as required by the CEC, shall be installed and connected to foundation or footing rebar.
- G. Non-current carrying metal parts of high-voltage equipment enclosures, signal and power conduits, switchboard and panelboard enclosures, motor frames, equipment cabinets, and metal frames of buildings shall be permanently and effectively grounded. Provide a CEC sized grounding conductor in every raceway.
- H. Metallic or semi-conducting shields and lead sheaths of cables operating at high voltage, shall be permanently and effectively grounded at each splice and termination.
- I. Neutral of service conductors shall be grounded as follows:
1. Neutral shall be grounded at only one point within the Project site for that particular service. Preferable location of grounding point shall be at the service switchboard, or main switch.
  2. Equipment and conduit grounding conductors shall be bonded to that grounding point.
  3. If other buildings or structures on the Project site are served from a switchboard or panelboard in another building, power supply is classified as a feeder and not as a service.
  4. Equipment grounding conductor is installed from switchboard to each individual building. At building, grounding conductor is bonded with power equipment enclosures, metal frames of building, etc., to "made" electrode for that building.
  5. Feeder neutrals shall be bonded at service entrance point only, neutrals of separately derived systems shall be bonded at the source only.
- J. If there is a distribution transformer at a building the secondary neutral conductor shall be grounded to "made" electrode serving the building.

- K. Within every building, the main switchboard or panelboard, shall be bonded to the cold water line. Metallic piping systems such as gas, fire sprinkler, or other systems shall be bonded to the cold water line.

#### 1.4 SUBMITTALS

- A. Provide in accordance with Division 01.

### **PART 2 - PRODUCTS**

#### 2.1 MATERIALS

- A. Furnished yard boxes shall be precast concrete and shall be approximately 14 inches wide by 19 inches long by 12 inches deep or larger, if necessary to obtain required clearances. Boxes shall be furnished with bolt-down, checkered, cast iron covers and cast iron frames cast into boxes. Yard boxes shall be Jensen Precast, Oldcastle Precast, Western Precast, Kistner, or equal.
- B. "Made" electrodes shall be copper-clad steel ground rods, minimum 3/4 inch diameter by ten feet long.

### **PART 3 - EXECUTION**

#### 3.1 INSTALLATION

- A. Grounding electrodes shall be installed in the nearest suitable planting area, where not otherwise indicated on Drawings, and each electrode shall terminate within a concrete yard box installed flush with finish grade. In planting areas, finish elevation of concrete yard boxes shall be two inches above planting surfaces.
- B. If concrete enclosed electrode is provided, grounding wire shall be terminated to a suitable copper plate with grounding lugs and must be enclosed in a raceway or box..
- C. Grounding rods shall be driven to a depth of not less than eight feet. Permanent ground enhancement material, (GEM) as manufactured by Erico Electrical Products, Loresco Powerset, Tessco Ultrafil or equal, shall be installed at each ground rod to improve grounding effectiveness. Install in accordance with manufacture's installation instructions.
- D. Grounding electrodes shall provide a resistance to ground of not more than 25 ohms.
- E. When installing grounding rods, if resistance to ground exceeds 25 ohms, two or more rods connected in parallel, or coupled together shall be provided to meet grounding resistance requirements.
- F. Ground rods shall be separated from one another by not less than ten feet.
- G. Parallel grounding rods shall be connected together with recognized fittings and grounding conductors in galvanized rigid steel conduit, buried not less than 12 inches below finish grade.

#### 3.2 TESTING

- A. Provide the services of an approved independent testing laboratory to test grounding resistance of "made" electrodes, ground rods, bonding of building steel, water pipes, gas pipes and other utility piping. Tests shall be performed as follows:

1. Visually and mechanically examine ground system connections for completeness and adequacy.
  2. Perform fall of potential tests on each ground rod or ground electrode where suitable locations are available per IEEE Standard No. 81, Section 8.2.1.2. Where suitable locations are not available, measurements will be referenced to a known dead earth or reference ground.
  3. Perform the two point method test per IEEE No. 81, Section 8.2.1.1 to determine ground resistance between ground rod and building steel, and utility piping - such as water, gas and panelboard grounds. Metal railings at building entrances and at handicapped ramps shall also be tested.
  4. Test shall be performed in the presence of the Inspector.
- B. Submit 3 copies of test results to the Architect. Test results shall be submitted on an official form from the independent testing laboratory recording Project location, test engineer, test conditions, test equipment data, ground system layout or diagram, and final test results.

3.3 PROTECTION

- A. Protect the Work of this section until Substantial Completion.

3.4 CLEANUP

- A. Remove rubbish, debris, and waste materials and legally dispose of off the Project site.

END OF SECTION

## SECTION 26 05 33

### RACEWAYS, BOXES, FITTINGS, AND SUPPORTS

#### PART 1 - GENERAL

##### 1.1 SUMMARY

###### A. Section Includes:

1. Raceways and wire ways.
2. Conduit installation.
3. Underground requirements.

###### B. Related Requirements:

1. Section 26 05 00: Common Work Results for Electrical.
2. Section 26 05 13: Basic Electrical Materials and Methods.
3. Division 27: Communications.
4. Division 28 - Electronic Safety and Security.

###### C. Applicable Standards and Codes.

1. EIA/TIA 569 Standards.
2. National American Standards Institute (ANSI).
3. National Electrical Manufacturer's Association (NEMA).
4. Nationally Recognized Testing Laboratory (NRTL).
5. California Electrical Code (CEC).
6. Uniform Building Code (UBC).
7. Underwriters Laboratory (UL).

##### 1.2 SUBMITTALS

- ###### A. Materials List: Provide in accordance with Division 01.

## PART 2 - PRODUCTS

### 2.1 RACEWAYS

#### A. Conduit Materials:

1. Metallic conduit, and tubing shall be manufactured under the supervision of an UL, or another NRTL factory inspection and label service program. Each ten-foot length of conduit and tubing shall bear the UL or another NRTL label and manufacturer's name.
2. Rigid metallic conduit shall be rigid steel, heavy wall, mild steel, zinc-coated, with an inside and outside protective coating manufactured in accordance with ANSI C 80.1. Couplings, elbows, bends, conduits, bushings and other fittings shall be the same materials and finish as the rigid metallic conduit. Fittings, connectors, and couplings shall be threaded type, manufactured in accordance with ANSI C 80.1 and UL 6.
3. Electrical metallic tubing shall be steel tubing, zinc-coated with a protective enamel coating inside, manufactured in accordance with NEMA C 80.3. Fittings, couplings, and connectors shall be gland compression type, set screw couplings and connectors not permitted. All parts shall be manufactured in accordance with NEMA C80.3 and UL 6A Electrical metallic tubing is designated hereinafter as EMT. Steel and rain tight fittings shall be approved and listed for the intended application.
4. Flexible steel conduit shall be of flexible interlocking strip construction with continuous zinc coating on strips, manufactured in accordance with UL 1.
  - a. Connectors and couplings shall be required fittings of the type, which threads into convolutions of flexible conduit.
5. Liquid-tight flexible metal conduit shall be galvanized heavy wall, flexible locked steel strip construction, UV rated, with smooth moisture and oil-proof, abrasion-resistant, extruded plastic jacket. Connectors shall be as required for installation with liquid-tight flexible conduit and shall be installed to provide a liquid-tight connection.
6. Non-metallic conduit shall be rigid PVC electrical conduit extruded to schedule 40 dimensions of Type II. Grade 1 high impact, polyvinyl chloride, sweeps, couplings, reducers and terminating fittings shall be listed under the UL, or another NRTL, and shall bear the manufacturer's listed marking.
7. Multi-cell raceway shall be four inch PVC, Type 40, UL or another NRTL listed for underground use with optical fiber and signal system cables. Raceway shall be furnished with 3-1/2 inch factory installed inner ducts with required internal spacers, and required couplers, sweeps, and end bells. Multicell raceway shall be Carlon Multigard, or District approved equal.
8. Metal Clad (MC) cable system is not allowed.

- #### B. Sleeves for Conduits:
- Sleeves shall be adjustable type by Carlon, U.S. Plastic, PEP Plastic or equal.

- C. Where conduit enters a building through a concrete foundation below grade, or ground water level, or where it is necessary to seal around a conduit where it passes through a concrete floor or wall, provide O-Z/Gedney Type FSK Thru Wall and Floor Seal, equivalent Cooper Crouse Hinds Thru-Wall, Legrand Thru-Wall, or equal.
- D. Expansion Joints-Seismic Separations between building(s) and other locations as indicated on drawings:
1. Provide Thomas & Betts XJG-TB, O-Z/Gedney type AX with bonding strap and clamps, Cooper XJGD or equal. At exterior locations, provide Thomas & Betts XJG-TB, O-Z/Gedney type EX, Cooper XJGD, or equal. Provide O-Z/Gedney type AXDX, or equal combination deflection/expansion fittings at all seismic separations. Provide manufacture's internal and external bonding jumpers at all locations. Liquid-tight metal conduit or flexible metal conduit shall not be approved at expansion joints, separations between buildings or seismic separations.
  2. Provide expansion fittings at intervals not exceeding 100 feet in conduits exposed to direct sunlight. Fittings may be installed in the conduit run or where conduit attaches to junction or pull boxes. OZ/Gedney type AX, TX or EXE series, or equivalent by Thomas and Betts, Crouse-Hinds or approved equal.
- E. Conduit Seal Fittings:
1. Provide conduit seal fittings where indicated on the Drawings. Conduit seals shall be of rigid galvanized steel. Seals in horizontal conduit installations shall be Thomas & Betts EYS, Appleton Type ESU, Crouse Hinds Type EYS, or equal. Seals in vertical conduit installations shall be Thomas & Betts EYD, Appleton Type SF, Crouse Hinds Type EYD, or equal, with continuous drain. When installing conduit seals make provision for percent fill space reduction in accordance with CEC.
  2. Install sealing compound after wire has been installed. Ensure drain is not blocked in vertical seals when installing compound. Where conduit seals are installed in hazardous area applications, there shall be no conduit coupling, fitting, etc., between seal and boundary of hazardous area.
- F. Surface Steel Raceway:
1. The surface steel raceway system for branch circuit wiring, data network, voice, video, and other low voltage wiring shall be as manufactured by the Wiremold Company, Hubbell, or Mono-Systems, Inc. or equal. The raceway system may be supplied pre-wired in accordance with all sections of these specifications and requirements herein, and shall be UL or another NRTL listed. Computer data installation shall be as required by other sections of this Division.
    - a. If furnished pre-wired, the system must be listed in accordance with UL or another NRTL for "Multiple Outlet Assemblies" and so labeled on interior of the assembly. The pre-wired installation must contain no extra wire splices in the raceway as compared to a contractor assembled installation assembled from components. The pre-wired steel raceway shall be Hi-Pot tested at the factory to prevent any potential bare wire or shot circuit defects.

2. The raceway base, cover, and device bracket shall be manufactured of steel and finished in ivory, gray enamel or custom colors suitable for field painting to match adjacent finishes.
3. The raceway shall be a two-piece design with a metal base and snap-on metal cover, except for the Wiremold V700 system, Hubbell HBL750 series and Mono-Systems Inc. S145-700 series that shall be a one-piece design. The base and cover sections shall be a minimum of 0.040 inch wall thickness. The base section shall be available in ten-foot lengths. A hand-operated cutting tool shall be available for the base and cover to ensure clean, square cuts. Wiremold V500, Hubbell V500, and Mono Systems inc. SM500 series are not permitted.
4. A full complement of fittings shall be furnished, including but not limited to, flat internal and external elbows, tees, entrance fittings, wire clips, cover clips, couplings, support clips, C-hangers and end caps. The fitting color shall match the raceway color. Fittings shall be supplied with a base where indicated and/or required. A take-off fitting shall be furnished as required to adapt to existing flush wall boxes.
5. Device brackets shall be furnished for mounting single or two-gang devices within the raceway. Devices shall be provided with the ability of mounting flush or in conjunction with standard steel, stainless steel, or manufacturer's metal faceplates.
6. The raceway shall be furnished with a complete line of connectivity outlets and modular inserts for unshielded twisted pair including category 5, fiber-optic, coaxial, and other cabling types with face plates and bezels to facilitate installation. Computer data installation shall be as required by other sections of this Division, and Division 27.
7. Raceway shall be furnished with corner elbows and tee fittings to maintain a cable bend radius which meets the requirements of fiber-optic and copper cables under EIA/TIA 569 for communications pathways.

G. Factory Pre-Wired Surface Metal Raceway:

1. Furnish and install pre-wired surface metal raceways as indicated on Drawings and as specified.
2. Metal Raceway shall be galvanized steel Wiremold V4000, Hubbell 4000 series, or Mono-Systems Inc. SMS-4000 series complete with raceway base, cover, fittings, receptacles and mounting plates required for a complete assembly. Raceway shall have two wiring compartments with integral dividing barrier for isolating the wiring compartments.
3. Pre-wired assembly shall be UL, or another NRTL listed as a multi-outlet assembly and surface raceway as labeled on interior of assembly.
4. Wiring devices and other components shall be factory installed, electrically wired and covers labeled as indicated on drawings. Each receptacle shall be identified with panelboard and circuit number from which it was fed. Grounding shall be maintained by means of factory installed grounding conductors.

5. Where shown on Drawings, Raceway covers shall have provisions for mounting computer data outlets.
  6. Complete assembly is to consist of required fittings such as elbows, slide couplings for joining raceway sections, blank end caps and flat tees.
  7. Prewired assembly must contain no wire splices.
  8. Receptacles and wiring shall be as indicated on drawings and as specified.
  9. Where raceway is used for power and computer data outlets, installation of data outlets shall be as required by other sections of this specification.
  10. Prior and during installation, verify and comply with manufacturer's installation instructions.
  11. Entire assembly shall be tested for shorts, opens, ground faults, and wire insulation at factory and certified. Raceways shall be electrically continuous and bonded in accordance with California Electrical Code.
  12. Submit shop drawings for approval showing the complete layout of all components of each raceway, raceway lengths, each component description, location and circuit identification.
  13. All wiring devices shall be removable without requiring disassembly of wireway.
  14. Standard non OEM wiring devices shall be used as specified in District's specifications.
- H. Wireways shall be 16 gage galvanized steel enclosed hinge/screw wiring troughs, surface metal raceway, wireway, and auxiliary gutter designed to enclose electrical wiring. Wireway fittings shall be furnished with removable covers and sides to permit complete installation of conductors throughout the entire wireway run. Cover shall be furnished with keyhole slots to accept captive screws locking the cover securely closed. Wireways shall be UL or another NRTL listed, and shall be Square D Type LDB NEMA-1 enclosure for interior applications, or Type RDB NEMA-3R enclosure for exterior applications, or equal by Cooper B-line, Hoffman, Wire Guard, or Circle AW.
- I. Penetration in Fire-Rated Structures: Provide 3M, or equal, sealant and fire barriers for installing fire-rated seals around penetrations through floors, walls, and elevator hoistways. Fire stop system must be UL, or another NRTL listed, and classified for through-penetration applications of metallic conduits and busways.
- J. Pull Wires: Install 1/8 inch polypropylene cords in empty or spare conduits.

### **PART 3 - EXECUTION**

#### **3.1 CONDUIT INSTALLATION**

- A. General Requirements:

1. Provide complete and continuous systems of rigid metallic conduit, outlet boxes, junction boxes, fittings and cabinets for systems of electrical wiring including lighting, power, and signal systems, except as otherwise specified.
2. EMT may be installed in interior concealed applications and in areas approved by owner. EMT shall not be installed in concrete, directly buried underground, outdoors, in boiler rooms, elevator pits, or where subject to damage.
3. Within buildings, flexible steel conduit may be installed instead of rigid steel conduit where permitted by code. Flexible steel conduit shall be installed:
  - a. For continuous lengths not exceeding more than 50 feet between pull points (pull boxes, outlet boxes, etcetera).
  - b. With no maximum total raceway length located within a building interior when the flex is located in concealed locations.
4. Flexible Steel conduit shall not exceed 1-1/2 inches in size.
5. Liquid-tight flexible steel conduit shall only be installed, except where otherwise specified, for final connection of motor terminal boxes, shop equipment, cafeteria equipment, HVAC equipment and other equipment, or for frequent interchange, and shall be of sufficient length, not exceeding 36 inches, to permit full travel or adjustment of motor on its base. Liquid-tight flexible conduit shall not be used for equipment not requiring adjustment or frequent interchange.
6. Connectors for flexible metal conduit shall be made of steel, and of the types which threads into convolutions of conduit. Connectors for watertight flexible metal conduit shall be as required for installation and shall be installed to provide a watertight connection.
7. Exposed conduit shall be installed vertically and horizontally following the general configuration of the equipment, using cast threaded hub conduit fittings where required and shall be clamped to equipment with suitable iron brackets and one hole pipe strap.
8. If connection is from a flush wall-mounted junction box, install an approved extension box.
9. Underground feeder distribution conduits for systems may be non-metallic conduit instead of rigid conduit except where otherwise specified or indicated.
10. Conduit shall be concealed unless otherwise indicated. Conduits exposed to view, except those in attic spaces and under buildings, shall be installed parallel or at right angles to structural members, walls, or lines of building. Conduits shall be installed to clear access openings.
11. Bends or offsets will not be permitted unless absolutely necessary. Radius of each conduit bend or offset shall be as required by ordinance. Bends and offsets shall be performed with standard industry tools and equipment or may be factory fabricated bends or elbows complying with requirements for radius of bend specified. Heating of metallic conduit to facilitate bending is not permitted. Public telephone conduit bends

and offsets shall be provided with a radius which is not less than ten times trade size of conduit unless otherwise permitted. Refer to underground installation, specified in this section, for radius of bends and offsets required for underground installations.

12. Running threads are not permitted. Provide conduit unions where union joints are necessary. Conduit shall be maintained at least six inches from covering of hot water and steam pipes and 18 inches from flues and breechings. Open ends of conduits shall be sealed with permitted conduit seals during construction of buildings and during installation of underground systems.
13. Expansion Joints/Seismic Separations/Separations between buildings/Locations Indicated: Provide Thomas & Betts XJG-TB, O-Z Electrical Mfg. Co. Inc. Type AX with bonding strap and clamps, Crouse Hinds XJGD, or equal. At exterior locations, provide Thomas & Betts XJG-TB, O-Z Electrical Mfg. Co. Inc. Type EX, Crouse Hinds XJGD, or equal. Provide Crouse Hinds, Thomas & Betts, or O-Z Electrical Mfg. Co. Type AXDX, or equal Combination Deflection/Expansion Fittings at all seismic separations. Provide manufactures internal and external Bonding Jumpers at all locations. Liquid-tight flexible conduit shall not be approved at expansion joints or seismic separations.
14. Where conduits are terminated in groups at panelboards, switchboards, and signal cabinets, etc., provide templates or spacers to fasten conduits in proper position and to preserve alignment. Conduits terminating at signal cabinets shall only enter cabinets in the following locations:
  - a. Conduits entering top, side, and bottom of cabinets shall be aligned in a single row, centered two inches from rear of cabinet.
  - b. Conduits entering back of cabinet shall be aligned in a single row centered two inches from top of cabinet.
  - c. Conduits shall not be spaced closer than three inches on centers.
15. Conduits above metal lath ceilings shall be rigidly suspended with pipe hangers or pipe racks or shall be secured to superstructure with factory fabricated pipe straps. Conduits in metal lath or steel stud partitions shall be tied to furring channels or studs. In ceiling spaces and in partitions, tie wires shall be spaced not more than 5 feet apart, shall fasten conduit tight against channels and studs at point of tie and shall not support any of conduit weight. Tie wire shall be 16 gage galvanized double annealed steel.
16. Where auxiliary supports, saddles, brackets, etc., are required to meet special conditions, they shall be fastened rigid and secure before conduit is attached.
17. Conduit in ceiling spaces, stud walls, and under floors, shall be supported with factory fabricated pipe straps or shall be suspended with pipe hangers or pipe racks. Pipe straps shall be attached to and shall fasten conduit tight at point of support against ceiling and floor joists, rafters, and wall studs, or two-inch x four-inch headers fitted between joists or wall studs.
18. Conduits installed on exposed steel trusses and rafters shall be fastened with factory fabricated conduit straps or clamps, which shall fasten conduit tight against supporting member at point of support.

19. Conduits installed under buildings shall be strapped with factory fabricated conduit straps to underside of concrete floor or joists, or wood floor joists, or shall be suspended with pipe hangers or pipe racks. Conduits under building are not permitted to be placed directly on grade; they shall be suspended from building or shall be buried below surface or ground. 1-1/4 inch and larger conduits under buildings shall be installed with conduit hangers or racks.
20. Pipe hangers for individual conduits shall be factory fabricated. Steel rods shall be 3/8 inch for two-inch conduit hangers and smaller and shall be 1/2 inch for 2 1/2-inch conduit hangers and larger.
21. Pipe racks for groups of parallel conduits and for supporting total weights not exceeding 500 pounds shall be trapeze type and shall consist of a cross channel, Steel City Kindorf B-900, Unistrut P-1000, equivalent Cooper B-Line or equal, suspended with a 3/8 inch minimum diameter steel rod at each end. Rods shall be fastened with nuts, top and bottom to cross-channel and with square washers on top of channel. Conduits shall be clamped to top for cross-channel with conduit clamps, Steel City Kindorf C-105 or Unistrut P-1111 through P-1124, equivalent Cooper B-Line, or equal. Conduits shall not be stacked one on top of another, but a maximum of two tiers may be on same rack providing an additional cross-channel is installed. Where a pipe rack is to be longer than 24 inches, or if the supported weight exceeds 500 pounds, submit Shop Drawings of installation to the Architect for review.
22. Conduits suspended on rods more than two feet long shall be rigidly braced to prevent horizontal motion or swaying. Installation shall meet zone 4 seismic requirements.
23. Factory fabricated pipe straps shall be one or two-hole formed galvanized clamps, heavy-duty type, except where otherwise specified.
24. Hangers, straps, rods, or pipe supports under concrete shall be attached to inserts set at time concrete is placed, or with approved concrete anchors. Under wood, install bolts, lag bolts, or lag screws; under steel joists or trusses, install beam clamps. Contractor shall submit size of anchors, bolts, screws, and installation method to Architect for approval prior to start of any work.
25. Conduits shall be supported at intervals required by code, but not to exceed ten feet. One inch and smaller exposed conduits shall be fastened with one-hole malleable iron straps. Perforated straps and plumber's tape is not permitted for the support of conduits.
26. Conduits stubbed up through a roof or an arcade shall be flashed with a waterproof flashing. Refer to Division 07 for additional requirements.
27. Bushings and locknuts for rigid steel conduit shall be steel threaded insulating type. Setscrew bushings are not permitted.
28. Flex conduits shall be cut square and not at an angle.
29. Routing of conduits may be changed providing length of any conduit run is not increased more than ten percent of the length indicated on Drawings.

B. Underground Requirements:

1. Conduits and multicell raceways installed underground shall be entirely encased in three inch thick concrete on all sides , except where otherwise specified. Provide required spacers to prevent any deflection when concrete is placed and to preserve position and alignment. Conduits and raceways shall be tied to spacers. Anchors shall be installed to prevent floating of conduits and raceways during placing of concrete. Provide red colored concrete to encase conduits of systems operating above 600 volts.
2. Underground conduits and raceways shall be buried to a depth of not less than 24 inches below finished grade to top of the concrete envelope, unless otherwise specified.
3. Assemble sections of conduit with required fittings. Cut ends of conduit shall be reamed to remove rough edges. Joints in conduits shall be provided liquid-tight. Bends at risers shall be completely below surface where possible.
4. Conduits and raceways in a common trench shall be separated by at least three inches of concrete. Electrical power and/or lighting conduit runs installed in a common trench with conduits containing signal system wiring such as public address, telephone, intrusion detection, fire alarm, television, computer networking, and clock systems shall maintain a separation of a minimum of six inches from these types of signal system conduits and raceways. Electrical power, lighting and signal conduits and raceways installed in a common trench with other utility lines such as gas, water, sewer and storm lines shall maintain 12 inches separation from these types of utility lines.
5. The Inspector will observe underground installations before and during concrete placement. A mandrel shall be drawn through each run of conduit in presence of the Inspector before and after placing concrete. Mandrel shall be six inches in length minimum, and have a diameter that is within 1/4 inches of diameter of conduit to be tested.
6. Non-metallic conduit installations shall comply with following additional requirements. Joints in PVC conduit shall be sealed by means of required solvent-weld cement supplied by conduit manufacturer. Non-metallic conduit bends and deflections shall comply with requirements of applicable electrical code, except that minimum radius of any bend or offset for conduits sized from 1/2 inch to 1 1/2-inch inclusive shall not be less than 24 inches. Bends at risers and risers shall be PVC-coated rigid steel conduit. Radius of curve of bends or offsets in non-metallic conduit for public telephone system shall be not less than ten times trade size of conduit, unless otherwise specifically permitted.
7. Furnish and install a six-inch wide, polyethylene, red underground barrier type 12 inches above full length of concrete reading, "CAUTION ELECTRIC LINE BURIED BELOW".
8. Underground conduit systems provided for utility companies shall be furnished to meet the requirements of the utility companies requiring service.
9. Protect inside of conduit and raceway from dirt and rubbish during construction by capping openings.

10. Add bell-end bushings for conduit stub-up including underground entries to pull boxes, and manholes. Under floor standing switchboards and motor control centers provide a four-inch galvanized nipple with ground bushing.
11. Underground conduit for systems operating above 600 volts shall be a minimum size of four inches.
12. At portable classroom all stub ups shall be installed with a coupling flush to finish grade.
13. Underground conduits and raceways shall be swabbed prior to wire pull.

C. General Installation Requirements for Computer Network System Conduits:

1. Location of outlet boxes and equipment on Drawings is approximate, unless dimensions are indicated. Drawings shall not be scaled to determine position and routing of wireways, drops, and outlet boxes. Location of outlet boxes and equipment shall conform to architectural features of the building and other Work already in place and must be ascertained in the field before start of Work.
2. The maximum pulling tensions of the specified cables shall not be exceeded and proper radius of cable bends shall be maintained.
3. For computer network wiring, conduit types shall be limited to rigid metal conduit, electrical metallic tubing, schedule 40 PVC, multi-cell raceways, and flexible metallic conduit for lengths less than six feet.
4. Interior section of conduit run shall be not longer than 100 feet and shall not contain more than two bends of 90 degrees between pull points or pull boxes.
5. The inside radius of a conduit bend shall be at least six times the internal diameter of the conduit. When the conduit size is greater than two inches, the inside radius shall be at least ten times the internal diameter of the conduit. For fiber-optic cable, the inside radius of a conduit bend shall be at least ten times the internal diameter of the conduit.
6. Conduit shall be sized in accordance with Table 4.4-1 of EIA/ TIA 569 standard.
7. Splicing or terminating cables in pull boxes is not permitted.
8. For indoor application, a pull box shall be provided in conduit run where:
  - a. The length is over 100 feet.
  - b. There are more than two bends of 90 degrees.
  - c. There is a reverse bend in the run.
9. Boxes shall be provided in a straight section of conduit and shall not be installed in lieu of a bend. The corresponding conduit ends are to be aligned with each other. Conduit fittings shall not be installed in place of pull boxes.
10. Where a pull box is provided with raceways, pull box shall comply with the following:

- a. For straight pull-through, provide a length of at least eight times the trade-size diameter of the largest raceway.
- b. For angle and U-pulls:
  - 1) Provide a distance between each raceway entry inside the box and the opposite wall of the box of at least six times the trade-size diameter of the largest raceway, this distance being increased by the sum of the trade-size diameters of the other raceways on the same wall of the box.
  - 2) Provide a distance between the nearest edges of each raceway entry enclosing the same conductor of at least:
    - a) Six times the trade-size diameter of the raceway; or
    - b) Six times the trade-size diameter of the larger raceway if they are of different size.
    - c) For a raceway entering the wall of a pull box opposite to a removable cover, provide a distance from the wall to the cover of not less than the trade-size diameter of the largest raceway plus six times the diameter of the largest conductor.

11. Drawings generally indicate Work to be installed, but do not indicate all bends, transitions of special fittings required to clear beams, girders or other Work already in place. Investigate conditions where conduits and wireways are to be installed, and furnish and install required fittings.

D. Slabs on Grade:

- 1. Unless specifically reviewed by the Architect and DSA, conduits 1 ¼-inches and larger are not permitted to be installed in structural concrete slabs. Where conduits are permitted, and are installed in concrete slabs on grade, slabs shall be thickened at bottom where conduits occur to provide three inches of concrete between conduit and earth. Required excavation shall be part of the Work of this section.
- 2. If concrete slab is five inches or more in thickness with a moisture barrier plastic sheet between earth and slab, one inch and smaller conduits shall be installed in the slab with a minimum of one inch concrete between earth and conduit.

E. Concrete Walls, Beams, and Floors: Provide sleeves where conduits pierce concrete walls, beams, and floors, except floor slabs on grade. Sleeves shall provide 1/2 inch clearance around conduits. Sleeves shall not extend beyond exposed surfaces of concrete and shall be securely fastened to forms. Where conduits pass through walls below grade, seal with required sealant and backer materials between conduit and sleeve to provide a watertight joint. Sealant shall be as indicated in Section 07 92 00: Joint Sealants.

### 3.2 STUBS

- A. Panelboard: Install two one inch conduits from each flush mounted panelboard to access under floor space and to access above ceiling space where these conditions occur. Cap conduits with standard galvanized pipe caps.
- B. Floor: At points where floor stubs are indicated in open floor areas, for connections to machines and equipment, conduits shall be terminated with couplings, tops flush with finished floor. Stubs shall extend above couplings the indicated distance. Where capped stubs are designated, couplings shall be closed with cast iron plugs with screw drive slots.
- C. Underground:
  - 1. Underground conduit stubs shall be terminated at locations indicated, and shall extend five feet beyond building foundations, steps, arcades, concrete walks and paving. Rigid metallic conduit stubs and non-metallic conduit stubs shall be capped by installing a coupling flush in end wall of concrete encasement and plugging with a permitted plug. Project record drawings shall indicate location of ends of underground conduit stubs fully dimensioned and triangulated with reference to buildings or permanent landmarks. These dimensions, including depth below finished grade, shall be marked on project record drawings in presence of the Inspector before backfilling trench. Where extending existing concrete encased stubs, clean, chip and wire brush end of existing concrete and brush on a heavy coat of neat cement paste or epoxy bonding agent.
  - 2. Over ends of individual underground conduit stubs or groups of conduit stubs, install four-inch by 18-inch deep PVC filled with concrete, flush with finished grade in asphaltic concrete or lawns, and two inches above finished grade in planting areas. Cast a three-inch by three-inch brass plate engraved "ELECT" flush in top of concrete. Secure plate to concrete with brass dowels or as indicated on drawings.

### 3.3 PROTECTION

- A. Protect the Work of this section until Substantial Completion.

### 3.4 CLEANUP

- A. Remove rubbish, debris and waste materials and legally dispose of off the Project site.

END OF SECTION

## SECTION 28 31 00

### FIRE DETECTION AND ALARM

#### PART 1 - GENERAL

##### 1.1 SUMMARY

###### A. Section Includes:

1. Fire alarm system shall consist of fire alarm control panel or networked nodes, of the same make and CSFM (California State Fire Marshall) listed for the application.
2. Labor, equipment, materials, connections, testing, and performance of operations in the installation of fire alarm system.

###### B. Related Requirements:

1. Division 01 General Requirements.
2. Section 21 13 13: Fire Suppression Sprinkler Systems.
3. Section 23 09 00: HVAC Instrumentation and Controls.
4. Section 23 80 00: Heating, Ventilating, and Air Conditioning Equipment.
5. Section 26 05 00: Common Work Results for Electrical.
6. Section 26 05 13: Basic Electrical Materials and Methods.
7. Section 26 05 19: Low-Voltage Wire (600 Volt AC).
8. Section 26 05 26: Grounding and Bonding.
9. Section 26 05 33: Raceways, Boxes, Fittings, and Supports.

##### 1.2 SYSTEM REQUIREMENTS

###### A. Fire detection system shall continually supervise and monitor the following initiating, signaling, and monitoring circuits:

1. Manual fire-pull stations.
2. Smoke and heat detectors, duct detectors, including those installed under other sections.
3. Fire sprinkler flow and tamper switches. In existing installations also include PIV tamper switches.
4. Alarm signaling circuits including alarm bells, horns and visual alarm units.

5. Annunciators.
  6. Power supplies and batteries.
  7. Interconnection with Central and Autonomous Public Address systems, telephone network system, Clock System-Classroom or Program schedule change, HVAC system where applicable, kitchen fire suppression system, Theatrical and House Lighting, and elevator equipment for control of recall function and elevator circuit breaker shunt trip.
- B. System controls shall be UL listed for power limited applications in accordance with California Electrical Code.
  - C. The fire alarm devices and equipment shall be listed for installation for the fire alarm control panel to which they are being connected.
  - D. Complete installation shall conform to the version of NFPA 72, California Fire Code, California Building Code (CBC), and California Electrical Code (CEC) as approved by DSA on stamped drawings.
  - E. System labels and devices programming addresses shall be based on final signage and building labeling submittals. For existing facilities contractor shall obtain from Owner Authorized Representative a copy of the current site layout and building labeling designations.

### 1.3 CERTIFICATION

- A. Certification: Installation of fire alarm system shall not begin until Shop Drawings, including State Fire Marshal listing numbers of fire alarm components, are submitted and reviewed by the Architect. Written certification by fire alarm equipment distributor or manufacturer shall be submitted to the Architect stating that system and its component parts are as approved and listed by the State Fire Marshal, and that the design conforms to requirements set forth in CBC.

### 1.4 PERFORMANCE

- A. System shall be fully programmable, configurable, and expandable in the field without special tools or PROM programmers and shall not require replacement of memory ICs. Installer shall provide a CD of system installed software, site specific system programming and information and tools required to re-program or modify the system.

### 1.5 SYSTEM FUNCTIONAL OPERATION

- A. When a fire alarm condition is detected by one of the system alarm initiating devices, the following functions shall occur:
  1. System alarm LED shall flash.
  2. Local sounding device in panel shall be activated.
  3. The LCD display shall indicate type of device, custom label location label and point status alarm condition.
  4. Appropriate change of status message shall be transmitted to remote annunciator(s).

5. Automatic programs assigned to alarm point shall be executed and associated indicating devices and relays activated.
  6. In the event of a fire alarm control panel activation, manual and automatic electronic tone or electromechanical bell class passing signals shall be disabled.
  7. In the event of a fire alarm condition the Central and Autonomous Public Address System shall be overridden.
  8. UDACT (Universal Digital Alarm Communicator Transmitter) shall activate.
  9. Provide necessary hardware and labor for a complete and tested interfacing of the fire alarm system with the lighting controls systems in Auditoriums, Multi-Purpose rooms, and Gymnasiums; lighting in these areas shall be brought to full brightness in the event of a fire alarm.
- B. Trouble and Supervisory Conditions.
1. When any trouble condition is detected the following functions shall occur:
    - a. System trouble LED shall flash.
    - b. Local sounding device in panel shall be activated.
    - c. The LCD display shall indicate the type of trouble and custom label location associated with the trouble condition and its location. Unacknowledged alarm messages shall have priority over trouble messages. If such an alarm is displayed, then trouble messages shall not be displayed.
    - d. Appropriate message shall be transmitted to remote annunciators.
    - e. UDACT shall activate.
- C. When any supervisory condition occurs such as a sprinkler valve tamper, the following function shall occur:
1. System supervisory LED shall flash.
  2. Local sounding device in panel shall be activated.
  3. Appropriate message shall be transmitted to remote annunciators.
  4. UDACT shall activate.
- D. Activation of control panel ACKNOWLEDGE switch in response to a single new alarm, trouble or supervisory condition shall silence panel sounding device and change system alarm, trouble, or supervisory LED from flashing to steady-ON. If additional new alarm, trouble, or supervisory conditions exist in the system; activation of this switch shall advance display to next alarm, trouble, or supervisory condition that exists, and shall not silence local audible device or change LED to steady until new conditions have been so acknowledged. New alarm conditions shall always be displayed before new trouble conditions. Occurrence of a new alarm, trouble, or supervisory condition shall cause panel to resound, and sequences as described above, shall repeat.

- E. Activation of the signal silence switch shall cause appropriate notification (indicating appliances and relays to return to normal condition. Selection of notification appliance circuits and relays silenced by this switch shall be fully programmable.
- F. Activation of system reset switch shall cause electronically latched initiating devices or zones, as well as associated output devices and circuits, to return to normal condition after sixty seconds of alarm. If alarm conditions exist in system after system reset switch activation, system shall then re-sound alarm conditions as indicated hereafter.
- G. Activation of lamp test switch shall turn on LED indicators, LCD display, and local sounding device in panel, and then return to previous condition.
- H. Fire alarm indicating appliances may be silenced or extinguished, after one minute, by operating signal silence switch at the FACP or by use of key supervised alarm silence switch at remote annunciators. A subsequent zone alarm shall reactivate signals. Audible indicating appliances shall be automatically silenced after no less than five nor more than ten minutes of operation. Visual indicating appliances shall be extinguished at system reset, or automatically after no less than five nor more than ten minutes of operation. Fire sprinkler flow alarm bells shall not silence until the contacts in the fire sprinkler flow switch return to the normal non-alarm state. Appropriate signage must be installed on or next to the sprinkler alarm bell.
- I. Elevator lobby, machine room and hoistway smoke detectors shall, in addition to operations listed above, cause elevator cars to be recalled as follows:
  - 1. Elevator cars shall be recalled to main level of egress through the use of a primary recall interface relay.
  - 2. Elevator cars shall be recalled to predetermine alternate level if main lobby smoke detector is activated.
  - 3. Fire Fighter's hat light indicator in elevators shall provide visual warning when elevator lobby, machine room, and hoistway smoke detectors are activated.
- J. System's circuits including but not limited to initiation, indicating, and equipment interfacing shall be monitored for open or short circuit and ground fault conditions, these conditions shall be indicated on the Fire Alarm Control Panel and Annunciator displays while remaining circuits continue to operate normally.
- K. Notification appliance circuits shall be silenceable for testing purposes by authorized persons. Protected pass-codes, keys, or another secure method that does not require entering into the system programming shall be used.

## 1.6 POWER REQUIREMENTS

- A. The fire alarm control panel and remote power supply shall receive 120 VAC power, 60 Hz, through a dedicated 20 amps circuit. Circuit breaker protection for the dedicated fire alarm power circuits shall be equipped with a handle lock-on device; the breaker handle shall be colored red and labeled "FIRE ALARM". Clearly label the Electrical panel name, location and circuit number on the inside of the fire alarm control panel and remote power supplies using a p-touch style labeling system. Transient voltage surge suppression shall be provided at the 120VAC input terminal.
- B. System shall be provided with sufficient battery capacity to operate entire system upon loss of normal 120 VAC power, in a normal quiescent mode, for a period of 24 hours with five minutes of alarm indication at end of this period. System shall automatically transfer

to standby batteries upon power failure. Battery charging and recharging operations shall be automatic. Batteries, once discharged, shall recharge at a rate to provide a minimum of 70 percent capacity in 12 hours.

- C. Circuits requiring system operating power shall be 24 VDC and shall be individually protected at control panel.

## 1.7 SUBMITTALS

- A. Provide in accordance with Division 01.
- B. Component Plan Submittal: Availability and listing for its application shall be verified for system components before presentation of the submittal. Include the following information and details as applicable:
  - 1. Installer name, address, telephone number.
  - 2. List of system components, equipment and devices, including manufacturer model numbers, quantity and California State Fire Marshal listing numbers, mounting heights, and symbols per MUSD symbol list.
  - 3. Copies of manufacturer specification sheets for equipment and devices indicated. Highlight or identify the specific components on Catalog cut sheets.
  - 4. Voltage Drop Calculations: Include the following information for the worst case:
    - a. Point-to-point or Ohms law calculations.
    - b. Zone used in calculations.
    - c. Voltage drop percent. Voltage drop shall not exceed manufacturer's requirements. If voltage drop exceeds ten percent, indicate manufacturer listed operating voltage ranges for equipment and devices.
  - 5. Battery types, amp hours, and load calculations including the following:
    - a. Normal operation: 100 percent of applicable devices for 24 hours to equal control panel amps plus list of amps per device that draw power from the panel during standby power condition including, but not limited to, zone modules, detectors and devices as identified.
    - b. Alarm condition: 100 percent of applicable devices for five minutes to equal control panel amps plus list of amps per device that draw power from panel during alarm condition including, but not limited to, the following:
      - 1) Zone modules.
      - 2) Signal modules.
      - 3) Detectors.
      - 4) Signal devises.
      - 5) Annunciator.

- 6) Other devices as identified.
- c. Normal operation plus alarm operation load calculation shall include total amp hours required and total amp hours provided.
- 6. Provide one copy of testing procedures.
- C. Shop Drawings: Provide Shop Drawings, in the same size as the design Drawings, include the following:
  - 1. Provide drawing scale, elevations of system enclosures, and actual layout of the Fire Alarm Control Panel, power supply, annunciator, and main system components.
  - 2. Site Plan indicating PIV and related fire sprinkler system devices and equipment to be monitored or supervised; such as water flow valves, and main equipment such as control panels, power supplies, annunciators, and components such as outdoor wall-mounted horns, sprinkler bells, pull boxes, underground pull boxes , wiring routes on buildings exterior and underground locations. In each conduit or raceway run indicate conduit sizes, and quantities and type of wires.
    - a. In existing facilities make a distinction between existing and new installation.
  - 3. Complete battery calculations, and voltage drop calculation shall be included; these calculations shall be based on the devices maximum UL current rating.
  - 4. One line drawing for the entire system network indicating system components and wiring. The one line diagram shall show but not be limited to panel to panel interconnections, conductors gage and quantity, conduit size and type (designation) and specific function.
  - 5. System panel one-line drawings indicating the quantity and type (designation) of conductors entering and exiting the fire alarm terminal cabinet in each building (enclosure) for initiating, notification, or other command control functions required for complete system operation:
    - a. Individual floor or building plan view drawings indicating device locations including end of line resistors "EOLR" in accordance with the legend provided.
    - b. Individual point addresses for initiation and notification devices.
    - c. Device "typical" wiring diagrams. These drawings shall indicate specific termination details for peripheral equipment and interface devices.
  - 6. Provide interfacing with equipment furnished by others including voltages, and other required coordination items. Refer to 3.01-B.
  - 7. Each of the pictorial diagrams included shall appear identical to the products they are intended to depict, in order to speed installation of the system, and to enhance the accuracy of the installation Work. Typical wiring diagrams or catalog sheets are not permitted.
  - 8. Background Drawings with device locations of DSA approved drawings are available in electronic format and may be obtained from the Owner Authorized

Representative (OAR). Contractor is solely responsible for the accuracy and completeness of shop drawings. Buildings that are not part of the contract shall be clearly identified "NOT IN CONTRACT". Shop Drawings shall be prepared in the latest version of AutoCAD with three – CD ROM electronic copies submitted along with full sized Shop Drawings.

9. Other installation and coordination drawings specifically related to this section shall be included as follows:
    - a. Size A (8 ½ by 11) and size B (11 by 17) shall be bound into the manual.
    - b. Larger drawings shall be folded and inserted into transparent envelopes and bound into the manual.
  10. Installation and coordination drawings for items in other sections shall be included with submittal of Shop Drawings. Submit blue line copies and one reproducible copy of installation and coordination drawings.
  11. Samples: Provide Samples of material and equipment as required by the Architect. If Samples are requested, they shall be submitted within ten days from date of request.
- D. In addition to the above requirements, provide submittals to meet any additional requirements of DSA.
- E. Submittal of Equivalent Systems:
1. In addition to the submittal requirements of this section, if an equivalent system listed in Section 2.01A is submitted in lieu of the designed system shown on DSA approved drawings, the Contractor shall also submit a letter stating that the system is equivalent, and that device locations and quantities of devices are unchanged. Attached to this letter shall be a copy of the revised equipment schedule with corresponding CSFM numbers and a cut sheet for each item.
- F. Modifications or additions to existing fire alarm systems shall be compatible and of the same manufacturer as the existing system. Contractor shall be solely responsible for engineering, plan check and any fees resulting from an installation that deviates from this requirement.
- G. Prior to Substantial Completion submit to the Architect or Engineer of Record and to Owner Authorized Representative a complete updated set of the Shop Drawings showing changes made to the Fire Alarm System during construction. These drawings will become the System As-Built Drawing set for the Fire Alarm System Owner's Manual.

## 1.8 QUALITY ASSURANCE

- A. Installer shall have successfully completed at least five projects of equal scope in the past five years, and have been in business of furnishing and installing fire alarm systems of this type for at least five years.
- B. Installer shall be a factory authorized distributor and service provider for the brand of equipment offered and shall provide documentation to the Architect upon request.
- C. Installer shall maintain a fully equipped service organization capable of furnishing repair service to the equipment and shall maintain a spare set of major parts for the system at all times.

- D. Installer shall furnish a letter from manufacturer of equipment certifying equipment has been installed according to factory standards and that system is operating properly.
- E. Certifications: Installer shall submit certification from the equipment manufacturer indicating that installer is an authorized representative of the equipment manufacturer and is trained on network applications.
- F. Materials and equipment installed shall be new.
- G. Equipment in this specification shall be furnished and installed by the Authorized Factory Distributor of the equipment. Furnish a letter from the manufacturer of major equipment, which certifies that the installer is an authorized distributor and that the equipment has been installed according to factory intended practices. Furnish a written guarantee from the manufacturer that they will have a service representative assigned to this area for the life of the equipment.
- H. Installer shall be Underwriters Laboratory (UL) listed company under the UUJS classification, and shall certify that the installation has been made in accordance with UL requirements.
- I. The fire alarm contractor shall have a NICET II Certified Technician on staff in their facility directly involved with this project to ensure technical expertise to this project and adherence with these specifications.
- J. Contractor or Installer's Electricians and fire and life safety technicians shall be certified in accordance with Labor Code sections 3099, and 3099.2, and section 209.0 of the California Code of Regulations.
- K. System startup and testing shall be performed under the direct observation of the Project Inspector and OAR. Provide a legible half size reproduction of the original completed fire alarm red-line drawings (this copy will be retained by the Owner), an accurate copy of the fire alarm system points list, and a copy of the construction drawings on CD in AutoCad format.
- L. At the time of installation the most current software package available shall be provided.
- M. Provide at the time of Owner Acceptance of the installation, equipment, and updated software which is to include the appropriate operating system, pass-codes, electronic keys and program disks, manuals and cables employed in the installation of the system. These components shall be delivered to the OAR.
- N. Provide a backup copy of the most current software revision, in disk format. This copy shall be delivered to the OAR
- O. A software license agreement shall be made available for the responsible Owner representative to sign at the time of training.

#### 1.9 WARRANTY

- A. The Fire Alarm Equipment Manufacturer shall provide a three year material warranty. Installer shall provide a three year labor warranty. Products shown defective in workmanship or material during the warranty period shall be repaired, replaced or adjusted at no cost to Owner.

- B. Complete maintenance and repair service for the fire alarm system shall be available from a factory trained authorized representative of the manufacturer for a period of five years after expiration of the warranty.
- C. Owner personnel will conduct annual City of Camarillo Fire Department Regulation 4 Tests. Defects noted during these tests shall be corrected by the Contractor during the warranty period specified.

## **PART 2 - PRODUCTS**

### **2.1 ACCEPTABLE MANUFACTURERS**

- A. Fire alarm equipment shall be standard products of the Silent Knight company to match existing.
- B. Catalog and model numbers listed are intended to establish type and quality of equipment and system design as well as operating features required. Deviations from intended functions of specified system are not permitted. Equipment shall not be ordered or installed until such equipment has been reviewed and approved by the Architect.
- C. Products specified below are based on Silent Knight system components. For other manufacturers approved system components, refer to Attachment A.

### **2.2 (EXISTING) FIRE ALARM CONTROL PANEL (FACP) OR NETWORK NODES**

- A. Farenhyt Model No. IFP-2000 (CSFM 7165-0559:0158) Fire Alarm Control Panel as indicated on drawings.

### **2.3 (EXISTING) REMOTE ANNUNCIATORS**

- A. Silent Knight Model RA-2000 (CSFM7165-0559:0158) alphanumeric display remote annunciator.

### **2.4 (EXISTING) POWER SUPPLIES**

- A. Remote Notification Appliance Circuit (NAC) extender power supplies are Silent Knight No. 5495 (CSFM 7300-0559:0123).

### **2.5 (EXISTING) PERIPHERAL DEVICES AND EQUIPMENT**

- A. Manual Stations: Interior Use: Station are Silent Knight, Model No. IDP-PULL-DA (CSFM 7150-0559:0140).
- B. Smoke Detectors: Smoke Detectors shall be Silent Knight Model No. IDP-PHOTO (CSFM 7272-0559:0149) to match existing, addressable smoke detectors. Provide base Model No. B210LP. (CSFM 7300-0559:0159). Detector shall be microprocessor based, using a combination of photoelectric, and thermal sensing technologies. The smoke detector shall have its loop number and electronic address permanently and clearly labeled onto the device base using a p-touch type labeling system. The label shall be visible without removing the detector head.
- C. Non-Explosion Proof Automatic Heat Detectors shall be combination rate-of-rise and fixed-temperature type. When fixed-temperature portion is activated, units shall provide visual evidence of such operation (LED). Addressable Heat detectors shall be Silent Knight Model No. IDP-HEAT (CSFM 7270-0559:0147) to match existing. Provide base Model No. B210LP. (CSFM 7300-0559:0159) The location of the heat detector must be

clearly marked below the ceiling and the detector must be readily accessible. The heat detector shall have its electronic address permanently and clearly labeled onto the device and be readily accessible. For spaces where the normal ambient temperature can reach temperatures as high as 150 degrees F. such as in attic spaces, use Silent Knight IDP-HEAT-HT with base B210LP. The heat detector shall have its loop number and electronic address permanently and clearly labeled onto the device using a p-touch labeling system. The label shall be visible without removing the detector head.

- D. Projected Beam Infrared Type Smoke Detectors shall be Notifier Silent Knight No. IDP-BEAM (CSFM 7260-0559:0148), or equal, and shall consist of a transmitter / receiver unit and reflector to be used in accordance with manufacturers recommendations. Each detector shall include six user-selectable sensitivity levels. Alignment shall be achieved with a signal strength meter incorporated into the beam detector. The detector shall feature automatic detection and adjustment to the optimum level for the specific environment. Provide remote test stations with key lock for detectors, System Sensor Model RTS-451KEY, or equal, located below ceiling.
- E. Control Modules:
1. Control module shall be Air Products Model No. MR-101 (CSFM 7300-1004:0101), or equal power supervision relay to monitor 24 volt DC power.
- F. Monitor Modules:
1. Monitor module shall be Silent Knight Model No. IDP-MINIMON (CSFM 7300-0559:0155), or equal. Module shall connect a supervised zone of conventional initiating devices, N.O. dry contact devices, including four-wire smoke detectors, to one of SLC loops. Monitor module shall install in a four-inch square by 2 1/8-inch deep electrical box. The module shall have its loop number, electronic address, and function label on the front cover using a P-Touch type or equal labeling system.
  2. Monitor module shall provide address-setting means using rotary decimal switches and shall store an internal type of device. An LED shall be provided which shall flash under normal conditions indicating that monitor module is operational and in regular communication with control panel.
- G. Relay Modules:
1. Relay Module shall be Silent Knight IDP-RELAY (CSFM 7300-0559:0155) the module shall provide as a minimum one set of form "C" dry contacts and have its loop number, electronic address, and function labeled on the front cover using a P-Touch type labeling system.
  2. Provide a buffer relay that is part of the control system if controlled circuit(s) exceeds the voltage or current rating of the relay module.
  3. Relays used to interface control of other systems shall be electrically supervised and shall only be wired in a fail-safe mode of function during a power failure.
- H. Horns and Strobes: Horns and strobes shall be products of the same manufacturer. In order to establish a standard of quality, items are specified from the products manufactured by Gentex to match existing. Addressable or multifunction two wire indicating (Audible or Visual) appliances shall not be acceptable.

1. Existing Strobe indicating appliances are Gentex Model No. GES3-24WR standard candela output (CSFM 7125-0569:0123) and Horn/Strobe indicating appliances are Gentex Model No. GEC324WR (CSFM 7135-0569:0122). Exterior horns are Silent Knight Model No. GEH-24 (CSFM 7135-0569:0122).
- I. (Existing) Water-flow Switches:
1. Water-flow switches are Potter Electric Model No. VSR-F (CSFM 7770-0328:0001).
  2. Sprinkler valve tamper switches are Potter Electric Model No. PCVS2 (CSFM 7770-0328:0010).
- J. Network Cables or SLC or Annunciator Data or Audio Output Cables: The construction and physical characteristics such as aqua-seal water block, wire gage, insulation and jacket types, etc. shall not be altered. Equivalent cables must be specifically approved and recommended by the manufacturer of the fire alarm system equipment. Substitutions will require review from the Architect or Engineer of Record.
- K. The cable types listed below are based and specified on the recommendations of Notifier Fire Alarm Systems. If the submitted fire alarm system requires a different cable configuration with additional conductors, multi-conductor versus twisted pairs, etcetera than is specified above, request a substitution to supply and install the configuration of cables by the make and model of the fire alarm system that is to be installed.
1. Indoor Network and EVAC System Audio Output Circuit(s) applications shall be in conduit or in surface mounted raceway as indicated on drawings: West Penn No. D980, one pair 18 gage solid copper, unshielded, Copolene II insulated and PVC jacketed, or equal.
  2. Indoor SLC applications in conduit or in surface mounted raceway where it is indicated on drawings: West Penn No. D990, one pair 16 gage solid copper, unshielded, Copolene II insulated and PVC jacketed, or equal.
  3. Indoor Annunciator applications in conduit or in surface mounted raceway where it is indicated on drawings: West Penn No. D975, one pair 18 gage solid copper, shielded, Copolene II insulated and PVC jacketed, or equal.
  4. Outdoor or Underground Network Applications: West Penn AQ224, two-conductor 18 gage stranded copper, unshielded, water-blocked construction and PVC insulated, or equal.
  5. Outdoor or Underground SLC applications: West Penn AQ225, 2-conductor 16 gage, AQ226, 2 conductor 14 gage, or AQ227, 2 conductor 12 gage stranded copper, unshielded water-blocked construction and PVC insulated, or equal.
  6. Outdoor or Underground Annunciator applications: West Penn AQ293, 2 conductors, 18 gage stranded copper, shielded water-blocked construction and PVC insulated, or equal.
- L. Protective Covers
1. Provide protective covers for pull stations, smoke and heat detectors, and audible and visual devices located in areas occupied by students that can be subjected to vandalism such as gyms, restrooms, locker and shower rooms, and

all hallways and corridors associated with these spaces. Installation of cover must not protrude over current ADA limitations.

### **PART 3 - EXECUTION**

#### **3.1 GENERAL**

- A. Fire alarm system shall not be used for any purpose other than fire alarm functions.
- B. Fire alarm shall be interconnected but not limited to the following systems:
  - 1. Systems required by code to be connected to the fire alarm systems shall be connected.
  - 2. Public address system for disabling the manual and automatic bell or tone class passing signals. Manual and automatic class passing signals shall not be operable during alarm conditions.
  - 3. Ventilation systems where required for the purpose of fan shutdown
  - 4. Damper control or smoke management systems.
  - 5. Water based fire sprinkler systems.
  - 6. Chemical fire extinguisher systems.
  - 7. Central and Autonomous PA system(s).
  - 8. Theatrical lighting control system.
  - 9. Elevator controls for the purpose of elevator cab Phase 1 recall and shunt trip control, circuit supervision and shunt trip power supervision.
  - 10. Fire pump controller for required signaling and trouble supervision.
- C. Fire alarm system shall not be interconnected to any of the following:
  - 1. Sump warning systems,
  - 2. Carbon monoxide detection systems.
  - 3. Methane gas detection systems.
  - 4. Elevator car alarm bell circuit.
  - 5. Other unrelated system.

#### **3.2 SYSTEM INSTALLATION**

- A. Install required conductors to devices indicated on Drawings. Provide required conductor terminations to devices for a complete system to function as specified and indicated on Drawings. Refer to Section 26 05 19: Low-Voltage Wire (600 Volt AC), for installation and color coding requirements.

- B. Splices are not allowed in junction boxes. Terminations shall be in terminal cabinets or on equipment terminals.
- C. Conductors shall be installed within conduits, boxes, and terminal cabinets in a totally enclosed installation. Furnish and install conductors required to connect incoming and outgoing circuits, including spare conductors, to terminal strips within terminal cabinets.
- D. Wiring within equipment and terminal cabinets shall be installed to conform to contract documentation and NFPA 72 standards, and shall be terminated on terminal blocks having terminals for required connections. Wiring shall be cabled, laced, and securely fastened in place so that no weight is imposed on equipment or terminals.
- E. Install required terminal blocks within terminal cabinets. Terminal blocks shall be installed on inside back of cabinets only, not on side. Incoming wiring shall be terminated on the left side of terminal blocks; outgoing wiring shall be terminated on the right side of the terminal blocks.
- F. Conductors shall be color-coded per specification section 26 05 19 Low Voltage wires and tagged with code markers at terminal cabinets, and equipment. A wire index shall be typed and installed on terminal cabinet doors. Index shall be covered with clear plastic adhesive covers. Wiring shall be identified as to building and location of devices in the index.
- G. Wiring within equipment and terminal cabinets shall be carefully strapped, and shall be formed in rectangular configuration. Wires shall be properly numbered in numerical order and shall maintain same number throughout the Project site.
- H. Complete installation shall comply with local building codes and applicable provisions of the California Electrical Code, California Fire Code and the NFPA 72 National Fire Alarm Code.
- I. Location of outlet boxes and equipment on Drawings is approximate, unless dimensions are indicated. Do not scale Drawings to determine locations and routing of conduits and outlet boxes. Location of outlet boxes and equipment shall conform to architectural features of the building and other Work already in place, and must be ascertained in the field before the start of Work.
- J. Drawings generally indicate Work to be provided, but do not indicate all bends, transitions or special fittings required to clear beams, girders or other Work already in place. Investigate conditions where conduits are to be installed, and furnish and install required fittings.
- K. Provide P-touch label of approximately one inch wide with red lettering for each initiating device that is hidden from view. Tags shall indicate the name and type of device: Heat Detector, or Duct Smoke Detector. Tags shall be permanently attached on access panel or t-bar grid which is used to access a hidden device.
- L. Provide smoke and heat detectors in elevator hoist-ways if a fire sprinkler head is located at the top of the elevator hoist-way. Provisions shall be made for access to the detector without entering the elevator hoist-way. Access shall be provided through an approved enclosure with self-locking fire rated door. The detectors shall be so placed as to allow service to them without the service personnel having to reach into the hoist-way in the way of travel of the elevator car. Access to elevator hoist-ways and machine rooms (including escalators) must be supervised by the Owner's licensed elevator or escalator maintenance contractor. OAR is responsible for coordinating access in accordance with Contractor's schedule. Contractor shall provide a minimum of 48 hours notice.

- M. Provide adjacent to each annunciator a neatly typewritten copy of the Fire Alarm Operating Instructions. The instructions shall reflect the installed and programmed features of the system. Instructions that include information on non-installed or programmed features will not be acceptable. The instructions shall be placed into a suitably sized dark colored wood or metal frame with a glass document face cover. The frame shall be attached to the wall with a minimum of two screws into the wall material with appropriate anchors.
- N. Provide adjacent to each annunciator a neatly drawn site map showing rooms with designations and buildings with names as programmed into the system. This map shall be sized to allow (normal vision) reading of the designations, names etc. A map so reduced in size to the point of not being readable will not be acceptable. This map shall include symbols indicating the locations of installed fire sprinkler flow switches, riser shut off valves, post indicating valves and manual pull stations. Provide a symbol list on the map for the symbols used. The site map shall be placed into a suitably sized dark colored wood or metal frame with a glass document face cover. The frame shall be attached to the wall with a minimum of two screws into the wall material with the appropriate anchors.

### 3.3 SYSTEM PROGRAMMING

- A. Programming shall be performed in accordance with District requirements set forth in this section – the local authority having jurisdiction and applicable codes. If a conflict arises or a clarification is required, the contractor through the project's OAR shall contact the Districts Fire Life Systems Testing Group (FLSTG) for clarification
- B. As part of the 50 percent construction completion label devices and locations in the manner indicted in the attached guidelines on a separate copy of the shop drawings. Request a meeting with OAR, Project Inspector, and representative of FLSTG to review, finalize and obtain approval of the proposed device, equipment and location descriptors that will be programmed into the system. The District may at time of substantial completion request minor changes to program descriptors if needed to conform to site conditions.
- C. The following functions and features as required by the site or system configuration and installed peripheral equipment and systems shall be programmed into MUSD fire alarm systems. The definition of programming shall include but not be limited to the use of a built in keyboard, the use of a connected PC with the appropriate software, dip or rotary switches, wiring or installable or removable jumpers as required or provided in the fire alarm equipment.
  - 1. Signal Silence Switch Inhibit: The audible signal silence switch located on the remote fire alarm annunciator(s) or any fire alarm control panel(s) shall be programmed to not silence the audible or extinguish the visual alarm circuits during the first minute (60 seconds) of the fire alarm horn or strobe activation. Activation of this switch after the initial 60 seconds signaling shall silence only the audible signals. Enabling or disabling this feature shall be allowed only by authorized District maintenance personnel and shall be protected by a maintenance level password.
  - 2. Audible and Visual Signal Auto Silencing Extinguishing: Audible coded signals and visual signals throughout the site, unless silenced by the above switch, shall be programmed to automatically self-silence or extinguish in no less than 5 minutes (300 seconds) and no more than 10 minutes (600 seconds). This feature shall not apply to the fire sprinkler water flow audible appliance.

3. Fire Sprinkler Water Flow Audible Appliance: The fire sprinkler water flow appliance (bell) shall not require any programming because of our requirement for this appliance to be directly controlled by a set of dry contacts within the associated sprinkler water flow switch(s). The 24 volt DC auxiliary power for the sprinkler water flow audible appliances shall be supplied by an FACP or a remote power supply. This audible appliance shall operate continuously during the detection of fire sprinkler water flow and shall not be coded in any manner nor silenced automatically by any FACP or manually by any user controls at any FACP or remote annunciator.
4. Fire Sprinkler Water Flow Switch: Fire sprinkler water flow switches shall be programmed in a manner that shall prevent the above Signal Silence Switch from silencing the audible coded signals or visual signals after the initiation of an alarm by a fire sprinkler flow switch.
5. Audible Notification Appliance Circuits: Audible notification appliance circuits shall be programmed to emulate the temporal code (ANSI S 3.41) from fire alarm audible appliances (horns). This coding shall originate and be controlled by a single coder residing within the FACP(s). The use of coders within remote power supplies either mounted adjacent to an FACP or at a remote location or directly by an audible notification appliance will not be permitted. Programmable audible notification appliances shall be configured to emulate a steady tone at approximately 1000 Hz. Audible notification appliance circuits shall be programmed to be silenced as described above. Notification appliance circuits throughout the site shall be activated by any alarm initiating device. Coded audible signals shall be controlled by a single synchronized FACP.
6. Visual Notification Appliance Circuits: Visual notification appliance circuits shall be programmed to provide steady non-coded power to the visual appliances (strobes). As required by code and the system configuration, a synchronization signal shall be superimposed onto the NAC by the FACP, a remote power supply or an add-on synchronization module. Visual notification appliance circuits shall be programmed to be extinguished as described above. Visual notification appliance circuits through out the site shall be activated by any alarm initiating device.
7. System Reset Button: The system reset button located on FACPs and remote annunciators in addition to resetting the fire alarm system and silencing or extinguishing notification appliances except for the sprinkler water flow appliances shall be programmed to reset analog and addressable smoke detectors, duct detectors, beam detectors and relays, addressable control modules and addressable relay modules used to interface to other systems and equipment. Each installed system reset button shall be programmed to operate as a "single point of reset" for the complete system.
8. HVAC Shutdown: Relays and addressable relay modules used to interface to HVAC equipment dampers, and supply and exhaust fan motors shall be programmed to shut down this equipment only within the same building where the detection of smoke, heat or fire sprinkler water flow has taken place. Manual pull stations within any building shall not effect the operation of the HVAC equipment. These relays shall return to normal only after the system is reset.
9. Smoke Detector Maintenance Alert: Addressable smoke detectors shall be programmed with the capability of initiating a maintenance alert when any one detector becomes obscured by dust or any other contaminates at approximately 10 percent below the level of obstruction that would initiate an alarm.

10. Disabling Class Passing Signals: The relay or addressable relay module shall be programmed to disable the class passing signals during any alarm condition at the site. This relay or addressable module shall return to normal only after the system is reset.
11. UDACT: The FACP and the associated Universal Digital Alarm Communication Transmitter shall be programmed to transmit to the central monitoring station separate indications for General Alarm, Fire Sprinkler Water Flow Alarm, System Trouble and Supervisory Conditions. These indications shall be in addition to any indications initiated by the UDACT itself.
12. Power Failure Reporting Time Delay: Main and remote NAC power supplies shall be programmed to delay the reporting of a site AC power failure for a minimum of 6 hours.

D. Device Descriptors:

1. Descriptors shall enable responding personnel to identify the location of a fire quickly and accurately, and shall indicate the status of emergency equipment or fire safety functions that might affect the safety of occupants. The minimum required information for devices intended to report smoke, fire, or fire sprinklers water flow include, but may not be limited to: Building, floor (if multiple floors exist in the building), room or space description, and device type and digital address (Smoke detector, Heat detector, Fire sprinkler water flow switch, etc).
  - a. Building: The building must always be included in the descriptor, even if there is only one building on the site. Additional building(s) may be added at a later date creating the possibility of confusion by similar designated spaces, such as "Work room" or "Staff restroom" if more than one building has these similar designated spaces. The building designation in the descriptor must be what the site-based personnel call the building. The building should be provided with signage to aid fire department personnel in the identification of the building.
  - b. Floor: In multi-floor buildings the floor designation (1st, 2nd, etc) must be included in the descriptor.
  - c. Room Description: The room or space description must be unique. Using the same designation for multiple spaces, such as "Workroom", "Counselor's Office", or "Men's restroom", etc. is not acceptable. If, during a project, the room numbers or the use of the room changes then the room or space descriptor must be changed to agree with the change. Proper signage should be provided for each space to aid fire department personnel in the identification of the room or space.
  - d. Device Type, Address and Compass Designations: The device type and digital address must be included with the descriptor, such as smoke detector or heat detector, etc. Some systems provide this information automatically in the descriptor. Compass designations, (N, S, E, and W) are required in spaces such as corridors where there are multiple detectors and this information would be helpful to responding fire department personnel in locating the device reporting alarm. It is not necessary to include compass designations in smaller spaces where there are multiple detectors located in close proximity to each other.

E. ACCEPTABLE ABBREVIATIONS

Rm.- Room	Bldg.- Building	Smk. - Smoke
Corr.- Corridor	Lby- Lobby	Asst. - Assistant
Eng.- English	N – North	Nrs. - Nurse
Flr.- Floor	S – South	Cnclr - Counselor
Ht.- Heat	E – East	Off. - Office
Lib.- Library	W – West	PE – Physical Education
Lkr. – Locker	Kit- Kitchen	RR- Rest Room
Stu Str – Student Store	Sci - Science	By = near
Stor Rm – Store Room	Café - Cafeteria	PM – Plant Manager
1 <sup>st</sup> - First	2 <sup>nd</sup> - Second	3 <sup>rd</sup> - Third
Hopr Rm – Hopper Room	Det - Detector	Elev - Elevator
Prin – Principal	Blr Rm – Boiler Room	Conf – Conference
Park – Parking	Bsmt –Basement	MPR.- Multi-Purpose room

### 3.4 SYSTEM OPERATION

- A. Unless otherwise specified, but not limited to actuation of manual stations, smoke detectors, heat detectors, linear heat or smoke detectors, or water-flow switches shall cause the following operations to occur, refer to Attachment B:
1. Activate audible circuits.
  2. Actuate strobe units until the panel is reset or strobe circuit time-out.
  3. Release magnetic door holders to doors to adjacent zones on the floor from which the alarm was initiated.
  4. Where required, return elevators to the primary or alternate floor of egress.
  5. Smoke detectors in elevator lobbies shall, in addition to the above functions, return elevators to the primary or alternate floor of egress.
  6. Smoke detectors in elevator machine rooms or tops of hoist-ways shall return elevators to the primary or alternate floor. Smoke detectors or heat detectors installed to shut down elevator power shall perform this function in accordance with ANSI A 17.1 requirements and shall be coordinated.
  7. Duct type smoke detectors shall, in addition to the above functions, shut down the ventilation system or close associated control dampers as required.
  8. Activation of fire sprinkler system low-pressure switches, post indicator valve or tamper switches shall initiate a system supervisory alarm indication.

9. UL listed central station shall be notified via – Universal Digital Alarm Communicator Transmitter (UDACT).

### 3.5 TESTING

- A. A 48 hour notice shall be provided to the Project Inspector before final testing.
- B. Testing of fire detection system shall be as required by the State Fire Marshal and local authorities having jurisdiction. Installer is responsible for identifying required testing, coordinating, scheduling, and conducting tests before Substantial Completion. Tests shall include the following:
  1. Operation of signal-initiating devices (smoke detectors, heat detectors, pull stations etc.).
  2. Operation of indicating devices (alarm horns, alarm bells and alarm strobes).
  3. Operation of system features under normal operation.
  4. Operation of system supervisory features.
  5. Operation of system features on standby power, with primary power turned off.
  6. Before energizing the cables and wires, check for correct connections and test for short circuits, ground faults, continuity, and insulation.
  7. Close sprinkler system flow valves and verify proper supervisory alarm at the FACP.
  8. Verify activation of flow switches.
  9. Open initiating device circuits and verify that trouble signal actuates.
  10. Open signaling line circuits and verify that trouble signal actuates.
  11. Open and short notification appliance circuits and verify that trouble signal actuates.
  12. Open and short (wire only) network communications and verify that trouble signals are received at network annunciators or reporting terminals.
  13. Ground initiating device circuits and verify response of trouble signals.
  14. Ground signaling line circuit and verify response of trouble signals.
  15. Ground notification appliance circuit and verify response of trouble signals.
  16. Check alert tone to alarm notification devices.
  17. Check installation, supervision, and operation of intelligent smoke detectors.
  18. Alarm conditions that the system is required to detect shall be introduced on the system. Verify the proper receipt and the proper processing of the signal at the FACP and the correct activation of the control points.

19. When the system is equipped with optional features, consult the manufacturer manual to determine proper testing procedures.
  20. Theatrical lighting house light control override.
  21. Central and Autonomous PA systems for muting during the sounding of the audible notification appliances and voice evacuation announcements.
  22. Disabling electronic tone or electromechanical bell class passing signals until system reset.
- C. Upon completion of installation of fire alarm equipment, provide to the OAR a signed, written statement confirming that fire alarm equipment was installed in accordance with the Specifications, Shop Drawings, instructions and directions provided by the manufacturer.
- D. Demonstrate in presence of the Project Inspector that circuit and wiring tests are free of shorts and grounds and that installation performs as specified herein and within manufacturer's guidelines.
- E. Software Modifications:
1. Provide the services of a factory trained and authorized technician to perform system software modification, upgrades or changes. Response time of the technician to the Project site shall not exceed 24 hours.
  2. Provide hardware, software, programming tools, and documentation necessary to modify the fire alarm network on the Project site. Modification includes: addition and deletion of devices, circuits, zones and changes to system operation and custom label changes for devices or zones. The system structure and software shall place no limit on the type or extent of software modification on-site. Modification of software shall not require power-down of the system or loss of system fire protection while modifications are being provided.
- F. Complete the inspection and testing form as required by NFPA 72, and submit one copy of the completed form to the Architect and Project Inspector.

### 3.6 SERVICE MANUALS

- A. Deliver to OAR, three copies of the service manuals. Each manual shall include the following:
1. Installation manuals, programming manuals and user manual if applicable for every control panel, control panel power supply, FACP input or output or relay or control module, auxiliary power supply, UDACT, remote NAC extender power supply, door holder power supplies, installed annunciators, initiating and indicating devices and addressable monitor, relay and control modules. Catalog cut sheets are not acceptable.
  2. A printed copy of the system configuration as programmed, including system labeling codes, and passwords.
  3. An electronic copy on compact disk of the system configuration program
  4. Final test report.

5. Detailed explanation of the operation of the system.
6. Instructions for routine maintenance.
7. Detailed wiring diagram for the connection of relays, addressable monitor, and control or relay modules as applied in the interfacing of peripheral systems or equipment to the fire alarm system. Updated shop drawings shall include revisions made in the field via plan changes, RFIs, Field Change Directives, and any other construction change documents including interface details with ancillary systems.
8. An electronic copy (CD) of the posted site or fire alarm map in Auto-Cad and pdf formats.
9. Provide a CD ROM electronic copy of the updated system As-Built Drawings to the OAR, prepare this copy in the latest version of AutoCAD; along with the electronic copy provide a full size bond copy. Include one CD-ROM of the updated As-Built Drawings into each of the Service Manuals. CD and folded drawings shall be secured and inserted into the Service Manuals via a three-hole punched protective CD case and protective envelopes for the drawings.
10. Provide codes and passwords for fire alarm system at testing.

### 3.7 SPARE PARTS

- A. The following new spare parts shall be furnished in unopened boxes:
  1. Five percent spare pull stations including the associated monitor module (minimum one spare pull station per type).
  2. Five percent spare smoke and heat detectors (minimum one spare smoke and heat detector per type).
  3. Five percent spare audible devices (minimum one spare audible device per type).
  4. Five percent spare strobe devices (minimum one spare strobe device per type).

### 3.8 SYSTEM USER AND MAINTENANCE PERSONNEL TRAINING

- A. Before Substantial Completion, provide one instruction period for the Project site based Owner operators and system users. The instruction period shall be scheduled and coordinated by the OAR.
- B. Training materials and required deliverables shall be submitted to the OAR.
  1. Prior to beginning the operational demonstration, notify Central monitoring Station that an instructional activity is beginning; inform them that it includes setting and resetting the system in test mode. After the demonstration is completed and the system restored, notify the Central Monitoring Station that the system has been restored and it is back on line for continuous monitoring.
- C. User Instruction and Training
  1. Before substantial completion and with a fully functional fire alarm system installed at the site, the contractor shall provide a minimum of four hours of user

training for site based staff. The date and time for this training shall be coordinated by the project OAR.

D. Instruction period training for site based staff shall consist of the following:

1. Overview:

- a. Explain the fire system is “addressable” which means every device-smoke detector, heat detector, sprinkler water flow switch, manual pull station, etc. has a unique address or identity. This makes it possible to positively identify the exact device causing an alarm, trouble or supervisory condition.
- b. Explain the fire alarm control panel also controls the horns and strobes throughout the campus or building.
- c. Explain that the fire alarm system is interconnected to various other systems and equipment through out the site such as:
  - 1) Elevators to recall them to the main floor or to an alternate floor and as an option dependent circumstances turn off the power to the elevators.
  - 2) Heating and air conditioning equipment to turn off fans and close dampers to stop the spread of smoke through out a building.
  - 3) The class passing signaling system to disable the bells or tones to not accidentally signal students and staff to return to the buildings.
  - 4) Magnetically held doors to close them to stop the spread of smoke.
  - 5) To turn up house lighting in an occupied Auditorium or Multi-Purpose room to provide adequate egress lighting.
  - 6) The Central and Autonomous PA systems to mute them during the sounding of the alarm signal.
- d. Explain the fire system has a battery backup in case of power failure and that it will continue to function for a minimum of 24 hours after a total power failure.
- e. Explain that the fire alarm system components and wiring are monitored to report a malfunction, damage or vandalism. When this occurs, a trouble indication will appear on the fire alarm annunciator and FACP and this indication will be transmitted to the central monitoring station.
- f. Explain that other equipment and systems are monitored for abnormal conditions such as the fire sprinkler water being turned off. When this occurs, a supervisory condition is created. A supervisory indication will appear on the fire alarm annunciator and FACP and this indication will be transmitted to the central monitoring station.
- g. Explain that the fire system in addition to notifying the occupants of a possible fire condition also transmits an alarm indication to the central

monitoring station that will in turn notify and dispatch the local fire department to your site.

2. Basic:
  - a. Hand out the SYSTEM OPERATION instructions to attendees.
  - b. Point out the Fire Alarm Control Panel and have them observe the normal LED status (one green LED only should be on):
    - 1) GREEN = Normal.
    - 2) YELLOW = Trouble.
    - 3) RED = ALARM.
  - c. Have the attendees observe the LCD display that should be indicating a SYSTEM NORMAL message.
  - d. Point out the Fire Alarm System Annunciator and have attendees observe the LCD display that should be indicating a SYSTEM NORMAL message.
3. Operation and Demonstration:
  - a. After putting the system or having someone put the system central station monitoring into the test mode demonstrate the following:
  - b. Activate a Manual Pull Station to demonstrate ALARM.
    - 1) Demonstrate audible and visual notification appliances and if installed the voice evacuation signal announcement.
    - 2) Demonstrate panel or annunciator sounder tone for ALARM.
    - 3) Have staff SILENCE system.
    - 4) Show LCD display and LED of alarm.
    - 5) Demonstrate and have staff reset the manual pull station.
    - 6) Have staff RESET fire system.
  - c. Activate Smoke Detector with canned smoke to demonstrate address identification:
    - 1) Have staff SILENCE system.
    - 2) Show LCD and display LED of ALARM.
    - 3) Have staff RESET fire system.
  - d. Remove Smoke Detector to demonstrate SYSTEM TROUBLE.
    - 1) Demonstrate panel or annunciator sounder tone for TROUBLE.

- 2) Have staff SILENCE system.
  - 3) Show LCD display and LED of TROUBLE.
  - 4) Replace the smoke detector.
  - 5) Have staff RESET fire system.
- e. Remove power to demonstrate function during power failure.
- 1) Have staff SILENCE system.
  - 2) Show LCD display and LED of TROUBLE.
  - 3) Activate Manual Pull station to demonstrate audible or visual functions in power failure mode.
  - 4) Reset manual pull station.
  - 5) Reset fire system.
  - 6) If applicable, point out sprinkler riser and shut off valves.
  - 7) Show location of a water flow switch.
  - 8) Show location of a valve tamper switch.
  - 9) Point out valves must always be OPEN or fully counter clock wise.
  - 10) Point out PIV (Post Indicator Valves) if applicable.
  - 11) Have water flow through the inspectors test valve and point out the ringing water flow bell.
  - 12) After the horns are silenced by an assistant, show that the water flow bell is ringing continuously indicating water flow.
  - 13) Have the assistant turn off the inspectors test valve to show that water flow alarm bell turns off.
  - 14) Reset system.
  - 15) Unlock and turn off a PIV or riser valve to show a supervisory condition.
  - 16) Turn valve back on, lock the valve open and demonstrate the end of the indication of a supervisory condition.
4. Training documentation.
- a. Insure fire panel is reset and indicates normal and central station monitoring is taken off of the test mode.

- b. Have staff attendees sign off training sheet and provide a copy to the PROJECT INSPECTOR.

3.9 PROTECTION

- A. Protect the Work of this section until Substantial Completion.

3.10 CLEANUP

- A. Remove rubbish, debris, and waste materials and legally dispose of off Project site.

END OF SECTION

**SECTION 31 10 00  
SITE CLEARING**

**PART 1 - GENERAL**

1.01 SUMMARY

- A. Contractor shall furnish all labor, materials, services, testing, transportation and equipment necessary for the completion of all site clearing work as required and as indicated on drawings and specified herein. Work materials and equipment not indicated or specified which is necessary for the complete and proper operation of the work of this Section in accordance with the true intent and meaning of the contract documents shall be provided and incorporated at no additional cost to the Owner.
- B. Removal of surface debris; removal of paving and curbs; removal of trees, shrubs, and other plant life; topsoil excavation; and repair of damaged vegetation and/or irrigation systems/system components.
- C. Removal of concrete and bituminous surfacing where applicable.

1.02 RELATED SECTIONS

- A. Section 02 41 19 - Demolition.

1.03 REFERENCE STANDARDS

- A. The work provided herein shall conform to and be in accordance with the Contract Plans, General Conditions/Specifications and Special Provisions, as well as the Standard Specifications for Public Works Construction ("GREENBOOK"), 2018 Edition, adopted by the Southern California Chapter, American Public Works Association; herein referred to as the "Standard Specifications". In case of conflict between the "Standard Specifications", the General Conditions/Specifications and these Special Provisions, the General Conditions/Specifications and these Special Provisions shall have precedence.

1.04 REGULATORY REQUIREMENTS

- A. The Contractor shall obtain all necessary permits, licenses, or agreements required by any legally constituted agency, pay for all fees and give all necessary notices required for the construction of the work. The College of the Desert shall reimburse the contractor for all necessary permits or inspection fees by any legally constituted agency.
- B. Perform all work of this Section in strict accordance with applicable Government Codes and Regulations especially meeting all safety standards and requirements of CAL/OSHA, County of Los Angeles and the City of Los Angeles. Provide additional measures, added materials and devices as may be needed as directed by the District Representative at no added cost to the District.
- C. Comply strictly to Rule 1404, South Coast Air Quality Management District.
- D. Coordinate clearing Work with utility companies.

## **PART 2 - PRODUCTS**

2.01 Satisfactory Soil Materials: Requirements for satisfactory soil materials are specified in Section 02 41 19 – Demolition.

- A. Obtain approved borrow soil materials off-site when satisfactory soil materials are not available on-site.

## **PART 3 - EXECUTION**

### 3.01 PREPARATION

- A. Verify that existing plant life designated to remain is tagged or identified.
- B. Identify a waste area for placing removed materials.

### 3.02 PROTECTION

- A. Protect existing structures and site improvements indicated to remain, from damage by approved methods and/or as authorized by the *District Representative*. Removal of all protections shall be when work of this Section is completed or when so authorized by the District Representative.
- B. Protect Existing Utilities indicated or made known to remain traversing the job-site and serving existing adjacent facilities.
- C. Protect Existing Trees and Shrubs indicated to remain by providing temporary surrounding fencing so located a sufficient distance away so that trees and shrubs will not be damaged by site-clearing operations.
  - 1. Protection Barrier: A protection barrier shall be installed around the shrubs or trees to be preserved. The barrier shall be constructed of a durable fencing material, such as plastic construction fencing, snow fence, or chain link. The barrier shall be placed at or beyond the drip line. "Drip line" as referred to herein means a line which may be drawn on the ground around the tree directly under its outermost branch tips and which identifies that location where rainwater tends to drip from the tree. Placement of barrier to be approved by District Representative (Grounds Supervisor). If barrier is placed inside the drip line, then 3/4 inch plywood must be placed over the root zone up to the drip line. The fencing shall be maintained in good repair throughout the duration of the project, and shall not be removed, relocated, or encroached upon without permission of the District Representative (Grounds Supervisor).
  - 2. Storage of Materials: There shall be NO storage of materials or supplies of any kind within the area of the protection barriers. Concrete, cement, asphalt materials, block, stone, sand and soil shall not be placed within the drip line of the tree(s).
  - 3. Fuel Storage: Fuel storage shall NOT be permitted within 150 feet of any tree to be preserved. Refueling, servicing and maintenance of equipment and machinery shall NOT be permitted within 150 feet of protected trees.
  - 4. Vehicles/equipment: NO parking or driving of vehicles or storage of equipment shall be permitted within the drip line of any tree to be preserved.

5. Debris and Waste Materials: Debris and waste from construction or other activities shall NOT be permitted within protected areas. Wash down of Concrete, cement or asphalt handling equipment, in particular shall NOT be permitted within 150 feet of protected areas.
6. Grade Changes: Grade changes can be particularly damaging to trees. Any grade changes should be approved by the District Representative (Grounds Supervisor) before construction begins and precautions taken to mitigate potential injuries.
7. Damages: Any damages or injuries to the preserved trees (including pruning or cutting of such trees not in conformity with the International Society of Arboricultural Pruning Guidelines and ANSI A300 Pruning Standards) shall be reported immediately to the District Representative (Grounds Supervisor). Severed roots shall be pruned cleanly to healthy tissue, using proper pruning tools. Broken branches/limbs shall be pruned according to International Society of Arboricultural Pruning Guidelines and ANSI A300 Pruning Standards. In the event that any damage, injury, improper pruning or cutting of a protected tree is deemed to be so substantial as to require its replacement (such determination to be made in the sole discretion of the District Representative), Contractor shall replace such tree with the same species and variety of tree, up to a box size of 48 inches, or if no such replacement is available, with a substitute species or variety as determined in the sole discretion of the District Representative. Any replacement tree shall be approved in advance by the District Representative. The value of the tree to be replaced shall be determined by a Certified Arborist selected by Contractor from the District's approved list of Registered Consulting Arborists. To the extent that the value of the replaced tree as determined by the Certified Arborist exceeds the cost of the replacement tree, Contractor shall be liable to District for such difference in value in addition to all costs associated with replacement of the damaged tree.
8. Removal of Existing Tree or Shrub: Prior to removing or cutting any trees designated for removal, the contractor shall coordinate with the District's Ground Supervisor. In the event that Contractor, a Subcontractor, Sub-Subcontractor, material supplier or anyone else performing the Work of the Contract willfully, negligently or mistakenly removes any tree or shrub not designated for removal, Contractor shall immediately report such removal to the District Representative (Grounds Supervisor). Contractor shall replace such tree with the same species and variety of tree, up to a box size of 48 inches, or if no such replacement is available, with a substitute species or variety as determined in the sole discretion of the District Representative. Any replacement tree shall be approved in advance by the District Representative. The value of the tree to be replaced shall be determined by a Certified Arborist selected by Contractor from the District's approved list of Registered Consulting Arborists. To the extent that the value of the replaced tree as determined by the Certified Arborist exceeds the cost of the replacement tree, Contractor shall be liable to District for such difference in value in addition to all costs associated with replacement of the damaged tree.
9. Unauthorized Tree Removal or Injury: Criminal Penalties: Reference is made to California Penal Code §384a which provides that any person who willfully or negligently cuts, destroys, mutilates or removes any tree or shrub or portion thereof growing on public land without a written permit from the owner of said public land is guilty of a misdemeanor, subject to a fine of up to \$1,000, imprisonment in county jail for up to 6 months, or both. Contractor is advised that, in addition to all remedies provided herein and in the Contract Documents, the District shall cooperate with appropriate authorities in prosecuting and

enforcing Penal Code §384a and other criminal sanctions as appropriate concerning trees and shrubs located on District property.

10. Preventive Measures: Before construction begins fertilization of the affected areas to be applied at a rate to be determined by the District Representative (Grounds Supervisor).
- D. Protect bench marks, survey control points, and existing structures from damage or displacement.
  - E. Protection of Persons and Property (existing structures and site improvements):
    1. Provide barricades, warning signs at open depressions and holes on adjacent property and public accesses.
    2. Provide operating warning lights during hours from dusk to dawn each day or as otherwise required.
    3. Protect existing remaining structures, utilities, sidewalks, pavements other facilities from damage as caused by settlement, undermining, washout or other hazards created by site-clearing operations of this Section.
  - F. Use means necessary to prevent dust from becoming a nuisance to the public, to neighbors and to others performing work on or near the job-site.
  - G. Maintain access to the job-site at all times.

### 3.03 CLEARING

- A. Clear areas required for access to site and execution of Work.
- B. Remove all rubbish and debris existing and resulting from work operations of this Section as soon as possible, do not allow to pile up. Do not burn rubbish and debris on the job-site.
- C. Where active utility lines need to be capped or plugged, perform such work in accordance with requirements of the Utility Company.

### 3.04 REMOVAL

- A. Remove debris, rock, and extracted plant life from site.
- B. Excavate and remove associated plumbing piping.
- C. Prior to demolition work, the Contractor shall notify the District Representative to identify the existing items for salvage purposes. The materials identified for salvage shall be returned to the District in a timely manner agreed upon by the District Representative.

### 3.05 CONCRETE AND BITUMINOUS SURFACE REMOVAL

- A. Where noted on the construction drawings, break up and completely remove all existing concrete surfacing, curbs, gutters, walks and bituminous surfacing to limits indicated to be removed. All cutting shall be done to a neat and even line with proper tools or a concrete cutting saw. Minimum depth of cut shall be 1-1/2", unless otherwise specified. Remove any concrete broken beyond the indicated limits to the nearest joint or score line and replace with new concrete to match the existing.

- B. Removed concrete and bituminous materials shall be disposed of off-site unless otherwise noted on the construction drawings. All such items to be removed shall be disposed of off the property in a legal manner.
- C. Bituminous pavement saw cutting shall conform to the provisions of Section 300-1.3.2 (a) of the Standard Specifications. The residue resulting from the saw cutting operations shall not be permitted to flow beyond the specific work location and shall be removed the same day.
- D. Removal of concrete curb / curb & gutter covered by this section shall include saw-cutting and removal of a twelve (12") inch wide section of the adjacent bituminous pavement.
- E. When saw cutting concrete curb / curb & gutter, the cuttings shall be continuously wet vacuumed to prevent the materials from entering catch basins, storm water conveyances, or waters of the State. Vacuumed cuttings shall be disposed of according to applicable regulations.
- F. Concrete curb and concrete curb and gutter shall be removed to the lines, grades and locations shown on the plans in accordance with Section 300-1.3.2 of the Standard Specifications.
- G. Concrete removal in sidewalk and driveway areas shall extend to existing score lines unless specifically indicated otherwise on the Plans or in the Project Special Provisions, or unless otherwise approved by the Engineer.
- H. Reinforcing or other steel may be encountered in portions of concrete to be removed. No additional compensation will be allowed for the removal of concrete containing reinforcing or other steel.
- I. In those areas where existing bituminous surfacing is removed to make way for new planting or lawn areas, remove soil 6" below existing exposed soil surface. Removed soil may be used only as fill under buildings or other areas to be paved, only if approved by the District Inspector. Legally dispose of off site, if material is not approved as fill material.

### 3.06 REPAIRS

- A. During demolition and construction, ensure that trees, shrubs and other plant material and vegetation are protected inside and outside of the work zone and that the vegetation is being watered, maintaining the proper moisture content according to the season. Failed vegetation, including sod, due to lack of water, and/or plant material destroyed during construction period are to be replaced to equal or better size and condition at no additional cost to the District.
- B. If the irrigation system is damaged or modified during construction, it shall be repaired to the Districts standards, and shall be in equal or better condition than prior to damage or modification. All repairs shall be, inspected and approved by the District Representative (Grounds Supervisor) prior to backfilling or covering of said repairs. The District representative requires forty-eight hours prior notice, when contractor requests inspection of completed repairs. All repairs shall be made so as to ensure proper operation prior to the close of the contract at no additional cost to the District.
- C. Controller Wires: If damaged, cut or removed, repair by splicing, soldering and silicone sealing. To ensure proper operation, reconnect the wires to the valve to correspond with the map on the controller to the correct station.
- D. Hydraulic Tubes: If damaged/cut or removed, repair by replacing the tubing using equal or better material.

- E. Valves: If damaged, repair/replace with equal or better material. All valves are to be flushed/cleaned thoroughly.
- F. Mainlines: If damaged, repair/replace with equal or better material. All lines are to be flushed/cleaned thoroughly.
- G. Lateral Lines: If damaged, repair/replace with equal or better material. All lines are to be flushed/cleaned thoroughly.
- H. Irrigation Heads: If damaged, repair/replace with equal or better material. All heads are to be flushed and filters cleaned thoroughly.
- I. Controllers: If damaged repair/replace with equal or better material.
- J. Backflow Prevention Devices: If damaged, repair/replace with equal or better material.
- K. Gate/Ball/Quick Coupler Valves: If damaged repair/replace with equal or better material.
- L. Valve Boxes: If damaged, repair/replace with equal or better material. Concrete boxes and concrete lids with the appropriate markings for identification shall be used. The top of the box shall be buried below finish grade, equal to existing depth or deeper. The top of the valve stems shall be 6" below the underside of the top of the box.
- M. Construction in grass areas: Sod shall be removed by sod cutting at a soil depth of 2", stored on site, and watered on a daily basis. Upon completion of work, stored sod shall be reinstalled over the areas disrupted due to construction. An option may be to bypass cutting the sod, however at the completion of the project, finish grading and installation of new Hybrid Bermuda GN -1 sod over the areas disrupted by construction shall be required.

### 3.07 EXCESS MATERIALS DISPOSAL

- A. Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials, including trash and debris, and legally dispose of them off Owner's property.

### 3.08 SITE CLEANUP

- A. Cleanup of branches, limbs, logs, or any other debris resulting from any operations shall be promptly and properly accomplished. The work area shall be kept safe at all times until all operations are completed. Under no circumstances shall the accumulation of brush, limbs, logs, or other debris be allowed in such a manner as to result in a hazard to the public. All debris shall be cleaned up each day before the work crew leaves the site, unless permission is given by the Owner to do otherwise. All lawn areas shall be raked, all streets and sidewalks shall be swept, and all brush, branches, rocks or other debris shall be removed from the site. Areas are to be left in a condition equal to or better than that which existed prior to the commencement of operations.

END OF SECTION

**SECTION 32 13 13  
SITE CONCRETE**

**PART 1 – GENERAL**

1.1 SECTION INCLUDES:

- A. Concrete walks, paving, ramps, curbs, walls, mow strips, fence footings and catch basins, and miscellaneous concrete site work as indicated on the drawings.
- B. Furnishing and installing formwork.
- C. Furnishing and installing reinforcing steel.
- D. Furnishing and placing concrete, including joints and finishing.
- E. Curing concrete.
- F. Repairing concrete work as required.

1.2 RELATED SECTIONS:

- C. Division 03 30 00 - Cast-In-Place Concrete

1.3 SUBMITTALS

- A. All submittals shall be made in accordance with Division 1.
- B. Submit concrete mix designs for approval. Indicate intended use of each proposed mix design submitted.
- C. Samples: Prepare three samples of each type of concrete flatwork finish delineated on the plans for approval by the Architect. Each sample is to be a minimum of 4 square feet in area, and may be a part of the finished concrete site-work. Remove and properly dispose of any rejected samples, or those which are not part of the finished work, at no additional cost to Owner.

1.4 QUALITY ASSURANCE

- A. Conform to Section 01 43 00 - Quality Control.
- B. Standards: Concrete work shall conform to the requirements of Standard Specifications for Public Works Construction”, Current Edition, PWC Specifications and herein specified.

**PART 2 – PRODUCTS**

2.1 MATERIALS

- A. Conform to Section 201 – “Concrete, Mortar and related materials” of the Standard Specification for Public Works Construction.
- B. Forms: Steel, wood, or other suitable material of size and strength to resist moving during concrete placement and to retain horizontal and vertical alignment until removal. Use straight forms, free of distortion and defects.

1. Use flexible spring steel forms or laminated boards to form radius bends as required.
  2. Coat forms with a non-staining form release agent that will not discolor or deface surface of concrete.
- C. Reinforcing Steel:
1. Reinforcing Bars: ASTM A615, Grade 60.
  2. Welded Wire Mesh: ASTM A185.
  3. See Division 03: Reinforcing Bar.
- D. Concrete Materials:
1. Finished Concrete: Concrete class per PWC Specifications Section 201-1 12, except 6-inch reinforced concrete paving shall be 560-C-3500 concrete.
  2. Combined Aggregate: Gradation per PWC Specifications, Section 201-1.3.2.
  3. Cement: Portland Cement, Type II conforming to ASTM C-150.
  4. Water: Clear, clean and free from oil, vegetable matter and other deleterious substances.
- E. Redwood Headers: "Foundation" grade redwood as graded by Redwood Inspection Service.
- F. Control Joint Material:
1. Metal: "Keyed-Kold" with retained (removable) cap as manufactured by Burke Concrete Accessories, Inc., or approved equal.
  2. Plastic: "Quickjoint" T-shaped 1/16" plastic strip, 1 Inch minimum depth as distributed by J.A. Crawford Co. Phone (562) 698-0901, or approved equal.
  3. Pre-molded Expansion Joint Filler: ASTM 1751 non-extruding bituminous saturated resilient Joint filler.
- G. Bond Breaker: Resin type sealer. "Formfilm by A.C. Horn Co., "Form- Saver" by Sonneborn, or approved equal.
- H. Curing Materials:
1. Curing Paper: ASTM C171, non-staining, reinforced.
  2. Liquid Curing Compound: Non-staining, complying with ASTM C309 at manufacturers recommended rate of application. Deliver curing compound in unopened labeled containers.
    - a. For Gray Concrete (non-pigmented); Wax-free, fugitive resin type. Thompson's "Waterseal" or approved equal.
    - b. Pigmented Curing Compound: AASHTO Designation: M148, Type 11, white pigmented except that the loss of water in the water retention test shall not exceed 0.040- gram per square centimeter of surface.

- I. Abrasive Aggregate: Aluminum oxide (emery), alumina, or carborundum grains. "Emerendum" by Anti-Hydro, "Durafax" by Grace Construction Products, "Alundom Crystolon" by Norton Co., or approved equal.

### **PART 3 - EXECUTION**

#### **3.1 GENERAL**

- A. After PCC pavement areas have been brought to subgrade, the Soils Engineer shall test the subbase to verify the design R Value used. If required, Soils Engineer will recommend changes to the pavement section:
- B. If paving thicknesses changes due to required testing, contractor shall justify pavement sections accordingly.

#### **3.2 PREPARATION**

- A. General; Coordinate work with related trades. Do not locate related work in concrete except as detailed. Place conduits in concrete slabs with a minimum cover of 2" above and below conduit. Locate accurately and secure in place all inserts, bolts, ties, dowels, miscellaneous plates, etc., before pouring. They shall be clean and free from any coating which would reduce their bond.
- B. Base Course: Subgrade shall be smooth, true to line and grade, and tested for required compaction prior to start of placing concrete. Dampen subgrade 24 hours before placing. Reroll as required. Wet forms to tighten cracks.
- C. Reinforcing Steel: Position, support and secure reinforcement against displacement. Locate and support with metal chairs, runners, bolster, spacers and hangers, as required. Set wire tie so ends are directed into concrete, not toward exposed concrete surfaces.
- D. Formwork: Stake rigidly at 4 feet on center and secure against displacement. Install stretched wires or other devices to indicate displacement. Formwork shall not deviate more than 1/8" from required positions and levels. Curb forms shall be smooth on the side placed next to the concrete, and shall have a true smooth upper edge. The depth of forms for back of curbs shall be equal to the full depth of the curb. The depth of face forms shall be equal to the full face height of the curb. Carefully set forms to alignment and grade and to the required dimensions. Hold forms rigidly in place by stakes, clamps, spreaders and braces as required to insure rigidity. Benders or thin plank forms may be used on curves, grade changes, or for curb returns. Back forms for curb returns may be made of 1/2 inch thick benders cleated together for full depth of the curb. Do not remove the form on the front of the curbs in less than one hour nor more than six hours after the concrete has been placed. Do not remove side forms for sidewalks, gutter depressions, island paving and driveways, less than 12 hours after the finishing has been completed.

#### **3.3 CONCRETE MIX**

- A. Comply with requirements of PWC Specifications, Section 201-1.3 proportioning and Section 201-1.4 mixing and as herein specified. Concrete strength shall be 2500 psi at 28 days unless specified by Architect to be of a greater strength for the application-specific purpose.

#### **3.4 PLACING CONCRETE**

- A. General: Place concrete in accordance with PWC Specifications Section 303-5.3.

### 3.5 CONTROL JOINTS

- A. Control Joints; Locate as indicated; where not shown locate at maximum 15 feet on center for flatwork and 30 feet on center for curbs. Tool edges except at structures.
1. Plastic Joints: Immediately following preliminary troweling, part concrete to a depth of 2 inches with #750 Lightweight Cutter Bar. Install plastic joint material so that the pull-top stiffener is flush with the top of concrete and immediately peel off pull-top stiffener. After pull top is removed, float concrete to fill all voids adjacent to strip. During final troweling, finish edge to a maximum radius of 1/8" Using a #355 or #350 slit jointer tool.
  2. Metal Joints: Install "Key-Kold" metal joint form. Set top of stakes 3/8" below slab surface elevation. Install with minimum of 5 stakes per 10 foot length. When concrete is not poured continuously over both sides of the joint, the knock-out anchors shall be bent at a 45 degree angle into the pour. Finish the concrete to the top of the joint and burn in with hand trowel.
  3. Saw Cutting: Prior approval of Architect required. Saw cut shall be 1/4 depth of slab. Joints shall be cut to a chalk line. Saw cutting time shall be determined from preliminary saw cut indicating that concrete is set up sufficiently to prevent raveling at the cut.
- B. Expansion Joints at Structures: Provide 1/2" minimum pre-molded Joint filler for expansion joints abutting concrete curbs, catch basins, manholes, nets, structures, walks and other fixed objects, unless otherwise indicated.
1. Extend joint fillers full-width and depth of joint, and not less than 1/2" or more than 1" below finished surface where joint sealer is indicated. If no joint sealer, place top of joint filler flush with finished concrete surface.
  2. Joints between slabs and structures: install 30 lb. building paper strip against wall of structure for pour splash protection as well as to prevent bond to wall. Trim off even with surface of concrete slab.
- C. Design/Control Joints:
1. General: Joints shall be true to line and profile. tooling shall be done while concrete is plastic. Joint may be started with a straightedge inserted into concrete.
  2. Jointing Tool: Shall be 1/4" wide at surface, tapered, with top edges rounded to 1/4" radius.
  3. Location: As shown on drawings, but in any case not more than 15 feet on center both ways. Typical sidewalk joints shall be jointed at 5 feet on center or as directed by Architect.

### 3.6 FINISHING

- A. Smooth Finish: Steel trowel and burnish to a smooth, dense, and hard finish.
- B. Medium Broom Finish: Broom finish by drawing a fine-hair broom across concrete surface, perpendicular to line of traffic. Repeat operation if required to provide a fine line texture acceptable to Architect.

- C. Walks and Sidewalks:
  - 1. Slopes less than 6 percent: Surfaces with a slope equal to or less than 5 percent gradient shall be at least as slip-resistant as that described as a medium broom finish.
  - 2. Slopes 6 percent or greater: Surfaces with a slope of 6 percent grade shall be heavy broom finish.
- D. Abrasive: Exterior stair treads, ramps and landings shall receive a nonslip, light broom finish in addition to abrasive finish of abrasive grains in amount of 30 pounds per 100 square feet shall be evenly applied by the "dust-on" method and embedded in to the surface during the first troweling operation. Additional abrasive grains, in the amount of 30 pounds per 100 square feet, shall then be evenly applied and embedded into the surface during the final troweling operation.
- E. Curbs. Prior to the removal of curb forms, the surface shall be finished true to grade by means of a straight edge float, not less than 10 feet in length, operated longitudinally over the surface of the concrete. Smooth trowel face of curb immediately after removal of front curb form to a depth of not less than 2 inches below the flow line. Steel trowel face and tops of curb and provide rounded front and back edges. After the face of the curb has been troweled smooth, it shall be given a final fine brush Finish with brush strokes parallel to line of curb. Top and face of curbs shall be true and straight, of uniform width, free from humps, sags or other Irregularities.
- F. Other Flatwork: Finish to grade and cross section with a float, trowel smooth and finish with a broom, unless otherwise specified. Float shall not be less than 10 feet in length and not less than 6 inches in width.

### 3.7 CURING

- A. Moist Curing for Natural concrete: Cover with reinforced waterproof curing paper. Seal all joints and weight down edges. Maintain moist for 14 days.
- B. Liquid Curing Compound for Natural Concrete: Locations as approved by Architect. Apply a uniform coating within 2 hours of final troweling.

### 3.8 REPAIRS AND PROTECTIONS

- A. Repair or replace broken or defective concrete, as directed by Architect.
- B. Protect concrete from damage until acceptance of work. Exclude traffic from pavement for at least 14 days after placement. When construction traffic is permitted, maintain pavement as clean as possible by removing surface stains and spillage of materials as they occur. If appropriate, concrete may be covered with construction plastic guard or visquene to protect surface finish.
- C. Sweep concrete pavement and wash free of stains, discolorations, dirt and other foreign material just prior to final inspection.

END OF SECTION

**SECTION 32 31 13  
SITE METAL FABRICATIONS**

**PART 1 - GENERAL**

1.1 SECTION INCLUDES:

- A. Metal fabrications as indicated or required, including items such as:
  - 1. Steel pipe
  - 2. Square and rectangular steel tubing
  - 3. Pipe columns
  - 4. Gratings, frames and covers
  - 5. Miscellaneous fabrications as indicated

1.2 RELATED SECTION:

- A. Section 03 30 00 - Cast-in-Place Concrete
- B. Section 05 12 00 - Structural Steel
- C. Section 05 50 00 - Metal Fabrications
- D. Section 09 90 00 - Painting

1.3 QUALITY ASSURANCE:

- A. Reference specifications and standards:
  - 1. Design, fabricate and erect miscellaneous metals in accordance with AISC'S Design, Fabrication and Erection of Structural Steel for Buildings, Titles 24, CCR.
  - 2. AWS D-1. Code for Welding in Building Construction.

1.4 SUBMITTALS:

- A. All submittals shall be made in accordance with Section 01 33 00.
- B. Shop Drawings: Submit shop drawings showing materials used, dimensions, and anchoring details. In addition include the following: steel grades, fasteners, size and extent of welds.
- C. Certifications: Submit for items hot dip galvanized to identify items and to show compliance of application.

1.5 PRODUCT HANDLING:

- A. Store miscellaneous metal items above ground on platforms, skids or other approved supports.
- B. Protect metals from corrosion.

**PART 2 - PRODUCTS**

2.1 MATERIALS:

- A. Structural Steel Shapes: "Standard Specifications for Structural Steel", ASTM A 36.
- B. Steel Pipe:
  - 1. Steel pipe other than pipe used for structural purposes shall conform to "Standard Specification for Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Ordinary Uses", ASTM A120, or ASTM A53.
- C. Cast Steel: "Standard Specification for Mild-to-Medium Strength Carbon-Steel Castings for General Application" ASTM A 27, Grade 65-35.
- D. Steel Bolts: "Standard Specification for Carbon Steel Externally and Internally Threaded Standard Fasteners", ASTM A 307, Grade A, with bolt head and nut dimensions conforming to ANSI B 18.2.1.
- E. Rolled steel plates and shapes:
  - 1. Shapes and plates shall conform to ASTM A 36, except for plates to be bent or cold-formed.
  - 2. Plates to be bent or cold-formed shall conform to ASTM A283, Grade C.
- F. Stainless Steel: ASTM A167 and A269, ANSI Type 304.
- G. Aluminum
  - 1. Extrusions: ASTM B221, 6063-T5 alloy, 1/8" thickness minimum.
  - 2. Sheets: 6061 alloy, No. 16 gage minimum.
- H. Cast Iron: Provide with minimum tensile strength in accordance with ASTM A48, Class 30, unless otherwise required.
- I. Malleable Iron casting: ASTM A47.
- J. Ductile Cast Iron: ASTM A536.
- K. Fastening Devices
  - 1 Threaded Fasteners:
    - a. For Steel: Low carbon steel, ASTM A307, hot dip galvanized for exterior use and where galvanized assemblies are indicated.
    - b. For Stainless Steel and Aluminum: Use stainless steel, ANSI Type 304.

2. Stud Bolts and Concrete Anchors: Galvanized studs of type and size as specified or required for each loading condition.

L. Primers and Protective Coatings

1. Ferrous Metal Primer-General Purpose: Use where no other primer specified on commercial blast or power tool cleaned prepared steel as undercoat for alkyd or oil base finish systems.
  - a. Modified Alkyd rust-Inhibitive Primer, Series 4 - "Versare 4-55", as manufactured by Tnemec Inc.
  - b. Alkyd Metal Primer "Kem Kromik" by Sherwin-Williams Co.
  - c. Or equal.
2. For Elements of Steel Specified to be Top Coat Finished with Polyurethane Paint: Use two part high build Epoxy Primer with minimum 54% solids by volume. Provide Series 69, Hi-Build Epoxoline II, as manufactured by Tnemec, Epoxy high build by Sherwin Williams, Pitt-Guard DTR 97-147/149 by P.P.G., or equal. Use color tinted to approximated finish top coat. See also Section 09900, Painting.
3. Protective Coatings For Other Conditions Specified for Item Fabrication or Installation:
  - a. Bituminous Paint: Fed. Spec. TT-C-494.
  - b. Zinc Dust Primer: Fed. Spec. TT-P-460.
  - c. Galvanizing Repair Paint: High zinc dust content paint for regalvanizing weld areas made in galvanized steel.
4. Galvanizing: Reference Finishes for Fabrication Standards (Article 2.2) as specified herein.

- M. Supplementary Parts: Provide materials or assembly components as specified or shown for fabricated item or as necessary to complete each item of work, even though such supplementary parts are not shown or specified.

2.2 FABRICATION:

A. General:

1. For the fabrication of items which will be exposed to view, use only materials which are smooth and free of blemishes. Remove blemishes by grinding or by welding and grinding, prior to cleaning, treating and application of surface finishes including zinc coatings.
2. Form exposed work true to line and level with accurate angles and surfaces, and straight sharp edges.
3. Ease exposed edges to a radius of approximately 1/32 in., unless otherwise indicated or specified.
4. Form bent metal corners to the smallest radius possible without causing grain separation or otherwise impairing the work.
5. Form exposed connections with hairline joints that are flush and smooth, using concealed fasteners wherever possible.

6. Remove loose rust, mill scale, cutting and punching burrs.
7. Fabricate items in as large sections as practical to minimize field jointing.

B. Welding:

1. Weld all shop connections and all field connections unless indicated or specified otherwise.
2. Weld corners and seams continuously and in accordance with the requirements of the AWS Code. All welds shall be inspected as required in section "Structural Steel".
3. Grind exposed welds smooth and flush to match and blend with adjoining surfaces.

C. Galvanizing:

1. "Standard Specification for Zinc (Hot-galvanized) Coatings on Products Fabricated from Rolled, Pressed and Forged Steel Shapes, Plates, Bars, and Strip", ASTM A123.
2. All exposed items shall be hot-dip galvanized, in as large sections as possible.

D. Protective Coatings

1. Contact Condition Requiring Protection
  - 1) Whenever dissimilar metals will be in contact.
  - 2) Wherever aluminum metals will be in contact with or embedded in concrete, cement, mortar, plaster, or masonry.
2. Application: Separate contact surfaces by coating each contact surface prior to assembly or installation with one coat of bituminous paint or zinc based primer to suit condition and approved by Architect. Mask off those surfaces not required to receive protective coating.

E. Shop Finish:

1. All miscellaneous metal fabrications, except galvanized items, which will be exposed when the building is completed, shall receive a coat of primer.
2. The primer specified shall be spray applied, covering all surfaces with a smooth unbroken film. The minimum dry film thickness of the primer shall be 2. mils.
3. Preparation for Painting: All miscellaneous ferrous metal, except items specified galvanized or shop primed, shall be thoroughly cleaned of all mill scale, grease, dirt or rust, by scraping, wire brushing, or sandblasting and shall be delivered to the job unpainted, but in proper condition for painting. Shipping oil or other protective coatings shall be removed.

## 2.3 FABRICATED ITEMS

A. Miscellaneous Steel Framing

1. Framing, bracing, supports, framing, clip angles, shelf angles, plates, grating, etc., shall be of such shapes and sizes as indicated on the drawings and details, or as required to suit the condition.

2. Fabricate with all necessary supports and reinforcing such as hangers, braces, struts, clip angles, anchors, bolts, nuts, welds, etc. as required to properly support and rigidly fasten and anchor steel framing in place and to steel, concrete, masonry and all other connecting and adjoining work.
  3. Framing steel shall be furnished in accordance with the applicable requirements of the "Specifications for the Design, Fabrication, and Erection of Structural Steel for Buildings" by the American Institute of Steel Construction and as herein specified.
  4. All exposed items shall be hot-dip galvanized, in as large sections as possible.
- B. Sleeves in Foundation and Structure: Furnish for setting with concrete placement.
1. Sleeves through exterior foundation walls shall be minimum Schedule 40 steel pipe with inside diameter 2" larger than outside diameter of pipe or conduit (including insulation, if any) to be accommodated. Sleeves shall project one-half inch (1/2") on each side of finished wall. Fabricate with rectangular one-quarter inch (1/4") steel plate collar at center of wall condition, continuously welded to the perimeter of the sleeve, and six inches (6") wider than the sleeve outside diameter.
  2. Slots in concrete slabs shall be 12 gauge steel sheet, galvanized, of opening dimensions indicated, with strap anchors welded in place not more than twelve inches (12") on centers.
  3. All exposed items shall be hot-dip galvanized, in as large sections as possible.
- C. Steel Ladders: Conform to OSHA standards.
1. Vertical steel ladders shall be 18" wide with 3/4" diameter non-slip steel rungs spaces 12" on center welded to minimum 3/8" thick by 2-1/2" wide steel bar stringers.
    - a. As shown on drawings, or determined by detail engineering of Contractor's Engineer, provide ladder stringer of larger size to accommodate height (span) of ladder assembly.
  2. Fit rungs in centerline of side rails, plug weld and grind smooth on outer rail faces.
    - a. Use welded or bolted steel brackets, designated for adequate support and anchorage, and to hold the ladder clear of the adjacent wall surface with a minimum of 7" clearance from wall to centerline of rings.
    - b. Extend rails 42" above top rung, and return rails to wall or structure. Do not rest bottom of roof rails on finished roofing or waterproofing surface.
  3. Fabricate to install ladders with attachments to walls 6" from top and bottom and with maximum intermediate support spacing 36" on center from the specified top and bottom locations. All exposed items shall be hot-dip galvanized, in as large sections as possible.
- D. Steel Pipe Railing Handrails and Gates
1. Provide 1-1/2" "nominal diameter" (actual O.D. 1.9") steel pipe, minimum size, in accordance with ASTM standard, Schedule 40 minimum.
    - a. Brackets shall be as detailed on drawings or subject to approval of Architect.

- b. Use heavier weight rails (Schedule 80) or reinforce rails internally if necessary to meet Performance Standards specified in Article 1.2, herein.
- 2. Construction: Form direction changes in rails using solid bar stock or elbows. Connections shall be shop welded and ground smooth and flush, except where field connections and expansion joints are required. Field connections may be welded, internal sleeve and plug weld, or internal sleeve and set screw. All exposed items shall be hot-dip galvanized, in as large sections as possible.
- 3. Secure handrails to walls with wall brackets. Coordinate bracket spacing to meet architectural alignments or otherwise required by Project Conditions.
  - a. Drill wall plate portion of the bracket into concrete to receive expansion bolts for concealed anchorage.
  - b. Locate brackets at not more than 5'-0" on center unless otherwise shown.
- 4. Provide wall return fitting, flush-type, with the same projection as indicated for wall brackets.
- 5. Post Anchorage: Provide side mounted or base mounted (set in concrete) post anchorage as indicated for each location and in accordance with approved shop drawing.
  - a. For steel pipe posts base mounted and set in concrete: Anchor posts in concrete by means of pipe sleeves set and anchored into concrete.
    - 1) Provide sleeves for core drill installation of galvanized steel pipe, not less than 9" long, and having an inside diameter not less than 1/2" greater than outside diameter of the inserted pipe. Provide steel plate closure secured to bottom of sleeve and of width and length not less than 1" greater than outside diameter of sleeve.
    - 2) After posts have been inserted into sleeves, fill annular space between post and sleeve solid with non shrink, non-ferrous grout.
    - 3) Cover anchorage joint with a round steel flange welded to post with welds ground smooth. Posts shall be set plumb within 1/8" vertical tolerance for full post height.
- 6. Longitudinal members shall be parallel with each other and with floor surface or shape of stair to a tolerance of 1/8" in each 10'-0" length. Center line of members within each run of railing shall lie in the same vertical plane.
  - a. Posts and other vertical components shall be set plumb within 1/8" from top to bottom of assembly.
  - b. Shop and field joints of connecting sections shall be hairline (1/32" or less).

E. Metal Saddles

- 1. General: Metal saddles shall be of profiles indicated on drawings, or otherwise approved by Owner's Representative in single piece, full wide of door jambs (unless indicated otherwise), shaped to fit jambs and other adjoining work.
  - a. Cut, drill and fit saddles as required to for door hardware.

- b. Saddles for exterior doors shall have weather-stop rabbet (unless indicated otherwise).
- 2. Aluminum Saddles: Typical for Project conditions unless steel or other material indicated. Provide extruded aluminum with fluted top surface, 1/2" high maximum, 1/8" thick minimum. Caustic etch and clear anodized (0.07 mil thickness) finish, Aluminum Association finish designation C22-A31.
- F. Water Heater Brackets: Fabricate of structural shapes as detailed. Coordinate with Division 15 to assure fit of water heater to be furnished.
- G. Ornamental Fences and Gates:
  - 1. Provide ornamental fence and gates as indicated and detailed on the drawings. Fabricate from hot or cold-rolled tubing, bars and shapes, welded at all joints and ground smooth. Hot dip galvanized after fabrication. All gate mounting hardware shall be furnished by gate manufacturer, padlocks shall be furnished under Section 08710, Finish Hardware.
  - 2. Set posts into concrete footings as indicated or, if not indicated, into 3'-0" deep minimum footing to withstand strain of use.
- H. Other Miscellaneous Items: Provide of materials, sizes, profiles, and conditions shown on Contract Drawings and as specified in Article 3.1 herein, for installation. Items include but are not limited to the following:
  - 1. Pipe Guard Posts and Bollards: Fabricate of hot dip galvanized steel.

### **PART 3 – EXECUTION**

#### **3.1 INSTALLATION:**

- A. General: Install work of this Section square, plumb, straight, true to line or radius, accurately fitted and located, with flush tight hairline joints (except as indicated otherwise or to allow for thermal movement), with provisions for other work, with provisions to allow for thermal movement, with provision to exclude water where exposed to the weather, and with attachment devices as required for secure and rigid installation.
- B. Attachments: Unless indicated otherwise, work to be built into concrete shall be anchored with shop-welded-on steel strap anchors, work to be attached to concrete or masonry shall be anchored by bolts into embedded metal inserts or expansion shields.
  - 1. Provide shims, slotted holes, or other means necessary for leveling, plumbing and other required adjustments.
  - 2. Steel attachment devices for exterior steel work and for galvanized steel work shall be galvanized.
  - 3. Attachment devices for work exposed to view shall be concealed, unless indicated otherwise; all other attachment devices shall be located where least conspicuous. Where bolts or screws are permitted to work exposed to view, they shall be flat and countersunk, with projecting ends cut off flush with nuts or adjacent material.
  - 4. Do all necessary drilling, tapping, cutting or other preparation of surrounding construction in the field accurately and neatly. Provide for the attachment and support of work specified in this Section.

- C. Structural/Loading Criteria
1. Railings: All railings shall be fabricated and installed in accordance with design requirements specified herein.
  2. Install work of this Section to provide items with capabilities to safely sustain or withstand stresses and strains to which materials and assembled work will be subjected. Comply with Project loading and structural criteria and regulatory requirements.
- D. Field Welding: Comply with AWS Code for the procedures of manual shielded metal-arc welding, the appearance and quality of welds made, and the methods used in correcting welding work.
- E. Do not cut or abrade finishes which cannot be completely restored in the field. Return items with such finishes to the shop for required alterations, followed by complete refinishing or provide new units at Contractor's option.
- F. Field Painting: See Articles "Fabrication Standards" and references to "Prime Painting", and "Protective Coatings". Finish painting is specified in Section 09900, "Painting".
- G. Dissimilar Materials
1. Field Painting: See Articles "Fabrication Standards" and references to "Prime Painting", and "Protective Coatings". Finish painting is specified in Section 09900, "Painting".
  2. Aluminum to Other Metals: Isolate aluminum tubing from dissimilar metals by coating dissimilar metals with heavy-bodies bituminous paint or with one (1) coat zinc chromate primer and two (2) coats aluminum metal and masonry paint or by using a non-absorbent gasket.
  3. Aluminum to Treated Wood: Isolate aluminum from non-compatible preservative treated wood, and from all absorptive material subject to repeated wetting. Paint aluminum with two (2) coats of aluminum metal and masonry paint.
  4. Touch up: Recoat shop applied protective coatings if damaged.
- H. Apply bitumastic coating (bituminous paint) to steel at all concrete embedments, and extend coating one inch past top of concrete in a neat manner.

END OF SECTION